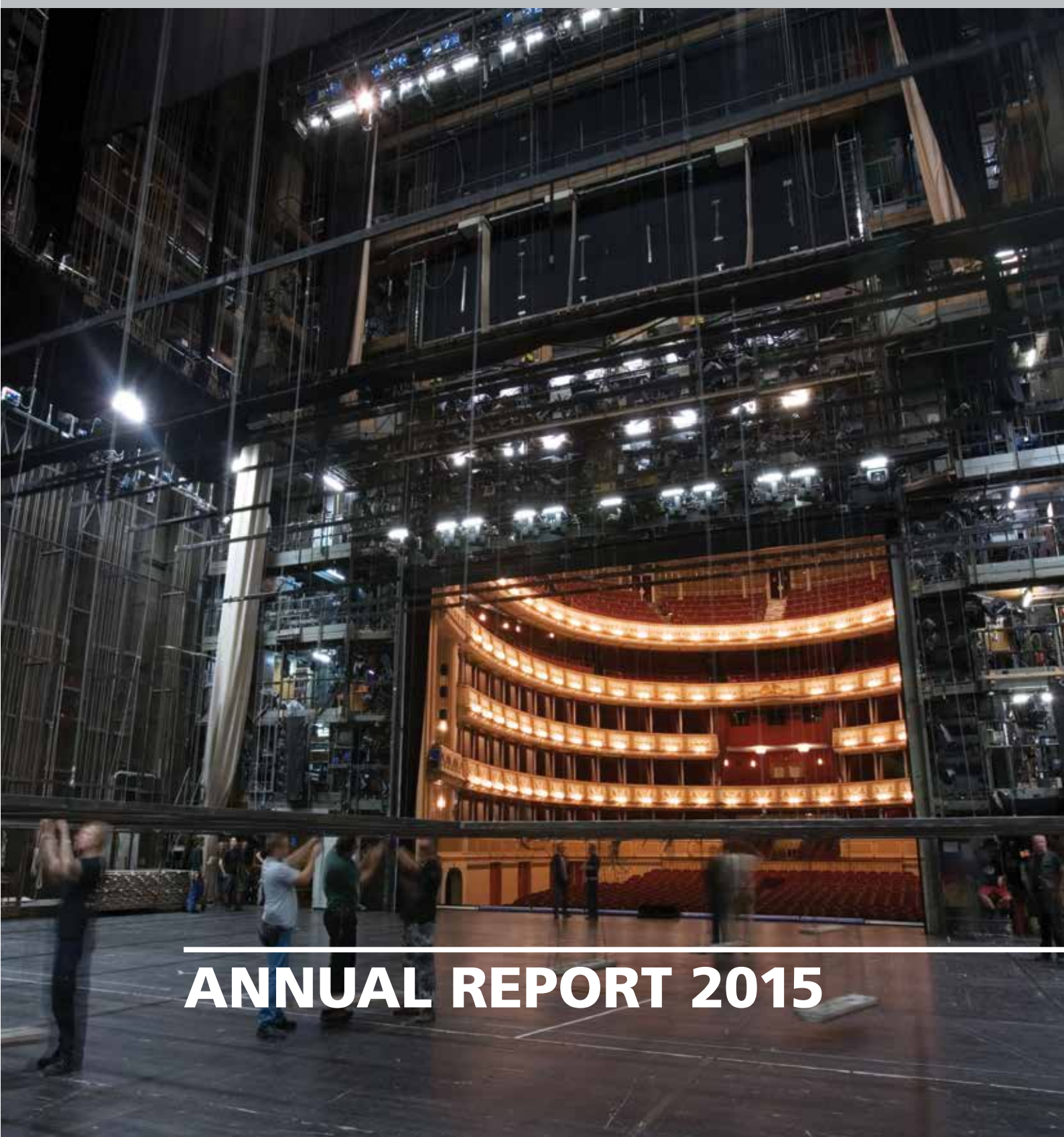# Fraunhofer

PORTUGAL

ASSOCIAÇÃO FRAUNHOFER PORTUGAL RESEARCH

ANNUAL REPORT 2015

Associação Fraunhofer Portugal Research

Research of Practical Utility lies at the heart of all activities developed by Fraunhofer Portugal.

Founded in 2008 – as a result of the long-term Portuguese-German collaboration in Science and Technology – Associação Fraunhofer Portugal Research focuses on companies as customers and partners to promote innovative product development by delivering applied research results in an international context.

Adopting the well tested – and undisputedly successful – model operated in Germany by Fraunhofer-Gesellschaft, Fraunhofer Portugal supports economic development and social well-being by contributing to the population's quality of life.

Currently, Associação Fraunhofer Portugal Research (Fraunhofer Portugal) owns and operates the Fraunhofer Portugal Research Center for Assistive Information and Communication Solutions (Fraunhofer AICOS) – a partnership between Fraunhofer-Gesellschaft and the University of Porto – focusing on Ambient Assisted Living (AAL) and Information and Communication Technologies for Development (ICT4D).

Acknowledged by the Portuguese Government as an 'Entity of Public Interest', Associação Fraunhofer Portugal Research was named after Joseph von Fraunhofer (1787-1826), the illustrious Munich researcher, inventor and entrepreneur.

A investigação de utilidade prática está no centro de todas as atividades desenvolvidas pela Fraunhofer Portugal.

Fundada em 2008 – e resultando de uma colaboração de longo prazo em Ciência e Tecnologia entre Portugal e a Alemanha – a Associação Fraunhofer Portugal Research mantém um enfoque nas empresas como parceiros, promovendo e desenvolvendo atividades de investigação aplicada num contexto internacional.

Adotando o bem-sucedido modelo de negócio operado na Alemanha pela Fraunhofer-Gesellschaft, a Fraunhofer Portugal apoia o desenvolvimento económico e promove o bem-estar social, ao contribuir para a melhoria da qualidade de vida das populações.

Neste momento, a Associação Fraunhofer Portugal Research (Fraunhofer Portugal) detém e opera o Fraunhofer Portugal Research Center for Assistive Information and Communication Solutions (Fraunhofer AICOS) – uma parceria entre a Fraunhofer-Gesellschaft e a Universidade do Porto – dedicada às áreas de "Ambient Assisted Living" (AAL) e de Tecnologias de Informação e Comunicação para o Desenvolvimento (ICT4D).

Reconhecida pelo Estado Português como Pessoa Coletiva de Utilidade Pública, a Associação tem o nome do famoso cientista, inventor e empreendedor Joseph von Fraunhofer (1787-1826), originário de Munique, Alemanha.

ANNUAL REPORT 2015

Deus ex Machina: FhP AICOS working on the backstage!

For Fraunhofer AICOS the year 2015 started, passed and ended ambivalent. Most of our assumptions regarding critical developments from 2014 became realities, some of them even exceeding our expectations. On the other hand side we also were achieving important milestones that we will benefit from in the future, both institutional and also from the scientific perspective!

We had already warned in 2014 of the gap between the end of the QREN – Quadro de Referência Estratégica Nacional funded innovation programmes and the beginning of its successor, PT2020 – Portugal 2020, in the absence of other financing instruments for the Portuguese industry. The result has been temporary decline of our industry revenues, that we already expected to happen by the mid of 2015. Unfortunately the start of PT2020 and consequently the call evaluations got so much delayed that new projects did not start within the second half of 2015 as we expected from the information available in 2014.

But still at the end we were growing our total revenues to 1.651K€, which is even slightly above the result of 2014 (+2%), but missed our goal of 1.844K€ (BGT 2015) by 10%.

On the side of our expenses we were able to, once more, reduce some costs of our operation slightly and also benefitted from the possibility to adjust some reserves related to our running costs for the offices in Porto. We also executed our plans for the investments and even more important the related running costs for the new offices in Lisbon fully according to our budget.

Therefore and despite the lower global revenues, we were able to increase the Fraunhofer AICOS' efficiency ratio by 2% to 64%, which is exactly on track with the planned budget for 2015!

Once more the results of our scientific work have been recognized various times in competitions and we were awarded with four prizes and two nominations:

- OurMoz – 1st Place | #APPS4MAPUTO (World Bank Contest);

– ShopView – 1st Place | Sonae Companies Innovation Award;

– GoLivePhone – 1st Place | AAL Forum Excellent Smart Health Innovation Award;

– PIL – 3rd Place | Microsoft Indoor Location Competition;

– ChefMyself – Finalist | AAL Forum Awards;

– ChefMyself – Finalist | Innova eVIA Awards.

In addition, our senior user test and co-design network COLABORAR was once more growing and is to date, and to our best knowledge, the largest of its kind in Europe and thus contributes to Fraunhofer AICOS being one of the most advanced places for AAL – Ambient Assisted Living research. Therefore we are also very satisfied with the result of our submissions to the latest call of the EU AAL JP – Active and Assisted Living Joint Programme, where we submitted two projects and both were selected for funding!

Another highlight is the opportunity that arises from a joint initiative of ARCTEL – Associação de Reguladores de Comunicações e Telecomunicações da CPLP (Association of Communications and Telecommunications Regulators of the Community of Portuguese Speaking Countries) and Fraunhofer Portugal in order to implement the so called 'Sustainable Villages for Development' (SV4D). The planned project aims at the implementation of connecting villages in rural areas of all CPLP – Comunidade dos Países de Língua Portuguesa (Community of Portuguese Speaking Countries) member states with ad-hoc broadband networks and the development of services that meet local demands. This project would be a direct result of the work of Fraunhofer AICOS' ICT4DCC – Information and Communication Technologies for Development Competence Center and the project volume is estimated to be in the dimension of 5M€ distributed over 3 years in total. The project also would incorporate the collaboration with two German SMEs[1], both spin-off companies from Fraunhofer-Gesellschaft. More details on the project can be found in the section 'Outlook and Strategic Development'.

1 *SMEs – Small and medium-sized enterprises.*

Given the project will realize, this would be a tremendous success of our ICT4D Competence Center and would ensure a sustainable future operation as planned just with this single project. Though, aside from this opportunity, we are also following various other leads mainly related to our very good relation to Mozambique (CIUEM – Centro de Informática Universidade Eduardo Mondlane[2]), which serves today as a permanent hub for our activities in Africa. Currently under discussion is the commercialization of two solutions that have been developed in Mozambique by a joint team of UEM – University Eduardo Mondlane students and FhP scientists, as well as customizing some components related to precision farming of trees.

The Fall Competence Center (FCC) also developed very well and is in a transition phase towards new goals, related to what might be the most important success regarding our long-term development: in December 2015 we received the preliminary information that the follow up project of our competence centre projects, that have been externally funded to a large extent until mid-2015, has been granted and actually achieved a very good evaluation result.

This project is called 'Deus ex Machina' (DeM) and is related to the development of context aware sensor technology for the IoT[3], related big data solutions and specialized interfaces between humans and 'the machine' that have been coined as 'companions'. This project proposal has been submitted with various Portuguese partners, that all have been ranked as 'excellent' or 'very good' by FCT – Fundação para a Ciência e a Tecnologia in 2014/2015 and are in their respective field of expertise leading in Portugal. The total project volume is about 3M€ and will generate a revenue for Fraunhofer AICOS in the dimension of 1,3M€.

After the funding programme PT2020 finally started in March 2015, we have been submitting already 11 proposals with industrial clients, of which to date 3 were approved. More details on DeM and our future industry projects can be found in the section 'Outlook and Strategic Development'.

2 *Computer Centre of the University Eduardo Mondlane.*

3 *IoT – Internet of Things.*

From the organizational point of view, in 2015 we have not been growing year to year, even though we peeked between April and June with a team of 104 members. The decision from 2013 to open up a branch office in Lisbon to be closer to various clients and the fact that our offices in Porto have been designed for 90 persons has led to the implementation of new offices in Lisbon not only for representative purposes, but also to host more scientists and to allow the fluctuation of team members, that otherwise would have been lost.

We have also been active to extend our patent portfolio and another patent has been filed related to our indoor positioning technology that, as mentioned already above, does provide very good results and thus is considered by us highly attractive for commercial customers.

Regarding our global financial situation we consider it stable and were able to cover the investments for the new offices in Lisbon without requests for additional funding due to a very economic construction activity, while still, like in Porto, it did lead to a high quality result.

All in all this leaves us with the aforementioned ambivalent result of 2015. In the difficult environment we did not achieve all our goals, but we have good reasons to believe that our achievements will contribute to a strong 2016!

Dirk Elias

Deus ex Machina: FhP AICOS a trabalhar nos bastidores!

Para o Fraunhofer AICOS o ano de 2015 começou, decorreu e terminou de forma ambivalente. Grande parte dos pressupostos relativos a fatores críticos identificados em 2014 tornaram-se realidade, e alguns até excederam as expectativas mais pessimistas. Por outro lado, conseguimos alcançar metas importantes que nos podem beneficiar num futuro próximo, não só numa perspetiva institucional mas também científica!

Em 2014 tínhamos já alertado para o hiato entre o fim dos programas de financiamento para a inovação QREN – Quadro de Referência Estratégico Nacional e o início do seu sucessor o PT2020 – Portugal 2020, isto na ausência de outros instrumentos de financiamento para a indústria portuguesa. O resultou foi um decréscimo temporário nas nossas receitas de indústria, algo que já em meados de 2015 antecipámos que viesse a acontecer. Infelizmente, a abertura dos concursos do PT2020 e as consequentes avaliações atrasaram-se de tal forma que os projetos não chegaram a iniciar na segunda metade de 2015, tal como estava previsto em função da informação disponibilizada em 2014.

Ainda assim, no final, conseguimos aumentar as nossas receitas para 1.651K€, ligeiramente acima do resultado de 2014 (+2%), mas 10% abaixo do objetivo inicial definido no orçamento de 2015, 1.844K€.

Em termos das despesas conseguimos, uma vez mais, reduzir ligeiramente alguns custos operacionais e também beneficiar da possibilidade de ajustar algumas reservas relacionadas com os custos de funcionamento das nossas instalações no Porto. Conseguimos também executar os planos de investimento, e ainda mais importante, assegurámos que os custos de funcionamento das nossas instalações de Lisboa estão em pleno acordo com o orçamento.

Por conseguinte, e apesar das receitas globais serem menores, conseguimos aumentar os índices de eficiência de performace do Fraunhofer AICOS em 2%, atingindo os 64%, que é exatamente o valor que estava planeado no orçamento de 2015!

Uma vez mais os resultados do nosso trabalho científico foram reconhecidos em diversas competições, nas quais fomos galardoados com quatro prémios e duas nomeações:

- OurMoz – 1° Classificado | #APPS4MAPUTO (World Bank Contest);

- ShopView – 1° Classificado | Sonae Companies Innovation Award;

- GoLivePhone – 1° Classificado | AAL Forum Excellent Smart Health Innovation Award;

- PIL – 3° Classificado | Microsoft Indoor Location Competition;

- ChefMyself – Finalista | AAL Forum Awards;

- ChefMyself – Finalista | Innova eVIA Awards.

Adicionalmente, a nossa rede de utilizadores e co-designers seniores COLABORAR continuou a crescer e é, à data e tanto quanto nós sabemos, a maior do seu género na Europa, contribuindo para que o Fraunhofer AICOS seja um dos mais avançados locais para desenvolver investigação em *AAL – Ambient Assisted Living*. Consequentemente, estamos também bastante satisfeitos com o resultado do último concurso *EU AAL JP – Active and Assisted Living Joint Programme* ao qual submetemos duas propostas de projetos, tendo ambas sido selecionadas para financiamento!

Outro destaque é a oportunidade que surgiu de uma iniciativa conjunta da ARCTEL-CPLP – Associação de Reguladores de Comunicações e Telecomunicações da Comunidade dos Países de Língua Portuguesa e a Fraunhofer Portugal, com o intuito de implementar o projeto designado por SV4D – Sustainable Villages for Development. Este projeto tem como objetivo conectar aldeias em zonas rurais de todos os estados membros da CPLP, através de ligações de banda larga *ad hoc*, bem como promover o desenvolvimento de serviços que respondam às exigências locais.

Este projeto será um resultado direto do trabalho que realizamos no ICT4DCC – Information and Communication Technologies for Development Competence Center, estando o volume do projeto estimado em 5M€ distribuídos por um período de 3 anos. O projeto irá também incluir a colaboração com duas PME[1] alemãs, ambas *spin-off* da Fraunhofer-Gesellschaft. Mais detalhes sobre este projeto podem ser encontrados na secção "Perspetivas e Desenvolvimento Estratégico".

Admitindo que o projeto se venha a realizar, isto seria um tremendo sucesso resultante do nosso Centro de Competências para ICT4D, e asseguraria o futuro da nossa operação de forma sustentável de acordo com o planeado, apenas com este único projeto. No entanto, e para além desta oportunidade, estamos também a seguir diversas outras, derivadas essencialmente das nossas boas relações com Moçambique (CIUEM – Centro de Informática Universidade Eduardo Mondlane), que serve atualmente como um *hub* permanente para as nossas atividades em África. Presentemente está em discussão a comercialização de duas soluções que foram desenvolvidas em Moçambique por uma equipa conjunta de estudantes da UEM – Universidade Eduardo Mondlane e cientistas da Fraunhofer Portugal, bem como a customização de alguns componentes relacionados com agricultura de precisão para árvores.

1 *PME – Pequenas e Médias Empresas.*

O FCC – Fall Competence Center evoluiu também bastante bem e encontra-se em fase de transição para atingir novas metas, direcionadas para o que pode vir a ser o maior sucesso da nossa evolução no longo prazo: em Dezembro de 2015 recebemos a informação preliminar que o projeto que será o prolongamento dos nossos Centros de Competências, que decorreram até meados de 2015 e foram em grande parte financiados externamente foi aprovado tendo inclusivamente conseguido uma avaliação muito boa.

Este projeto designa-se por DeM – Deus ex Machina e visa o desenvolvimento de tecnologia de sensores adaptados ao contexto para a Internet das Coisas (*IoT – Internet of Things*), soluções relacionadas com *big data* e interfaces especializadas entre humanos e "máquinas", designados por "companheiros". Esta proposta foi submetida em conjunto com vários parceiros portugueses, todos avaliados em 2014/2015 pela FCT – Fundação para a Ciência e a Tecnologia como "excelentes" ou "muito bons", e considerados em Portugal como sendo peritos no seu campo de atuação. O volume total do projeto ronda os 3M€ e poderá gerar cerca de 1,3M€ de receita para o Fraunhofer AICOS.

Após o programa de financiamento PT2020 ter finalmente iniciado em Março de 2015, já submetemos 11 propostas com clientes de indústria das quais 3 foram aprovadas. Mais detalhes sobre a proposta DeM e sobre os futuros projetos de indústria podem ser encontrados na secção "Perspetivas e Desenvolvimento Estratégico".

Do ponto de vista organizacional, em 2015 não conseguimos manter o crescimento anual, mesmo tendo alcançado um pico de 104 colaboradores na equipa entre Abril e Junho. A decisão de 2013 para abrirmos uma extensão em Lisboa para estarmos mais perto de diversos clientes e o facto das nossas instalações no Porto terem sido desenhadas para 90 colaboradores levou à abertura de um espaço em Lisboa, não apenas para efeitos de representação mas também para acolher mais cientistas, e também para permitir a mobilidade geográfica de elementos da equipa, que, caso contrário, teriam rescindido a sua colaboração com a Fraunhofer Portugal.

Estivemos também ativos no aumento do nosso portfolio de patentes, tendo sido submetido um novo pedido de patente relacionado com a nossa tecnologia de localização *indoor* que, tal como já mencionado acima, conseguiu muito bons resultados e como tal é considerado por nós como sendo de elevada atratividade para clientes comerciais.

Em relação à nossa situação financeira global consideramos que está estável, sendo que conseguimos cobrir os investimentos nas novas instalações de Lisboa sem requerer financiamento adicional, fruto de uma construção bastante económica mas garantindo simultaneamente, tal como aconteceu no Porto, um resultado final de elevada qualidade.

Em suma, tudo isto contribuiu para um resultado ambivalente no ano de 2015, tal como havia sido mencionado acima. Neste ambiente difícil não conseguimos alcançar todos os nossos objetivos, mas temos boas razões para acreditar que os resultados conseguidos irão contribuir para um forte 2016!
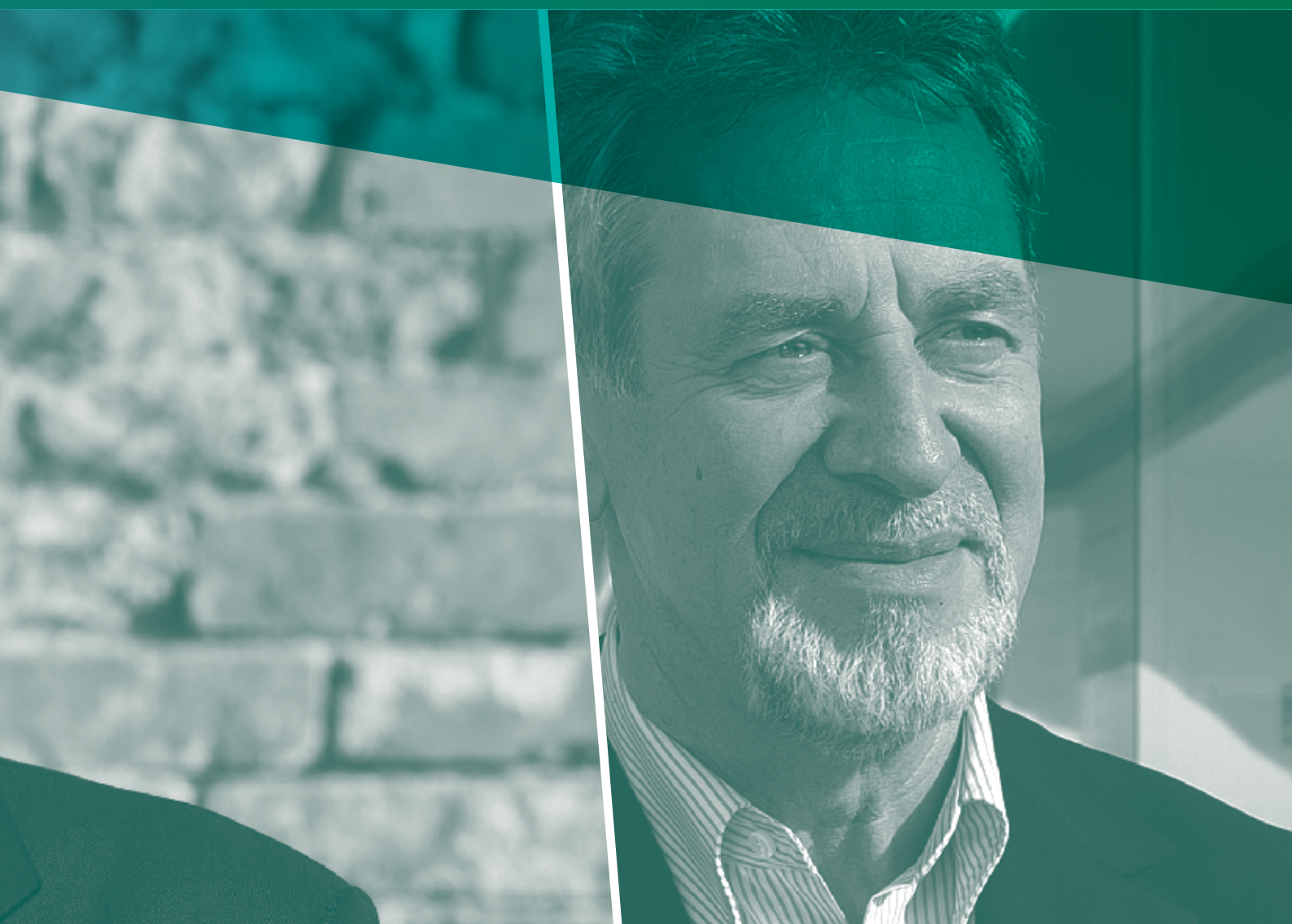
Dirk Elias

REPORT OF THE EXECUTIVE BOARD

GOVERNANCE & MANAGEMENT

OVERVIEW OF FRAUNHOFER PORTUGAL

MANAGEMENT REPORT 2015

GOVERNANCE & MANAGEMENT

GOVERNANCE STRUCTURE

Associação Fraunhofer Portugal Research		
General Assembly		
Scientific Advisory Council	Fiscal Board	Scientific Board
Supervisory Board		Executive Board
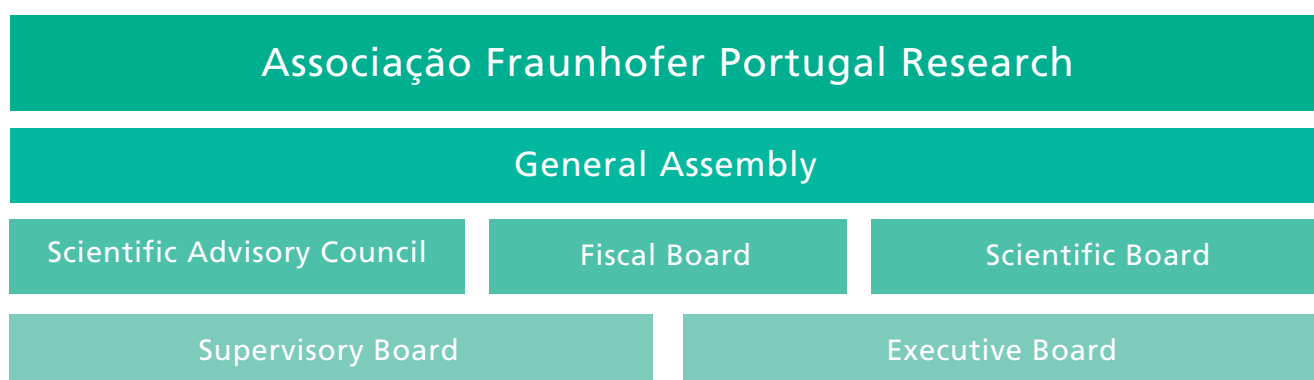
We seek to follow the best practices in every area of the Association's governance by reflecting such practices in our organization, principles and transparency.

The Associative Structure of Fraunhofer Portugal clearly distributes functions, duties and responsibilities among its board members.

Management

Fraunhofer Portugal management is a shared responsibility of both the Supervisory Board (with broad assessment powers) and the Executive Board (responsible for daily management and current management actions).

SUPERVISORY BOARD

President
Georg Rosenfeld
Director Research
Fraunhofer-Gesellschaft

Vice-President
João Paulo Oliveira
Board of Directors
The Navigator Company

Member
Manfred Hauswirth
Board of Directors
Fraunhofer FOKUS

Member
Paulo Simões
Board of Directors
Sonae SR, SGPS, SA

Member
Steffen Schudt-Pialat
Board of Directors
Volkswagen Autoeuropa

EXECUTIVE BOARD

Dirk Elias 1
President of the Executive Board

With a professional career ranging from R&D activities to entrepreneurial experiences and management, Dirk Elias is a Dipl. Ing. in Electrotechnical Engineering by the Technical University of Munich, and holds a PhD from the Technical University of Berlin.

Functional Assignments: General Administration, R&D Planning, Business Development, Facilities.

Pedro Almeida 2
Executive Board Member

With a professional career that started with R&D activities through to the full innovation cycle with the creation of a spin-off of a prestigious University in Portugal, Pedro Almeida holds a MSc in Electronics and Telecommunications Engineering by the University of Aveiro, and holds a post-graduation in Advanced Management for Executives also from the same university.

Functional Assignments: Business Development, Planning & Control, Accountancy & Finances, Human Resources, Legal, Facilities.

Berthold Butscher 3
Executive Board Member

With a career highly oriented towards R&D, both in industry and in R&D institutions, Berthold Butscher holds a Dipl. Ing. in Electrotechnical and Computer Engineering from the University of Applied Sciences of Konstanz and from the Technical University of Berlin.

Functional Assignments: R&D Planning Support.

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OVERVIEW OF FRAUNHOFER PORTUGAL

Vision

A Driving Force in Innovation

Fraunhofer Portugal proposes a radical change regarding technological innovation in collaboration with scientific institutions in Portugal, and aims at creating scientific knowledge capable of generating added value for its clients and partners, exploring technology innovations oriented towards economic growth, social well-being and the improvement of the quality of life of its end-users.

Mission

Research of Practical Utility

Fraunhofer Portugal promotes applied research of direct utility to private and public institutions and of broad benefit to society, by managing and coordinating the cooperation of its research centres with:

– Other Research Institutions – such as universities and other relevant Portuguese or non-Portuguese research institutions, as well as Fraunhofer Institutes and other research centres integrated in the Fraunhofer-Gesellschaft knowledge network;

– Industry Partners – clearly perceived and understood as our main customer group, we are developing partnerships and cooperation agreements with private and public enterprises, as well as participating in business associations;

– Supporting Partners – Government Institutions and other Institutional partners.
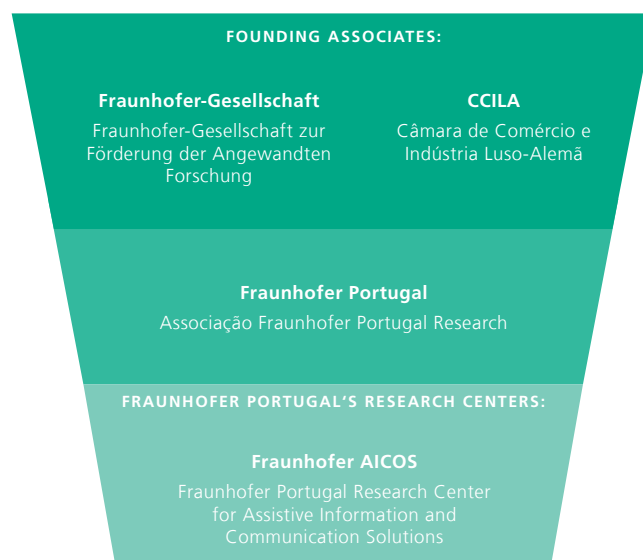
Funding Model

Fraunhofer-Gesellschaft and the Portuguese Foundation for Science and Technology (FCT) agreed on a tripartite funding model similar to the one used by Fraunhofer-Gesellschaft.

At Fraunhofer Portugal, our scientists and engineers work with a budget financed by external revenue (projects and licensing) and institutional funding provided by FCT and Fraunhofer-Gesellschaft.

The base line for this type of funding determines that it will be granted in progressively smaller amounts over the initial years, encouraging the implementation of an efficient business model mainly financed by external revenue.

External revenue should be guaranteed through research projects, development projects, contracts signed with third parties within Fraunhofer Portugal's fields of activity, intellectual property rights and licensing of the commercial optimization of products and services resulting from Fraunhofer Portugal's R&D results.

FOUNDING ASSOCIATES:

Fraunhofer-Gesellschaft
Fraunhofer-Gesellschaft zur Förderung der Angewandten Forschung

CCILA
Câmara de Comércio e Indústria Luso-Alemã

Fraunhofer Portugal
Associação Fraunhofer Portugal Research

FRAUNHOFER PORTUGAL'S RESEARCH CENTERS:

Fraunhofer AICOS
Fraunhofer Portugal Research Center for Assistive Information and Communication Solutions

Fraunhofer-Gesellschaft

Research of practical utility lies at the heart of all activities pursued by the Fraunhofer-Gesellschaft. Founded in 1949, the research organization undertakes applied research that drives economic development and serves the wider benefit of society. Its services are solicited by customers and contractual partners in industry, the service sector and public administration.

At present, the Fraunhofer-Gesellschaft maintains 67 institutes and research units. The majority of the nearly 24,000 staff are qualified scientists and engineers, who work with an annual research budget of more than 2.1 billion euros. Of this sum, more than 1.8 billion euros is generated through contract re-search. More than 70 percent of the Fraunhofer-Gesellschaft's contract research revenue is derived from contracts with industry and from publicly financed research projects. Almost 30 percent is contributed by the German federal and Länder governments in the form of base funding, enabling the institutes to work ahead on solutions to problems that will not become acutely relevant to industry and society until five or ten years from now.

International collaborations with excellent research partners and innovative companies around the world ensure direct access to regions of the greatest importance to present and future scientific progress and economic development.

With its clearly defined mission of application-oriented research and its focus on key technologies of relevance to the future, the Fraunhofer-Gesellschaft plays a prominent role in the German and European innovation process. Applied research has a knock-on effect that extends beyond the direct benefits perceived by the customer: Through their research and development work, the Fraunhofer Institutes help to reinforce the competitive strength of the economy in their local region, and throughout Germany and Europe.

They do so by promoting innovation, strengthening the technological base, improving the acceptance of new technologies, and helping to train the urgently needed future generation of scientists and engineers.

As an employer, the Fraunhofer-Gesellschaft offers its staff the opportunity to develop the professional and personal skills that will allow them to take up positions of responsibility within their institute, at universities, in industry and in society. Students who choose to work on projects at the Fraunhofer Institutes have excellent prospects of starting and developing a career in industry by virtue of the practical training and experience they have acquired.

The Fraunhofer-Gesellschaft is a recognized non-profit organization that takes its name from Joseph von Fraunhofer (1787–1826), the illustrious Munich researcher, inventor and entrepreneur.

German-Portuguese Chamber for Industry and Commerce (CCILA)

With over 1.000 associates in Portugal and Germany, the objective of the Chamber is to enhance and promote the economic relationships between the two countries.

Associação Fraunhofer Portugal Research

Founded in 2008 – within the framework of a long-term Portuguese-German collaboration in Science and Technology – Associação Fraunhofer Portugal Research (Fraunhofer Portugal) promotes applied research that drives and encourages economic development and serves the wider well--being of society. The Association's services are sought out by customers and contractual partners in industry, the service sector and public administration.

Currently, Fraunhofer Portugal owns and operates the Fraunhofer Portugal Research Center for Assistive Information and Communication Solutions (Fraunhofer AICOS) – a partnership between Fraunhofer-Gesellschaft, Fraunhofer Portugal and the University of Porto – focusing on Ambient Assisted Living (AAL) and Information and Communication Technologies for Development (ICT4D).

Fraunhofer Portugal's development strategy accommodates the option to establish additional research units whenever a sustained demand for R&D services applied to a specific area of scientific knowledge is detected in the market.

Services

Fraunhofer Portugal's Research Services, rendered through the research institutions it operates, provide three different types of collaboration to industrial customers, also provided within public funded project participations:

- R&D Contract;
- R&D Consulting;
- Living Labs.

Fraunhofer Portugal is committed to building a reputation of excellence within different service dimensions such as knowledge, credibility, professionalism, creativity, flexibility, response time and cost.

Fraunhofer AICOS

Fraunhofer Portugal Research Center for Assistive Information and Communication Solutions

Incorporated as a partnership between Fraunhofer-Gesellschaft and the University of Porto and focusing its activity on Ambient Assisted Living (AAL) and Information and Communication Technologies for Development (ICT4D), Fraunhofer AICOS is the first research institution operated by Fraunhofer Portugal.

Extending the Reach of the Information and Knowledge Society

Fraunhofer AICOS aims to enhance people's living standards by offering intuitive and useful technology solutions, capable of facilitating their access to the Information and Communication Technologies, and in this way assisting in the integration of an increasingly larger sector of the population in the Information and Knowledge Society.

Remarkable Technology, Easy to Use

Fraunhofer AICOS' mission is to generate Remarkable Technology, Easy to Use. This means offering specialised competences centred on the improvement of end-user experience and usability of applications, generating applied research solutions capable of contributing to the market success of our client's products and services.

Collaboration plays an essential role in enabling the research centre to fulfil its mission. Therefore, Fraunhofer AICOS strongly promotes and consolidates partnerships and cooperation with key players and decision makers in its strategic research areas, namely:

- *Association européenne pour la maladie de Parkinson* (Belgium): charitable organisation that brings together several national Parkinson organisations from Europe. Collectively, these organizations have more than 250.000 members in 36 countries and advocate for the rights and needs of more than 1.2 million people with Parkinson's and their families;

- *Center of Excellence for Dematerialization of Transactions*: leading entity that coordinates a network of knowledge and competences in the dematerialization of transactions in Portugal;

- *Charité - Universitätsmedizin Berlin* (Germany): with more than 300 years old, it is one of the largest university hospitals in Europe. At the university, approximately 3.700 doctors and scientists heal, do research and teach at the top international level. More than half of the German Nobel Prize winners in medicine and physiology come from the Charité, among them are Emil von Behring, Robert Koch and Paul Ehrlich;

- *College of Health Technology of Coimbra*: a centre of creation, transmission and dissemination of science, technology and culture, holds as its mission the intervention and development at the levels of graduate and postgraduate education and research in health sciences and related areas, as well as the service to community and cooperation with national and international organizations in common interest activities and society in general;

- *Eduardo Mondlane University* (Mozambique): the oldest and largest university in Mozambique which focuses on producing and disseminating scientific knowledge, as well as promoting innovation through research, educating generations to face challenges to benefit society's development, namely in the scientific fields of Biology, Agronomy, Engineering, Human Sciences and Linguistics;

- *Faculty of Economics of the University of Porto*: with a long and prestigious history in the teaching of Economics and Management in Portugal, it is considered the best Portuguese University according to most international rankings;

- *Faculty of Engineering of the University of Porto*: a top-level faculty that awards degrees in several engineering fields, such as, computer engineering, mechanical engineering, chemical engineering, etc.;

- *Faculty of Medicine of the University of Porto*: well renowned faculty that promotes teaching and provides scientific research of excellence and medical support activities to the community;

- *Fraunhofer FOKUS* (Germany): Fraunhofer Institute, based in Berlin, operates closely in related scientific fields, in this way pooling expertise in interdisciplinary collaborative projects as well as facilitating Fraunhofer AICOS' seamless integration with Fraunhofer-Gesellschaft in different institutional aspects;

– *Fraunhofer IDMT* (Germany): Fraunhofer Institute focused on developing cutting-edge solutions in the digital media domain, consistently designed to meet user requirements and expectations;

– *Fundación Privada Cetemmsa* (Spain): technology centre with over 19 years of experience in carrying out applied research on Smart Materials and Smart Devices that bring new uses and experiences to a wide range of economic sectors;

– *Gaia Vocational Rehabilitation Centre*: an association focused on the rehabilitation of people affected by accidents or diseases, which also assists young people with disabilities in their transition from school into an active life;

– *German Sport University Cologne* (Germany): the only university in Germany dedicated exclusively to the field of sport and exercise science, which is studied in detail at 21 institutes, four affiliate institutes and nine academic centres;

– *Health Cluster Portugal*: organization which focuses on the promotion and implementation of initiatives and activities leading to the creation of an innovative and technology-based national cluster;

– *Institute of Development, Aging and Cancer, Tohoku University* (Japan): is a Usage /Research Centre for Aging Research affiliated with Japanese universities that promote aging sciences and aims to clarify basic mechanisms of aging, as well as to control age-related diseases, such as dementia and intractable cancers;

– *Instituto de Biomecánica de Valencia* (Spain): is a technological centre that studies the behaviour of the human body and its interaction with products, environments and services, aiming to improve competitiveness among the business sector, by promoting people's well-being through the combination of knowledge in areas such as: Biomechanics, Ergonomics and Emotional Engineering, and its application to diverse sectors;

– *ISCTE - Lisbon University Institute*: a public university that pursues teaching, research and community service activities, in areas such as, business, sociology, public policy, social sciences, technology and architecture;

– *Istituto Superiore Mario Boella sulle Tecnologie dell'Informazione e delle Telecomunicazioni* (Italy): is a research and innovation centre operating in the Information and Communication Technologies domain, playing an active role in devising innovative solutions on research areas such as: Advanced Computing; Mobile Solutions; Pervasive Technologies (Internet of Things);

– *KempenLIFE* (Netherlands): a cooperative established by and for older citizens living in the rural Kempen area, Netherlands. It aims to organise new services for comfort, welfare and care, making use of ICT and broadband internet, and collaborating with hospitals and care organisations in the field of eHealth to increase independent living and quality of life for its members;

– *Loughborough University* (United Kingdom): a UK top 15 University with an international reputation for excellence in teaching, research and sport, producing research that matters, with strong links with industry, commerce and the professions, in areas such as: Computer Science; Electronic, Electrical and Systems Engineering; Sport, Exercise and Health Sciences;

– *National Health Institute Dr. Ricardo Jorge*: public organization of the Ministry of Health, endowed with scientific, technical, administrative, financial and property of its own, that plays a triple role as State Laboratory in the Health Sector, National Reference Laboratory and National Health Observatory;

– *Nelson Mandela Metropolitan University* (South Africa): a dynamic African university offering professional and vocational training for leadership in generating cutting-edge knowledge for a sustainable future, specialised in the scientific fields of Health, Engineering, Business and Economics and Law;

– *Polytechnic University of Catalonia* (Spain): a public institution dedicated to higher education and research, specialised in the fields of engineering, architecture and science;

– *Portuguese Institute of Oncology*: the largest national institution dedicated to the research, diagnosis, treatment, prevention, study, and teaching of areas within the domain of oncologic diseases;

– *Seniornett Norge* (Norway): a non-governmental organization working for the inclusion of elderly people in the 'e-'world (PC, Internet, social media, etc.), in cooperation with the Norwegian Government, Microsoft (Gates Foundation), several non-profit organizations and telecom companies. It has established 200 training centres all over Norway where senior citizens can go for training, meet peers, ask questions and socialize;

– *Seoul National University* (Republic of Korea): one of the world's top 50 institutions, aims at creating a vibrant intellectual community where students and scholars join together in building the future, by committing to diversifying its student body and faculty, fostering global exchange, and promoting path-breaking research in all fields of knowledge;

– *Università degli Studi di Torino* (Italy): one of the most ancient and prestigious Italian universities, aims at promoting culture and producing research, innovation, training and employment, by covering several fields of knowledge. Its Medical Diagnostic, Biosensor and Nanotechnologies research centres are amongst the best ones in Italy;

– *Universität Siegen* (Germany): a modern, high-profile university with an international orientation guided by the central principle 'creating a humane future', by offering a variety of degree programmes in areas such as: Communications Technology; Computer Science Technology; Human-Computer Interaction; Information Systems; Microsystem Technology; Visual Computing;

– *University of Limerick* (Ireland): distinctive, pioneering and connected university that undertakes world-class research and delivers innovative teaching in the fields of Science and Engineering;

– *University of Porto*: our primary and distinguished university partner offering access to university know-how and infrastructures, as well as privileged contact with students interested in enrolling in advanced training at Fraunhofer AICOS labs. We have closer cooperation with some of its faculties, namely the ones described above;

– *University of the Sunshine Coast* (Australia): is one of Australia's newest and fastest growing universities, offering more than 100 undergraduate and postgraduate study programmes in Business and Information Technology; Communication and Design; Education; Health; Humanities and Social Sciences; and Science and Engineering;

– *UPTEC*: official Science and Technology Park of the University of Porto that fosters the creation of technology-based companies and the establishment of national and international private R&D centres, supporting an effective knowledge and technology transfer between academia and the market.

Strategic Research Agenda

Fraunhofer AICOS constitutes a new approach to Information and Communication Technologies through Fraunhofer-Gesellschaft and contributes to the creation and development of competences in activities of great relevance for the future, addressing two main business fields: Ambient Assisted Living (AAL) and the emerging field of Information and Communication Technologies for Development (ICT4D).

– AAL includes methods, concepts, (electronic) systems, devices and services that are providing unobtrusive support for daily life, based on the context and the situation of the assisted person. The technologies applied for AAL are user-centric, i.e. oriented towards the needs and capabilities of the actual user. They are also integrated into the immediate personal environment of the user. Consequently, the technology is adapted to the user rather than the other way around. In order to share relevant information between systems and services, technologies for AAL should ideally be based on modular and interoperable concepts.

Fraunhofer AICOS intends to mainly address the needs of the ageing population, to reduce innovation barriers of forthcoming promising markets, but also to lower future social security and healthcare costs. This goal can be achieved through the use of intelligent products and the provision of remote services, including care services that extend the period during which senior citizens can live in their home environment. The services envisioned and developed by Fraunhofer will increase the individual's autonomy and assist them in carrying out their daily activities.

– ICT4D is a general term which refers to the application of Information and Communication Technologies (ICT) within the field of socioeconomic development or international development. ICT4D focuses on the direct application of information technology approaches to contribute to poverty reduction and to reduce the digital divide.

Fraunhofer AICOS currently intends to focus its ICT4D activities on the African continent, with special emphasis on Mozambique and Angola. The primary target user group will be ICT users in rural and developing areas, and the objective is to provide solutions for mobile device services and applications which meet the local users' demands, contributing to a more positive user experience which, in many cases, may be their first contact with ICT.

Among the significant diversity of topics related to AAL and ICT4D, Fraunhofer AICOS focuses on a reduced set of business sub-fields that our customers consider relevant and that are directly related to our core competences.

In the AAL business field, Fraunhofer AICOS currently covers the following sub-fields:

– Fall and Activity Monitoring;

– Chronic Diseases and Well-Being Management;

– Assistive Environments.

With regards to the emerging ICT4D business field, one sub-field has currently been defined:

– ICT4D on Mobile Devices.

Additionally, Fraunhofer AICOS supports the creation of scientific knowledge capital in three key areas that define the Center's core competences developed to date:

– Human-Computer Interaction (HCI): focusing on User & Social Experience, Mobile & Future Devices and Evaluation & Usability;

– Information Processing (IP): focusing on Content Retrieval, Context Awareness, and Multimodal Information Fusion;

– Autonomic Computing (AC): focusing on Remote Management, Control and Configuration.

MANAGEMENT REPORT 2015

Summary of Key Figures

	2015	2016 (Plan)
Total Budget	3.266.879 €	3.753.467 €
Staff Costs	2.031.455 €	2.281.261 €
Non Personnel Costs	534.562 €	850.376 €
Industry Revenues	452.619 €	875.000 €
Public Revenues & Others	1.199.236 €	1.080.395 €
Base Funding	1.615.024 €	1.798.072 €
FTE (Full Time Equivalent)	55,9	56,0

Economic and Political Background

- Consolidation of Portuguese economy recovery.

- PT2020 programme becomes operational.

- Prof. Doutor Manuel Heitor nominated as Minister of Science, Technology and Higher Education.

Current projections issued by Banco de Portugal for the Portuguese economy in December 2015 point to a continuous gradual recovery of economic activity over the period 2015-2017, ranging from an average annual GDP growth of 1.6% in 2015, to a growth of 1.7% and 1.8% in 2016 and 2017 respectively. These projections suggest that the growth of the Portuguese economic activity is being consolidated and that we can expect a slight improvement in the business environment at national level in the next couple of years. Nevertheless, the projections issued for 2016 and 2017 are surrounded by a particular uncertainty due to the electoral process that led to a political change in the Portuguese government at the end of 2015 and delayed the presentation and approval of the State Budget for 2016, which is still not known at the time of writing this report.

The recovery of the Portuguese economy is relatively slow at the moment, particularly taking in to account the contraction of the GDP of the last years due to the effects of the economic and financial crisis. Over the horizon, it is expected that the Portuguese economy continues to grow but some major challenges are still present.

On the one hand it is essential to foster the increase in productivity of the different economic sectors, which can be achieved through the adoption of strategies based on innovation and R&D, and on the other hand it is important to continue the adjustments in the macroeconomic imbalances that still characterize the Portuguese economy, having once again innovation and R&D an important role as they can foster the creation of high-tech products and services that can generate added value for the Portuguese industry, namely in what concerns the increase of exports.

In terms of the national financing programmes related to innovation and research activities, the transition from the previous framework support programme QREN to the new Portugal 2020 (PT2020) has been concluded and the first calls for R&D projects were issued during the 1st quarter of 2015, being the first results published at the end of the 3rd quarter of 2015. An initial version of a call calendar has been published at the beginning of 2015 but due to several reasons, delays in the preparation of the PT2020 regulation, changes in the political ecosystem, etc., the announcement of some calls is being postponed causing delays in the submission of projects and consequently on the execution of investments. Although some members of the previous government of PSD/CDS announced an execution of 5% of the PT2020 programme at the end of 2015, the reality is that there is no official report of the execution of the programme and apparently, at least in what concerns the activities in which Fraunhofer Portugal is directly involved, most of the investments will be performed after the end of 2015.

Although the results of the calls are already known and the first PT2020 contracts are being signed, the operational and management rules are still being published, namely in what concerns the anti-fraud strategy, code of conduct, the expenses eligibility rules, compliance rules associated with public procurement, rules for presentation of payment reimbursements and the rules to organize the files related to the execution of the operations.

Regarding the political environment, the previous government based on the coalition PSD/CDS ceased functions by the end of October after winning the legislative elections and forming a minority government. An alliance based on the left wing parties with the majority of the deputies in the parliament was then nominated as government being headed by the socialist party, PS. This political change led to changes at the ministerial levels and in November 2015 Prof. Doutor Manuel Heitor was appointed as Minister of Science, Technology and High Education. As he was one of the people directly involved in the creation of Fraunhofer Portugal, and since the beginning has been a strong enthusiast of the concept of Applied Research for the benefit of the economy and society, we expect that his appointment can contribute to the dissemination of Applied Research initiatives in Portugal.

Business Evolution

– Consolidation of growth and performance level of the last two years.

– Transition of framework support programme affects industry projects acquisition.

– National and EU projects acquisition ensures excellent position to maintain growth plan 2014-2018.

After a period of two years were the business evolution has increased significantly, 2015 revealed itself as the year of consolidation of the previously achieved growth and performance level. It is important at this stage to remember that the external conditions of the Portuguese economy were quite challenging during the last 3 years, during which the investment in R&D by public and private entities reduced significantly. In fact 2015 was the year in which we suffered most of the impact of the transition of framework programmes, but despite the challenging external environment our business volume increased once again, this time mainly driven by CAPEX investments related to the creation of the Lisbon branch office. Our revenues also increased slightly when compared with last year results, but unfortunately we were not able to achieve the desired level of revenues expected for 2015, mainly due to the level of Industry revenues being below the initial plan. Nevertheless, considering that the growth rate of our operation in the last two years was quite high, a period when we actually more than doubled our project revenues, being able to maintain and consolidate the previously achieved growth and performance level of the organization is, in our opinion, an excellent outcome for Fraunhofer Portugal.

Business Development

2015 will be inevitably marked as the year of transition of national framework support programmes, changing from QREN to PT2020, which originated several challenges internally in terms of the management of our operation!

The last call of the previous framework programme QREN ended in August 2013 and the first call of the PT2020 ended in June 2015. During almost two years the main source of national funding for innovation and R&D projects in Portugal was not available, which was quite a long and challenging period when we look at the dynamics of normal operation of an R&D organization in Portugal.

Another fact associated with this transition period was that all projects funded by QREN had to be operationally and financially concluded until the end of the first semester of 2015. In practical terms, this meant that at the end of June the number of active external projects being developed at Fraunhofer Portugal reduced significantly and all revenues associated with Industry projects being supported by the national funding mechanisms to R&D projects ceased at the same time.

In the beginning of 2014, when the framework program PT2020 was being discussed and approved in Brussels, our initial expectation was that by the end of 2014 the first calls would be eventually published and the first contracts signed during the 2nd quarter of 2015. As the announcement of the first innovation and R&D calls was delayed until the end of the 1st quarter 2015, the first results were only announced close to the last quarter of 2015, and consequently the contracts could only be signed by the end of 2015, beginning of 2016. Therefore we had to deal with this significant constraint during 2015, as the unavailability of funding mechanisms at national level to develop new R&D projects was blocking a relevant number of potential business initiatives.

As a consequence of this delay in our Business Development, the increase in the global revenue streams was not as high as initially expected during the preparation of the Budget 2015, being the revenues from Industry projects below the initial expectation. In part this loss was compensated by an increase in the revenues coming from National R&D projects, but this shift in the source of revenues had also a direct impact in the revenue based performance indicators, which we will explain in more detail in the next chapters.

To bridge the gap between the funding periods, it was decided to launch a set of short duration internal projects related to external projects' proposals or with our strategic interest, in terms of development of our research agenda. As by the end of 2015 some of the external projects' proposals were approved, we were able to partially account as WIP some of the work developed in these internal projects, and therefore overcome part of the impact of the transition period.

At the moment, we are already recognizing a new dynamics of project acquisition associated with different calls of PT2020 and we have been able to successfully contract a significant volume of new R&D projects at the end of 2015. We hope that this *momentum* keeps its energy during the next years and that it stimulates the continuous growth envisaged for Fraunhofer Portugal.

Based on the considerations explained above, the evolution of the acquisition of Industry projects along the year was far from the initial expectation envisaged for the organization. There was a continuous effort by all collaborators to acquire new industry projects, with new and existing clients, but due to different reasons, the success of project acquisition was more concentrated at the end of 2015, after the announcement of the results of the calls associated to PT2020.

In total we have submitted directly or indirectly (i.e. projects in which FhP would be subcontracted) 9 proposals for Industry projects that were related to funding of PT2020 and out of these proposals we were able to successfully contract 3 projects. The success rate of this first round of applications was quite satisfactory and it evidences a strong difference in terms of our capacity to leverage the development of the projects with Industry after the funding from PT2020 became available. Actually the success rate could have been even better, but due to some changes in the regulation of the PT2020 call one project that was scientifically positively evaluated unfortunately was not funded due to an administrative issue with the company leading the consortium.

In September 2015 our first PT2020 industry project was formally approved. The main outcome of this project will be a fall risk screening and falls prevention solution based on existing technologies developed by Fraunhofer Portugal and Sensing Future, a Portuguese SME that coordinates the project.

Also worth mentioning, was the approval of the ShopView-2Market demonstrator project with SONAE. This project is the continuation of the former ShopView project which has finished having its R&D objectives accomplished. Although it is capable of doing the job with a considerable degree of reliability, some challenges and limitations were identified through the execution of the project: Automatic Integration, Usability, Auditing features should be completed with Correction features – to be able to act upon the information created by ShopView, e.g. for restocking, rearranging and optimizing shelf product placement.

During the second semester of 2015 we were also engaged in some important missions with the Association of Communications and Telecommunications Regulators of the Community of Portuguese Speaking Countries (ARCTEL-CPLP), namely one mission to Guiné-Bissau and two others to São Tomé e Príncipe. The goal of these missions was to promote a joint initiative for the creation of the Sustainable Villages for Development (SV4D) project, which aims to increase the access to broadband communications in remote areas of CPLP countries and promote the usage of ICT technologies for the benefit of local communities of rural areas. In both countries we had meetings with high level representatives of the local governments and in general the project goals were highly appreciated by the different stakeholders. Worth mentioning was the case of São Tomé e Príncipe where we first had the opportunity to meet with the prime minister and ministers of ICT, Telecommunications and Infrastructures during a donors conference in London. Afterwards, during the second mission to São Tomé e Príncipe, we had once again the opportunity to meet with the different ministers (ICT, Health, Environment, Telecommunications and Infrastructure) and make a final presentation of the project to the prime minister of São Tomé e Principe, Mr. Patrice Trovoada. Besides these joint missions to Guiné-Bissau and São Tomé e Príncipe, we had the opportunity to present directly the SV4D project to the Telecommunication regulators of Mozambique and Angola, being their reaction also positive in terms of their interest to implement the project locally. We expect that during 2016 some of these activities start being implemented and therefore that we are able to implement this concept of the Sustainable Villages in African countries of CPLP.

In terms of the development of international contacts, several initiatives were implemented along 2015 with the goal of promoting Fraunhofer AICOS' solutions with Higher Technology Readiness Level in international markets. New business opportunities were developed mainly in European and Sub-Saharan African countries in the fields of Ambient Assisted Living and ICT4D, respectively. While a medium-term strategic approach for internationalization started being implemented, new business opportunities were sought and developed within FhP's current activities and from the interaction with customers, partners, suppliers and competitors.

In 2015 FhP succeeded to increase its network of new international contacts as a result of the participation in external events, either exhibitions or B2B networking events, and in close cooperation with AICEP and intergovernmental organizations, such as European Enterprise Network, Eureka and CGIAR (Consultative Group for International Agricultural Research).

Some of the identified business opportunities with important players in the health sector are still in the prospect stage, e.g. Novartis, Roche and J&J-Janssen Healthcare Innovation, but we are fully committed to achieving positive results with the necessary actions and resource allocation.

In terms of the European projects evolution, the year of 2015 was particularly satisfactory, although we had to face some serious constraints in terms of the negotiations of AAL JP projects. During the first quarter we started the negotiation process of the SmartBeat project, an initiative associated with the AAL JP which is being coordinated by Fraunhofer AICOS.

During the third quarter of 2015 we've received excellent news about the outcome of the submitted EU project proposals! In total, we had 3 projects approved out of 11 proposals, which reveals a significant success rate of project acquisition (typical success rates are <10%). The three projects approved were: 1. My-AHA, which is related to the development of an innovative ICT-based platform to act upon frailty amongst older adults by detecting subtle changes in physical, cognitive and social domains that indicate an increased risk of subsequent vicious cycle of disability and diseases, including dementia, depression, frailty and falls; 2. Active@Home, which aims at developing a holistic solution, focusing on physical, cognitive and social aspects, to promote physical activity at home and allow fall prevention (and provide fall risk prediction), based on typical exergames, dance and Tai Chi; and 3. CordonGris, designed to demonstrate the 'flat rate food' concept, it proposes to develop a convenient system that leverages the potential of the Internet of Things to guarantee longer living at home by tackling malnutrition.

Also related to EU projects, during 2015 once gain we faced some unexpected problems with the Clockwork project. This time the problem was related to an Italian partner that left the consortium due to problems with their National Funding Agency. As it was the only partner that included a doctor specialist in the scientific area related to the scope of the project, the consortium was left unbalanced and a solution would have to be found to ensure the existence of the minimum set of resources necessary for the implementation of the project. Meanwhile another Italian partner arranged a potential solution and the project was reformulated to accommodate this change in the organization of the consortium. The coordination unit of the Ambient Assisted Living Joint Program accepted the project reformulation but the modifications must also be accepted by the National Funding Agency of Italy. Unfortunately this decision is taking longer than initially expected and therefore the project is still delayed,

being Fraunhofer AICOS at the moment maintaining all the activities related to the management of the project but not developing any scientific activity.

During the third quarter of 2015 our team was highly engaged in the preparation of a very important project proposal: DeM – Deus ex Machina. This proposal was presented to CCDR-N, the funding entity of the north region, and it is related to the creation of two new Competence Centres in Fraunhofer AICOS: the Eyes of Internet of Things Competence Centre and the Companion Competence Centre.

The Eyes of Internet of Things Competence Centre – EITCC – focuses on the development of an infrastructure to physically observe multiple data sources, act accordingly in the environment and provide a 'holistic' understanding of the user. The Companion Competence Centre – C3 – concerns the creation of Companions as specialized frontends of 'big machines' (IoT/ Big Data solutions) that serve human users and focuses on the creation of real working prototypes built on top of processed data provided by the technology developed in the EITCC.

Both Competence Centres were presented in a single proposal jointly with 6 Portuguese scientific partners due to the common objectives and complementary goals of the project's activities, being the ultimate objective to achieve efficiency gains in different scientific areas in which Fraunhofer AICOS is currently involved, namely health, community tools, activity monitoring, agriculture, nutrition, etc. The planning that was prepared for these new Competence Centres reflects our ideas for the next 2-3 years regarding the topics that we are interested to research on, and they represent the natural and continuous evolution of the scientific results of the Competence Centres that were initially created in 2012, the Fall Competence Center (FCC) and the ICT4D Competence Center (ICT4DCC). The activities planned for the new Competence Centres will be the guidelines for the future activity of Fraunhofer AICOS,
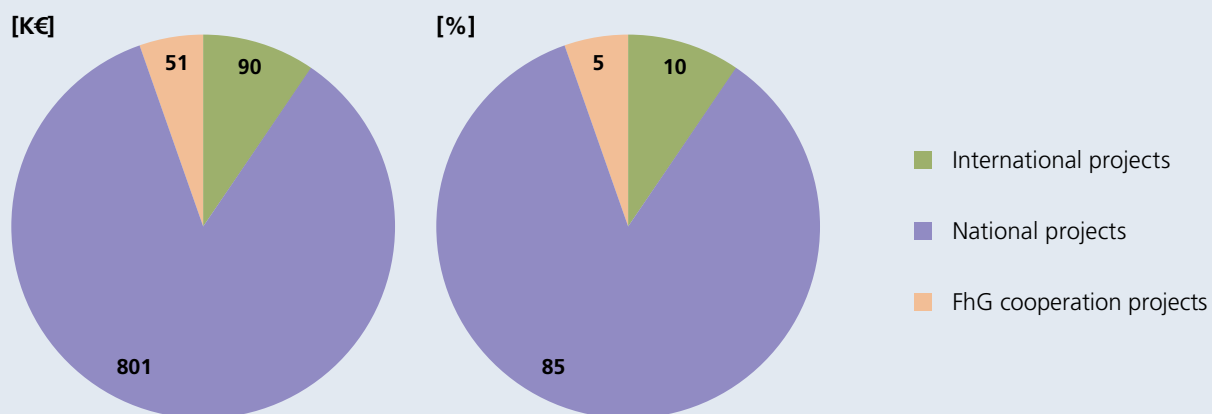
being the speed of implementation and the number of topics addressed simultaneously the variables that are directly dependent on the funding available for the project.

Another initiative developed during 2015 and related to business development in National projects concerns the preparation of two mobilizer projects associated to the TICE. PT and HCP clusters. At the time of writing this report, both clusters are waiting for the final results of a PT2020 call that was launched to refinance these national sectorial clusters but we have already positioned ourselves as key stakeholders for future mobilizer projects.
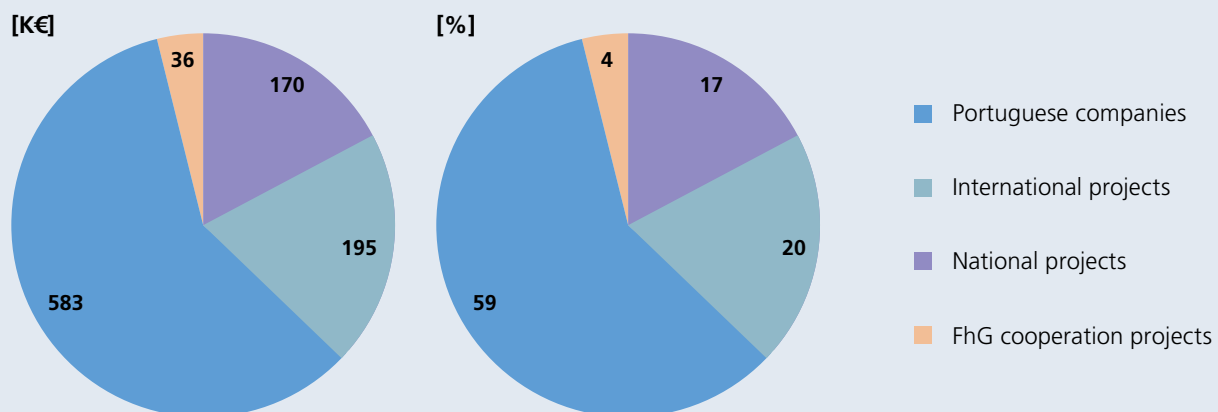
An important Key Performance Indicator (KPI) of our activity is our ability to involve German and Portuguese partners, either as contractors or partners, in the projects that we develop at Fraunhofer AICOS. During the period 20092015 we were able to generate 3M€ of revenues in projects that involve German partners and 3,8M€ of revenues in projects that involve Portuguese partners, which reveals our continuous and strong commitment to work together with German and Portuguese institutions and in this way contribute towards strengthening the economic relationship between Portugal and Germany.

In 2015, we generated revenues of 90K€ with German institutions in international projects, 801K€ in national projects that include the participation of three Fraunhofer Institutes: Fraunhofer FOKUS, Fraunhofer IDMT and Fraunhofer IZFP and finally 51K€ related to a project contracted by a Portuguese SME that involves Fraunhofer FOKUS. Regarding Portuguese partners, in 2015 we generated 170K€ of revenues in projects that involve Portuguese companies, 583K€ of revenues in national R&D projects, 195K€ of revenues in international R&D projects that involve other Portuguese organizations and, finally, 36K€ of revenues in projects with Portuguese organizations that directly involve Fraunhofer-Gesellschaft's institutes.

Revenues Involving German Partners 2015

[K€]

- 51
- 90
- 801

[%]

- 5
- 10
- 85

- 🟩 International projects
- 🟪 National projects
- 🟧 FhG cooperation projects

Revenues Involving Portuguese Partners 2015

[K€]

- 36
- 170
- 195
- 583

[%]

- 4
- 17
- 20
- 59

- 🟦 Portuguese companies
- 🟦 International projects
- 🟪 National projects
- 🟧 FhG cooperation projects

Scientific Results & Corporate Development

– Success in the implementation of Fall Competence Center and ICT4D Competence Center conveys new opportunities for Fraunhofer AICOS.

– 27 Master theses concluded being one of them financed by an industry client.

– Creation of Lisbon branch office.

2015 was a year in which Fraunhofer AICOS achieved a significant impact in terms of the outputs and results of the scientific activity and its consequent socio-economic outcomes. After two years of hard work and dedication of the R&D team, a significant level of development and maturity of scientific activities related to Fall and Activity Monitoring and ICT4D technologies was achieved, mainly associated with the execution of two important projects, the Fall Competence Center and the ICT4D Competence Center.

In terms of the developments associated with the Fall Competence Center, during 2015 the final iterations of prototypes were implemented and tested, eight Master Theses related to falls and activity monitoring were concluded and four publications related to scientific results achieved within the Competence Centre were issued in proceedings of scientific conferences. Several dissemination actions have been carried out with the participation on the European Summit for Active & Healthy Ageing, European Falls Festival, pHealth, IEEE MeMeA, PervasiveHealth and Semana das Ciências Aplicadas à Saúde. A final workshop was organized by the FCC team and counted with the presence of Fraunhofer AICOS' directors and Dr. Andreu Català from Technical Research Centre for Dependency Care and Autonomous Living (Universitat Politècnica de Catalunya).

In this FCC workshop the projects developed in the scope of the Fall Competence Center have been showcased giving the opportunity to participants to better understand each of them. A result of this workshop was the enlightenment and enrichment of existing and new ideas with new projects gaining shape as the results were being discussed.

Final iteration prototypes of the Fall Competence Center were successfully obtained for each of the four main tasks of the project, namely in terms of scientific outcomes related to Fall Risk Analysis, Age and Illness Related Fall Detection, Falls in Extreme Sports and Assault Detection and Documentation. Among the several applications developed, we would like to highlight the creation of a smartphone-based tool to assist healthcare professionals on the execution of fall risk evaluation tests, the development of a fall detection algorithm which reached an accuracy of 97.5% for the pocket usage and 97.6% for the belt as tested in a group of 36 subjects following a simulated falls and activities of daily living protocol, the development of algorithms based on smartphone and wearable sensors which are being used for detection of movements and falls in watersports such as surf, sailing and windsurf and, finally, the development of a smartphone based solution for assault detection and documentation which comprehends a module to automatically detect the body movement of safety and security personnel at duty (field operatives). This specific prototype also includes real-time video communication from the operative to the command centre and falls and activity detection.

Within the ICT4D Competence Center also important scientific results were achieved. During 2015 the final prototypes related to mGovernment, mHealth and mAgriculture projects were released, five Master Theses were concluded and one scientific article was published in an International Journal. In terms of dissemination of the project's results, several actions were developed in cooperation with African countries, namely in Mozambique and South Africa, and a final workshop was organized in Fraunhofer AICOS to present the final prototypes to different stakeholders involved in the project.

An improved version of the MalariaScope prototype was developed within the ICT4D Competence Center and the project is now entering a new phase, with upgrades and advanced enhancements. Since the beginning of the project, the goal is to develop a cheap alternative to the current microscopes that can easily be adapted to a smartphone and used in Sub-Saharan African countries. The great improvement in this version of the prototype is the inclusion of a self-powered motorized automated stage system that can move the blood smear and allows to automatically capture several snapshots of the sample, following the protocol defined in the gold standard recommended by World Health Organization (WHO).

To assess the level of scientific achievements associated with both Competence Centres we have participated in different contests organized by third party independent organizations throughout the year. The results attained reveal that in some specific areas we accomplished world class results that make us extremely proud! In the Microsoft Indoor Location Competition – IPSN 2015, which was hosted in Seattle, USA, we have participated in a competition in the category of solutions without external infrastructure with the Precise Indoor Location technology developed within the Fall Competence Center and we have achieved the 3rd position.

Just as a term of comparison, the solution that won this competition was based on a back pack used for military purposes that costs thousands of euros, while our solution was based on algorithms running in a single smartphone without any additional devices or infrastructure, which demonstrates the level of achievements that we have accomplished with 'off the shelf' devices.

In another competition, the #APPS4MAPUTO contest promoted by UX and the World Bank in Maputo, Mozambique, which aimed to select a mobile app for use on the project Participatory Urban Service Monitoring for Maputo Municipality (MOPA), the OurMoz project developed in the scope of the ICT4D Competence Center achieved the 1st place! Within this competition the challenge was to develop a mobile app aiming to enhance the events management and reporting processes carried out by the supervisors from the Management of Municipal Solid Waste and Health Division of the Municipality of Maputo, which use would allow a more efficient process of event identification, as well as the evaluation of solid waste collection services in the municipality.

Besides these two awards, one of the scientific publications associated with the Fall Competence Center was also distinguished. Joana Raquel Silva, received the award for 'Young Scientist Best Paper Award' at the international conference pHealth 2014, held in Vienna, Austria, with the study 'Human Activity Classification with Inertial Sensors'.

As it was initially envisaged, the results achieved within the Competence Centres were also of extreme importance in terms of the future developments for Fraunhofer Portugal. In this sense, a significant number of industry project proposals presented during 2015 were related to achievements accomplished within the Competence Centres, being the current expectation that part of these proposals generate additional Industry contracts during 2016. The Deus ex Machina proposal, which aims for the creation of two new Competence Centres and, was mentioned in the previous section, was also developed having as groundwork the results achieved in the Fall Competence Center and ICT4D Competence Center, which demonstrates the importance that these two projects had for the development of Fraunhofer AICOS.

Important to mention is that the DeM project proposal also serves a second purpose: being developed by a large part of our scientific team and in collaboration with scientific partner institutions from the domains that we consider key for the deployment of mobile and IoT technologies and also having reflected on its content with various business partners and institutions, the proposal can be considered truly as an update of our strategic research agenda for the next years! It is a high quality document that reflects our planned activities from a multitude of angles: next to the highly interesting techno-scientific ideas it contains also important aspects of the potential socio-economic impacts and potential new business models, ethics and future societal needs and demands.

Besides the awards associated with scientific results accomplished within the scope of the Competence Centres, during the second semester three of our projects were also distinguished with different awards. The ChefMyself project, which aims to develop a customizable, open and extensible cloud-based service ecosystem built around an automatic cooking solution to support elderly users in preparing meals and maintaining healthy eating habits, was one of the three finalists of the AAL Forum awards; GoLivePhone, the user-friendly smartphone that results from the work of scientists and developers of Fraunhofer AICOS and the Dutch company Gociety, has been awarded for 'Excellent Smart Health Innovation – Entrepreneurs with guts and spirit' by the Community of Regions for Assisted Living (Coral) during the AAL Forum; and finally, the ShopView project, an innovative solution designed to validate the implementation of store planograms that is being developed by Fraunhofer AICOS, WeDo Technologies and Modelo Continente, won the 'Sonae Companies Innovation Award 2015', among 37 participants. The 'Sonae Companies Innovation Awards' are given annually to the most innovative project and, every year, dozens of projects apply for it.

Within the ChefMyself project, a field trial was conducted with the final solution and during two months 18 participants tested the system in Italy and the Netherlands. The enthusiasm to participate in the ChefMyself field trials was great and following the cooking practice with the system developed in the project within older adults' home environment was a great experience. The improvement and raising of awareness regarding dietary habits of elderly people remains an important topic in Europe and the next step is to investigate how the results can be integrated in future developments in the field of nutrition and aging.

Another scientific activity that generated important results was the AAL4ALL project, which was promoted by the Health Cluster Portugal and involved some of the most important national stakeholders of the health sector. A workshop was organized during the first quarter of 2015 with the main partners and end users of the consortium to showcase the ecosystem of products and services in assisted environment - Ambient Assisted Living (AAL) – developed during the project and which were validated through large-scale pilots in Portugal.

An additional important scientific result achieved in the SMART-SKINS project, developed in cooperation with researchers from INEGI-LAETA and medical specialists from the Dermatology Department of the Portuguese Institute of Oncology of Porto, was the creation of a Mobile Risk Triage Framework prototype which automatically pre-processes, segments and extracts significant features for skin cancer pre-diagnosis and calculates an risk assessment from mobile-acquired skin images.

In terms of social networking and non-academic dissemination we have also developed important initiatives during 2015. Most of these activities are related to the network COLABORAR, which aims to bring humanness to technology. The network is being built since 2011, has interacted with over 1000 users, over 800 of whom having participated in research activities, and has helped conduct over 2000 usability tests, focus groups, demonstrations, questionnaires and interviews. Within the scope of this network, Fraunhofer Portugal and Santa Casa da Misericórdia de Lisboa (SCML) have established a partnership in order to promote older adults' well-being and quality of life through technology. Both institutions organized the Feira Tecnológica para Seniores (Technological Fair for Seniors), which took place in December 2015, at Mitra – Pólo de Inovação Social, Lisbon.

This event allowed over 100 seniors associated with SCML to learn about and test new technologies for everyday life. The systems developed by Fraunhofer AICOS and demonstrated during the Technological Fair covered the areas of communication support, medication management, cognitive stimulation, skin care, physical activity, nutrition and fall prevention.

With regards to European projects, we have strengthened our participation in the AAL Joint Programme with two new projects being approved for funding which have been mentioned in the previous section: Active@Home and CordonGris. In the latter, Fraunhofer AICOS assumes the role of coordinator of the consortium being the project an extension of ongoing scientific activities related to providing intelligent and healthy food and meal recommendations to older adults based on health characteristics, lifestyle, culture, resources, availability, local production and season.

The Fraunhofer Portugal Challenge completed its sixth edition, reinforcing our high profile position within the Portuguese Academic Institutions. In this edition we were able to attract the interest of post graduate students who responded to our challenge with outstanding scientific research work. Evidencing this statement are the numerous visits to the Challenge's website (circa 3.000) and the numerous applications submitted from 9 universities country-wide, encompassing several heterogeneous courses, but in line with the scientific activities of Fraunhofer AICOS. As an example, the 6 finalists came from courses as varied as Biomedical Engineering, Computer Engineering, Electrical Engineering and Information and Communication in Digital Platforms. In total we received 41 applications, 19 in the PhD category and 22 in the MSc category.

In terms of the number of Master theses hosted by Fraunhofer AICOS during 2015, we have reached a record level: 27 in total. Important to mention is that for the first time one of these theses was fully supported by Industry, as the results of the theses would be used for the benefit of the own company. In our opinion, this was also a quite interesting model of cooperation with Industry partners and opens the possibility to explore similar activities in future years. Actually, at the end of the Master Thesis development the client was highly satisfied and we have been discussing with him future projects based on the results achieved with the initiative.

Scientific Activities	
Papers	22
Master Theses	27
Book Chapters	1
Patents filings	1

In terms of the boards of Associação Fraunhofer Portugal Research, in the meeting of June 26th 2015, the General Assembly of Fraunhofer Portugal extended the term of Prof. Dr. Georg Rosenfeld, Eng. João Paulo Oliveira and Eng. Paulo Simões as Members of the Supervisory Board and elected additionally Prof. Dr. Manfred Hauswirth, of Fraunhofer FOKUS and the Technische Universität Berlin, and Dr. Steffen Schudt-Pialat, Volkswagen Autoeuropa Lda., as new members. Since the newly elected members of the Supervisory Board had already in advance accepted vis-à-vis Fraunhofer the vote in case of their election, their term of office started immediately.

The construction works related to the preparation of the Lisbon branch office were concluded at the end of the first semester, being currently the space completely operational. A workshop was organised there at the beginning of July with the purpose of showing the new facilities to all collaborators of Fraunhofer Portugal and to present the Master theses of the students from Lisbon. Five people work currently in the Lisbon facilities and the expectation for the next year is that the number of collaborators working in Lisbon will increase organically. As mentioned in previous reports, the Lisbon branch office works as an extension of Fraunhofer AICOS and therefore the collaborators that work in this branch office are integrated in existing projects and communicate on a daily basis with the remaining team that works in Porto.

Business Performance

– Business Volume circa 3,3M€.

– Slight increase in project revenues to 1,65M€.

– Performance levels sustainable after significant increase in 2012-2014.

In 2015, Fraunhofer AICOS consolidated its growth trajectory and maintained the performance of its activity. With the delay of PT2020 and the challenges encountered along the year, the planned expenses of the organization were slightly adjusted, which led to an organic growth of our team. By the end of the year, the total Business Volume was circa 3,3M€, representing a growth of 17% compared with the previous year, but slightly below the initial plan of 3,4M€. The main contribution for the increase in the total Business Volume was due to the CAPEX investment related to the creation of the Lisbon branch office.

The total project revenues surpassed 1,65M€ representing a total increase of 2% when compared with the previous year. National project revenues increased 46%, industry projects revenues decreased 32% and EU project revenues reduced 13%.

Total Business Volume (cash basis) 2012–2015 [€]
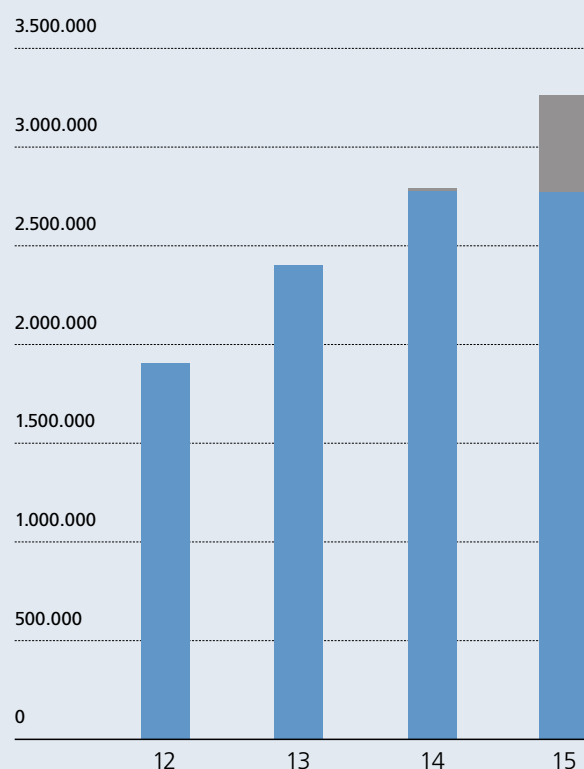
	2012	2013	2014	2015
⬛	-10.000 €	0.00 €	10.000 €	474.668 €
⬛	1.903.541 €	2.386.466 €	2.781.572 €	2.792.212 €

⬛ Major Infrastructure Capital Expenditure

⬛ Contract Research
(Total Expenses and Research Capital Expenditure)

40

As a result, and in combination with lower expenses, our organization was able to fulfil the global KPI that measures the volume of revenues over the total operational costs. With our total operational costs decreasing 2%, in combination with the slight increase of external revenues, we achieved a global performance (total external revenues / total operational costs) of 64%, complying with the demanding plan we had for 2015, and resulting in an increase of 2% when compared to 2014.

Once again, and contrasting with the evolution of the Portuguese economy in 2015, our achievements allowed us to maintain the growth and global performance level of Fraunhofer Portugal and, therefore, we once again consider this year to have been an important step in the success story of our operation.

– Staff costs on similar levels of the previous year.

– Non-staff costs consistent with activity growth.

– Increase in CAPEX related to investment for the creation of Lisbon branch office.

Personnel expenses for contract research increased 4%, and represented 79% of our total operational cost in the financial year of 2015. This is in line with the same levels of activity of last year, and have allowed us to be prepared to the start of PT2020 projects which have started only during last quarter of 2015.

Non-personnel costs decreased by 19%, as a result of the evolution of the operational activity.

Capital expenditure with R&D contract research rose by 29% when compared with 2014. This evolution is a direct consequence of Fraunhofer AICOS' current project investment profile.

Fraunhofer AICOS improved its revenues by 2% vs. 2014. Since 2011, our compound annual growth rate[4] is 29.42%, which are very good results considering the economic adjustment period experienced in Portugal since 2011.

4 *Compound Annual Growth Rate (CAGR) is a geometric average growth rate over a period of several years.*

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Our Industrial revenue decreased 32% vs. 2014. This is a result of delay in the start of PT2020 projects. In terms of geographical distribution, 50% is obtained from international clients. When compared with our Operational Revenues, Industry revenues now account for 27,4%.

Revenue from national projects increased 46% when compared to the last year. The projects were mainly driven by the Competence Centres, as the first instalment of payment corresponding an additional 7,5% of funding was received from FCT, and we were already able to start work on the new Competence Centres – see chapter 3.2.3 for more information on these new projects.

Revenue from EU-funded research projects maintained their share of 20% in our Operational Revenues. Since 2012, EU revenue has grown 44%.

Contract Research Revenue Evolution 2012–2015 [€]

|	2012	2013	2014	2015
Contract Research	761.998 €	1.310.220 €	1.626.224 €	1.651.855 €
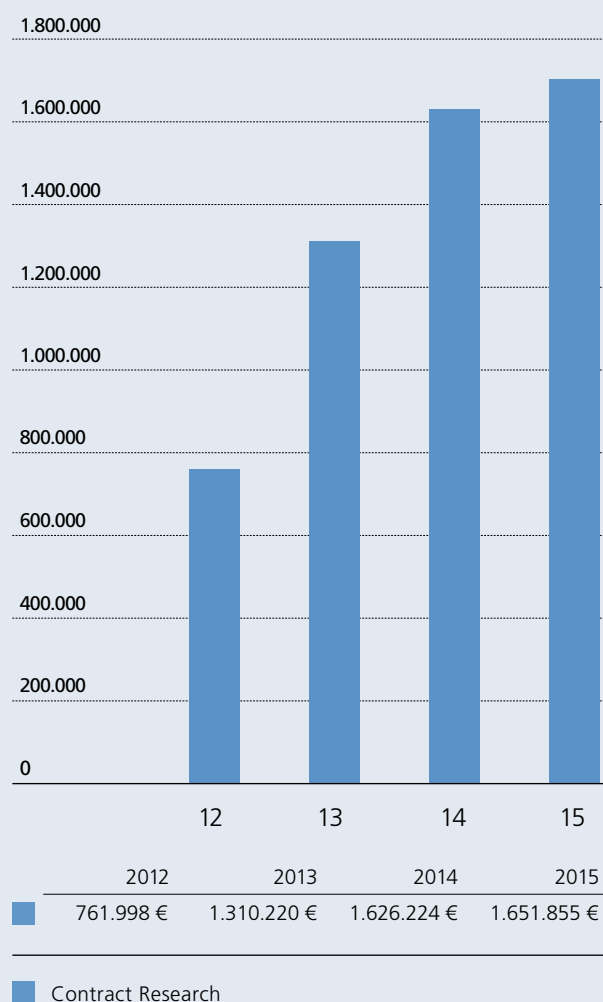
Employees

- Peak of 103 collaborators between April and June.

- Increase of 7 collaborators in the average headcount number (89 vs. 82 in 2014).

- The average of PhD increase in 13% (9 vs. 8 in 2014).

Fraunhofer Portugal's success and its Human Resources policy is based on the respect for human values, merit, pro-activity, observance of the law, and on knowing how to reach the goals we propose, in order to build a motivated team united towards innovation.

During 2015, in average, we were able to increase our team by 8%, closing the year with a total headcount of 74 collaborators, corresponding to ~56% Full Time Equivalent (FTE). It is noteworthy that we exceeded for the first time the number of 100 collaborators since the beginning of our activity, achieving a peak of 103 collaborators between April and June. This significant growth has been accomplished in a sustainable way, always guaranteeing optimum working conditions for the team, both in terms of office facilities and IT equipment.

Headcount Evolution 2012 – 2015

Year	Scientific, technical and administrative personnel
2012	63
2013	69
2014	82
2015	74
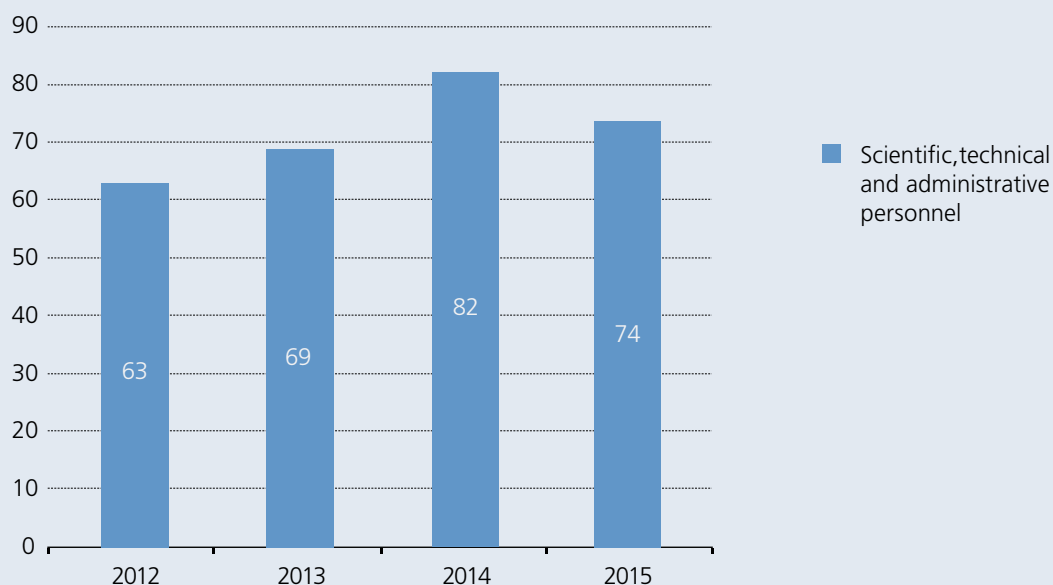
All in all we operate a young talented team, and we managed to maintain a significant gender distribution increasing our ratio of female collaborators at the end of the year (27% vs. 23% in 2014). Furthermore, we run a highly qualified team, as 95% of our staff members have a university degree, 72% are MSc and 11% have a PhD degree.

The headcount evolution changes throughout the year due to the profile of our activity and the collaboration with students. We have therefore registered a peak of 103 people during the second quarter of 2015, and the average number of people throughout the year was 89.

The positive evolution of Fraunhofer AICOS headcount registered in 2015 is a direct consequence of the rising number of research projects and contracts, evidencing that the Centre's reputation among its clients and partners is becoming more solid and indicating that year after year we are building an image of professionalism and quality as an R&D institution of excellence.

Also, during 2015, some collaborators left Fraunhofer Portugal, being the main reason behind this change new work contracts offered by the industry sector. This is a result of the training and technical skills acquired at Fraunhofer AICOS and, once again, proves that we are accomplishing our mission to increase the innovation pace of the Portuguese Economy by contributing to the qualification of highly skilled individuals that are of interest to industry.

Outlook and Strategic Development

As already indicated in the editorial section, the year of 2015 has been strongly influenced by the gap between the end of QREN financed projects and the opening of calls for the new PT2020 programme.

Therefore in 2015 we concentrated our internal research on topics that were strongly influenced by predicted short term demands from the side of industry and programmes that were known to get launched during the second half of the year. The idea was to prepare our team for likely upcoming projects in order to save time for the execution and to increase our revenues retroactively, as most of the programmes allow for accounting of expenses from the time of the submission of a proposal, independent from the date of contract signature.

Therefore we launched the following internal projects:

- Comm4Dev – Communications for development;

- EyeFundusScope – Mobile-based Risk Assessment of Diabetic Retinopathy by Image Processing with Near-Infrared;

- MalariaScopeV2 – Digital Analysis of Malaria Infected Blood Smears via Mobile Devices (Phase II);

–   nPandlets – Lite version devKit;

–   PILV2 – Precise Indoor Location (Phase II);

–   SmartMoves – Monitoring and Improving Physical and Cognitive Abilities;

–   SousChefV2 – Mobile application for older adult nutrition (Phase II).

Most of those internal activities are also related to our project proposal Deus ex Machina, which is structured into two lines, the EITCC (Eyes of the Internet of Things Competence Centre) and the C3 (Companion Competence Centre).

When thought of at a distance, many of today's societal challenges stem from waste, inadequate use of resources, lack of integrated solutions and effort replication. All of these are leading not only to citizens being unable to maintain their living standards, but most importantly, to what some academics call 'defuturing'.

Facing this challenge, societies demand 'more from less for more', seemingly unsolvable, but which appears to be the point in ancient Greek drama, when such an impenetrable problem is suddenly disentangled by a new element coming onto the play: the Deus ex Machina.

Societies are striving for these new elements towards efficiency gains mediated by a symbiotic relationship of humans with technology. We need elements such as these, which are able to deal with complex problems and, at the same time, be transparent to the users, as 'companions' who assist in difficult, unknown or just prosaic tasks.

We have devised a clear proposal to begin tackling these challenges. It consists of two research lines, being one built on top of the other. The first one will research and create building blocks – from tangible to intangible elements –, while the second will put these building blocks at the service of pressing societal needs in European and African countries, as described below.

EITCC – Eyes of the Internet of Things Competence Centre

This research line will concentrate on the aspects of understanding the environment, the user, his/her context and actions, and is serving as a technological base to all target domains in the other research line (C3). Four work packages build the EITCC:

– Sensing and acting – Bringing novel sensing mechanisms and actuation by accessing existing devices and developing new IoT sensing sources;

– Local information fusion – Research on data aggregation algorithms to create refined and contextual information obtained in multiple local sensing devices;

– Remote information fusion and big data analytics in the cloud – Implement information fusion from multiple distributed sensors, historical and contextual data to provide higher level abstraction data to C3;

– Networks for ICT4D – Development of solutions for ad-hoc broadband networks for remote locations in developing countries.

C3 – Companion Competence Centre

Using the tools emerging from EITCC, C3 will study relevant societal challenges within scientific domains in relation to humans in order to design 'companions', which are non-intrusive, assistive tools for everyday life in the domains below:

– Mind and behaviour – Researching human interaction with computers, with a particular focus on ethics, perception, cognition, communication and cultural aspects;

– Health – Researching solutions for patient empowerment, reducing burden in public health care and streamlining the road to full electronic health records;

– Activity Monitoring – This area is focused on understanding activities by detecting specific human movements, applied to the specific domains of safety, security and sports;

– Nutrition – Understanding what people eat, why they eat it, and how healthier and more sustainable behaviours could be encouraged towards gains in health and reduction of food waste;

– Agriculture – Main focus in this area will be in precision agriculture, considering applications in Europe and in Africa towards sustainability and efficiency gains;

– Community tools and social inclusion – Using crowdsourcing and data mining for citizen empowerment, disease prevention and well-being.
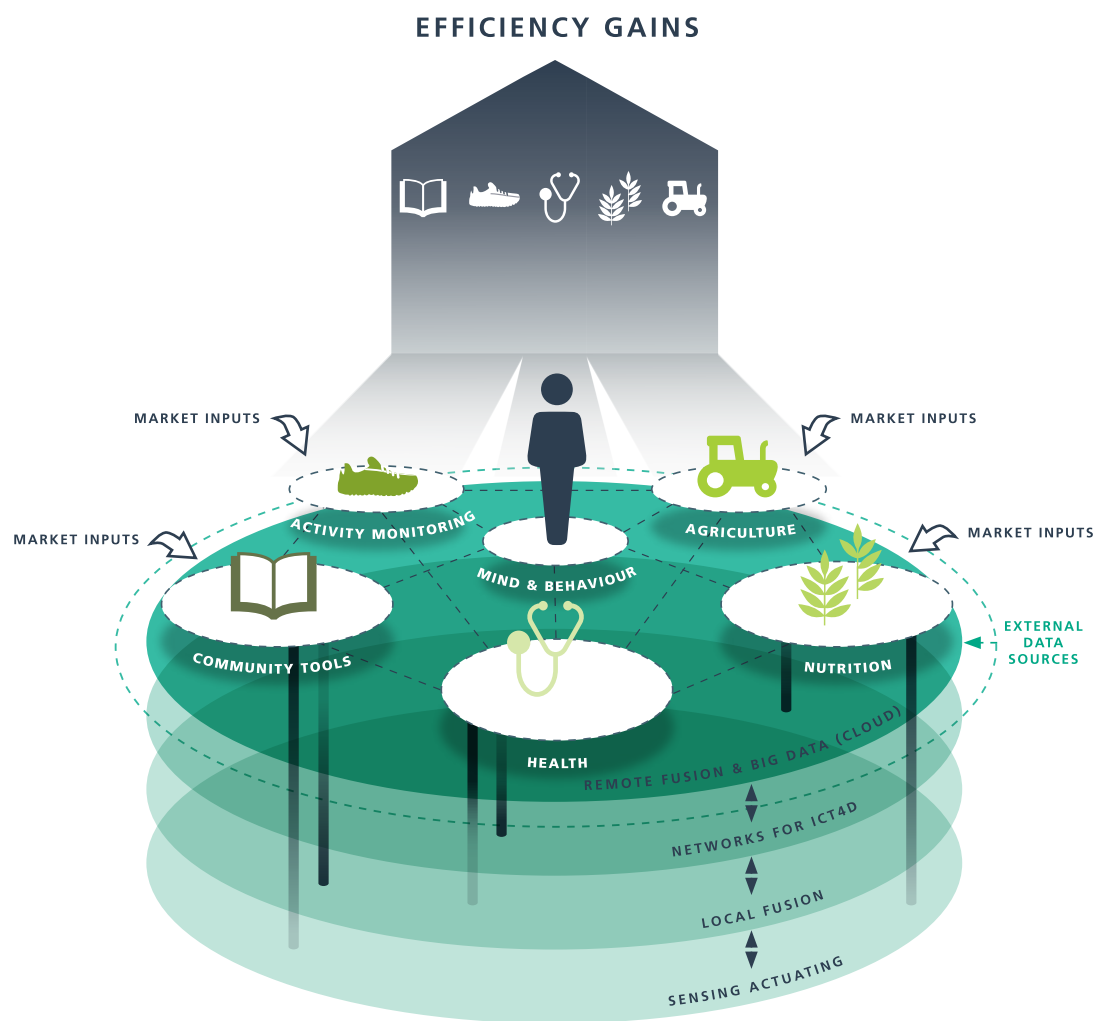
EFFICIENCY GAINS

MARKET INPUTS

MARKET INPUTS

MARKET INPUTS

MARKET INPUTS

ACTIVITY MONITORING

AGRICULTURE

MIND & BEHAVIOUR

COMMUNITY TOOLS

NUTRITION

EXTERNAL
DATA
SOURCES

HEALTH

REMOTE FUSION & BIG DATA (CLOUD)

NETWORKS FOR ICT4D

LOCAL FUSION

SENSING ACTUATING

Fig1. *Articulation between the EITCC and the C3.*

Both competence centres are, on the one hand, an evolution of the activities of the FCC (Fall Competence Center) and the ICT4DCC (ICT for Development Competence Center) and, on the other hand, our approach to team up with relevant excellent scientific institutions in order to develop in interdisciplinary teams world class solutions for the niches we address and to become industries' when looking for a partner to develop related innovations.

While the above activities are helping us to prepare our future, we currently strongly benefit from the internal R&D activities of the past in our latest and planned industry projects, most prominent the solutions that have been developed in the FCC and ICT4DCC. Examples of this are:

Within the FCC we have been developing a wireless ultra-low energy with miniature dimensions and the option of wireless charging. Originally planned to be a platform for a multi-sensor and multi-channel motion detection to enhance our fall and activity monitoring algorithms, the solution, coined 'Pandlets' (Personal area networks: letting everything sense) has been successfully adopted for sensing soil and irrigation parameters in farming (AE4HF and Visiolyptus), synchronization of cameras (ShopView), wearables to detect motion of elderly, work ergonomics and for sports (GoLiveWear, mGapFlushCS and SmartSurf).

The fall and activity monitoring algorithms and knowledge obtained in the FCC also serve as basis for the inertial sensor algorithms used in indoor positioning, which in turn led to various patent applications and interest from the retail and hospitality industry.

Within the ICT4DCC and based on the 'Pandlets' already mentioned above, we have been developing a platform to monitor the environment parameters of plants in hydroponic farms. This knowledge enabled us to submit projects related to the production of trees and tomatoes in Portugal and likely will lead to another proposal for the growth of trees in Mozambique.
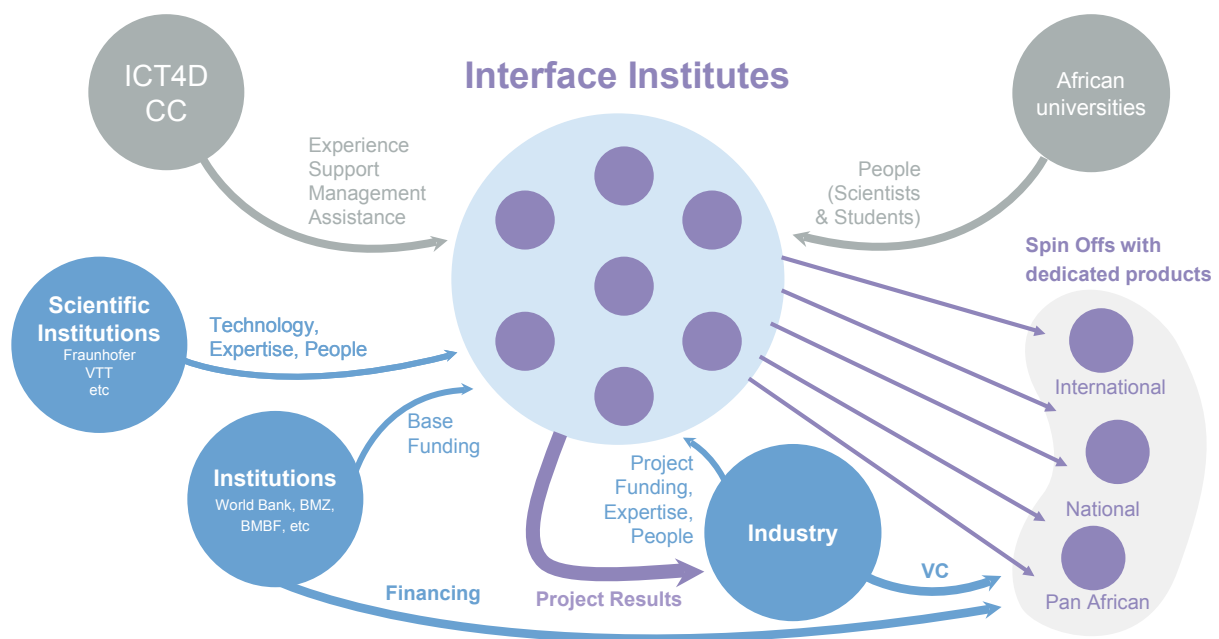

Fig2. *ICT4DCC supports Interface Institutes.*

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In the ICT4DCC we have been developing various applications and solutions, ranging from the integration of various network technologies (WiBACK, PostboxWeb and network management software (OpenEPC[5])) to meet local demands in developing countries for cost efficient and easy to operate broadband networks up to the creation of services and applications for health, social inclusion, education and eGovernment. Most important to mention are the developments that took place in Mozambique where two applications (IZIDoc and OurMoz) have been developed mainly by local students with the help of our team in Portugal and a senior scientist from CIUEM. The quality of the software, aside from being prepared for a future commercial deployment, is 'industry standard' and therefore is proving our interface institute concept that is underlying model of our collaboration with African partners and that could serve for many more projects in the future well beyond the scope of our own activities. One of the team student members individually already published recently an app (FindUEM) in the Google play store and received very positive ratings from the users. He claims that the knowledge he obtained in the project with us was a key element for enabling him to develop this app. Thus he became also a multiplier and will contribute to the economic development of his country.

Aside from this, the most important outcome of the ICT4DCC is the project 'Sustainable Villages for Development' (SV4D) that we are currently developing jointly with ARCTEL, the association of the regulators of Portuguese speaking countries (CPLP). The idea is to implement a minimum of one 'Sustainable Village' in all member states. 'Sustainable Villages' will be located in rural areas that currently have no or poor connectivity and the idea is to implement services and applications that meet local demands preferably with the help also of local teams, like we exercised in Mozambique. Due to the magnitude of the villages it is also planned to make services accessible in between the villages, so there will also be a significant likelihood that the villages profit from the solutions and experiences amongst each other. Last but not least we will provide the required networks and thus will gain a very significant experience with regards to optimize the network technology for providing this knowledge to industry in order to develop large scale solutions that meet the demands in the respective markets.

The above demonstrates well how the investment in the CCs for the last years paid off. Therefore we are now very pleased that we will receive again the opportunity to develop our skills and knowledge under the umbrella of the project 'DeM'. It should be noted that our past and new competence centres are co-financed by the CCDR-N/FCT programmes ON.2 – O Novo Norte and NORTE2020 and consider the project as one of the best investments that we have been involved so far in Portugal.

5 *OpenEPC – Open Evolved Packet Core (by Fraunhofer FOKUS).*

Perspetivas e Desenvolvimento Estratégico

Tal como mencionado no Editorial, o ano 2015 foi fortemente influenciado pelo hiato entre o fim dos programas de financiamento QREN e a abertura dos novos concursos para o programa PT2020.

Consequentemente, em 2015 concentrámos a nossa investigação interna em tópicos fortemente influenciados pelas previsões de curto prazo para as exigências do lado da indústria, bem como para programas de financiamento que sabíamos que iniciariam na segunda metade do ano. A ideia foi preparar a equipa para os projetos cujas propostas tinham mais probabilidade de sucesso, para assim reduzir o tempo de execução e aumentar as receitas de forma retroativa, uma vez que a maioria dos programas permite contabilizar despesas desde o momento da submissão da proposta, independentemente da data de assinatura do contrato.

Por esta razão, lançamos os seguintes projetos internos:

– Comm4Dev – Communications for development;

– EyeFundusScope – Mobile-based Risk Assessment of Diabetic Retinopathy by Image Processing with Near-Infrared;

– MalariaScopeV2 – Digital Analysis of Malaria Infected Blood Smears via Mobile Devices (Phase II);

– nPandlets – Lite version devKit;

– PILV2 – Precise Indoor Location (Phase II);

– SmartMoves – Monitoring and Improving Physical and Cognitive Abilities;

– SousChefV2 – Mobile application for older adult nutrition (Phase II).

A maioria destas atividades internas está também relacionada com a nossa proposta do projeto Deus ex Machina, que assenta em duas linhas de investigação: EITCC – Eyes of the Internet of Things Competence Centre e C3 – Companion Competence Centre (ver Fig1., página 47).

Quando analisados à distância, muitos dos desafios da sociedade de hoje estão relacionados com o desperdício, o uso inadequado dos recursos, a ausência de soluções integradas e a duplicação de esforços. Tudo isto está a levar a que os cidadãos não consigam manter os seus padrões de vida, mas também e mais importante, àquilo que alguns académico designam por *defuturing*[2].

Face a este desafio, as sociedades exigem "*more from less for more*", algo aparentemente irresolúvel, mas que se assemelha aos dramas representados nos antigos teatros gregos, onde um problema impenetrável é subitamente desembaraçado por um novo elemento que entra em cena: o Deus ex Machina.

As sociedades estão a desenvolver esforços para que estes novos elementos originem ganhos de eficiência, mediados por uma relação simbiótica entre humanos e tecnologia. Precisamos de elementos como estes, que sejam capazes de lidar com problemas complexos, mas que ao mesmo tempo sejam "transparentes" para os utilizadores, como que "companheiros" que os ajudam nas tarefas difíceis, desconhecidas ou meramente prosaicas.

Para começar a enfrentar estes desafios, elaborámos uma proposta formada por duas linhas de investigação, estando uma construída sobre a outra. A primeira irá investigar e criar blocos elementares – de elementos tangíveis a intangíveis – enquanto a segunda irá colocar estes blocos ao serviço das exigências sociais prementes na Europa e nos países Africanos, tal como descrito abaixo.

EITCC – Eyes of the Internet of Things Competence Centre

Esta linha de investigação irá focar-se nos aspetos de compreensão do ambiente, do utilizador, do seu contexto e ações, e servirá como base tecnológica para todos os domínios alvo da outra linha de investigação (C3). O EITCC é constituído por quatro blocos de tarefas:

– *Sensing and acting* – Identificar novos mecanismos de sensores e atuadores, através dos dispositivos já existentes aos quais se juntam novos desenvolvimentos fruto da *IoT*;

– *Local information fusion* – Investigação em algoritmos de agregação de dados para gerar informação contextualizada e refinada obtida de múltiplos dispositivos sensoriais;

– *Remote information fusion and big data analytics in the cloud* – Implementar técnicas de fusão de informação recolhida de múltiplos sensores, através de dados históricos e contextuais para fornecer ao C3 dados com elevado nível de abstração;

– *Networks for ICT4D* – desenvolver soluções de redes de internet de banda larga *ad-hoc* para zonas remotas de países em desenvolvimento.

C3 – Companion Competence Centre

Utilizando as ferramentas resultantes do EITCC, o C3 irá estudar os desafios sociais relevantes dentro do domínio científico no que diz respeito aos humanos, com o intuito de desenhar "companheiros" que se configuram como ferramentas não-intrusivas e que auxiliam a vida quotidiana nos domínios abaixo descritos:

– *Mente e comportamento* – Investigar a interação humana com computadores, com foco particular nos aspetos éticos, percecionais, cognitivos, comunicacionais e culturais;

– *Saúde* – Investigar soluções para capacitação dos pacientes, redução dos custos para o sistema público de saúde e otimizar os registos de saúde eletrónicos;

– *Monitorização de atividade física* – Esta área foca-se em compreender as atividades físicas através da deteção de movimentos humanos específicos, aplicados a domínios específicos nas áreas da segurança e do desporto;

– *Nutrição* – Compreender aquilo que as pessoas comem, e de que forma comportamentos mais saudáveis e sustentados possam levar a ganhos na saúde e a reduzir o desperdício alimentar;

---

2 *Defuturing – atividades, processos e produtos que reduzem, em vez de melhorar, a possibilidade de um futuro que pode ser sustentado.*

– *Agricultura* – O foco principal desta área será a agricultura de precisão, considerando a sua aplicação na Europa e em África, rumo a um desenvolvimento sustentável e com ganhos de eficiência;

– *Ferramentas comunitárias e inclusão social* – Utilizando *crowdsourcing* e *data mining* para a capacitação dos cidadãos, prevenção de doenças e aumento do bem-estar.

Ambos os centros de competência são, por um lado, uma evolução das atividades do FCC – Fall Competence Center e do ICT4DCC – ICT for Development Competence Center, e por outro lado, a nossa abordagem para nos aliarmos a instituições científicas relevantes e de excelência, com o intuito de, com base em equipas interdisciplinares, desenvolver soluções reconhecidas a nível mundial para os nichos de mercado aos quais nos dirigimos, reforçando assim o nosso posicionamento no sentido de sermos uma referência para a indústria que procura parceiros para a criação de soluções inovadoras nas áreas em questão.

Enquanto as atividades acima nos ajudam a preparar o futuro, presentemente estamos a beneficiar, em grande parte, dos resultados das atividade internas de I&D – Investigação e Desenvolvimento realizadas no passado, que serão incorporados nos projetos de indústria mais recentes mas também nos planeados, com especial destaque para os resultados alcançados no FCC e no ICT4DCC. Exemplos disto são:

Dentro do FCC temos vindo a desenvolver uma solução *wireless ultra-low energy* de reduzidas dimensões e com opção de carregamento sem fios. Originalmente planeada para ser uma plataforma multisensor e multicanal para deteção de movimento, por forma a potenciar os nossos algoritmos de monitorização de atividade e de quedas, esta solução designada por Pandlets – Personal area networks: letting everything sense foi adotada com sucesso em projetos de controlo e análise de parâmetros do solo e de irrigação na agricultura (AE4HF e Visiolyptus), projetos de sincronização de câmaras fotográficas (ShopView), projetos de wearables para deteção de movimento em seniores, ergonomia no posto de trabalho, e para atividades desportivas (GoLiveWear, mGapFlushCS e SmartSurf).

O conhecimento e os algoritmos de monitorização de atividade e de quedas produzidos pelo FCC servem também como base para os algoritmos dos sensores inerciais utilizados na nossa tecnologia localização indoor, que por sua vez levou à submissão de vários pedidos de patente e ao interesse por parte do sector do retalho e da indústria hospitalar.

Dento do ICT4DCC e com base nos Pandlets mencionados acima, temos vindo a desenvolver uma plataforma para monitorização dos parâmetros ambientais das plantas em quintas hidropónicas. Este conhecimento permitiu-nos submeter propostas relacionadas com a produção de árvores e de tomates em Portugal e muito provavelmente irá contribuir também para a submissão de uma outra proposta para o crescimento de árvores em Moçambique.

No âmbito do ICT4DCC temos vindo a desenvolver diversas aplicações e soluções, desde a integração de variadas tecnologias de rede (WiBack, PostboxWeb e software de gestão de redes (OpenEPC[3])) como resposta às exigências locais dos países em desenvolvimento para a otimização e simplificação da utilização de internet de banda larga, até à criação de serviços e aplicações para as áreas da saúde, inclusão social, educação e governação eletrónica. Importa aqui mencionar os acontecimentos ocorridos em Moçambique onde duas aplicações (IZIDoc e OurMoz) foram desenvolvidas por estudantes locais com a ajuda da nossa equipa em Portugal e um cientista sénior do CIUEM – Centro de Informática Universidade Eduardo Mondlane. A qualidade do software, à parte de ter sido preparado para um futuro lançamento comercial, obedece aos standards da indústria, o que comprova que o nosso conceito de instituto interface subjacente ao modelo da nossa cooperação com parceiros africanos poderá servir para suportar muito mais projetos no futuro, inclusive projetos muito para além do foco das nossas próprias atividades (ver Fig2., página 48). Um dos estudantes pertencentes a uma das equipas publicou recentemente, de forma individual, uma app na Google Play Store, tendo recebido dos utilizadores uma pontuação muito positiva. O estudante refere que o conhecimento que adquiriu no decorrer do projeto desenvolvido com o Fraunhofer AICOS foi um fator chave que lhe possibilitou o desenvolvimento da app. Como tal, ele tornou-se num fator multiplicador e irá contribuir para o desenvolvimento económico do país.

Para além destes, o resultado mais proeminente do ICT4DCC é o projeto SV4D – Sustainable Villages for Development que estamos presente a desenvolver em conjunto com a ARCTEL – Associação de Reguladores de Comunicações e Telecomunicações da Comunidade dos Países de Língua Portuguesa. A ideia é implementar um mínimo de uma "aldeia sustentável" em todos os estados membros da CPLP. Estas aldeias estarão localizadas em zonas rurais onde atualmente as ligações à internet são fracas ou inexistentes, sendo que o objetivo passa por implementar serviços e aplicações que respondam às exigências locais, de preferência com o suporte de equipas locais, tal como fizemos em Moçambique. Devido à magnitude das aldeias, está também previsto disponibilizar estes serviços entres aldeias vizinhas, para que beneficiem amplamente da troca de soluções e experiências entre si. Por último, mas não menos importante, uma vez que vamos ser nós a fornecer estas redes, iremos adquirir experiência significativa em otimização de tecnologias de redes, que podemos posteriormente disponibilizar à indústria, suportando o desenvolvimento de uma solução em grande escala que vá ao encontro da procura existente nos respetivos mercados.

O acima descrito demonstra bem como o investimento nos Centros de Competências feito em anos anteriores está a compensar. Como tal, estamos muitos satisfeitos com o facto de termos novamente a oportunidade para desenvolver as nossas competências e conhecimento ao abrigo do projeto DeM. Importa realçar que os anteriores e os novos Centros de Competências são cofinanciados pelos programas ON.2 – O Novo Norte e NORTE2020 da CCDR-N/FCT, sendo que consideramos este projeto como um dos melhores investimentos nos quais estivemos envolvidos até hoje em Portugal.

3 *OpenEPC – Open Evolved Packet Core (by Fraunhofer FOKUS).*

REVIEW OF FRAUNHOFER PORTUGAL RESEARCH

STRATEGIC RESEARCH AGENDA

PROJECTS AND RESULTS 2015

STRATEGIC RESEARCH AGENDA

AS FRAUNHOFER PORTUGAL CURRENTLY ONLY OPERATES ONE RESEARCH CENTER (FRAUNHOFER AICOS), ITS STRATEGIC RESEARCH AGENDA IS DICTATED BY FRAUNHOFER AICOS' INTERESTS AND ACTIVITIES.

Business Fields

Fraunhofer AICOS addresses two main business fields: Ambient Assisted Living (AAL) and the emerging field of Information and Communication Technologies for Development (ICT4D).

Ambient Assisted Living

Ambient Assisted Living (AAL) includes methods, concepts, (electronic) systems, devices and services that are providing unobtrusive support for daily life, based on the context and the situation of the assisted person. The technologies applied for AAL are user-centric, i.e. oriented towards the needs and capabilities of the actual user. They are also integrated into the immediate personal environment of the user. As a consequence, the technology is adapting to the user rather than the other way around. In order to share relevant information between systems and services, technologies for AAL should ideally be based on modular and interoperable concepts.

A main driver for the development of AAL technologies is the increasing number of ageing population and the inversion of the demographic pyramid that is occurring in developed countries. AAL technologies can be instrumental in tackling the massively increasing cost of healthcare and social security. Another driver is the rising number of single person households together with rising expectations towards the quality of life. AAL technologies also cater towards the increasing demand of safe and comfortable living environments, as well as the increasing demand for communication and stronger social interaction with others.

Fraunhofer AICOS intends to mainly address the needs of the ageing population, not only to reduce innovation barriers of forthcoming promising markets, but also to lower future social security costs. This can be achieved through the use of intelligent products and the provision of remote services, including care services that allow the time senior citizens can live in their home environment to be extended, while guaranteeing adequate comfort, safety and quality of life. These services will increase their autonomy and assist them in carrying out day-to-day activities.

The research and development of Ambient Assisted Living solutions by Fraunhofer AICOS aims at a primary target user group – the Ageing and Elderly – with the purpose of:

- Extending the time people are able to live in their preferred environment by increasing their autonomy, self-confidence and mobility;

- Maintaining health and functional capability of elderly individuals;

- Promoting a better and healthier lifestyle for individuals at risk;

- Enhancing security and safety, to prevent social isolation and to help maintain the multifunctional network around the individual;

– Supporting caretakers, families and care giving organizations;

– Increasing the efficiency and productivity of resources used in ageing societies.

Information and Communication Technologies for Development

Information and Communication Technologies for Development (ICT4D) is a general term used to refer to the application of Information and Communication Technologies (ICT) within the field of socioeconomic development or international development. ICT4D focuses on directly applying information technology approaches to reduce the digital divide and therefore contribute to poverty reduction in developing countries.

Fraunhofer AICOS intends to focus its ICT4D activities on the African continent, specifically on Mozambique and Angola. The primary target user group will be ICT users in rural and developing areas, and the objective is to provide solutions for mobile device services and applications matching the local users' demands and contributing to a more positive user experience which, in many cases, may be their first contact with ICT.

One of the most dominant differences between ICT usage in industrial and developing countries is the type of devices and technologies used when interacting with ICT. In industrial countries, interaction with ICT is made primarily via PCs, while in developing countries the mobile phone has taken over the role of primary device of access and interaction with ICT.

Mobile devices, like smart(er)-phones and Mobile Internet Devices will continue to play a dominant role in developing countries in terms of growing widespread usage. In developed countries, the same tendency occurs, although the current use of PCs potentially slows down this trend when compared to developing countries.

Business Sub-Fields

Due to the large amount of topics related to both fields, and our comparably small R&D team, we have chosen to focus on fewer subfields that our customers consider relevant and which, over the first period of operation, we were capable of creating, taking into account our core competences which clearly differentiate us from our competitors.

In the AAL business field we currently cover the following subfields:

Fall and Activity Monitoring

For frail and elderly individuals, falling can have serious consequences including injury, psychological damage, limitations on mobility and reduced quality of life. Technology addresses this issue following two different perspectives: providing a better emergency response after a fall has occurred and allowing for detection and prevention of falls, through continuous monitoring of senior adult activity. Despite the market potential, current technological solutions are cumbersome and are not inclusive, focusing only on formal caregivers, they present cost obstacles and are, in general, hard to handle and maintain. Fraunhofer AICOS' approach to fall prevention, detection and activity monitoring focuses on the development of solutions for smartphones which have several clear advantages: cost effectiveness, user friendliness and inherently manageable.

Chronic Diseases and Well-Being Management

Along with an ageing population comes the higher incidence of different chronic diseases. In high-income countries, chronic diseases are the greatest cause of early death and disability and also a major source of costs for social security systems. Fraunhofer AICOS partners with relevant entities (companies, health care providers, public entities, etc.) in an attempt to help society improve the services for chronic disease management, by creating valid prototypes and contributing to the standardization effort through several different existing solutions, or solutions which are yet to come.

Assistive Environments

As the world's population is ageing, there is a growing need to support independent living conditions for elderly individuals. Assistive environments incorporate the latest pervasive and ubiquitous technologies and provide a viable alternative to traditional assistive living solutions. One of the aims is to enhance the user comfort. Comfort can be an essential or fundamental benefit for people with disabilities or elderly individuals. Environments equipped with these solutions are able to compensate some disabilities of the senior users by simplifying daily routines and reducing the elderly individual's dependency on other people by taking advantage of the functionality of the environment by themselves, reinforcing their independence and personal freedom and allowing them to remain in their usual surroundings for longer time. Fraunhofer AICOS' approach is to simulate assistive environments as closely as possible by taking advantage of its Living Lab and to create applications that enable the consolidation of this vision.

With regard to the emerging ICT4D business field, one subfield has currently been defined:

ICT4D on Mobile Devices

The above mentioned subfield consists of mobile ICT solutions jointly developed with African partners for user groups in rural and developing areas in order to enhance the living standards of those groups. In the beginning, the solutions will target four application areas which were identified as the most market relevant in the next years: agricultural production chains (mAgriculture), micro-enterprises (ICT for Very Small Enterprises), mobile health (mHealth) and mobile Government (mGovernment).

Core Competences

Fraunhofer AICOS' core competences are strongly related to the demands of our customers in the above described business fields. Some competences have been specifically created based on the request of a specific customer, but the vast majority is related to our prediction of a future demand from the side of our customers. In order to gain competences, we are using internal projects that will ideally lead to existing results and competences when a customer requires them. In this case, we can successfully transfer an internal project into an external industry project. In other cases, we are able to convince customers with results from internal projects that do not yet completely match the requirements of our competence to achieve the desired result on time and with high quality. Thus, the selection process for internal projects is very important, as any competence that we create and which is not used afterwards within a reasonable time needs to be considered as holding academic value only and as an investment without return.

To date, Fraunhofer AICOS has developed the following core competences:

Human-Computer Interaction (HCI)

At Fraunhofer AICOS, designing products and services that are adapted to our specific target audiences and which meet their needs is a main goal to be addressed. The HCI team is responsible for performing user research, designing solutions according to its results and iterating them through evaluations with both experts and final users. As such, the group is expected to ensure the significance and usability of any solution developed at the institute. The research performed within the HCI core competence is focused on the following subfields:

- User & Social Experience, associated with research on users' characteristics as well as their environments and context. It provides the knowledge required to create meaningful solutions that meet users' demands;

- Mobile & Future Devices, a research field that includes the discovery of new technologies with the goal of enhancing users' interaction with current and novel systems;

- Evaluation & Usability, focuses on evaluating the extent to which developed solutions fit users' expectations. It includes systematic evaluation tests with both HCI professionals and end-users.

Information Processing (IP)

This core competence has originated from the demands imposed by our business fields and provides us with the capability to generate algorithms to solve the problems that arise in our projects. Advances in information and communication technology have triggered an exponential growth in the amount of data available. IP scientific area is related to the methods developed to cope with these vast amounts of information ranging from simple sensor events, over natural language to complex multimedia content. The IP core competence has been divided, according to our main activities, into three main subfields:

– Content Retrieval, a research field concerned with the search of information within multiple contexts. It is mainly related to the development of algorithms to extract and process the data retrieved from the different sources available;

– Context Awareness, focuses on the development of ubiquitous solutions that use unconventional sensor data and combine it with environmental context information, such as the users' location or even meteorological and other geographical information;

– Multimodal Information Fusion, concerned with the combination of the information retrieved by different sources. It is mainly applied in Fraunhofer AICOS to fuse the information retrieved by different sensors in order to replace external sensors by software for smartphones.

Autonomic Computing (AC)

Fraunhofer AICOS aims to create solutions adapted to people's needs and competences. However, the variety of communication technologies, Operating Systems and networked devices creates complexity in the daily life of non-technical people. The AC core competence addresses the aforementioned complexity by proposing solutions capable of adapting to time changing conditions while hiding the intrinsic complexity from the non-technical people. Moreover, due to the specific requirements of Fraunhofer AICOS business fields, there was the need to focus on one specific AC subfield:

– Remote Management, Control and Configuration, a research field consisting of reusing and extending remote management protocols and service discovery standards as well as implementing modular and adaptive software architectures. It is mainly applied at Fraunhofer AICOS to cope with the lack of interoperability between devices and applications and the reduced remote management capabilities in AAL and ICT4D.

As a consequence of the work we carried out in the business subfield 'Fall and Activity Monitoring' related to the very interesting achievements regarding the related competences in 'Multimodal Information Fusion', we decided to increase our activities in order to prepare for the predicted market demand through the creation of a Fall Competence Center (FCC). The FCC concentrates our efforts and extends the scope to go beyond the current focus on fall detection and fall risk prediction to the two additional application fields of falls in extreme sports and incident detection for security and safety personnel. Likewise, we extended our activities in the emerging business field ICT4D through the creation of the ICT4D Competence Center (ICT4DCC), which concentrates all the competences required to develop and assess solutions for mobile devices in the application fields of mAgriculture, mHealth, mGovernment and ICT for Very Small Enterprises (business solutions for the growing micro-enterprises in developing countries). It also allows us to form an international team with guests from Africa and Europe that have the potential to create a joint melting pot for the related activities of Fraunhofer in Germany.

PROJECTS AND RESULTS 2015

EXTERNAL PROJECTS

In accordance with the Fraunhofer Business Model, two thirds of Fraunhofer Portugal's income should be generated by external projects which can have one of two formats: Industry Contract Research, i.e. projects having industry partners as clients, or Government Contract Research, i.e. projects resulting from the participation in national and EU publicly funded programmes. This section describes the external projects that are being developed at Fraunhofer AICOS.

AAL4ALL – Primary care standard for AAL services

Description: The goal of the AAL4ALL project was the mobilization of an industrial ecosystem of products and services within the scope of AAL (Ambient Assisted Living), focused on the definition of specific standards. Only by assuring interoperability between products and services is the mitigation of investment risk possible in this emerging area, thus creating a better offer of products and services.

Partners: Microsoft Portugal MLDC (coordinator); Associação CCG/ZGDV - Centro de Computação Gráfica; Be Artis - Concepção, Construção e Gestão de Redes de Comunicações; Casa de Saúde de Guimarães; CASO - Consultores Associados de Organizações e Informática; CeNTITVC - Centro de Nanotecnologia e Materiais Técnicos, Funcionais e Inteligentes; CITEVE - Centro Tecnológico das Indústrias Têxteis e do Vestuário de Portugal; Conforto em Casa; Critical Health; Escola Superior de Educação de Paula Frassinetti; Exatronic - Engenharia e Electrónica; FCTUNL - Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa; FEUP - Faculdade de Engenharia da Universidade do Porto;

Glintt - Healthcare Solutions; HCP - Health Cluster Portugal - Polo de Competitividade da Saúde; INOV - INESC Inovação - Instituto de Novas Tecnologias; Inovamais - Serviços de Consultadoria em Inovação Tecnológica; IPN - Instituto Pedro Nunes - Associação Para a Inovação e Desenvolvimento em Ciência e Tecnologia; ISA Intellicare - Intelligent Sensing in Healthcare; ISCTE - Instituto Superior de Ciências do Trabalho e da Empresa; ISEP - Instituto Superior de Engenharia do Porto; Optimus Comunicações; Plux - Engenharia de Biosensores; ProcessNet - Sistemas de Informação; PT Inovação; PT Prime - Soluções Empresariais de Telecomunicações e Sistemas; UBI - Universidade da Beira Interior; Universidade de Aveiro; Universidade do Minho.

Outcome: Definition of reference models for different environments that reduce the investment risk and time-to-market of the products and services and establish solid partnerships with the national industry.

ACP Street Libraries – Culture for all [1]

Description: The main objective of the ACP Street Library project is to contribute to the development of culture in ACP (African, Caribbean and Pacific Group of States) countries mainly by promoting the creation of new Street Libraries and the modernization of existing ones. The partners involved in the project also plan to develop a set of activities related to the ACP Cultural sector promotion and consolidation mainly by encouraging the preservation of local cultures that are currently only transmitted in oral format.

There are four specific objectives associated to the project implementation, namely:

–   Increase the number of ACP Street Libraries;

1

– Increase the number of books available for oral reading in ACP Street Libraries;

– Improve existing databases of ACP countries local culture;

– Improve ACP countries discussion and cooperation platforms.

The key stakeholders of the project will be actual and future cultural entrepreneur's, who will benefit from project or to promote and disseminate their artistic work; NGOs (Non-Governmental Organizations) and private and public institutions, who will benefit from the project by building the necessary capacity to create new Street Libraries and cultural projects; universities and research centres, who will benefit from the new project results by promoting technology transfer to the local students, local partners and international ACP members; and finally, the local population, children and young people of ACP countries, who will have access to more cultural resources and who will be able to preserve their local legends and histories for the future generations. All the actions developed in the project will comply with user centred design methodologies, being the end-users always directly involved in all the project activities.

Partners: Fraunhofer AICOS (coordinator); ASRAD - Appui Solidaire Pour Le Renforcement De L'aide Au Developpement; Microsoft Portugal MLDC; VPWA - Volunteer Partnerships for West Africa; YCWL - Youth Crime Watch of Liberia.

Outcome: This project aims at the creation of a set of actions, services and features supported on mobile technologies, that will allow actual and future cultural entrepreneurs, NGOs and private and public institutions, to leverage Street Libraries in

ACP Countries, developing this cultural action at regional, national and international levels as well as maximize its impact on local populations, especially in children and young people.

ChefMyself – Assistance solution for improving cooking skills and nutritional knowledge for independent elderly people

Description: The main goal of the ChefMyself project is to develop a customizable, open and extensible ICT (Information and Communications Technologies) service ecosystem built around an automatic cooking solution to support elderly people in the preparation of meals and maintenance of healthy eating habits. A food processor with an accessible interface, specially tailored for older adults, encourages elders' self-care, according to their particular nutrition requirements. Simultaneously, a social network, focused on the topic of healthy ageing and eating, becomes a motivational tool for this user group to remain active, while encouraging existing social relationships and fostering new ones. The target group is composed of independent senior individuals with no severe illnesses or disabilities, not excluding those with some form of mobility or mild cognitive impairment.

Partners: CETEMMSA - Fundació Privada Cetemmsa (coordinator); ASM Market Research and Analysis Centre; Istituto Nazionale di Riposo e Cura per Anziani; Me.Te.Da.; Polne SL (Taurus Group); Unie KBO.

Outcome: The ChefMyself system can be divided into three main components – Cloud Services, User Interface and Food Processor – each interacting with the others over a set of secure, open and standardized interfaces. The proposed system follows the cloud computing paradigm, ensuring security, scalability and reliability.

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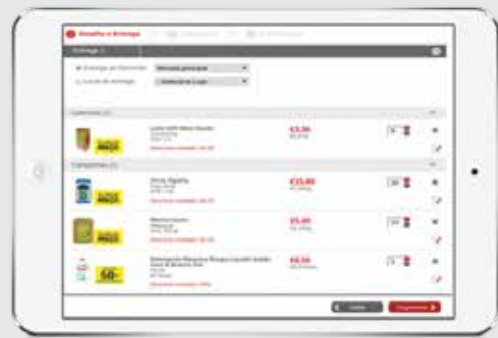
2

Clockwork – Smart System for the Management and Control of Shift Workers' Circadian Rhythms

Description: The main goal of the Clockwork project is to create a healthy and comfortable work environment by supporting middle-aged to older adults in the improvement of their circadian rhythms. Particularly, the solution will target shift workers, such as healthcare professionals, who are greatly affected by chronodisruption, which can thus lead to health issues, long absences or early retirement.

This objective will be achieved through the enhancement of external synchronizers that will help older adult workers maintain a healthy and robust day and night rhythm by introducing some imperceptible modification in their environment.

To do this, three main tools will be used: an activity monitoring device, a feedback and support application framework and an innovative environmental circadian empowering system module, which includes the design of a lighting device, a wireless sensor network and actuators to regulate the environment. The feedback and support application framework is not only the platform that communicates with the user, but it is also responsible for managing the information gathered by the sensors and controlling the different devices to adjust the environmental conditions to the person's needs.

Partners: Fraunhofer AICOS (coordinator); Ab.Acus; BCB Informática y Control; Grado Zero Espace; KOHS PIMEX; PT Comunicações; RK Tech; Università degli Studi di Ferrara.

Outcome: User activity monitoring and smart home environment to control users' circadian rhythm.

ContinenteRecommender – Mobile and web recommender system for shopping 2

Description: Given the number of available products at supermarkets, the constant appearance of new products and the unavailability of the clients (concerning both time and attention), it would be useful to have personalized recommendations to clients. This would, on the one hand, show to the clients products they otherwise may not be aware of and, on the other hand, would increase the sales of the supermarket. The large amount of information that a supermarket has about its products, clients and their shopping history can provide an important insight of its customers' preferences. Another important aspect is the availability of different categories of products within a supermarket which can satisfy different needs of clients in a single visit.

The objective of this project is to create a system that analyses the information available at supermarkets about its products, clients and their shopping history using data mining and machine learning techniques in order to automatically create personalized recommendations to clients. The idea is to explore the data using different angles and constraints to find the products which are more likely to draw the customers' attention. Some examples include, for instance, using temporal constraints to find products that people often buy in a given season, like Christmas, season fruit, etc.; analysing the shopping history to find products which are frequently bought together (Market Basket Analysis); analysing the price of the products bought by a customer to understand the usual price range of products, etc.

Partner: Sonae Modelo Continente (coordinator).

Outcome: Develop a system capable of analysing information of users, products and shopping history of a supermarket using data mining and machine learning techniques in order to create personalized recommendations of products to the clients of Sonae Modelo Continente.

EnAware – Domestic Energy Awareness 3

Description: The rising costs of energy and the increasing consumer awareness with regards to their ecological footprint, poses new challenges to industry. Especially in a domestic context, consumers demand energy efficient products and solutions that can be seamlessly integrated and which are easy to use. Moreover, the slow, but steady, introduction of the Smart Grid requires more intelligent domestic devices to enable Demand Side Management / Demand Response scenarios. The EnAware project addresses these challenges by developing an ecosystem of smart devices that are orchestrated by a home server. By allying the capabilities of the Advanced Metering Infrastructure (AMI) with Home Automation and domestic Intelligent Electronic Devices (IEDs), this project aims to innovate the way in which residential consumption data is presented and analysed in order to improve user comfort and, at the same time, motivate sustainable changes of behaviour.

Partners: EFACEC Engenharia e Sistemas (coordinator); Bosch Termotecnologia; EFAPEL - Empresa Fabril de Produtos Eléctricos.

Outcome: The EnAware system is composed of four main components: A household smartmeter provided by EFACEC, Zigbee-enabled smart-plugs and panels provided by EFAPEL, a Zigbee-enabled heat pump provided by Bosch, and the HomeServer developed and provided by Fraunhofer AICOS.

The HomeServer is fully modular, being the main service developed using the OSGi (Open Service Gateway initiative) specification, and is able to interact with all the equipment, collect and report consumptions, define and execute schedules, create and execute scenes, define goals, etc. The HomeServer is also able to run pluggable data analysis engines that provide data aggregation for faster query response times, consumer behaviour analysis, energy efficiency rating, etc., and provides a comprehensive and intuitive web portal that raises energy consumption awareness.

E-NO FALLS – European Network for Fall Prevention, Intervention and Security

Description: The main goal of the E-NO FALLS Thematic Network is to integrate and bring together knowledge, experiences and best practices acquired at the European and international level in the area of fall prevention, intervention and safety. E-NO Falls network aims at coordinating on-going activities and creating the necessary conditions and consensus on action plans, standards and specifications to ensure the widest future replication and co-deployment of innovative solutions (with special emphasis on Information and Communications Technology – ICT based ones).

Partners: Universitat Politècnica de Catalunya (coordinator); Ana Aslan International Foundation; Charite - Universitaetsmedizin Berlin; COOSS Marche ONLUS; Emergency Response; Fondazione Santa Lucia; FORTH-ICS; CETEMMSA - Fundació Privada Cetemmsa; Fundació TicSalut; MCRoberts BV; National University Ireland Galway (NUIG); Nordforce Technology AB; SeniorNett Norge; Siveco; Stichting Nederlands Normalisatie Instituut; Stichting Smart Homes, Nationaal Kenniscentrum voor Domotica & Slim Wonen; University of Limerick.

Outcome: The E-NO FALLS thematic network is a forum for all stakeholders within the value chain (such as industry, user organizations, formal and informal care providers, public authorities, investors, housing and insurance companies and service providers across Europe) to share knowledge, expertise, resources, best practice experiences and to build consensus to highlight the remaining obstacles to be overcome and to eventually provide guidance for ICT-enabled solutions and their roll-out.

Epidemiologic Surveillance Platform 4

Description: The Epidemiologic Surveillance Platform project led by the Portuguese company Critical Software aimed to collect structured clinical data on isolated populations in developing countries, using mobile devices on low coverage networks, and relate it with geo-location and earth observation data. Through the analysis of correlated data and applying methods of business intelligence, the solution allows detecting, monitoring, predicting outbreaks or epidemics, and acting to minimise the consequences of infectious diseases such as Malaria and HIV/AIDS.

Fraunhofer AICOS collaborated in this project by providing its PostboxWeb framework to collect data in locations where there is no network coverage and transmit them whenever network is available. Fraunhofer AICOS provided the technical and scientific knowledge in its areas of expertise, namely: information and communication technologies for development; mobile solutions; and interface design in human–computer interaction.

In the course of the project, mobile applications were developed together with a set of front-ends, for Malaria and HIV/AIDS, also featuring the automatic inference of the geographic locations where the clinical information is gathered.

Epidemiologic Surveillance Platform also aimed at the development of an interoperable health care monitoring system to allow the surveillance of the infectious diseases, generating estimates of the HIV/AIDS and Malaria in demarked regions, while assuring the interoperability with external health information systems.

Partners: Critical Software (coordinator); CINTESIS - Center for research in health technologies and information systems.

Outcome: In the course of the project, mobile applications were developed together with front-ends, for Malaria and HIV/AIDS, which featured interfaces aiming at the massive use of a channel for health records screening in developing countries by specific end-users, the Community Health Workers. The mobile module allows to collect Health data securely stored, Terrain data (for instance, mosquitoes concentration), Geolocated data, all of these on shared devices.

4

euPAmHealth – Eu Preciso de Ajuda - Sistema de Monitorização de Saúde e Localização de Emergência por GPS

Description: euPA Sistemas intends to develop a Caretaker Server that collects all the information from monitored patient's sensors and shows the information to the patients and to formal and informal caretakers.

Such server will rely on their (already developed) sensors and mobile application to collect health data about its users. We must ensure the system supports, among other features:

- Individualized access for patients, doctors and informal caretakers;

- Management of medical appointments;

- Historical registry of data collected by several sensors;

- Support for diverse sensors, including ECG (electrocardiogram);

- Wiki area for collecting frequently asked questions.

These developments will be split in two phases, a first one focused in the server's API (Application Programming Interface) and web interface, and a second focused on interactive features on the web application (wiki, position tracking, etc.).

Fraunhofer AICOS will reuse the technology developed in the eHealthCom project, which consists on a caretaker server that already has some of the features required in this context. However, additional developments are needed to fully comply with euPA's expectations.

The idea is then to improve eHealthCom's caretaker server with a new UI (User Interface), improved core API functionalities and integrate it with euPA's system.

Partner: euPA Sistemas (coordinator).

Outcome: The main outcome from this project is to enhance the caretaker server developed in the eHealthCom project. These outcomes can be summarized as:

- A more coherent and robust JavaScript Object Notation (JSON) API;

- Decoupling the API from the UI, which results in increased flexibility;

- Responsive UI, which works great both on large screens and smartphones;

- Streaming sensor data support.

Furthermore, at the end of this project, euPA might be interested in pursuing this further, with additional features on the backend.

FallSensing – Technological solution for fall risk screening and falls prevention

Description: Falls are one of the most common health problems in the elderly population, representing more than 50% of the hospitalizations due to lesions in this age group. Falls are also considered one of the main causes for loss of independence and institutionalization.

Falls have a multifactorial origin, however most of the fall risk factors are amendable by implementing falls prevention programmes based on improving strength and balance and modifying behaviours. Even though, fall risk screenings and the implementation of such falls prevention programmes are rarely part of the elder's routine.

In this project the creation of the FallSensing system is proposed. This system will enable the evaluation of multiple fall risk factors and the implementation of fall prevention exercise plans, while providing biofeedback during the execution of the exercises. The data collected during fall risk evaluations or performance of falls prevention exercises are stored in a medical record platform, so that the healthcare professionals and caregivers may follow the evolution of the user and define personalized exercise plans. These personalized exercise plans may also be automatically recommended by the system promoting a continuous adaptation of the intervention plans to the evolution of the user.

FallSensing system is intended to create a new technological solution to enable screening and monitoring of the risk of falling and the implementation of falls prevention programmes in the elderly population.

The system will be simple, adapted to different use cases, transportable and with low operation costs, so that everyone in risk of falling may have the possibility to reduce this risk and prevent falls.

Partners: Sensing Future Technologies (coordinator); ESTeSC – Escola Superior de Tecnologia da Saúde de Coimbra.

Outcome: The main outcome will be a fall risk screening and falls prevention solution based on technology.

The technology will be deployed and validated by ESTeSC physiotherapists in different settings: clinics, nursing homes, municipalities and local health facilities.

ARS Centro, the network Ageing@Coimbra and Municipality of Nordeste from Azores endorsed the project.

For Fraunhofer AICOS it's an opportunity to transfer the knowledge and solutions created in the FCC to the market.

FCC – Fall Competence Center 5

Description: The Fall Competence Center (FCC) aims to investigate in-depth all fall-related aspects, including activity monitoring and human motion analysis. The knowledge gathered in the FCC will be applied to viable solutions not only for fall detection, but also fall risk prediction and fall prevention. These technological developments are based on smartphones, since these devices are of easy access and continuously used in daily life. The new solutions have a great potential of being transferred to industry and converted into valuable solutions.

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There are some specific groups presenting higher risks of fall and damage, the FCC target groups are:

- – Elderly people;

- – Patients with specific illnesses;

- – Extreme sports athletes;

- – Security Field Operatives.

Frequently these high risk individuals act/live alone and, after a fall, they are not able to ask for help and receive fast and efficient assistance, increasing the risk of serious injury after a fall. These groups clearly benefit from strategies to automatically send an alert and call for help when a fall occurs. Additionally to these reactive strategies, falls can be prevented by modifying some specific risk factors.

Preliminary research results suggest that wearable inertial sensors can be a major strategy both to predict and detect falls and these topics are gaining attention from the research community. However, these strategies are not yet widely implemented, which makes falls an under-addressed health issue.

The new fall management solutions resulting from the FCC will allow to improve the efficiency of the assistance provided upon a fall and consequently minimise injuries, psychological damage, limitations on mobility and reduced quality of life. Therefore, these solutions are expected to have an important impact not only for individuals at higher risk of falling, but also in terms of improving the sustainability of health care systems.

Partners: Fraunhofer AICOS (coordinator); Fraunhofer IDMT; University of Limerick; Universitat Politècnica de Catalunya.

Outcome: Within the duration of 30 months, three key results are targeted:

- – Development of four advanced prototypes dedicated to three different target groups (elderly people & patients with specific illnesses, extreme sports athletes and security guards) based on mobile devices;

- – Application for at least two patents to secure the Intellectual Property Rights outcome and to support the commercialization efforts;

- – Sustainable operation of the FCC after the funding period according to the Fraunhofer Model and collaboration with other international partners besides Fraunhofer IDMT.

The FCC will help to create 15 new research positions for students and researchers at Fraunhofer AICOS and, due to its international background, will also attract experts from outside of Portugal. The goals of the FCC have been endorsed by a number of leading international research institutions in the field, such as Fraunhofer IDMT, University of Limerick and Universitat Politècnica de Catalunya and are also in line with the strategy defined by the Health Cluster Portugal. Fraunhofer Portugal will make all the efforts to ensure that knowledge and results obtained will be disseminated into the related industry, reinforcing one of the main cluster objectives.

ICT4DCC – ICT4D Competence Center

Description: The ICT for Development Competence Center (ICT4DCC) is an evolution of the highly successful Android for Developing (A4D) project that Fraunhofer AICOS carried out in 2009/2010 with partners from industry (SAP Research, South Africa; PT Inovação, Portugal) and science (Centro de Informática da Universidade Eduardo Mondlane, Mozambique).

The goal of the ICT4DCC was to set up a team of international experts at Fraunhofer AICOS dedicated to the field which work with international partners from Mozambique (Centro de Informática da Universidade Eduardo Mondlane), South Africa (Nelson Mandela Metropolitan University), Germany (Fraunhofer FOKUS) and Portugal (Center for Economics and Finance of the Faculty of Economy of the University of Porto) to develop dedicated pre-commercial ICT (Information and Communications Technologies) solutions for:

- mAgriculture;

- mGovernment;

- mHealth;

- Very Small Enterprises (VSE).

The activities and solutions developed within the ICT4DCC were based on a set of transversal actions related to:

- Socio-Economic Impact of ICT4D (Information and Communication Technologies for Development);

- Local Requirements and Key Performance Indicators (KPI) assessment;

- Human Computer Interaction (HCI) and User Experience (UX);

- Low Cost Networks;

- Knowledge Transfer.

The main objective of the ICT4DCC was to investigate all aspects and challenges of the application of state of the art of ICT in developing countries, with an initial focus on the African Sub-Sahara region namely Mozambique and South Africa. In addition, the Competence Center focused on the development of several activities related to bringing a sustainable benefit to the developing countries and the European partners.

Partners: Fraunhofer AICOS (coordinator); CIUEM - Centro de Informática da Universidade Eduardo Mondlane; FEP-CEFUP - Center for Economics and Finance at the University of Porto; Fraunhofer FOKUS; NMMU - Nelson Mandela Metropolitan University.

Outcome: The key objective of the project was to supply pre-commercial ICT solutions for the populations of developing countries in the fields: mAgriculture, ICT for Very Small Enterprises, mHealth, mGovernment.

The results include a set of software solutions that fit the demands of the different fields, were iteratively tested and trialled.

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All in all the outcome of the project were dedicated tool-boxes that can allow to start rapid commercial deployments. Thus the results of the project helped to increase the growth of the ICT sector in Mozambique and Sub-Saharan African countries and provided additional opportunities to Portuguese enterprises to participate, either as business partners of the ICT companies, or as indirect beneficiaries from the business sectors that can profit from the ICT solutions.

INNOVASmartInnovation – RD&I Partners

Description: The core business of the Portuguese company 'In-Corporate (Linkintense)' is the development of software tools for management support, such as Innovation Management Systems and Business Process Management Systems. RD&I Partners is a project of 'InCorporate' to improve and extend their 'Innovation & RDI Management System' which integrates their current product portfolio and is already in use by some R&D institutions.

Within the Innovation Management Support Tools, 'InCorporate' has developed a module to manage the workflow of ideas generation, validation and implementation (project management) and a first version of the module for innovation partners' integration.

This new project will be dedicated to the development of an integrated and improved innovation management system capable of supporting the following processes: Idea generation and implementation; innovation strategic partners' integration; knowledge management and technological surveillance; open innovation / crowdsourcing.

Partner: InCorporate (coordinator).

Outcome: Integrated and optimized innovation management software solution.

MASPARK – Characterizing freezing of gait in Parkinson's disease 6

Description: Among the symptoms that mostly impact quality of life for people affected by Parkinson Disease (PD) are the problems associated with walking: rate loss, slowing down, shuffling, and freezing. Freezing is strongly related to the cognitive disorders that many of these patients show. Freezing responds poorly and irregularly to drug therapy and deep brain stimulation. To improve this, rhythmic sensory stimuli at frequencies related to the speed and cadence of the march are successfully being used. In a previous project, REMPARK, an automatic mobility support system (SAM) for PD was developed, consisting of a wearable inertial sensor for real-time detection of abnormal gait, wirelessly connected to a mobile phone which, in turn, acts as a gateway and processes the data from the sensory stimulation devices.

In the MASPARK project we want to use this system to study freezing: there will be a group of 25-30 patients meeting inclusion criteria. The experiment will be performed at the day-care centre and at patients' homes.

The following parameters will be measured:

– The number of freezing episodes and how long they stay frozen at baseline, on and off. For one week;

– The same parameters while applying sensory stimuli: acoustic, for one week, after one month;

– Assessment of quality of life before and after wearing the SAM, with and without automatic application of the sensory cues.

Partners: Centro Médico Teknon (coordinator); Universitat Politècnica de Catalunya.

Outcome: Improve the Auditory Cueing System with music. Help evaluate the system's impact on quality of life through Technology Acceptance Models.

mWaterSafety – Mobile Water Safety System 7

Description: The mWaterSafety project is focused on the development of a new technological solution aiming to increase safety in nautical activities dedicated to fishing communities and watersports athletes, such as sailing and windsurf practitioners.

This solution is based on coupling smartphones and external sensors to vessels to obtain information about their positioning and routes. The information is processed in real-time by an independent alarm management framework that identifies high risk situations and automatically sends notifications to the community or trigger the intervention of rescue teams. In the case of watersports the solution additionally enables to obtain performance metrics that can be shared with coaches and colleagues and used to improve training techniques.

Partners: PontoC - Desenvolvimento de Sistemas de Informação / Digitalwind Lta. (coordinator); Associação Náutica da Gafanha da Encarnação; Clube de Vela da Costa Nova; Direcção-Geral da Autoridade Marítima (DGAM); PT Comunicações (PT); Sporting Clube de Aveiro.

Outcome: The main outcome is an information system that receives information from several sensors (smartphones and other external sensors) carried by the sailors and boaters during their nautical activities.

At the security level, an alarm management framework allows the detection of abnormal events that might generate an alert, such as a boat that is upside down or a boater who is moving away from his boat. This framework is intended both to nautical sports organization entities (sailing clubs, yacht clubs, windsurf associations) and fishing communities wishing to ensure the highest levels security for their members.

On sports performance, data from sensors will be collected to monitor several performance metrics such as: routes, travelled distances, average speed and the height of a jump. It will also be possible to share this information with coaches, friends, clubs and communities.

My-AHA – My Active Ageing Against Cognitive Frailty

Description: The project proposes a holistic view of interrelated frailties: cognitive decline, physical frailty, depression and anxiety, social isolation and poor sleep quality, which are a major burden to older adults and social and health care systems. Early detection and intervention are crucial in sustaining active and healthy ageing (AHA) and slowing or reversing further decline.

The main aim of My-AHA is to reduce frailty risk by improving physical activity and cognitive function, psychological state, social resources, nutrition, sleep and overall well-being. It will empower older citizens to better manage their own health, resulting in healthcare cost savings. My-AHA will use state-of-the-art analytical concepts to provide new ways of health monitoring and disease prevention through individualized profiling and personalized recommendations, feedback and support.

An ICT-based platform will detect defined risks in the frailty domains early and accurately via non-stigmatising embedded sensors and data readily available in the daily living environment of older adults. When risk is detected, My-AHA will provide targeted ICT-based interventions with a scientific evidence base of efficacy, including vetted offerings from established providers of medical and AHA support. These interventions will follow an integrated approach to motivate users to participate in exercise, cognitively stimulating games and social networking to achieve long-term behavioural change, sustained by continued end user engagement with My-AHA.

The proposed platform provides numerous incentives to engage diverse stakeholders, constituting a sustainable eco-system with empowered end users and reliable standardised interfaces for solutions providers, which will be ready for larger scale deployment at project end. The ultimate aim is to deliver significant innovation in the area of AHA by coopera-tion with European health care organizations, SMEs, NGOs.

Partners: Università degli Studi di Torino (coordinator); Deutsche Sporthochschule Köln; GESMED - Gestió Socio Sanitaria al Mediterrani; Institut für experimentelle Psycho-physiologie; Instituto de Biomecánica de Valencia; IP Health Solutions; Istituto Superiore Mario Boella sulle Tecnologie dell'Informazione e delle Telecomunicazioni; JIN CO; Johan-niter Österreich Ausbildung und Forschung gemeinnützige; Kaasa solution; Loughborough University; National University Corporation Tohoku University; Seoul National University; Universität Siegen; University of the Sunshine Coast.

Outcome: Development of an innovative ICT-based platform to detect subtle changes in physical, cognitive and social domains that indicate an increased risk of subsequent vicious cycle of disability and diseases, including dementia, depression, frailty and falls. The ICT-platform will continuously monitor individuals' risk profile including their lifestyles with cognitive, physical and social capabilities. This information will be used to determine individuals' risk profiles and to provide personalized intervention strategies for sustainable use.

The ultimate purpose of My-AHA is to contribute to the slow-down of cognitive and physical decline and, possibly, delay the onset of associated end-stage diseases through empowering citizens to manage their own health by improved health literacy.

OUTSIDE – Outage Management System for Improved Distribution Networks Efficiency

Description: The goal of this project is to develop an Outage Management System to improve the operational management of a power distribution system, therefore reducing the occurrence of blackouts.

The system is interoperable with existing solutions like SCADA (Supervisory Control and Data Acquisition), DMS (Distribution Management System), WOM (Work-Order Management), CIS (Customer Information Systems), IVR (Interactive Voice Response) enabled Call Centers, WFMS (Work Force Management Systems), GIS (Geographic Information Systems) and MDM (Meter Data Management).

Current solutions are very limited in what interoperability is concerned and do not support the widely spread power metering tools. This solution allows a real-time knowledge about planning, development and conclusion of corrective interventions in the power distribution network, based on the Smart Grids paradigm. The INOVGRID sub-network will be used for testing and demonstration.

Partner: EFACEC Engenharia e Sistemas (coordinator).

Outcome: A simulator of outages on the power distribution network, allowing a better understanding of their impact on the network, a better planning of interventions and providing useful data for analysis. The simulator has interfaces with the aforementioned existing solutions and may be used for demonstration purposes. The major goal of this project is to have a better efficiency of the power distribution network, lowering power wastage and therefore improving the environment.

REMPARK – Personal Health Device for the Remote and Autonomous Management of Parkinson's Disease

Description: The specific and ultimate goal of the REMPARK project is to develop a Personal Health System (PHS) with closed loop detection, response and treatment capabilities for management of Parkinson's Disease (PD) patients at two levels:

– At the first level, the project will develop a wearable monitoring system able to identify, in real time, the motor status of PD patients and evaluate ON/OFF/ Dyskinesia status with a sensitivity level greater than 80% and a specificity level greater than 80% in operation during ambulatory conditions. It will also develop a gait guidance system that is able to help the patients in real time during their daily activities;

– At a second level, the system will provide intelligent analysis of data, fed by the first level, and will be supported by a disease management system. This will allow neurologists to access accurate and reliable information to make better informed decisions about the treatment that best suits the patient, improving the management of their disease, in particular to adjust so called therapeutic window.

To achieve this global goal, four main objectives need to be achieved:

– Identification of motor status in real time;

– Development of a gait guidance system;

– Development of a user interface to collect direct feedback from the patient;

– Development of a server to allow interaction with the doctor in charge and track the evolution of the patient's condition.

REMPARK system will be tested in 60 real patients from four medical centres. The consortium is formed by medical and technical renowned specialists; PD patients are represented through the participation of the European Parkinson's Disease Association.

Partners: Universitat Politècnica de Catalunya (coordinator); Association européenne pour la maladie de Parkinson; Centro Médico Teknon; Fondazione Santa Lucia; M&M Qualtech; Maccabi Healthcare Services; National University Ireland Galway (NUIG); Neusta Mobile Solutions Group; Nordforce Technology AB; Telefonica Investigacion y Desarrollo.

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Outcome: Specification and development of a mobile gateway communication service for interconnection of the sensors and actuators. Smartphone user interface development for management of Parkinson's disease.

SAL – Service Assisted Living 8

Description: The Service Assisted Living project (SAL) is an Applied Engineering project that studied the application of Service Engineering and the adoption of Ambient Assisted Living technologies in the construction and operationalization of Complex Integrated Systems, namely the new Information and Communication Technologies in Health.

With the Industrial Research and with the resulting innovation, SAL designed and developed products in four specific areas, namely, skin lesions risk evaluation and skin cancer prevention; healthcare for Melanoma patients, haemophiliacs and hypo coagulation patients; component for the blood chain at the national and regional level; and component for transfusion security and blood surveillance in hospital internal blood services.

The SAL project has been developed in partnership with Glintt HS, the Engineering Faculty of the University of Porto and Fraunhofer AICOS, through the integration of the competences of the three entities for the research, innovation and consequent design of New Technical Solutions for Health.

Partners: Glintt - Healthcare Solutions (coordinator); FEUP - Faculdade de Engenharia da Universidade do Porto.

Outcome: The research results and Industrial Innovation that resulted from SAL were applied in the design and construction of marketable products, that answer the questions and challenges faced in the new paradigm in which the Citizen/End User/Patient has a central and active role in Health Management.

ShopView – a solution to validate the shelf layout

Description: Planning the shop layout is one of the most crucial tasks in the retail business nowadays. The right placement of products in a modern supermarket determines significantly the number of sold items. To maximize the overall income, supermarkets optimize the shelf layout and put products with a high profit margin on prominent places in the aisles. The manufactures of the products are willing to pay the supermarkets a so called shelf rent, in order to influence the shop layout and to promote their own goods. The wrong placement of a product might therefore not only result in worse revenue, but also in contractual penalties. As the shop layout changes frequently, there is a permanent need for control which involves high costs since currently the task must be manually performed.

Partners: WeDo Consulting - Sistemas de Informação (coordinator); Sonae Modelo Continente.

Outcome: The aim of the ShopView project was to automate the task of controlling the implementation of planograms, by creating a system which uses state of the art image processing technology to recognize misplaced products. The developed system consists in a semi-automatic device to take images of the supermarket and software which performs the image processing and compares the real world data with the information stored in the planning software of the supermarket. The ShopView significantly decreased the rate of wrong product placements while decreasing costs of control.

Shopview2Market – Automated Solution to Validate Shelf Layouts in Stores 9

Description: ShopView leverages computer-vision technology for retailers that want to gain a competitive edge in product placement auditing. The solution relies in a drivable platform equipped with a high speed flash synced with multiple digital cameras, aided by a light softener, a laptop and a couple of sensors to:

– Photograph shelves – controlling reflections and minimizing blur in high-resolution;

– Recognize the positioning of real products – via information and image processing algorithms;

– Evaluate product placement – validating against target planograms;

– Reporting errors to store manager in aisles covered by the Buggy's imaging system.

Other features include:

– Layout management of multiple stores;

– Map of aisles in floorplan;

– Panoramic full-length views;

– Label detection;

– European Article Number (EAN) decoding;

– Multiple-camera matching.

The former ShopView project has finished having its R&D objectives accomplished. Although it is capable of doing the job with a considerable degree of reliability, some challenges and limitations were identified through the execution of the project: Automatic Integration, Usability, Auditing features should be completed with Correction features – to be able to act upon the information created by ShopView, e.g. for re-stocking, rearranging and optimizing shelf product placement.

Fraunhofer AICOS proposed to address the identified issues in ShopView, and complete the validation of the solution throughout a long-term pilot, with demonstrators all over the world: the ShopView2Market.

Partners: WeDo Consulting - Sistemas de Informação (coordinator); Sonae Modelo Continente.

Outcome: ShopView2Market solution validated with high (7) Technology Readiness Level, with enough maturity for product roadmap and commercial use, which means:

– Demonstrations without critical failures in operational environment;

– Easy installation and configuration;

– Fully integration with retailer business model;

– Functionalities adapted to user expectations.

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ShopView Sonae Awards

Description: The ShopView project has been in the final stage of evaluation for the 'Sonae Companies Innovation Award 2015' an important event of the company for gathering recognition and internal funding for them.

It was very relevant for Sonae to demonstrate the current value of the solution through a pilot in untested stores. In this sense, we have received an express request for the planning and execution of a pilot in multiple stores to be done in just four weeks.

The ShopView's auditing features (Space Planning Department) has been completed exporting meaningful information necessary for restocking, rearranging and optimizing shelf product placement (Store Operations Department). The previous prototype was able to detect errors in product placement, comparing the planning of space with the reality. After the detection of non-conformities, placement errors are viewable in a Web interface. However, the extractor of information to enable the corrective process was not specified and developed before.

Sonae shared with us a document with requirements for this pilot since the current auditing ShopView prototype should provide more information relevant to Store Operations. By using the existent database that ShopView already generates, Fraunhofer AICOS developed the extraction to a spreadsheet of parameters related to problems with labels and products that are unknown in the planogram (to be classified by Sonae as discontinued or products too new to be in the planogram).

Partner: Sonae Modelo Continente (coordinator).

Outcome:

– The outputs have been used for the initial part of ShopView2Market project (proposal submitted to the PT2020 funding programme), by anticipating some tasks;

– Further validation step with the solution within Sonae;

– ShopView was the winner (first place among 37 projects) of Sonae Companies Innovation Award 2015.

SmartBEAT – Smart system for the management of Heart Failure in older adults

Description: The increasing number of patients with Heart Failure is overloading the public healthcare systems. In Portugal there are 260.000 individuals with Heart Failure and in Europe this figure reaches 15.000.000. The prevalence of the disease in citizens with 70+ years is of over 10%. In Portugal, Europe and in the U.S., the costs associated with this pathology represent 1–2% of all costs related to healthcare and it is estimated that the recurrent hospitalizations, common in Heart Failure patients, correspond to, approximately, 70% of all HF costs. An example of the increasing impact of Heart Failure on health systems is the priority given in the U.S. to the development of strategies that reduce readmission of patients with Heart Failure.

The SmartBEAT project aims to address the needs of senior Heart Failure patients and their formal and informal caregivers by offering an integrated solution to leverage patient self-care through autonomous condition monitoring and real-time feedback to their caregivers. Using SmartBEAT, it is possible to improve disease outcomes and enhance the quality of life of senior Heart Failure patients. This objective will be achieved through the acquisition of user's physiological data using a Vital Signs System and a smartphone application integrated with a Monitoring Engine and a Caregivers Gateway for data analysis, management and reporting.

Partners: Fraunhofer AICOS (coordinator); Faculdade de Medicina da Universidade do Porto; Hospital São João; KempenLIFE; LifeOnKey; Remedus; SeniorNett Norge; Stichting Smart Homes, Nationaal Kenniscentrum voor Domotica & Slim Wonen; Verhaert; Vigisense.

Outcome: SmartBEAT proposes to develop a system that allows for Heart Failure outpatients mobile monitoring and screening. The solution aims at early identification of hemodynamic imbalance inherent in an episode of acute decompensated Heart Failure. SmartBEAT is a simple, cheap and quick follow-up solution for Heart Failure older adults which allows to optimize the quality of care, reduce costs, reduce the number of readmissions and, ultimately, improve the prognosis and reduce mortality in this population.

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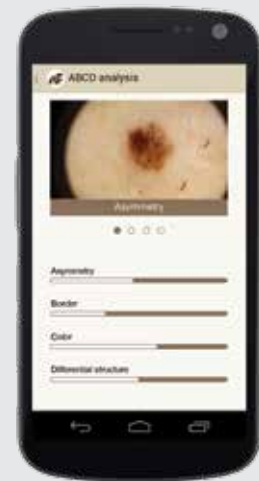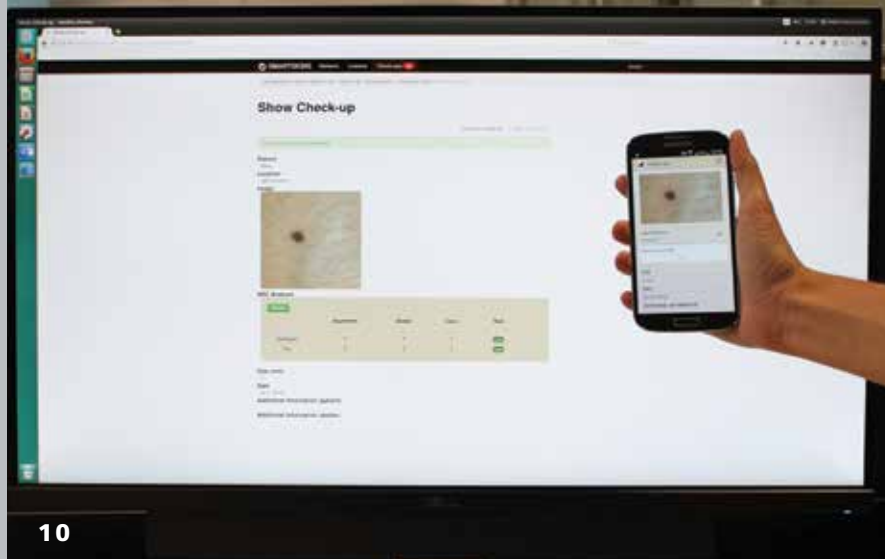
SMARTSKINS – A novel framework for Supervised Mobile Assessment and Risk Triage of Skin lesions via Non-invasive Screening **10**

Description: This project aimed to design and effectively develop and implement a framework of risk triage of skin cancer, which uses a new generation of mobile devices in its architecture to capture the images. The framework automatically pre-processes and segments mobile-acquired skin moles images, as well as perform extraction of significant features for risk assessment and Melanoma pre-diagnosis purposes. The automatic risk assessment is based on machine learning methods using extracted features, additional information available submitted by the patient and an adaptive reference atlas of classified skin lesions. The images that make up the reference atlas are previously classified by dermatologists and are used to provide a highly reliable triage of lesions based on images acquired by low cost devices such as smartphones.

Partners: INEGI-LAETA (coordinator); Instituto Português de Oncologia (IPO).

Outcome:

– Developed pre-processing computational techniques for image enhancement and illuminance corrections of mobile-acquired images;

– Developed and implemented a segmentation method specifically designed for skin lesion images acquired from mobile devices;

– Selected and effective extracted significant features from mobile-acquired skin images for risk assessment purposes;

– Developed machine learning approaches for the automatic classification of skin lesions. The machine learning classifiers were trained with an adaptive reference atlas of skin lesion images;

– Designed and implemented a Mobile Risk Triage Framework prototype, which automatically pre-processes, segments and extracts significant features for skin cancer pre-diagnosis and risk assessment of mobile-acquired skin images.

INTERNAL PROJECTS

In order to foster core competence building and to enhance our team's experience, we frequently assess ideas and launch internal project initiatives.

AE4HFExtension – Hydroponic Project Extension

Description: This project is an extension of the current Assistive Environment for Hydroponic Farming (AE4HF) project. The current AE4HF project is due to end in June 2015 hence a motivation for continuation of the project.

The motivation for extending the project is based on the need to scale up the AE4HF project to include extra monitoring parameters namely moisture and water flow.

The extension aims to provide a platform for rigorous tests (functional, load testing, user testing) on the solution in order to validate the applicability of the AE4HF in the real farm environment. At least two operational hydroponic farms will be installed each with 10 Wireless Sensor Nodes (consisting of temperature sensors, humidity, water flow, moisture, electric conductivity (EC), pH, battery life, and motion detection = Total of 20 Wireless Sensor Node (WSNs) to be developed). The results from the testing set the basis for wide implementation of the Hydroponic project at a larger scale and to demonstrate the business benefits / economic impact from such Hydroponic system.

Partner: Nelson Mandela Metropolitan University (NMMU).

Outcome:

– AE4HF system tested (beta version) and ready to be used (10 WSNs and 1 irrigation control actuator) in two different farms and tested with a limited set of friendly users;

– Business case demonstrating the applicability and business benefits of the system;

– Improved skills development local capacity to develop and maintain similar projects;

– Basis of assessment of the interfaces institutes model;

– Possible socioeconomic benefits, (Mobile4Development) more farm owners and farm workers using mobile phones in other aspects for improving lifestyles;

– Improved farm production and effective utilization of resources;

– Contribution to food security and alleviation of poverty.

APPS – Fraunhofer Apps

Description: The idea is to create a repository similar to the Google Play Store or Apple's App Store, but only accessible internally. It would grant access to each project application(s) either to everyone in FhP or to a specific group of people. Also, access to both Beta and Stable releases should be available, and optionally a reference to the corresponding Version Control revision identifier.

Developing mobile apps is an important part of several internal projects, and having the latest versions installed across each team member's device(s) is usually crucial.

However, this is not always an easy task to perform on a timely basis, due to factors such as miscommunication, lack of knowledge regarding version control systems or high number of devices.

Additionally, quickly accessing an application in development for an unscheduled demonstration can be very valuable.

Having an 'Application Store'-style platform where a user could find the desired app by simply typing its name on their device could solve all of these issues, while also helping keep track of Beta and Stable releases.

Outcome: Fully functional Application Store that allows users to quickly retrieve, from an internal server, a specific application on a new device or to update an existing version of their own software.

Comm4Dev – Communications for Development

Description: WiBACK and PostboxSync (the evolution of PostboxWeb) are joining forces to explore the lack of a GSM stable solution by creating the concept of the Comm4Dev – a reliable, stable, easy to use and self-configurable solution. Together with PostboxSync shall allow to greatly extend the covered and connected areas.

The Comm4Dev includes a communication system for voice (GSM) and data (IP/Internet via Wi-Fi and/or 3G/Sat) with an easy setup, and auto and/or remote configuration, opening the possibility to remove the need to have technical persons on site. Therefore, Comm4Dev (the WiBACK component) must support clients with third party SIM cards and data transmission on the smartphones using PostboxSync.

Partners: Core Network Dynamics; Fraunhofer FOKUS.

Outcome: WiBACK offers true and very economic Internet access in rural areas, while PostboxSync offers store-and-forward Internet access for Android Phones suitable for many scenarios without additional infrastructure. The milestones include:

– Integrated demo for infrastructure and software integration under a common environment, to serve remote and uncovered areas where the platform may address the communication needs;

– PostboxSync Framework for Android with analytics and PostboxServer;

– Postbox Companion with a set of applications installed according to the context of use, which are able to run within PostboxSync environment for Android.

ExerGames – Multi-sensor interactive games for physical activity, rehabilitation and fall prevention 11
(Associated with the FCC)

Description: The ExerGames project aimed at developing interactive games for physical activity and rehabilitation, as well as for fall prevention, in which the user's movements are monitored using sensors. The selected approach was to design and implement a multiplatform framework providing all the needed software interfaces for the games (sensor data, user profile management, etc.), which can be developed without being tied to specific equipment or service, thus achieving maximum modularity.

The framework already supports a wide array of motion sensors, which are commercially available and low-cost, such as Microsoft Kinect, Leap Motion, Orbotix Sphero or even Smartphones and Smartwatches. All game session data, including sensor data, may be stored for further analysis.

Partner: Centro de Reabilitação Profissional de Gaia (CRPG).

Outcome: A multiplatform (desktop/mobile/web) solution for featuring several interactive serious games focusing on physical rehabilitation for patients that suffered stroke or other neurological accident, as well as on fall prevention, with games promoting exercises that are known to reduce the risk of fall by improving balance, muscular strength, mobility and flexibility.

EyeFundusScope – Mobile-based Risk Assessment of Diabetic Retinopathy by Image Processing with Near-Infrared 12

Description: Diabetic Retinopathy is a Diabetes complication and the leading cause of avoidable blindness in adults. If detected early it can be treated by laser surgery, however its early detection is frequently missed since it progresses without symptoms until irreversible vision loss occurs. The continuous monitoring is therefore essential to protect the vision.

The EyeFundusScope concept comprises a smartphone, a low-cost ophthalmoscope mounted on the smartphone built-in camera, image processing algorithms for detection of microaneurysms (first sign) and decision-support to provide an indication of the presence of Diabetic Retinopathy. A solution based on this concept can be of great value in the context of large screening actions, in which a lower number of specialists needs to be involved, since it can be used by a general or non-specialist practitioner. In addition, it can be extended to other eye diseases and stand as a useful tool for eye health screening in developing countries.

Current work resulting from EyeFundusScope Master Thesis (MSc) already includes: a mobile app to capture images from the retina, optic disk tracking, vascular segmentation and microaneurysm detector, all running on a smartphone. However, we still need to improve the robustness of the detection methods and also to include a decision-support system.

This project aims at developing a smartphone-based image processing platform that will implement low computational-cost algorithms and yet highly efficient in the lower quality images of the smartphone camera. This platform will be structured in a flexible way so that it can be used to detect microaneurysms but also other image features, aiming to be re-used in other Fraunhofer AICOS projects.

In order to open the field-of-view and improve image quality, stitching algorithms similar to those used in ShopView can be implemented in the mobile framework (already tested in the MSc project). This is particularly important since drug-induced dilation of the pupil should be avoided in the screening scenario, for sake of simplicity and speed.

Moreover, it has been found that the ophthalmoscope adapters for smartphone can be improved, both in terms of the information acquired as in comfort to the user, by adding a Near-Infrared LED light.

Outcome:

– Image processing Android platform adapted to use the processing power of current smartphones in the images acquired using the built-in camera.

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– New prototype of a smartphone ophthalmoscope adapter using LED light. Fields of application:

  - Retinopathy screening solution and decision-support system;

  - Other eye diseases screening for developing countries;

  - Other Preventive Health projects using mHealth apps.

Fall Detect – Smartphone-based Fall Detection
(Associated with the FCC)

Description: The Fall Detect project aims at developing a smartphone-based fall detection solution to identify dangerous fall events and consequently alert emergency contacts when the user does not recover.

The data from the smartphone built-in accelerometer is continuously screened and upon the detection of a fall event, the user's location is tracked and SMS and email notifications are sent to a set of contacts.

Outcome: Smartphone app capable of screening the user's movement, detect falls and notify emergency contacts.

Fall Risk Assessment – Smartphone-based Fall Risk Screening
(Associated with the FCC)

Description: The Fall Risk Assessment Tool is a smartphone-based tool aiming to assist healthcare professionals on the execution of the fall risk evaluation tests, based on the smartphone built-in inertial sensors, both at seniors' homes and clinical environments.

Another tool, the My Fall Risk Meter aims to provide the elderly users with the means to monitor their fall risk factors continuously over time. This tool is meant for a daily-basis, unsupervised assessment of fall risk factors. The smartphone built-in inertial sensors are used to continuously assess the mobility of elderly users, as they perform their usual daily activities. Specific mobility impairments are assessed using exercises or serious games. Smartphone-based questionnaires are used to assess behavioural and environmental factors.

Partners: Escola Superior de Tecnologia da Saúde de Coimbra (ESTeSC); Escola Superior de Tecnologia da Saúde do Porto (ESTSP).

Outcome: Smartphone app for the execution of standard fall risk assessment tests by healthcare professionals.

Smartphone app for continuously self-assessment of fall risk factors over time.

Hydroponics – Assistive Environment for Hydroponic Farming 13
(Associated with the ICT4DCC)

Description: The Assistive Environment for Hydroponic Farming project aims to analyse the requirements of hydroponic farms in South Africa and Mozambique and suitably develop a mobile solution for farmers in order to improve the level of management, control and production of hydroponic farms. This approach makes possible for farmers to get to know the conditions in the hydroponic farm without physically visiting the farm, thereby saving time and reducing labour intensity while collecting accurate data.

Hydroponic farming is a means of precision agriculture where plants are grown in mineral nutrient solution instead of soil. Since it offers a controlled environment, this type of farming became popular in South Africa, making agriculture more practicable in lands with poor soils or recurrent droughts and floods. The effective management of hydroponic farming requires constant monitoring of inside and outside parameters: monitoring temperature, humidity, turbidity of the nutrients' solution, watering, among others. Currently, the whole process of monitoring the conditions in the hydroponic environment is done by manual systems, which are time consuming, labour intense and prone to inaccuracies.

The primary goal of this project was to develop a low cost mechanism for mobile monitoring of hydroponic farms. It included the development of WSNs (Wireless Sensor Nodes), as well as a mobile application to be easily and effectively used by farmers to reduce the time involvement required to monitor a hydroponic culture. This solution allows real time monitoring of environmental factors (ambient temperature, ambient humidity, hydroponics bags' water level, pH, lighting, etc.), and provides graphical data, crop statistics and equipment fault warnings.

Local hydroponic farmers from South Africa are the main target of this project since they will see their system optimized, saving time and money in their cultures.

Partner: Nelson Mandela Metropolitan University (NMMU).

Outcome: The final result was a prototype of a wireless sensor node based Android application to accurately monitor the essential variables for optimal plant growth in hydroponic environments. The system is expected to maximize crop yield with minimum resources. Globally, the initiative aims to boost farming markets in developing countries in Sub-Saharan Africa.

IZIDoc – Digital channel for administrative processes
(Associated with the ICT4DCC)

Description: The IZIDoc project targets the simplification of Mozambican administrative acts that require personal attendance at service provider's facilities (administration, police, pharmacy, bank, etc.). A mobile solution was developed to inform citizens of the availability and status of the requested goods or services. This saves time and avoids useless dislocations from the citizens. From the service provider point of view, this solution also reduces queuing and optimizes customer service.

When a citizen needs to obtain an official document (Identification Document, Passport, Visa, criminal record, statements, certificates, etc.), it is advantageous to know, among others, the requirements for getting it, the place, the price and the time it will take. The lack of information leads many people to the service provider's facilities, usually waiting a lot of time in long queues. Especially in developing countries, a notification mechanism to alert citizens about the status of document's procurement would have many advantages for both citizens and service providers.

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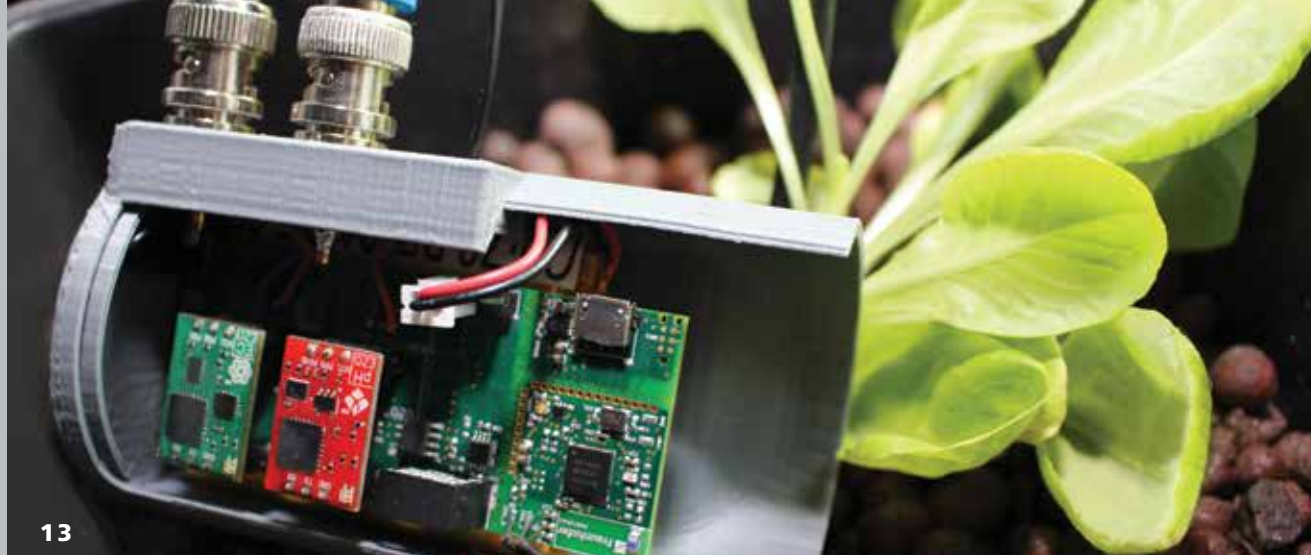
The project focused on the development of a mobile application that allows citizens to search information related to different types of documents addressing service requirements, places where to go (with map visualization), timetables, costs, average waiting times, document processing times, among others. It also allows to search for people or friends who have already dealt with the same type of document. Furthermore, a notifications module alerts citizens when the document is ready to be collected.

Similar ideas are already implemented in developed countries, where this type of service is usually integrated within a web platform of the entity that emits the documents. However, in Mozambique, this project has a special impact since IT (Information technology) and Internet services have still little presence. The innovation of this initiative relies on a mobile platform for Mozambicans, integrating different administrative services / institutions in one application.

This project provides to Mozambican citizens quick and easy access to official administrative acts' information, giving real-time notifications about the status of their request. Governmental Institutions (e.g. Conservatories, Criminal records, etc.) also benefit from the optimization effort and reduction of waiting queues.

Partner: Centro de Informática da Universidade Eduardo Mondlane (CIUEM).

Outcome: This project was first implemented in the secretariat services of a Mozambican University aiming to leverage awareness on the advantages of this kind of products and to influence other service providers to adopt the solution.

MalariaScope – Digital Analysis of Malaria Infected Blood Smears via Mobile Devices
(Associated with the ICT4DCC)

Description: Malaria is a leading cause of death and disease in many developing countries, where young children and pregnant women are the most affected groups. In 2012, there were an estimated 207 million cases of Malaria, which caused approximately 627.000 Malaria deaths. Around 80% of Malaria cases occur in Africa, where the lack of access to Malaria diagnosis is largely due to a shortage of expertise, being the shortage of equipment the secondary factor. This lack of expertise for Malaria diagnosis frequently results on the increase of false positives, since prescription of medication is based only on symptoms. Thus, there is an urgent need of new tools that can facilitate the rapid and easy diagnosis of Malaria, especially in areas with limited access to quality healthcare services.

MalariaScope was a project included in Fraunhofer AICOS' Information and Communications Technologies for Development Competence Center (ICT4DCC), in cooperation with the infectious diseases department of the Instituto Nacional de Saúde Dr. Ricardo Jorge. This project aimed to create a mobile-based solution that can provide an effective pre-diagnosis of Malaria to be used in medically underserved areas. It uses the new generation of cellular phones in the system architecture, which exhibit significant improvements in terms of image acquisition and image processing and that are becoming widespread worldwide, even in developing countries. Moreover, this project aimed to create a magnification gadget that can be connected to the smartphone and provide the necessary magnification capability. Thus, the project was divided into three main components: the optical magnification component, the image processing and analysis component, and the smartphone application component.

Partner: Instituto Nacional de Saúde Dr. Ricardo Jorge.

Outcome:

– Optical Magnification: The project aimed to develop a cheap alternative to the current microscopes, that can easily be adapted to a smartphone and to be used in the field. The developed optical magnification gadget guarantees the same magnification factor as a common microscope and uses the smartphone built-in camera to capture the images for further analysis. The process is to place the smartphone in the adapter along with the blood smear, and have the smartphone image sensor to record a set of magnified images. This collection of acquired images is then processed and an analysis report of the blood smear is provided;

– Image Processing and Analysis: For the automatic detection of Malaria parasites, this project aimed to investigate computer-aided methods that can be used for the successful automatic analysis of Malaria-infected blood smears. The developed image processing and analysis module designed is able to: (1) Determine the parasite density of Plasmodium Falciparum species in the trophozoite life-cycle stage in thick blood smear images; (2) Identify and count the *Plasmodium Falciparum* species in the trophozoite life-cycle stage in the thin blood smear images;

– Smartphone Application: The MalariaScope solution was envisioned to be used by technical personnel without specialized knowledge in Malaria diagnosis.

The user collects and prepares a blood sample of the patient, introducing it in a slot in the optical magnification prototype. Using the companion mobile application, installed in a smartphone that is coupled to the optical magnification prototype, the user can create new patients and add new samples (and the corresponding views) to a specific patient. The user can then take pictures of the sample using the smartphone's camera, while using the stage XY axes controllers on the prototype to change the magnified views. The captured views can then be sent to analysis through the mobile app, which returns a report indicating the parasite density of each sample, so the correct procedures and medication can be administered.

MalariaScopeV2 – Digital Analysis of Malaria Infected Blood Smears via Mobile Devices (Phase II) 14

Description: Excellence is a result of constant improvement. Bearing this thought in mind, Fraunhofer AICOS is now leading a new version of the MalariaScope, a project which first started in 2013 with the name ICT4DCCMalariaScope and is now entering a new phase, with upgrades and advanced enhancements. The project is divided into three main components: the optical magnification component, the image processing and analysis component, and the smartphone application component.

Partner: Instituto Nacional de Saúde Dr. Ricardo Jorge.
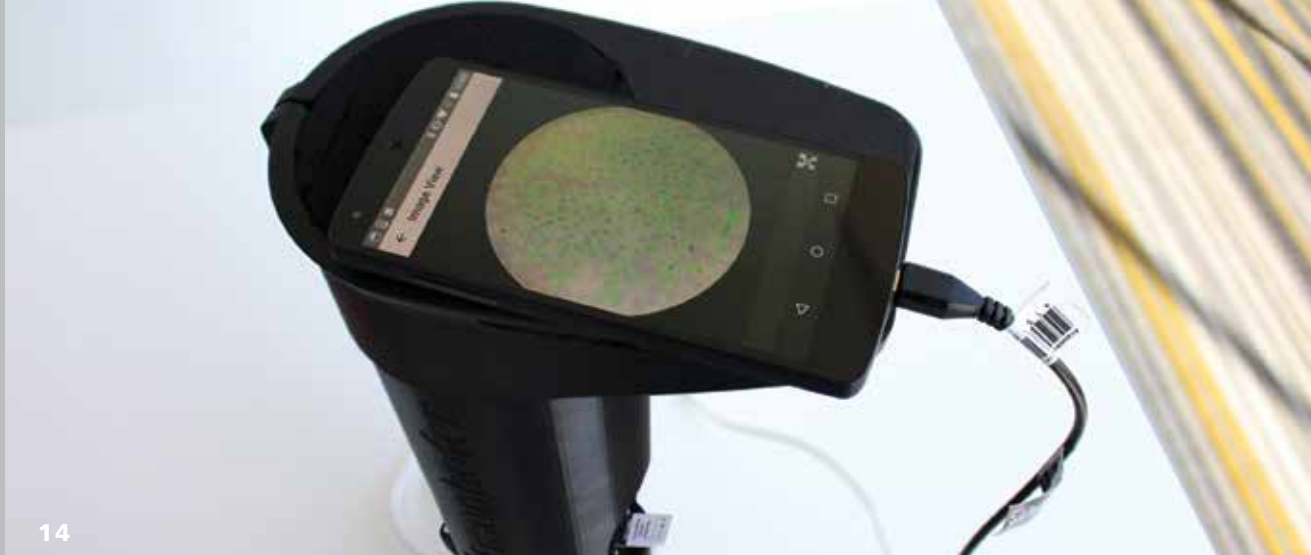
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Outcome: A stable version of the MalariaScope prototype, ready to be used in field trials. This version will be composed by: an Android app to be used by the technicians on the field; A web interface for the supervision of the microscopic specialists; A second version of the optical magnification prototype; Image processing modules for the automatic detection P.falciparum, P.ovale and P.malariae parasites.

Particularly, the following improvements are expected to be achieved:

– Optical Magnification: The great improvement in the new version of the prototype is the inclusion of the automated stage. A self-powered motorized automated stage system was developed in order to move the blood smear and allow the automatic capture of several snapshots of the sample. The capture of the images ceased to be manual and became fully automatic through small engines autonomously controlled by the phone, to get the desired number of images. In addition, many of the shortcomings of the first version of the prototype are being addressed, specifically in terms of stability and robustness;

– Image Processing and Analysis: In the first stage of the MalariaScope project we developed an image processing module for a particular species-stage combination (*Plasmodium Falciparum* species in the trophozoite life-cycle stage). But there are 12 different species-stage combinations, so in this new version we are developing image processing modules to identify and count all possible species-stages combinations of malaria parasites that can potentially infect humans;

– Smartphone Application: The new version of the Android app is being fully reformulated in order to receive the results for all species-stage combinations. Moreover, the control of the automated stage is also being integrated in this new version of the app.

Mover – Smartphone-based Activity Monitoring
(Associated with the FCC)

Description: Physical inactivity has been identified by the World Health Organization (WHO) as the fourth leading risk factor for global mortality. Mover is an application aiming to track all the movements of the user resorting exclusively to the built-in accelerometer from the smartphone. Mover is able to monitor the users' physical activity, motivating them to become more active.

Partners: Centro de Investigação em Actividade Física, Saúde e Lazer (CIAFEL) - Sports Faculty of University of Porto (FADEUP).

Outcome: Smartphone app to classify in real-time ambulatory activities and postures of the user and compute number of steps and speed of walking or running.

nPandlets – Add-on nodes for the Pandlets ecosystem 15

Description: This project follows the road map established on the FhPSafetySensor project, during which the Pandlets ecosystem was designed and the pandlet base dot, sensing dot and memory dot were produced, installed and used both in external and internal projects.

Based on this outputs several projects are now reusing the Pandlets devices and ecosystem, and this project will introduce new functionalities that will enhance the set of features in the Pandlets ecosystem.

Outcome: The Pandlets ecosystem will be enhanced with the following outcomes:

  – A miniaturized GPS node;

  – Additional sensing capabilities for precision agriculture;

  – Improved embedded algorithms for location invariant activity monitoring;

 – An Application Programming Interface (API) for controlling and collecting data from the new nodes.

OurMOZ online – Crowdsourcing platform to provide information based on the need of citizens
(Associated with the ICT4DCC)

Description: OurMoz online aims to be a mobile platform that provides real-time geotagged information of what is happening within Mozambican cities, everything obtained through citizens' contribution. The purpose is to combine the social network concept with citizen reporting and eCommerce. Information is thus collected and shared, being available for everyone. Associated parameters such as the lifetime of information, number of similar reports, number of positive feedbacks, etc., will provide consistency and credibility to the platform.

Citizens of developing countries have little access to information and poor involvement in what is related to local businesses, community services or institutional entities. The increasing adoption of smartphones in Mozambique opens thus an opportunity for mobile crowdsourcing platforms, which allow real-time gathering of contributions from a large local community. When used to enhance city services, it can be very useful, letting citizens play an active role in their community.

The objective is to create a mobile application to collect, report, share and search for information about all things that matter to citizens: from businesses' opening hours and promotions, to community problems, important events, advices and much more. Registered users (reporters/scouts) can provide geotagged facts and occurrences, while unregistered citizens can only add temporary information and see what happens in their neighbourhood. Institutional consumers can visualize stats or anonymous reports (e.g. a broken tube in a road, a leak in the roof of a school, etc.), which might be extremely valuable to promptly react to eventual problems.

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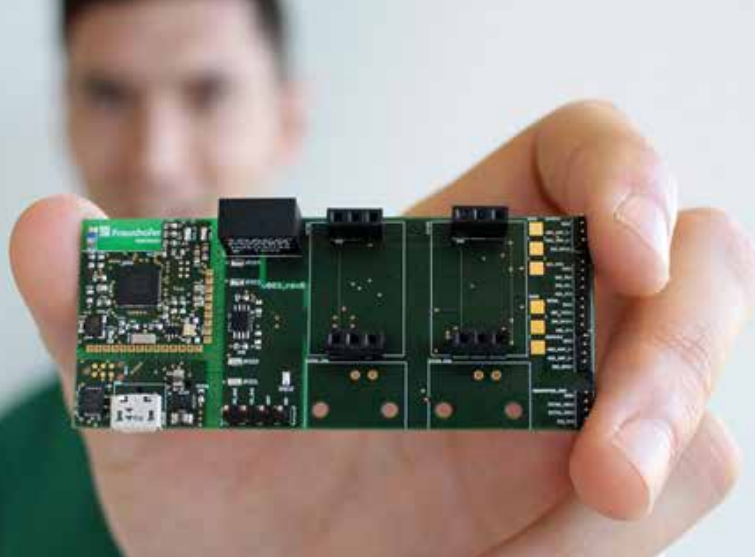
This initiative is fully citizen centered: information is relied from citizens to citizens. The innovation lies in the combination of different types of services, namely eCommerce, social network and citizen reporting, in one platform tailored to developing countries.

Partner: Centro de Informática da Universidade Eduardo Mondlane (CIUEM).

Outcome: The first deployment of the mobile platform will be more focused on eCommerce and business directed information. It is anticipated that this platform will boost small commerce and enhance the engagement between citizens and other local stakeholders.

PIL – Precise Indoor Location
(Associated with the FCC)

Description: Indoor location systems are an important enabling technology for applications such as indoor navigation, public safety and security management, ambient intelligence, as well as provide huge potential around advertisement and retail businesses.

Because of the lack of reliable GPS (Global Positioning System) signals inside buildings, the so-called pedestrian navigation systems (PNS) have been emerged as a solution for the indoor positioning unsolved problem. These systems rely on dead reckoning algorithms based on fused data provided by an Inertial Measurement Unit (IMU).

Since smartphones embrace always-on and sensor fusion was already a topic studied at Fraunhofer Portugal, under the scope of FCC, using these devices as IMUs seemed to be the obvious solution to achieve a highly accurate indoor location system at very low cost.

Dead reckoning based on the fused data provided by IMU on the smartphones can then be used to evaluate one's current position by using a previously determined position. Location-based sensor fusion will become a standard feature in next generation smartphones.

Since dead reckoning is subject to cumulative errors, navigational aids are needed in order to give accurate information on position. This aided information can be gathered from any system that can provide reference points with increased resolution.

In order to evaluate the accuracy of this location-based sensor fusion, Fraunhofer Portugal approach relies on the Ultra-Low Frequency Magnetic Communication (ULF-MC) system as a navigational aid. ULF-MC is a communication technology developed at Fraunhofer Portugal in 2012, that when combined with a last fix from a Global Navigation Satellite System (GNSS) will lead to absolute coordinates.

Outcome: This project will result in a service which maps navigational aids on a real-world indoor map model and project the path information, retrieved by the smartphone, over it.

PILV2 – Precise Indoor Location (Phase II) **16**

Description: The patent pending Motion Tracking solution developed by Fraunhofer AICOS differs from the classical dead reckoning approaches by employing filtering techniques that are based on the knowledge of human gait. Our body produces cyclic movement patterns as a consequence of the alternate movement of the legs while walking. The knowledge of human walking behaviour enabled the research team to link the data acquired by the IMU on the smartphone to the gait cycle, making possible to detect each time a step is taken and to quantify the amount of movement produced by the person.

However, as dead reckoning is subject to cumulative errors, navigational aids are needed in order to give accurate information on position. This aided information can be gathered from any system that can provide reference points with increased resolution.

The latest developments on PIL's solution led to an innovative approach for generating and maintaining reference points that later can be used to correct and calibrate the system. This innovative approach, that has already been the subject of a patent application, aims to achieve an overall sub-meter accuracy solution that does not require any kind of infrastructure and prerequisites in terms of specific actions to be taken by the operators of the indoor spaces.

The target markets are e.g. advertisement and retail businesses, public and private safety providers as well as continuous monitoring of elderly or other Ambient Assisted Living related activities.

Outcome: The main outcomes of this project are:

– A software library that exposes an indoor positioning service, that is able to map reference points and provide absolute positions on a path taken by an user;

– A cloud based solution that is able to generate reference maps, based on the information retrieved by an user's smartphone regarding its surroundings and context;

– An application that demonstrates the features of this solution to be show-cased to potential clients.

PostboxWeb – A framework for occasionally connected and shared Android smartphones
(Associated with the ICT4DCC)

Description: The African mobile market is the fastest growing mobile market worldwide, and prices for related technologies, including smartphones, are falling rapidly. The number of mobile device users is growing so fast that there are predictions that those countries will miss the PC (Personal Computer) era and will accomplish all their needs through smartphones and alike. Many people have adopted mobile phones for daily tasks, which range from basic communication with relatives to small family business support, either for communicating with customers or receiving service requests. However, missing or intermittent network coverage and low available bandwidth still pose serious barriers to mobile applications which rely on the Internet, especially in rural areas. Additionally, even though mobile phones and even smartphones' entry prices are quickly falling, shared phone usage in developing countries remains a very common reality.

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Taking these two facts into account, a framework called PostboxWeb has been developed and tested for Android which addresses the aforementioned issues. On top of this framework, a developer is able to create offline-capable native Android applications linked to REST (Representational State Transfer) services, which synchronize their data with the network only when sufficient connectivity is available. The framework supports data caching, multi-user access and sensitive data protection. The framework allows interested parties to adapt to these countries' realities as it is multi-user-capable with the possibility to manage users and possesses an incorporated personal data storage space that corresponds to each user, thus taking into account the prominent reality that shared phones are a common usage model in developing countries. There is also the possibility of profiling the users and logging their network traffic volumes to support a paid business model thus creating an additional new model for communications and phone rental.

In addition to this, the increased processing power and available sensors in the smartphone (e.g., GPS – Global Positioning System) provide an excellent way to manage and collect information for applications like medical surveillance, which can be tailored to developing countries.

Outcome: A simple, stable and developer-friendly API (Application Programming Interface) was developed and tested, and is viable in real scenarios, offering:

– Offline support;

– Automatic data synchronization with 3rd-party REST services;

– Geolocation data retrieval;

– Multi-user support with traffic and session management;

– Multiple data collection applications support;

– Data transfer support between devices via Bluetooth and NFC (Near Field Communication);

– Sensitive data encryption.

SAFETY – A Solution for Field Operatives and Operations Management
(Associated with the FCC)

Description: In the SAFETY project a smartphone-based system to assist in operations management was created. The aim of the project is increasing the safety of Field Operatives and allow them to document their activities easily.

This solution is meant to support and simplify operations that need to have several operatives in the field and a remote operations manager. While having operatives widely deployed on the field, it is difficult for managers to keep updated with real-time information, SAFETY solution enables Operation Managers to always have access to the latest information, allowing them to more effectively manage and take timely and informed decisions.

The solution consists of three main modules:

– Field Operatives Device: a smartphone is attached to the operative's chest, for example in the vest, with the camera facing forward to enable the video streaming of the operative's field-of-sight to the operations manager. Moreover, the smartphone is used for activity monitoring and detection of other relevant events in the safety context (e.g. falls, impacts, path/route). When available, connecting a heads-up display unit to the smartphone may enable the operative to receive visual information;

– Backend Server: creation of a backend server that is able to centralise information from all operatives, and send/receive data;

– Operations Manager Visualization Tool: this tool will be able to present the information regarding all the Field Operatives in a single screen, delivering direct information regarding user states (OK, Alerts, etc.) on top of a custom designed interface.

Outcome: Development of a prototype system including a smartphone-based solution for Field Operatives, a Backend Server and control solution for Operation Managers. The prototype system will be able to let the Operation Managers track and monitor the operatives' location, state and activity at all times, as well as see what they see in real-time in emergency situations.

SmartCompanionV2 – Smart Companion (Phase II)

Description: Smart Companion (SC) is an Android customization that was specially designed to address seniors' goals and needs. It aims to be a permanently available companion to support seniors in their daily activities, through a number of tools, from messaging to medication reminder applications. Smart Companion intends to create 2 ecosystems: a technological one where seniors can use multiple different gadgets like smartphones, tablets, TV's, bracelets, external sensors, weight scales, multimedia car systems, etc. And on the other side Smart Companion wants also to support a social ecosystem where all the 3 levels of users can interact between each other:

– Primary User (Seniors);

– Secondary User (Informal Caregivers: children, family, friends);

– Tertiary User (Formal Caregivers – doctors, nurses, physicians).

The Smart Companion makes it simple for inexperienced users to master general mobile phone features, such as making calls and sending voice and text messages. It also enables its users to receive medication reminders and call the emergency line from the Home screen in just one step. The main objective of Smart Companion is to develop a 'Swiss army knife' type of solution that is supposed to become a powerful and versatile companion for all everyday situations that matter.

Outcome:

– Scalable SC architecture – included the creation of new modules and maintenance of the previous ones: mover Library; location Library; CouchDB Library; SC Library;

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– Code-re-factoring – modularization of the code, which implied some code-re-factoring;

– Development Test Suit – In order to assure the quality of the developed software a test suit and test cases were maintained and updated each time a new app was integrated or an issue appeared;

– New SC smartphone apps and integration of thesis and improvements.

SmartFeet – Exergames for Fall Prevention 17
(Associated with the FCC)

Description: A general decline in physical function and balance problems make older people more prone to falls. Exercises for balance control, mobility and flexibility are effective strategies for fall prevention, however, older people lack motivation to perform these exercises at home, in a daily-basis.

In the SmartFeet application these exercises are implemented as interactive games, in a user-friendly way. Inertial sensors are used to evaluate the performance of the person during the game as well as the movement quality.

Partner: Escola Superior de Tecnologia da Saúde de Coimbra (ESTeSC).

Outcome: Interactive games and exercises for fall prevention that are assessed in terms of performance and quality of movement by inertial sensors.

SmartMoves – Monitoring and Improving Physical and Cognitive Abilities

Description: Physical activity and specific body movements are increasingly being recommended as preventive or therapeutic prescriptions, and also to improve well-being. Particularly, in the process of ageing, keeping the mobility, muscular strength, balance and cardiovascular resistance are essential protective measures against cardiovascular diseases, falls and associated consequences.

In a first stage the project is focused on monitoring specific movements performed in the context of rehabilitation or dance that require cognitive attention and a correct execution.

A tool to measure hip and knee angles during gait, lateral steps and knee bending was developed. The relative angles during movements are calculated using the inertial sensors and validated against goniometer measurements. Other metrics associated to rehabilitation movements are being studied and implemented.

A framework for evaluating dance movements is being developed taking into account similarities between the signals collected using inertial sensors and a previously generated template.

Outcome: One outcome of this project was a tool for accurate detection of angle variations in the hip and knee during the execution of three movements: hip lifting, lateral hip opening, knee flexing and extending. This tool will be extended to the evaluation of other specific movements and associated metrics in the context of rehabilitation.

Another outcome if the near real-time evaluation of dance movements and their classification in terms of correctness of execution and timing against a signal template.

SmartSurf – Surf Performance Monitoring
(Associated with the FCC)

Description: Surf performance evaluation is often qualitative. The aim of this project is to analyse the surf performance quantitatively using inertial sensors and GPS (Global Positioning System). The inertial sensors are embedded in a waterproof smartphone or dedicated device and may be attached to the surfboard or surf suit. The system collects several measurements and computes metrics such as the number of waves surfed per session, time and distance on each wave or the maximum and average speed. Moreover, it detects and gives information on manoeuvres, like the 'cutback', which can be used to improve the surfer's technique.

Partners: Surf School Onda Pura; Portuguese Surf Federation; Faculty of Human Kinetics (FMH) from the University of Lisbon.

Outcome: Smartphone app and data collection device to obtain quantitative information on surf performance.

SousChef – Mobile recommender system for older adult nutrition

Description: Older adults often struggle with making the right decisions regarding meal preparation, healthy diets or groceries shopping. Studies also suggest that many older adults neglect nutrition and are more inclined to do so if they happen to live alone. Furthermore, under financial restrictions, which older adults often find themselves in, balancing healthy eating habits with money saving can become a complicated task.

SousChef is intended to act as a nutrition companion that guides older adult users into making wise decisions regarding food management and healthy eating. For this purpose, Sous-Chef was created as a meal recommender system running on users' mobile devices. The target audience is people over 60, independent at BADLs (Basic Activities of Daily Living). The system is able to do the reasoning by overlaying best practices in nutrition for old age with other relevant aspects, e.g. available bio-markers that will provide data from the users' health status, or others.

Outcome: A smartphone application capable of gathering nutritional values of ingredients from collections of data and with a recommender system to help elderly plan their diets taking into consideration different bio-markers and users' preferences.

SousChefV2 – Mobile application for older adult nutrition (Phase II) 18

Description: Nutrition and physical activity are at the basis of active ageing. SousChef V2 is following Fraunhofer AICOS' previous developments in the field of nutrition. Field research and field trials have shown that older adults require information and guidance on nutrition-related decisions. Furthermore, monitoring of nutritional intake and physical activity are useful not only for users themselves, but also for professional caregivers.

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The project will enhance the original SousChef project to do the following:

– Integrate Fraunhofer AICOS' previous work on activity monitoring;

– Prepare the recommender system to be able to include: price, product season, weather, meal price, stock management, leftovers, food intake logging and generation of a shopping list;

– Develop a smartphone application that will be able to generate a meal plan, change meals according to users' preferences, log intake and easily visualize activity along with nutrition related information.

The resulting application is expected later to be able to integrate other developments made at Fraunhofer AICOS (e.g. Personal Finances, ANIEPIL). It is designed to act as a food companion for older adults, following the existing strategy at Fraunhofer AICOS with other mobile applications.

Outcome: Development of central components to support Fraunhofer AICOS' nutrition-related projects: data base, recommender system, mobile application.

User Interface Animation for Seniors

Description: The smartphone user interface (UI) contains several visual animations. These animations can be simple visual effects such as transitions, selections, focus, notifications, etc. From past usability tests, it was observed that animations could confuse seniors, allowing them reject the application more easily.

The project has four main objectives:

– Collect all animations from Google TV, Apple TV, Windows Phone, Android and iOS;

– Test all animations with seniors;

– Build an animation dataset and a report, which contains usage experience describing the advantages and problems of using the animations;

– Analyse and improve the UI, regarding animation usage, of current Fraunhofer Smart Companion Project.

Outcome: Development of user interface animations, and animation guidelines that can be used to improve the experience of seniors with our applications.

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UserNetwork2015 – The COLABORAR initiative: a user network supporting human-centred design **19**

Description: The user network COLABORAR aims at maintaining and enlarging a network of users to support human-centred design processes within Fraunhofer AICOS' projects. It began as a network of older adults, in 2013 it opened up to international collaborators and in 2015 its scope was expected to grow and settle at a European level. This would not only allow Fraunhofer AICOS to access users from different countries, but also help build a network for European projects.

COLABORAR provides researchers the conditions for user research and usability testing, by arranging protocols with specific institutions and finding specific users as demanded by internal and external projects. It serves as a communication channel between researchers and real users, after which the former are responsible for conducting their planned activities with the latter.

As such, projects should take into account the services provided by COLABORAR into their planning.

For 2015 the main goals were:

– Produce white papers to share with registered institutions;

– Invest on dissemination actions to establish a group of followers of COLABORAR's activities;

– Enlarge the national and international group of individual and institutional collaborators;

– Optimize the CRM (Customer Relationship Management) application;

– Offer training and support to researchers for qualitative research and interaction with older adults;

– Have a COLABORAR mobile app for remote user research.

Outcome: Currently, COLABORAR aggregates over 40 institutions with signed collaboration protocols, including senior universities, adult day-care centres, living centres and healthcare institutions. So far, it has supported over 2000 user research and testing activities.

INCUBATING PROJECTS

The scientific and business activities of Fraunhofer AICOS are driven by the performance related funding model operated by Fraunhofer-Gesellschaft, which means that Fraunhofer Portugal's research work is oriented toward concrete applications and results. In pursue of this objective we have submitted several proposals for projects to be developed in a near future.

Active@Home – Social ExerGaming, Dancing and Tai Chi for well-being, fall prevention, social inclusion and a longer life

Description: This project proposal aims at developing a holistic solution, focusing on physical, cognitive and social aspects, to promote physical activity at home and foster fall prevention (and provide fall risk prediction), based on typical exergames, dance and Tai Chi.

The solution should feature a frontend designed for large screens (TVs), and support motion capturing through inertial sensors (either as individual devices or the ones integrated in the smartphones/smartwatches) or through 3D sensors (Kinect). A hardware abstraction layer should be implemented so that the solution can be scalable and not be tight to a specific set of sensors.

The solution should be able to track and validate all movements through the use of specially designed Inertial Measurement Unit (IMU) signal processing algorithms. The project may also include the development of a specially designed sensor featuring an IMU that can be attached to specific parts of the body to allow proper and accurate tracking of all body movements.

The advent of social networks should not be neglected and the system should allow users to share results and therefore instigate healthy competition. Furthermore, group dancing (either locally or online) is a must-have, as it will nourish social interaction and integration and eventually reinforce adherence to the programme.

On the other hand, the solution should be supported by a backend that should not only be able to manage user profiles and store all game session data for further analysis, but also be able to design models of new dances or Tai Chi movements, so that the frontend can validate the user movements against these models, adding a new level of scalability to the solution.

The socio-cultural component is also quite important, revolving around the traditional dances of each country. Older adults are keen on traditions and customs, and presenting them the possibility of learning and being challenged to perform new traditional dances adds a new motivational factor while stimulating the cognitive function. Also, the possibility of organizing community events, dance groups and competitions using this system will strengthen bonds with the community and contribute to a support network that will further help people living in their homes.

Partners: Dividat (coordinator); Comfort Keepers Portugal; ETHZ Department of Health Sciences and Technology; MIRALab - University of Geneva - Centre Universitaire Informatique; Unie KBO.

Outcome: Fraunhofer AICOS will have the chance to reactivate and improve the well-known Dance! Don't Fall solution, as well as improve current ExerGames platform, namely in what it takes to designing new or improving DSP algorithms for motion tracking / movement recognition and expanding/ improving the sensor hardware abstraction layer. There may be also the opportunity to develop a sensor featuring a 6/9-DOF IMU, probably based on the SafetySensor.

Competence Centres – Companion Competence Centre (C3) & Eyes of the Internet of Things Competence Centre (EITCC)

Description: When thought of at a distance, many of today's societal challenges stem from waste, inadequate use of resources, lack of integrated solutions and effort replication. All of these are leading not only to citizens being unable to maintain their living standards, but most importantly, to what some academics call 'defuturing'.

Facing this challenge, societies demand more from less for more, seemingly unsolvable, but which appears to be the point in ancient Greek drama, when such an impenetrable problem is suddenly disentangled by a new element coming onto the play: the Deus ex Machina.

Societies are striving for these new elements towards efficiency gains mediated by a symbiotic relationship of humans with technology. We need elements such as these, which are able to deal with complex problems and, at the same time, be transparent to the users, as 'companions' who assist in difficult, unknown or just prosaic tasks.

We have devised a robust proposal to begin tackling these challenges. It consists of two research lines, being one built on top of the other. The first one (Eyes of the Internet of Things Competence Centre – EITCC) will research and create building blocks – from tangible to intangible elements –, while the second (Companion Competence Centre – C3) will put these building blocks at the service of pressing societal needs in European and African countries.

EITCC – Eyes of the Internet of Things Competence Centre

This research line will concentrate on understanding the environment, the user and his/her context and actions. The results of this work will serve as a technological base to all target domains in the research line C3.

Partners: Fraunhofer AICOS (coordinator); Centre for Textile Science and Technology; Centro ALGORITMI.

Outcome: Four work packages build the EITCC:

- – Sensing and acting: Bringing novel sensing mechanisms and actuation by accessing existing devices and developing new Internet of Things

(IoT) sensing sources;

– Local processing and fusion: Research on data aggregation algorithms to create refined and contextual information obtained in multiple local sensing devices;

– Remote fusing and big data analytics in the cloud: Implement information fusion from multiple distributed sensors, historical and contextual data to provide higher level abstraction data to C3;

– Networks for ICT4D: Development of solutions for ad-hoc broadband networks for remote locations in developing countries.

CCC – Companion Competence Centre (C3)

Using the tools emerging from the EITCC, C3 will study relevant societal challenges within scientific domains in relation to humans in order to design 'companions', which are non-intrusive, assistive tools for everyday life.

Partners: Fraunhofer AICOS (coordinator); Centre for research in health technologies and information systems; Centre for the Research and Technology of Agro-Environmental and Biological Sciences; Centro ALGORITMI; Centro de Psicologia do Porto; Research Centre in Sports Sciences, Health Sciences and Human Development.

Outcome: C3 will study relevant societal challenges within six

domains:

– Mind and behaviour: Researching human interaction with computers, with a particular focus on human dignity, ethics, perception, cognition, communication and cultural aspects;

– Health: Researching solutions for patient empowerment, reducing burden in public health care and streamlining the path to full digitally supported electronic health;

– Nutrition: Understanding what people eat, why they eat it, and how healthier and more sustainable behaviours could be encouraged towards gains in health and reduction of food waste;

– Agriculture: Considering applications suitable to developed and developing regions towards sustainability and efficiency gains by introducing precision agriculture;

– Activity monitoring: Understanding users, their activities, context and behaviour, and providing tailored recommendations and tools that will be useful for tackling the challenges of coping with ageing and health conditions, preventing diseases by keeping an active and healthy lifestyle, improving the performance of sports athletes and increasing public safety and security;

– Community tools and social inclusion: Developing inclusive tools, which make use of crowdsourcing and data mining concepts, focused on citizen

empowerment, participatory monitoring, urban service delivery, and social equity.

CordonGris – Making sense of data to promote effortless healthy eating habits and autonomy for older adults

Description: One major cause of older adults' frailty in many countries is malnutrition. A study from January 2015 reported that 1 in every 6 seniors reaching the emergency room are malnourished (Pereira, Bulik, Weaver, Holland, & Platts-Mills, 2015) and those at risk of malnutrition are estimated to be as much as 2/3. Malnutrition can have serious consequences on one's health and independence. Being unable to follow a healthy diet will most likely lead older adults into a vicious cycle: functional decline leads to malnutrition and malnutrition leads to further decline.

The project will create a system to gather and manage all the data that is relevant for the recommendation of a healthy diet, coming from different sources: sensors for activity monitoring, user reported data, country-specific food databases, retailers' information, producers' information, service providers' information. By making sense of all the data, the central intelligent system can generate recommendations that range from meals to physical activity or other healthy behaviours and prompt people to adopt a healthier lifestyle against malnutrition. With its intelligent treatment of the data, along with the recommendations, the project will provide the conditions for the 'flat-rate food' concept to become a reality.

The project is born out of previous knowledge from the different partners and it is designed to build on a strong contribution from field implementations in the three countries participating in the proposal: Portugal (R&D + food supplier + end-user), United Kingdom (food supplier + end-user) and the Netherlands (independent end-user).

Because food can take various forms, our idea is also to acknowledge and work with these different ways of consuming food, e.g. retailers, food producers, pre-prepared food or the well-known concept of meals-on-wheels.

Partners: Fraunhofer AICOS (coordinator); Can Cook; Red Ninja Studios; Santa Casa da Misericórdia de Lisboa; Sonae Modelo Continente; Unie KBO.

Outcome: To develop a convenient system that leverages the potential of the Internet of Things to guarantee longer living at home by tackling malnutrition. We will do this by:

- Helping older adults manage their groceries shopping;

- Leveraging the power of local communities to assist each other in food related aspects;

- Providing intelligent and healthy food and meal recommendations to older adults based on health characteristics, lifestyle, culture, resources, availability, local production and season;

- Creating a comprehensive system that brings together the needs of consumers, retailers and food producers;

- Proving the concept of 'flat-rate food' on field trials.

ACADEMIC ACTIVITIES

Regarding academic activities, it is worth highlighting that the Director of Fraunhofer AICOS is an invited Professor at the Faculty of Engineering of the University of Porto and Fraunhofer AICOS is responsible for proposing a set of topics for MSc theses. The MSc students join Fraunhofer AICOS team to work on applied research projects and also in their own thesis. The topics proposed for theses are aligned with the Strategic Research Agenda defined by the Scientific Board of Fraunhofer AICOS.

ALIAS – Ambient Lighting Integrated Assistance System 20

Description: The goal of this project is the development of a personalised wireless ambient lighting for assistive environments. The main idea is to use ambient lighting as a communication channel and as a health support system. This should be provided by using 'Philips Hue' Personal Wireless Lighting system. The system will be mainly composed by a web portal and an Android module, which will allow for configuration of the system and to interoperate with 'Philips Hue' bridge (which controls the lights). This enables the possibility of configuring and interacting with the system from anywhere.

Outcome: A web portal which allows the users to easily:

– Design scenes (configuration of a light or group of lights, including their colour, intensity, blink, etc.);

– Add channels to service providers (which will be the source of triggers), likewise the programming model of IFTTT (If This Then That – https://ifttt.com/). The portal should provide a plugin system so that new channels can easily be developed and added/removed;

– Define triggers, like a medication reminder, a call, a sms, an alert, a timer, a fall, etc. Triggers may also be health related, for instance when there's a new health condition (manually provided or based on vital sign measurements);

– Create recipes where they can associate triggers to scenes, likewise the programming model of IFTTT;

– Manually change the status of the lighting.

An Android module integrated in the Smart Companion configuration allowing the users to assign alarms to preconfigured scenes/lights.

ANIEPIL – Automatic Nutritional Information Extraction from Photographic Images of Labels

Description: The nutritional information included in most food products provides a great insight of its composition. This information is important not only to compare the nutritional value of similar products, but also be important to know if a given food is suitable for one's diet.

The purpose of this project was to explore the usage of a smartphone to acquire images of labels with nutritional information and to analyse them using image processing algorithms in order to automatically extract and recognize the contained nutrition information. This information can later be used to assist people interpreting these labels.

Outcome: Two use cases were considered for the ANIEPIL mobile application:

– Compare the nutritional values of two identical food products;

– Help users assess the suitability of a given food to their diet according to their personal information (anthropometric data, diseases, diet restrictions, etc.).

BikeNav – Bike Inertial Navigation System

Description: Global Positioning System (GPS) is a space based satellite navigation system that provides location and time information whenever there is an unobstructed line of sight for four (or more) GPS satellites. Although it is the main positioning system used nowadays, there are times when it is not possible to reach GPS satellites, such as within (really) big cities, inside buildings, underground, etc.

Inertial Navigation Systems (INS) on the other hand, is a navigation system that uses motion (accelerometer) and rotation (gyroscopes) sensors to continuously calculate via dead reckoning the position, orientation and velocity of an object without the need of any external reference.

The purpose of the BikeNav project would be to implement an INS system using smartphones for bicycles and evaluate the reliability of this approach. The main goal is to have an INS system capable of keeping the real time navigation when the GPS signal is lost. In order to achieve that this system must be able to keep track of the user orientation (heading), through the gyroscope and magnetometer available in the smartphone. Additionally, the system must also be able to detect accelerations, in order to keep track of the users speed.

The first practical application of BikeNav is helping the African Community Health Workers (CHW) on their daily job, in the context of Syndromic Surveillance project. These agents are chosen by the community to provide basic health and medical care in developing countries. CHWs can drive bicycles for more than 25km a day moving between isolated populations. The Syndromic Surveillance requires CHWs to collect clinical data using mobile devices in scenarios of failure/low coverage mobile networks. The data needs to be related to Geo-location and earth observation from satellite data. Syndromic Surveillance will allow detecting and predicting outbreaks or epidemics, through the analysis of correlated data.

CHWs are indeed the main agents of the Syndromic Surveillance and their mission needs to be performed by bicycles in the countries of Sub-Saharan Africa, with the following challenges:

– Dense forests or mountainous regions as barriers to the reception quality of GPS signal;

– GPS not always can be assisted by failing 3G networks, which leads to lower accuracy and longer time for location lock;

– Near real-time positioning tracking is crucial since each clinical data collected should be associated with GPS coordinates;

– Low precision positioning of 500 – 1.000m2 is an acceptable requirement for our client, since this is the maximum resolution of their Earth Observation software.

Outcome: This project aims to be a proof-of-concept of the feasibility and reliability of INS systems in bicycles using smartphones.

Besides, this project can share a lot of the base structure and knowledge with the PIL (precise indoor location) project, which aims to apply dead reckoning (DR) techniques to the person movement.

For short term practical applications and case the results are low, we could aim to use the developed work to extract simpler features, such as global distances and average speed information, which could also be useful for other solutions.

BlueWarnAAL – Bluetooth based Warning System Ambient Assisted Living 21

Description: Ageing is one of the greatest social and economic challenges of the 21st century for European societies. The European Union estimates that by 2025 more than 20% of Europeans will be 65 or over. When growing old, the physical ability of elderly people gradually wanes, making them prone to accidents that can result in injury, hospitalization, or even loss of self-care ability. Considering these challenges is important to ensure that older adults can extend the time they can live in their preferred environment by increasing their autonomy, self-confidence and mobility. In order to prevent household accidents, is important that houses are equipped with several sensors that can provide information and warnings on the well-being of older adults.

This project aims to develop a solution for a warning system that can, detect malfunctions in house environment, for instances, non-supervised electrical consumers, water leaks and gas/smoke leaks. The goal of this project is to design a Smart Bluetooth (formerly known as Bluetooth Low Energy) based hardware and software solutions that can monitor the aforementioned malfunctions and alert formal or informal caregivers. The developed solution should envisage Android smartphones, or other Android based platforms, as the interface and gateway to the system.

Outcome: The project aims to develop a solution that can demonstrate the potential of Smart Bluetooth enabled devices in AAL scenarios.

Besides this, the knowledge and experience of using Smart Bluetooth for the Internet of Things should be reused in Fraunhofer AICOS' on-going projects.

Ecosystem of
and services

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COPD – Use of a Smartphone for Improved Self-Management of Pulmonary Diseases

Description: According to the World Health Organization (WHO) estimates, currently 210 million people have Chronic Obstructive Pulmonary Disease (COPD) and 3 million people die of COPD every year. The WHO predicts that COPD will become the fourth leading cause of death worldwide by 2030. Total deaths from COPD are projected to increase by more than 30% in the next 10 years unless urgent preventive measures are in place. Also in the Portuguese media, the pulmonary diseases are having a lot of attention with the related health associations alerting to the rising incidence of the disease within the Portuguese population. Several national organizations recently alerted to the prevalence of this disease and the need for solutions to adequately monitor and support medication intake.

In fact, and although medical treatment of COPD has advanced, non-adherence to medication regimens poses a significant barrier to optimal management. Underuse, overuse, and improper use continues to be the most common causes of poor adherence to therapy. An average of 40%–60% of patients with COPD adheres to the prescribed regimen and only 1 out of 10 patients with a metered dose inhaler performs all essential steps correctly.

Outcome: COPD is a smartphone support app that, besides continuously monitoring (every day) the condition of the patient by asking five simple questions concerning the symptoms of the disease (or by using external sensors to monitor the vital signs considered relevant for these patients), educates, advises and monitors the inhaler usage, based on the time, current location, medication information (using the results of previous related MSc theses) and evolution of the patient's symptoms.

The developed app can be connected with the local pharmacy for priority communication and follows Smart Companion user interface and development guidelines.

EMGesture – Electromyography and inertial sensor-based gesture detection and control **22**

Description: Hand and arm gestures detection provides a natural way of human computer interaction. The ability to efficiently detect gestures can be applied not only to consumer electronics control (e.g. controlling the smartphone, tablet or smart TV), but also to the detection of functional motor activities for physical and cognitive rehabilitation and fall prevention.

Surface electromyography (EMG) is a technique for evaluating and recording the electrical activity produced by skeletal muscles. EMG signals can therefore be used to detect arm movements and recognize hand gestures. However, due to some problems inherent to the EMG measurements, the number of gestures which can be discriminated is still limited.

An inertial measurement unit (IMU), including a 3-axis accelerometer, a 3-axis gyroscope and (an optional) 3-axis magnetometer, enables the measurement of motions and rotations and, using specific sensor fusion techniques, it can also provide information about the arm segment orientation with increased accuracy. IMU signals can therefore be used to recognize gestures and evaluate the quality of movements.

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Considering the complementary features of EMG and IMU, their data fusion can be used to increase the number of hand, wrist and forearm gestures that can be discriminated with increased accuracy.

Outcome: Multi-channel surface EMG and IMU sensors attached to the arm were used to detect hand, wrist and forearm gestures. A data fusion algorithm based on the complementary features of EMG and IMU was developed so that an increased number of gestures could be detected. Gesture recognition finds application in many areas, including gesture-based interaction for people with disabilities and rehabilitation.

ExerBalance – Balance-board based system for rehabilitation of patients with balance disorders 23

Description: Acquired Brain Injury (ABI) is the main cause of death and disability among young adults. In most cases, survivors can experience balance instability, resulting in functional impairments that are associated with diminished health-related quality of life. Traditional rehabilitation therapy may be tedious. This can reduce motivation and adherence to the treatment and thus provide a limited benefit to patients with balance disorders. Moreover, falls and fall related injuries are one of the most serious problems in elderly people, many times leading to functional impairments, isolation and even death.

The idea around this project is to develop a system based on the Nintendo Wii Balance Board (WBB) or similar, which has been indicated by clinical therapists to improve standing balance in patients with ABI through motivational and adaptive exercises. The system should also be used for fall prevention, using the same type of exercises. The WBB contains four force sensors (located in each corner) that are used to measure the user's centre of balance and weight.

The system is composed by game-based exercises that were designed in cooperation with physiotherapists, as well as the associated evaluation metrics (Berg balance scale, Brunel balance assessment, etc.). The exercise sessions are tracked by continuously retrieving relevant data from the sensors and the results (according to the provided metrics) may be stored for further analysis by the physiotherapists.

The final result was integrated in the ExerGames platform.

Outcome: The virtual (physical) rehabilitation topic is being quite active over the last years. The outcome of this project expands the current offer of the ExerGames solution that was developed in the scope of the FCC – Fall Competence Center and improves our knowledge in body balance theory and its impact in psychological aspects (e.g., fear of falling) and objective aspects (e.g., fall prevention, risk of falling).

EyeFundusScope – Mobile-based Risk Assessment of Diabetic Retinopathy by Image Processing 24

Description: Diabetic retinopathy is a complication of diabetes that affects the eyes. In the initial stages, it is generally asymptomatic. However, diabetic retinopathy is the leading cause of new blindness in persons aged 25-74 years in the United States. The exact mechanism by which diabetes originates retinopathy remains unclear, but experts suggest that it may be caused by high blood sugar levels damaging the blood vessels of the light-sensitive tissue at the back of the eye (retina).

On early stages of retinopathy, the damage is limited to tiny bulges (microaneurysms) in the blood vessel walls. Although these can leak blood and fluid, they do not usually affect the vision. Visual loss due to diabetes can be prevented by retinal laser treatment if retinopathy is spotted early. In patients with type 2 diabetes, retinopathy may be the first sign of diabetes and vision-threatening retinopathy may already have developed by the time of diagnosis. To protect the vision, one has to take prevention seriously by carefully controlling the blood sugar level and performing regular eye exams.

The goal of this project is to create a mobile-based solution that can provide an effective pre-diagnosis of Diabetic Retinopathy to be used in self-monitoring end-users. On the latest generation of smartphones, which exhibits significant improvements in terms of image acquisition, portable adapters are mounted to built-in cameras to provide optical magnification required to reach the interior surface of the fundus of the eye (including retina, optic disc and macula). Automated image processing for the detection of microaneurysms on early stages of diabetic retinopathy is the first target given its great importance, in the context

of end-user self-exam. These users require a continuous monitoring solution with computer-aided alignment of the eye fundus on imaging exams. The self-exam is meant to be fast and simple, requiring the adapter to barely touch the face and without any discomfort, and also helping the user on the crucial alignment process of the eye in fundography.

Outcome:

– Smartphone application for computer-aided alignment of the eye fundus on imaging exams;

– Smartphone application for image recognition and automatic annotation of microaneurysms on eye fundus, for risk assessment of Diabetic Retinopathy.

EzNav – A Web browser for the elderly

Description: The evolution of technology and new application ideas happen so fast that it is hard to keep up with all the new features and capabilities on offer by the newly-launched smart phones and applications. This is an interesting phenomenon and keeps tech enthusiasts on their toes for the next big thing.

However, one thing that seems to be lagging behind is keeping in mind the people that aren't used to all the new advances in technology and need to be aided, the elderly in particular. At Fraunhofer AICOS, we aim to create innovative and targeted solutions for this group of users. However, we lacked a solution for these users that is able to leverage the kind of information discovery and creation made possible by one of the most important and successful platforms that our society created in the twentieth century: the World Wide Web. For that, it was necessary to 'reinvent the web browser' – and make it accessible to senior adults.
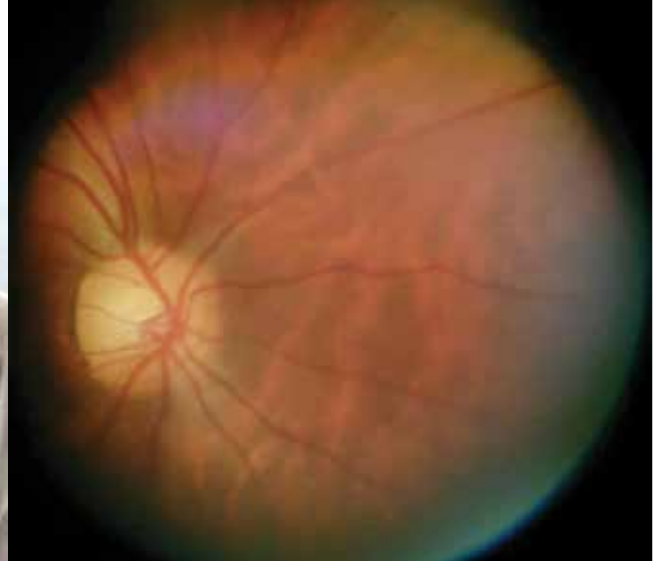
Outcome: Web browser application for Android that maintains consistency with the developments of the Smart Companion project by being targeted to older adults, having a simple and clever user interface, and being ready to be used as a module in those projects.

The finalized version is ready to be integrated with our current solutions as well as sold as an add-on application for the current users of Smart Companion.

HydroSNet4D – Hydroponic Sensor Networks for Developing

Description: The inception of intelligent control circuits that interface process monitoring systems with ubiquitous mobile based applications has proved to be effective in the management of industrial processes. Such benefits promise to be valuable in the hydroponic farming, and provide a low cost solution for the management of hydroponic farm environment.

Hydroponic farming is a mean of precision agriculture where plants are grown in mineral nutrient solution instead of soil. This type of farming became relevant in South Africa, since it offers a controlled environment, making urban farming a more practicable mean of agriculture.

An Assistive Environment for Hydroponic Farming system aimed at monitoring the farm environment was proposed and developed as a project under Fraunhofer AICOS Information and Communication Technologies for Development Competence Centre (ICT4DCC). The objective of the Assistive Environment for Hydroponic Farming has been to monitor the environmental variables in the hydroponic farm, and provide the farmer with alerts on any parameters that may deviate from the required range for the optimal growth of the plants.

However, just providing the farmers with notifications on any anomalies in the hydroponic farm still requires the farmer to physically go to the farm and make the rectifications on the alerts. This still remains cumbersome for the farmers who will still have to do other chores on farm management. So, the effective management of hydroponic farming requires constant monitoring and control of inside and outside parameters: temperature, humidity, turbidity of the nutrients solution, watering, among others. Such system requires the use of a reliable sensor/actuator networks spread along several farms, each with approximately 10.000 square meters, where an undelivered message could lead to the destruction of an entire greenhouse production. Hydroponic greenhouse sensors and actuators, as well as, monitoring and control solution, already exist in the market, however, are too complex and expensive to be applied in the South African context.

Following this premise, the objective of this project was to develop a robust sensor and actuator network suitable to be deployed on the South Africa greenhouses, and with them, build a sustainable (low power and low cost) and reliable monitor and control system for hydroponic greenhouses on the South African context.

Outcome: A reliable sensor network suitable to be applied on the South African hydroponic greenhouse context.

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ICT4Dgui – Graphical User Interface recommendations for ICT4D

Description: Smartphones are thriving in developing countries and a bit throughout rural communities. Many populations have skipped computers or laptops and are experiencing their first contact with Information and Communication Technologies (ICT) through smartphones. Furthermore, these are regarded as crucial in creating opportunities for human development, namely through new work opportunities or access to health services and information.

Nevertheless, there is still little research about how human diversity specifically affects the way in which elements in Graphical User Interfaces (GUIs) are perceived. Understanding prototypical images, visual references and the principles of how different cultures regard and interpret graphic elements (e.g., colour, shapes, human figures or gestures) is crucial to be able to design accessible and usable solutions which moreover do not risk going against or offending cultural values.

Researching these values and creating a repository along with guidelines for best practices in this domain would help bridge the gap between technology and humans within technology illiterate users and help boost the positive impact that ICT could have in rural communities.

Outcome: To conduct thorough research on visual aspects to inform the design of GUIs suited to different cultures and literacy levels. To conduct thorough research on polite/offensive manners in different cultures, and to translate these into guidelines for visual compositions. To create and test different examples of iconography often used in GUIs. To create a repository of recommended and avoidable GUI elements.

InvariantLoc – Body Location Independent Activity Monitoring

Description: Human physical activity monitoring is increasingly common in people's daily lives, being applied in health areas, sports and safety. Because of their high computational power, small size and low cost, smartphones and wearable sensors are suitable to monitor user's daily living activities. However, almost all existing systems require devices to be worn in certain positions, making them impractical for long-term activity monitoring, where a change in position can lead to less accurate results.

This project describes a novel algorithm to detect human activity independent of the sensor placement. Taking into account the battery consumption, only two sensors were considered: the accelerometer and the barometer, with a sample frequency of 30 and 5 Hz, respectively. The signals obtained were then divided into 5 seconds windows.

The dataset used is composed of 25 subjects, with more than 7 hours of recording. Daily living activities such as walking, running, sitting, standing, upstairs and downstairs were performed, with the smartphone worn in 12 different positions. From each window a set of statistical, temporal and spectral features were extracted and selected. During the classification process, a decision tree was trained and evaluated using a leave one user out cross validation.

The developed framework achieved an accuracy of 94.53 ± 6.82%, regardless the subject and device's position.

Outcome: The major outcome was to get a system which allows a smartphone to monitor users' activities in a simple way, not requiring a specific position.

There are many scenarios where the contributions of this project may be applicable, such as to monitor the elderly, as a rehabilitation tool in physiotherapy fields and also to be used by ordinary users, who just want to check their daily level of physical activity. In all cases, the independence of position is a big concern, not only to provide more comfort and usability, but also to avoid misplacement and, consequently, false positive or negative results.

KneeGraphy – Classification of knee arthropathy with accelerometer-based vibroarthrography 25

Description: Osteoarthritis is one of the most common diseases of the knee joint, especially among obese and elderly. However, the diagnosis rely on expensive and invasive methods as X-ray imaging or arthroscopy.

Vibroarthrography (VAG) has been proposed as a non-invasive tool for therapists to evaluate the pathological condition of the knee joint during physical therapy. It has been proposed to use accelerometers to determine if the vibrations of an osteoarthritis knee could be differentiated from a non-pathological knee under in-vivo conditions.

During a dynamic activity, the interaction between the moving articulating surfaces induces vibrations of the bones. In a healthy joint the articulating surfaces are smooth and the vibration is minimal, but as the cartilage degenerates, the articular surfaces become more rough and vibrations increase, and may become audible in extreme cases.

The accelerometers record the change in acceleration resulting from both the movement of the joint as well as from the vibration of the bones and feature extraction methods should be implemented to extract meaningful information from the accelerometer signals to develop pattern recognition algorithms for the classification task.

The inertial sensors could alternatively be coupled to an elastic knee brace to be more practical for elderly use and long term monitoring. This system could be used in the future as a non-invasive assessment tool of the articular cartilage condition. Further research could focus on determining earlier stages of arthritis, before they become symptomatic.

Outcome: Development of an accelerometer-based system for knee data acquisition and differentiation between normal and pathological knee.

This project could drive the study of specific pathological conditions that affect gait and that benefit from physiotherapy. It could also be incorporated as a screening tool for people with arthritic knee joints.

LandDemarc – Land Demarcation 26

Description: The demarcation of land is one of the earliest human activities, and its importance is transversal to many working areas. Today in Europe the demarcation of properties is quite simple to achieve and is performed by a competent team (usually working for government), but in the African continent those entities usually do not exist and the demarcation of land and properties is not properly documented. Recently, the World Bank has manifested the necessity of accurate land demarcation in Africa, considering it an issue of extreme importance for the evolution of the communities: 'Modern, efficient and transparent land administration systems are important in reduce poverty, and promoting growth and sustainable development'.

In this project, we developed a mobile app with territorial demarcation functionalities:

– Capture sets of geographical coordinates (with minimal error);

– Use geographical coordinates to map territorial areas (delimit a certain area in a map);

– Synchronize the captured information with a remote server, so it can be easily accessed and visualized by the competent authorities (for instance governmental entities).

This project also had an interesting scientific goal: to find a way of minimize the GPS+Glonas+Network location error, in order to make it viable for land demarcation, where precision is really important, even if it is needed some extra hardware or the combination of multiple smartphones or sensors.

Outcome: The main outcome of this project was a proof-of-concept application for land demarcation, adapted to the African context, combining several smartphones for coordinates capture. This coordinates were synchronized and analysed in a server, being the result a visual territory demarcation.

LiteracyTracker – Gamification and behaviour recognition in literacy assessments for Sub–Saharan African communities

Description: Literacy is transformative as it can increase earning potential, decrease inequality, improve health outcomes and break the cycle of poverty. In Sub-Saharan Africa (SSA), at least 1 in 3 adults cannot read.

Youth literacy rate in SSA, 72%, is the lowest of any region and there are many millions of children and youths that do not attend school. Youth engagement in reading and learning can be improved through the gamification of literacy and by using Information and Communication Technologies, namely mobile phones, which can take an important role in tracking literacy and in motivating people to learn how to read and write.

Several techniques for assessing literacy can be used: the traditional oral reading fluency tests, the Test of Written Spelling, lexile measurements, the early grade reading assessment, among others. Machine learning techniques can simultaneously be used to identify user literacy level specific behaviours during the literacy assessment. These behaviours can be identified, and analysed, helping to define user profiles and automatically adapt smartphone applications' interfaces for each user.

Outcome: This project aims to develop an innovative smartphone application to monitor community literacy in African countries by autonomously assessing user's literacy level through standardized but engaging tests, tracking user's literacy progress over the time, correlating user literacy level with user behaviour and interaction in the mobile app, and modifying app interface and usability according to the literacy level of the user.

The solution was built for English, but it is flexible to allow easy integration of other languages. It is important that the solution developed is tailored for African users, and has an optimized human-computer interface. The main users of this app will be Sub-Saharan African citizens, especially children in Ghana. The possibility of adaptation of user interfaces according to user's literacy can also be useful in other ICT4D solutions.

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mActivityClassify – Smartphone Real Time Classification of Activities of Daily Living

Description: A stroke is the condition that occurs when a rupture or blockage of the blood flow to the brain happens. In Europe, Japan and United States, this disease is the third leading cause of death. Each year 750.000 people have a stroke and from them, 200.000 don't survive. Most of the time, stroke survivors have to live with serious impairments in one or a few parts of the body. The rehabilitation after stroke must be a continuous process of several sessions of physiotherapy and of continuing staff and patients/families/carers education. It easily becomes tedious, repetitive and not motivational but it is extremely necessary for them, to recover their functional independence in activities of daily living.

The choice of a stroke rehabilitation treatment and of methodologies of assessment of patients' impairments is made according to the therapists' practical experience and the occurrence of abnormal or unwanted movements (compensations with non-paretic muscles) is only detected by direct observation during physiotherapy sessions. The empiric nature of physiotherapy can benefit from an extra source of information gathered outside a health facility. The exposure of the number of tasks that are indeed performed in patient's everyday life and the associated difficulty to each one of them can help therapists to tailor rehabilitation sessions that are more appropriate and adapted to each individual patient everyday difficulties.

Outcome: The goal of this project was the development of a real time classification algorithm using an Android smartphone and an external smartwatch/BLE (Bluetooth Low Energy) tag to classify activities of daily living.

The project extended our knowledge in the fields of activity classification. The correct detection of activities of daily living has big potential to be applied to the area of fall prevention. The correct assessment of different activities can also be directly applied in the gamification of rehabilitation exercises.

mBloodCounter – Image processing methodology for blood cell counting via mobile devices 27

Description: Several procedures in medicine require the counting of blood cells. The number of red blood cell (RBC) can be very important to detect and follow the treatment of many diseases like anaemia and leukaemia. The old conventional method for RBC counting under microscope is considered inaccurate and depends on the clinical laboratory technician skill. Currently, the automatic haematology analyser is vastly used for this purpose, but unfortunately is a very expensive machine. On the other hand, image processing approaches appears nowadays as a cost effective alternative to count blood cells. Most of the computer vision approaches proposed to date are based on high-quality microscopy images, so this work explored the analysis of microscope images acquired via mobile devices for blood cell counting.

Outcome: An image processing and analysis module was developed for the recognition and counting of blood cells, more specifically for counting and recognition of red and white blood cells (RBC and WBC, respectively). The images were acquired with a generic microscope using the Skylight smartphone-to-microscope adapter, as well as with the MalariaScope prototype. The developed image processing module is able to count RBC, as well as correctly differentiate and count 2 different groups of WBC (mononuclear and polymorphonuclear).

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MeasRepTasks – Measuring Repetitive Tasks using IMU's **28**

Description: Manufacturing industries rely on a set of predefined motions that need to be trained and executed in a form that should not generate health problems, as a result of the exposure time or the ergonomics execution. A set of pre-determined motions for specific tasks is used on a daily basis in large manufacturing industries and it has been extensively studied by the industrial engineering field.

Method Study (MS) is used in industrial engineering and addresses the proper standard movement execution for a well-defined task. In the past few years, solutions regarding MS had reached a stable plateau and still rely on a high workload process. On the other hand, we are assisting, on an everyday basis, to an increasing expansion of mobile and wearable solutions that are able to record Human motion. Combining the opportunities arising from the latest wearable solutions with the industrial engineering field, this project allowed to create a cost-effective accurate motion training, applied to the MS context.

The solution created to answer the proposed challenge is able to follow Human activity on the manufacturing context using a Pandlet wearable device previously developed by Fraunhofer AICOS. This device contains integrated Inertial and Environmental Units and transmits the data using Bluetooth 4.0 interface. The employee wears the device on the wrist which will automatically record data on an unobtrusive and ubiquitous philosophy. First, a reference sample is obtained from a high qualified worker in order to retrieve an approximate ideal sequence of motions for the executed task. Secondly, the acquired data of the group of employees is compared to the reference sample. Using signal processing techniques applied to time series data it is possible to present temporal and distance measurements.

Scores reflecting the proximity of the movement being performed against the reference, can also be computed, leading to a fine characterization of the movements that composes a specific task. The system output is based on a web application that is able to use the infrastructure and access real-time individual and collective information.

Outcome: This project delivered new insight on the understanding of how inertial information can be used to compare human complex movement. A framework capable of acquire, process and visualize motion information was developed and applied to the Industrial Engineering context. The achieved outcome can be considered as valuable asset that can act as a pedagogical tool to help the employee be more proficient in proper repetitive movement execution in order to identify and prevent wrong executed movements. The system was centred on the industry context on a first phase, but the developed algorithms can be used in a wide variety of repetitive activities such gait cycle analysis, electrophysiological data, rehabilitation exercises, and other repetitive activities that generate *quasi repetitive* data.

MoBIAC – Mobile multimodal biometric identification for African children

Description: In the developing world, namely Sub-Saharan Africa (SSA), the lack of official identification promotes a cycle of poverty and social exclusion for many individuals. Robust national identification systems are necessary for social, political, health and economic development, as well as aid delivery. Without a unique identification, such as the hundreds of millions of poor people who lack birth certificates in SSA, summed up with no addresses and single-word names, many individuals cannot exercise basic rights nor access several formal services, from health to financial insurance, formal employment, or democratic participation.

Biometric identification is considerably more accurate and secure than traditional methods of individual identification and authentication. When combined with technology such as mobile phones, biometrics can help streamline and extend services to remote, under-served locations, reaching marginalized groups, reducing fraud and corruption, and improving security. Biometric features can be extracted, for example, from iris scan, fingerprints, facial recognition, voice analysis, hand geometry, gait analysis, etc. One of the difficulties of biometric identification systems lies in the identification of children, elderly or disabled people. Additionally, children identification is very necessary in SSA for health and education initiatives, such as vaccination procedures.

The fusion of multiple biometrics, multimodal biometrics, helps to minimize identification error rates. Fusion methods include combining scores and classifiers or processing biometric modalities sequentially until an acceptable match is obtained.

Outcome: The project aimed to develop a multimodal biometric identification solution tailored for the Sub-Saharan Africa reality. An accurate combination of biometric characteristics for children identification was identified and implemented. The objective is to evaluate and establish an integrated mobile biometric identification mechanism that maximizes the accuracy of individual identification, especially for children. The approach integrates multiple biometric parameters and must be portable and cost-effective. The whole biometric identification process was created to be integrated in a smartphone application. The developed mechanism can be used to login or register users in smartphone applications under the ICT4D context.

MotoMask – Motorcycle HUD for navigation, communication and performance monitoring 29

Description: Smartphones on motorcycles and dedicated motorcycle navigation systems currently are not satisfying in many ways. This project followed a different approach based on a set of available hardware components (phone, Bluetooth headset, head up display (HUD), wristband controller, optionally a helmet camera), combining them through a software solution designed specifically for the needs of motorcycle riders.

The following features were implemented:

– Navigation information from the phones navigation (Google based) getting displayed in the drivers HUD (in different visualizations like an ordinary map, or as instructions in combination with animated symbols);

– Tour tracking (to record, comment and save a tour to redo, or share with other users. Optionally with multimedia support from the helmet camera);

– Call Handling for incoming and outgoing calls (using the HUD, the Bluetooth headset, and the wrist controller);

– Automatic crash detection and emergency calls (including GPS location and additional parameters (driver, blood group etc.);

– Drive performance logging (logging speed, acceleration etc.) and (if possible) to connect to on board diagnosis systems.

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Outcome: The main outcome of this project is a software solution, that combined with the already referred hardware components, creates a system that serves almost as an on board computer built with the motorcycle riders' needs in mind. It concentrates the relevant information in a screen near the user's eye, and allows easy interaction, through the remote controller in a safe and comfortable way.

MOTrack – Mobile Object Tracker 30

Description: The main goal of MOTrack is to implement a real-time visual object tracker algorithm. This algorithm will process the image of a camera to find an object of interest and track its position throughout time. It is not the goal of an object tracker to identify or categorize objects, which is done by other algorithms, the goal is to follow a generic object through succeeding video frames.

Outcome: The outcome of this project is a common component of Augmented Reality applications or any other applications which do video object/region detection. It has the potential to improve future and existing projects like: ShopView, PHAR, QuadAALper, MultiPersonTracking.

NeuropathyDetect – Early Detection of Peripheral Neuropathy in Diabetes Patients

Description: Diabetes patients often develop peripheral neuropathy, i.e. nerve damage in the upper and lower limbs, causing pain or loss of feeling in the toes, feet, legs, hands, and arms. As a consequence blisters and sores may appear on numb areas of the feet because pressure or injury goes unnoticed, resulting in spread infection and limb amputation if not treated in time.

About 60 to 70% of people with diabetes have some form of neuropathy. People with diabetes can develop nerve problems at any time, but risk rises with age and longer duration of diabetes. Diabetic neuropathies also appear to be more common in people who have problems controlling their blood glucose, also called blood sugar, as well as those with high levels of blood fat and blood pressure and those who are overweight.

Some people with nerve damage have no symptoms and in early stages this condition may be unnoticed. However, it is important to diagnose it early as it may be an indicator of poor blood sugar control. Moreover, protective measures can be taken to prevent feet injuries.

The aim of this project is to analyse the walking patterns of diabetic patients and identify early signs of peripheral neuropathy as it may also cause muscle weakness and loss of reflexes, especially at the ankle, leading to changes in the way a person walks.

Walking data from the inertial sensors built-in a smartphone or external will be collected from diabetes patients without peripheral neuropathy and with early stages of peripheral neuropathy. A gait analysis will be performed to identify the parameters that allow discriminating early peripheral neuropathy stages.

Outcome: This project extends our knowledge in gait analysis to a different application area. It can set the ground for the development of an integrated mobile solution for self-management of diabetes.

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PressureRef4PIL – Position reference with direction estimator for Indoor location systems 3 1

Description: Indoor navigation is an important enabling technology for applications such as navigation aid, location-based information and advertisement, as well to provide enhanced emergency response.

Several approaches have been proposed in recent years but none of them was able to achieve meter-level accuracy. More recently, a new approach has emerged as a solution for the accuracy issue. This approach relies on inertial sensors to track a user by continuously estimating displacement from a known position. Most recent smartphones are equipped with several sensors (e.g.: accelerometer, gyroscope, magnetometer) that provide the necessary hardware for this indoor navigation systems based on inertial sensors.

As previously stated, these indoor navigation systems, based on inertial sensor, define the actual position estimating displacement from a previously known position. On the other hand, these systems rely on low-cost sensors that introduce position errors due noise itself but also drift (from gyroscope) and magnetic interference (from magnetometer). Eventually, these cumulative errors will lead to an erroneous estimation current position.

This project proposed the development of pressure surface with communication capabilities to work as position references for an accurate indoor tracking system.

The main idea was to study and develop a pressure surface with an array of piezoelectric sensors that detect persons walking direction and send this information to the smartphone either using low energy Bluetooth or an ultra-low frequency antenna.

The later can interact with compass enabled phones in order to give those accurate references (less than one meter precision) and user orientation and direction.

Outcome: Development of smart surface to serve has a position reference, for smartphones that estimates direction and orientation for an accurate indoor tracking system.

QuadAALper2 – The Ambient Assisted Living Quadcopter (Phase II)

Description: Quadcopters are interesting pieces of engineering, accessible to the general public since the introduction of radio controlled and small-scale Unmanned Aerial Vehicle (UAV) models. Since then, major developments regarding size, stability, autonomy, control, Artificial Intelligence, hardware & software development tools, etc., have been introduced by academia and enthusiast community. Nevertheless, the vast majority of the application purposes given to these machines still fall into the recreational scope.

Recently, some have tried to exploit more 'useful' purposes for these machines, e.g. a brain-controlled quadcopter for the disabled, a quadcopter tower-building task force or surveillance tasks.

The goal of this project is to further explore the applicability of quadcopters to Ambient Assisted Living (AAL) scenarios, namely as an alternative to solutions such as Thought Controlled Quadcopter or AAL DOMEO showcased in the latest AAL Forum editions. This project intends to continue with the preliminary results achieved by a previous QuadAALper project, in which the basics – quadcopter setup (an Arducopter), wireless connectivity, basic interaction with mobile devices, etc. – have been established.

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We would be particularly interested in a further integration of the quadcopter with smartphones (or a dedicated system running Android) as an interesting solution for a quadcopter 'brain boost' (i.e. using the smartphone on the quadcopter, making it its brain, something like 'DroneItYourself' but with your smartphone as its brain. Some use cases can be explored to determine the feasibility of such solution in AAL scenarios, described below:

  – Response to voice commands (using Siri for iOs or Jeanni for Android);

  – Detection of alarm situations (burglars, temperature, CO2 – Carbon Dioxide saturation, etc.);

  – Activity monitoring, 'follow-me' modes for indoor guidance (i.e. the quad should also be capable of indoors autonomous guidance), additional inputs for fall detection solutions, etc.;

  – Applications needing user-authentication (taking advantage of facial recognition features);

  – Project images and video call on the wall.

Outcome: The goal of this project is to further explore the applicability of quadcopters to AAL scenarios. The outcome of the work should be a functional prototype, capable of carrying out at least one of the use cases previously described.

SmartRecovery – Gait analysis in patients recovering from total joint replacement using body fixed sensors **32**

Description: Osteoarthritis is a progressive musculoskeletal disorder characterized by gradual loss of articular cartilage. It is the most common cause of long-term disability for people over 65 due to the ageing process that reduces the ability of the cartilaginous tissue to withstand loads and stresses. The surgical procedure indicated for patients affected by severe osteoarthritis is the Total Joint Replacement (TJR) which aims to relieve pain and restore range of motion. However, after surgery, many individuals still experience an antalgic gait pattern and the motor pattern of the operated limb may remain slightly dysfunctional even years after the intervention and the contralateral limb may also adopt compensation strategies.

The goal of this project is to highlight the changes in post-operative stage of patients that underwent a Total Knee Replacement (TKR) with several Pandlets devices (with accelerometer, magnetometer and gyroscope) for measuring body movements, body mechanics, and electromyography (EMG) electrodes to monitor the activity of the muscles. The gait analysis will consider two different kinds of signals:

  – Spatio-temporal gait parameters (velocity, step length, cadence, balance, double support, single support and joint angles);

  – EMG (muscles activity).

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Outcome: The output of this project may promote the development of a mobile application that can help people suffering from musculoskeletal disorders improving and optimizing the recovery process, by enabling:

– The evaluation and gait analysis of patients during a 'functional' walk, typical of the daily life, outside of the laboratory/clinical environment;

– Clinicians or physiotherapists to analyse the processed data and adapt the rehabilitation program to the specific patient's dysfunctions;

– Patients to receive customized exercises proposals in the smartphone and exercise at home, without the presence of a physiotherapist;

– To fill the questionnaire for the evaluation outcome in the smartphone (no need for papers).

WESEJ – Design of wearable sensing devices **33**

Description: New technologies are ever more present in people's lives and their power can be harnessed to promote safety, independence and well-being amongst frail user groups. Wearable sensors, in particular, may play an important role in crucial matters, such as fall prevention or chronic disease management.

The aesthetics of new electronic devices to be worn or carried by the person, along with the quest for miniaturization, have been calling for major efforts from design to approach these challenges. Mobile phone producers, and the more recent wearable tech producers, have invested in creating appealing devices to be part of fashion apparel one is wearing.

This project studied and proposed new solutions and configurations for wearable sensors used in several body positions. The student worked amongst a broader team encompassing different disciplines and based his work on a set of physical, ergonomics, psychological and usability constrains that were challenged to produce novel creative solutions. Older adults were considered as the main user group.

Outcome: To design novel and yet acceptable wearable sensors suitable to older adults' needs and hopes.

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