FRAUNHOFER PORTUGAL AICOS
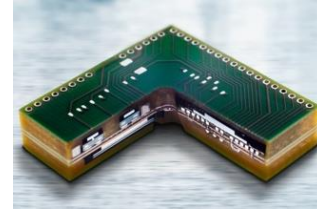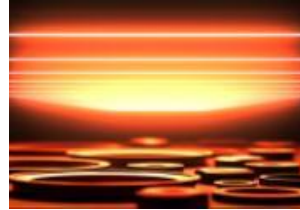
Research Center for Assistive Information and Communication Solutions

APPLIED SCIENCE BY FRAUNHOFER – MADE IN PORTUGAL

Fraunhofer Portugal

Fraunhofer – Gesellschaft

- Innovation Research
- Information and Communication Technology
- Life Sciences
- Light & Surfaces
- Microelectronics
- Production
- Defense and Security
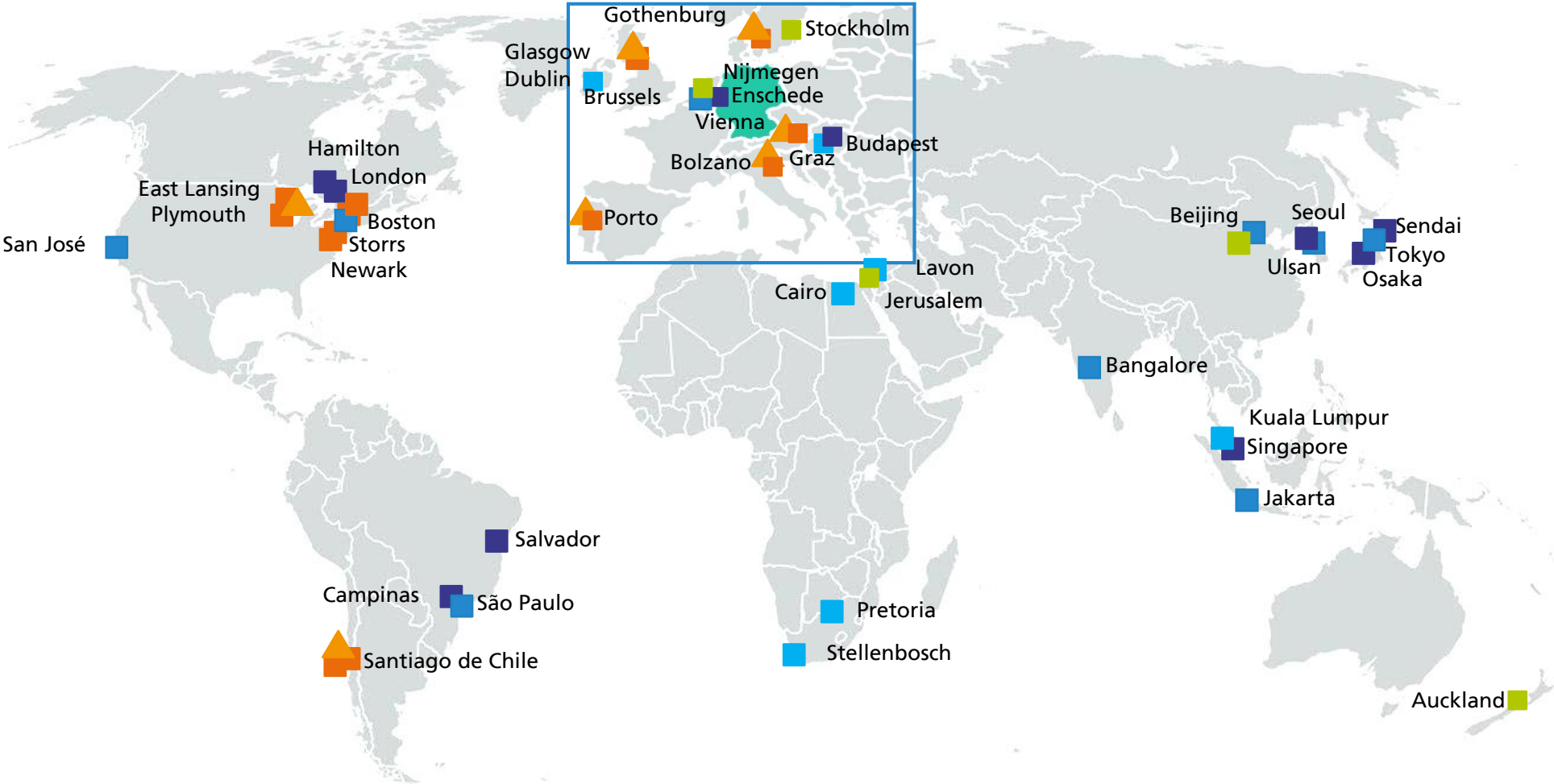- Materials and Components

72 Institutes

> 80 Research Units

~ 25,000 Employees

> € 2.3 billion R&D Budget
(€ 2 billion contract research)

Fraunhofer PORTUGAL

Fraunhofer Portugal
Fraunhofer – Gesellschaft

Subsidiary   Center   Project Center   ICON/Strategic Cooperation   Representative/Marketing Office   Senior Advisor

Fraunhofer Portugal

Institutional Background

ASSOCIAÇÃO FRAUNHOFER
PORTUGAL RESEARCH

FOUNDING ASSOCIATES

RESEARCH CENTRES

AICOS

COLA

...

2008 | Non-Profit
Research Institution of
Public Common Interest

Fraunhofer Portugal

Fraunhofer Operational Model and Technology Transfer

BASE FUNDING

~1/3 Revenues

DIRECT INDUSTRY CONTRACTS

~1/3 Revenues

NATIONAL / INTERNATIONAL R&D PROGRAMMES

~1/3 Revenues

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PORTUGAL

Fraunhofer AICOS

Vision and Mission

We create cutting-edge innovation based on end-user insights.

PROPOSING FUTURES.
IMPACTING LIVES.

REMARKABLE TECHNOLOGY,
EASY TO USE

As a leading partner for industry, we create applied research solutions capable of contributing to the market success of our clients' products and services by focusing on the value for their customers.
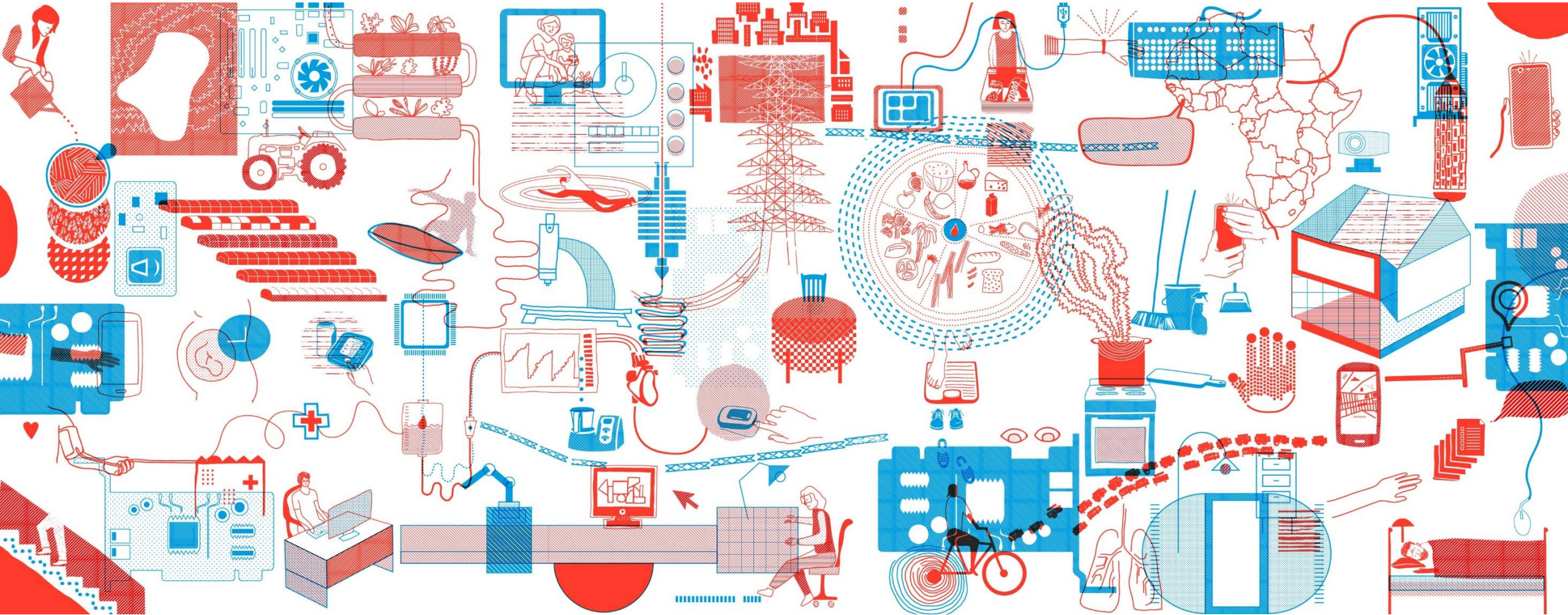
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PORTUGAL

Fraunhofer AICOS

Our Approach – Combining three perspectives in every challenge: **People**
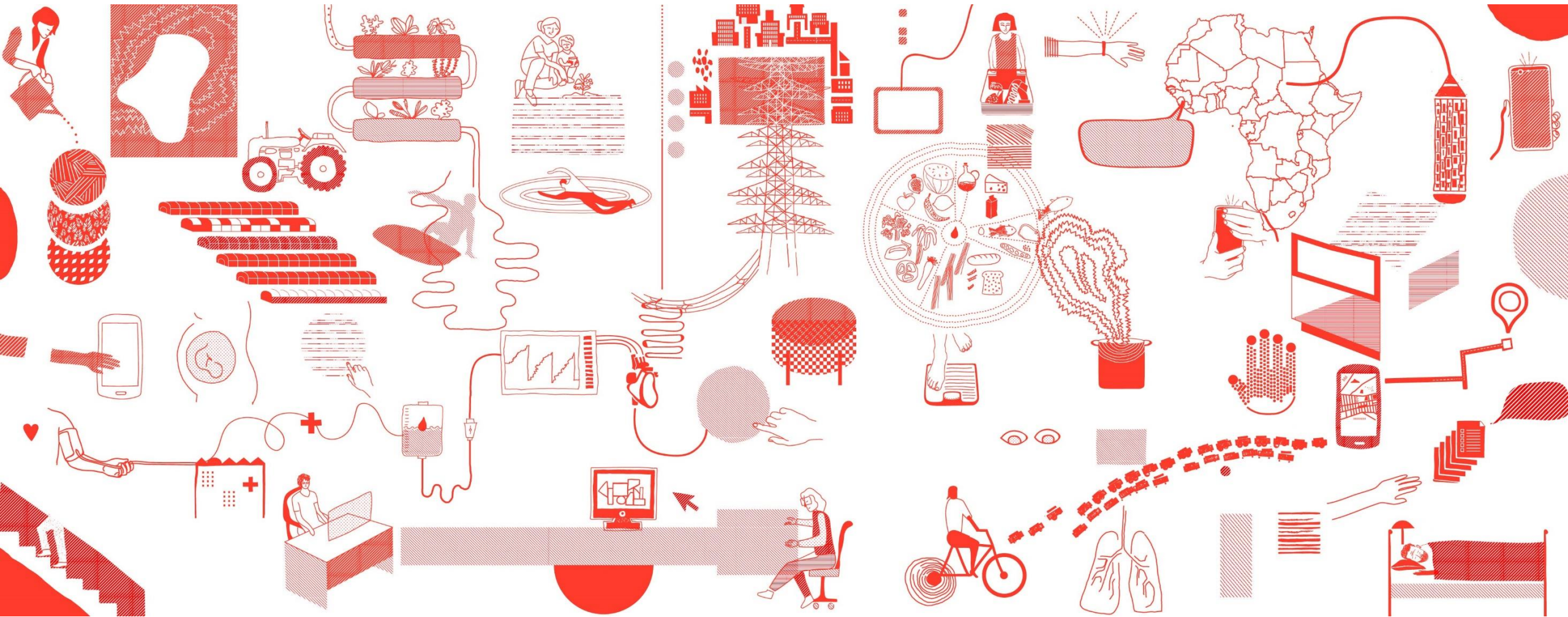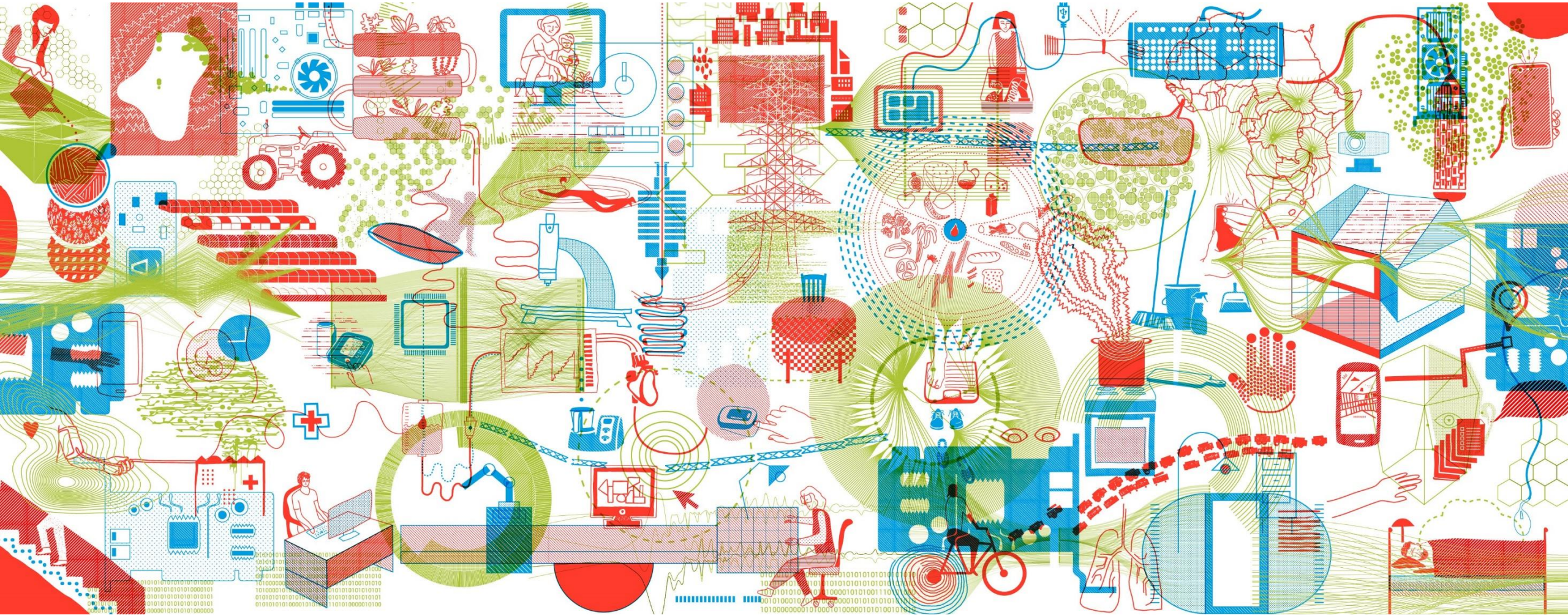
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Our Approach – Combining three perspectives in every challenge: People, **Things**

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Our Approach – Combining three perspectives in every challenge: People, Things, **Intelligence**
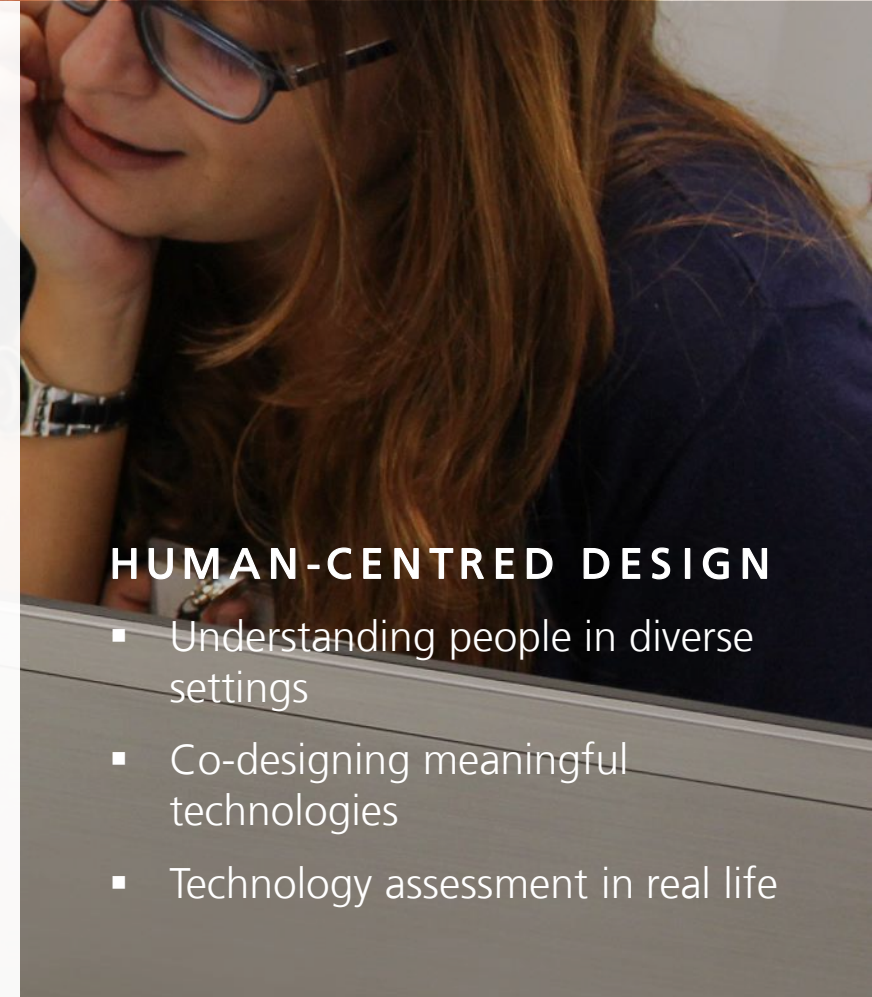
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Purpose and Scientific Areas

ASSISTIVE

INFORMATION AND COMMUNICATION SOLUTIONS

Understanding and supporting people in the fulfilment of their needs and aspirations

HUMAN-CENTRED DESIGN

- Understanding people in diverse settings
- Co-designing meaningful technologies
- Technology assessment in real life

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Purpose and Scientific Areas

ASSISTIVE INFORMATION AND COMMUNICATION SOLUTIONS

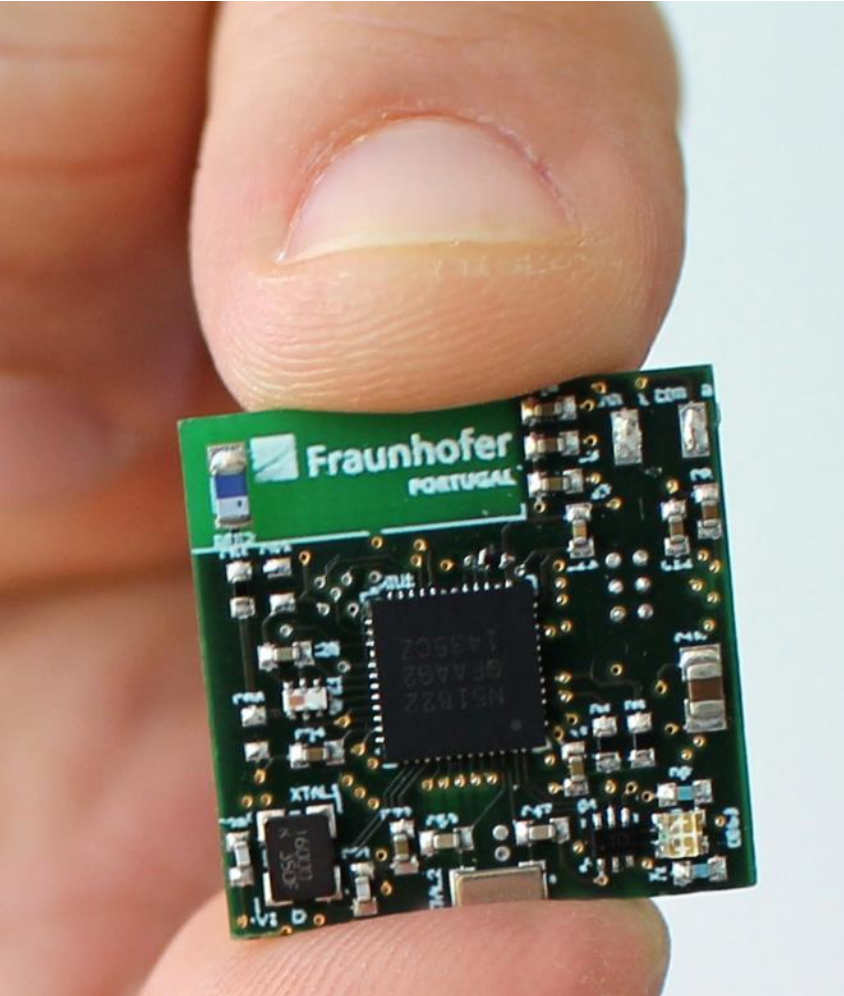Relying on data and treating it intelligently to unveil hidden patterns and support decisions

INTELLIGENT SYSTEMS

- Edge and Cloud Computer Vision
- Sensor Fusion & Embedded Intelligence
- Cognitive Systems & Deep Learning
- Predictive Modelling & Recommendation

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Purpose and Scientific Areas

ASSISTIVE INFORMATION AND COMMUNICATION SOLUTIONS

Enabling communication and supporting distributed systems through connected devices
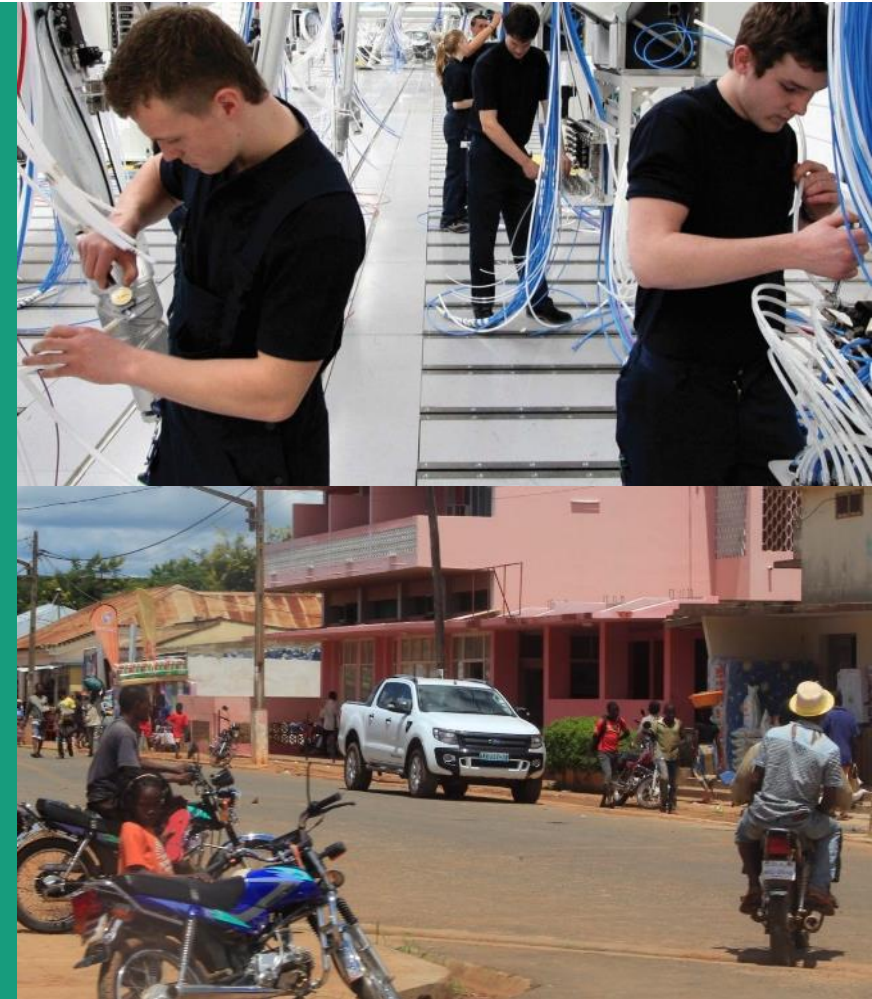
CONNECTED THINGS

- Embedded Electronics
- Communication and Networks
- Edge and Cloud Computing
- Quality Assurance & Regulatory Pre-Compliance

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ASSISTIVE INFORMATION AND COMMUNICATION SOLUTIONS

Applied research designed to bring value to businesses and society, connecting:

PEOPLE | INTELLIGENCE | THINGS

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Innovation Areas

COGNITIVE CONNECTED SOLUTIONS

- Letting everything sense
- Prediction and recommendation
- Natural user experience

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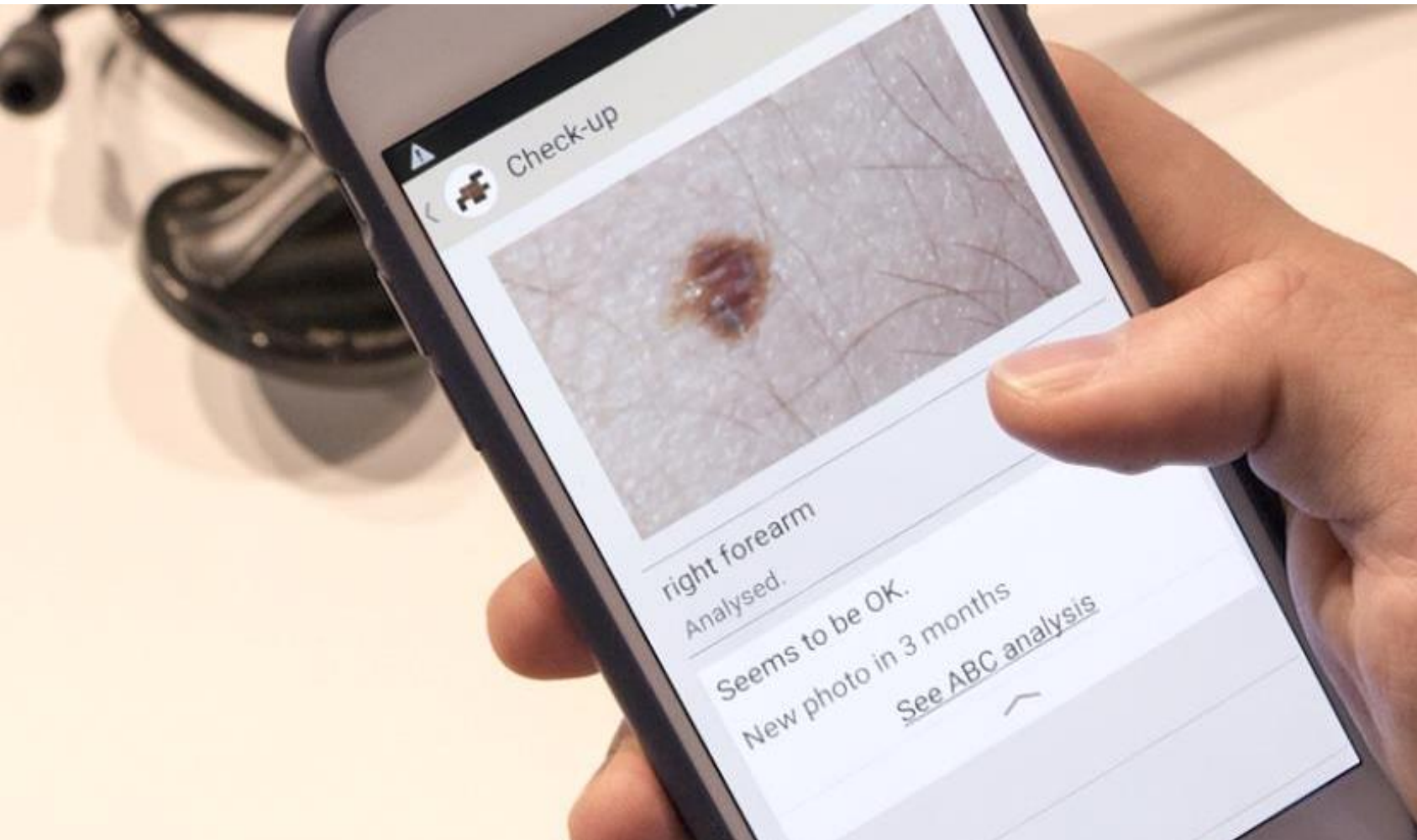
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DIGITAL FARMING

- Decision support
- Mobile crowdsensing
- Efficient and self-managed networks

ACCOUNTABLE ARTIFICIAL INTELLIGENCE

- Explainability, transparency and bias
- Accountability and governance
- Fairness and inclusion through technology

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Innovation Areas

DECENTRALISED HEALTH TECHNOLOGY

- Prevention
- Support to early intervention and diagnosis
- Self and informal care

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Innovation Areas

LIVING AND AGEING WITH DATA

- Personalised technology
- Socio-technical systems
- Technology design by non-technologists

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Portfolio

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PORTUGAL

Fraunhofer AICOS

What can we do for you?

We support our partners in the early phases of innovation and technology strategy identification, and in the design and development of innovative solutions.

We offer technical knowledge at the highest levels of science and technology and wide-ranging expertise in the areas of Intelligence, Connectivity and Human-Centred Design.

Rapid Prototyping

- 3D Printing
- Applications
- Electronics
- Machine Learning
- Networks

Innovation Studies

- Custom-designed Studies
- State of Art
- Technology Assessment
- User Research

Education & Training

- Technical and Scientific Workshops
- Professional Training

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Fraunhofer AICOS

What can we do for you?

R&D Consulting
We propose new solutions and ideas for evolving products and services;

Proofs of Concept
Initial implementation for proving that new ideas really work;

Prototype Implementation
Architectural specification; System implementation; System testing and validation;

Easy access to German Fraunhofer Institutes in other areas of competence;
8 Research Groups; More than 80 Research Units; 72 Institutes;

Member of National Scientific and Technology System
Eligible to participate in public incentive R&D programmes.

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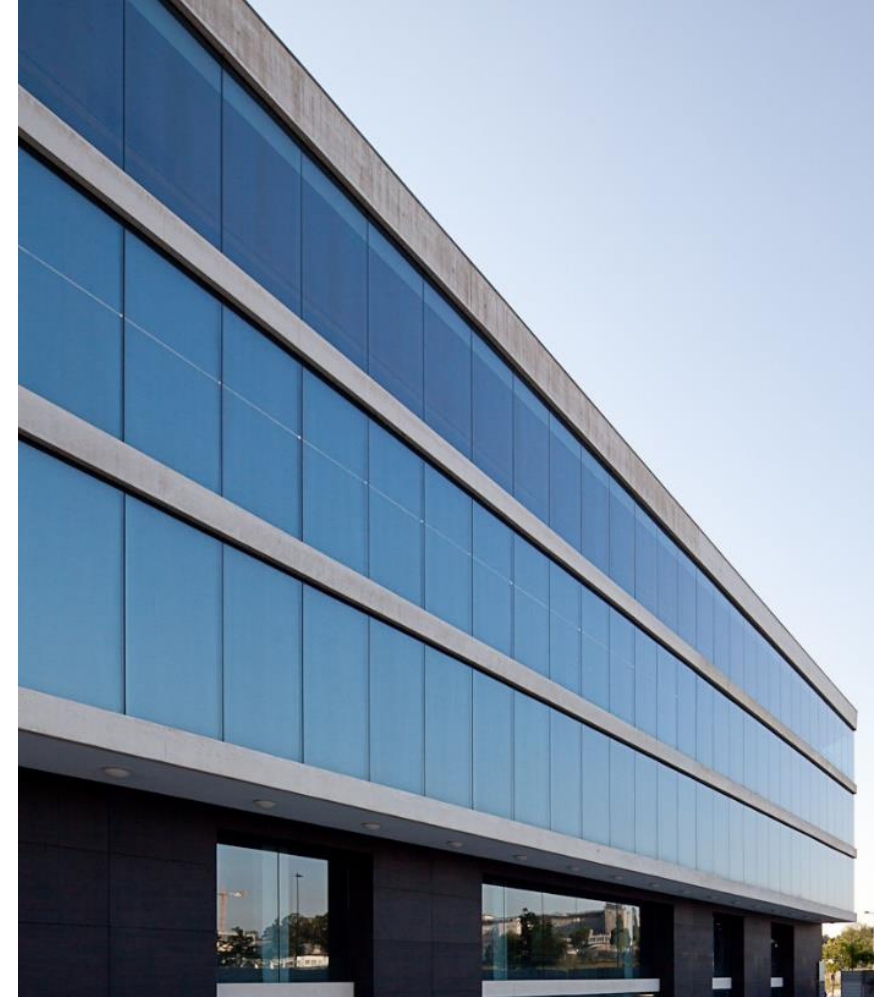
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Key Figures

72
Industry Partners

80
Researchers & Students

24
Achievements
Awards
(e.g. CES / Microsoft / Vodafone)
Honourable Mentions

199
Publications

+1,000
Research Participants

+130
Theses

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Fraunhofer Portugal Challenge | 9th Edition

PROMOTE 'RESEARCH OF PRACTICAL UTILITY'

Among Portuguese university students and researchers

IDEA CONTEST FOR MSC AND PHD THESES

Already in its 9th edition, the Challenge is based on MSc and PhD theses from Portuguese Universities

SCIENTIFIC PRIZES FOR THE FOR THE BEST IDEAS

Winning participants are awarded monetary prizes and get media coverage of their work

PORTO – Headquarters

Address: **Rua Alfredo Allen 455/461**

4200-135 Porto | **Portugal**

Phone: **+351 220 430 300**
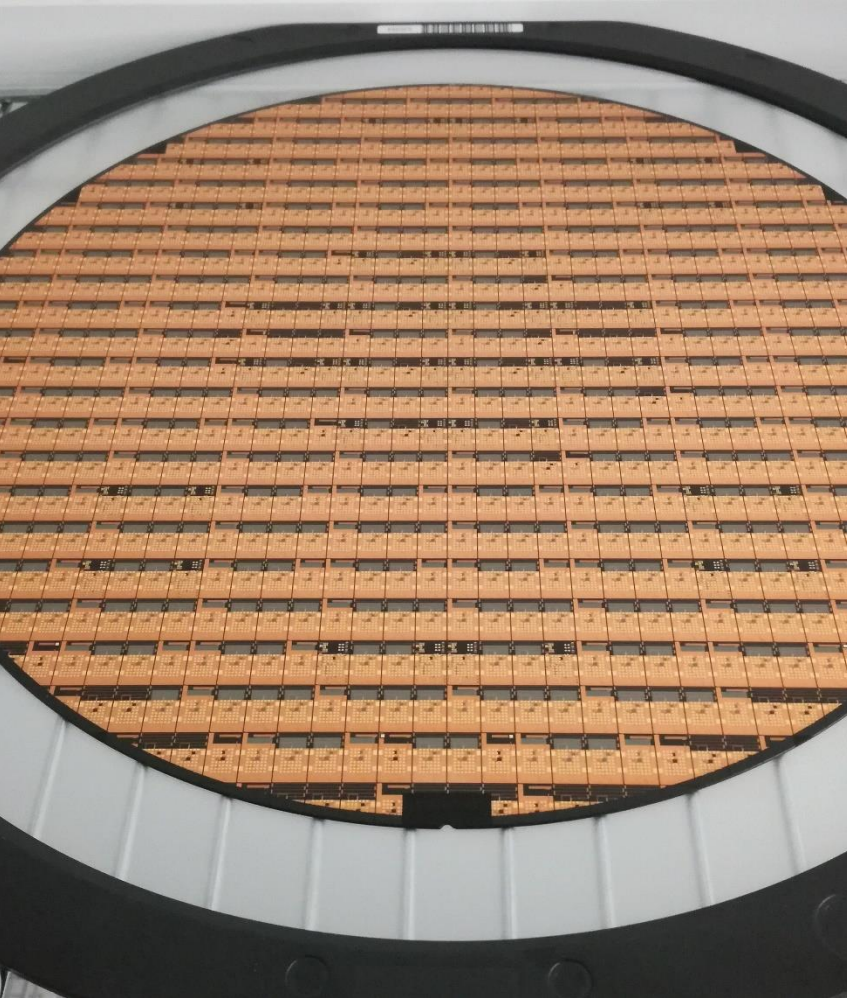
LISBOA – Branch Office

Address: **Avenida Prof. Gama Pinto 2**

1649-003 Lisbon | **Portugal**

Website: **www.fraunhofer.pt** | E-mail: **info@fraunhofer.pt** | Facebook: **facebook.com/fraunhoferportugal** | LinkedIn: **Fraunhofer Portugal**
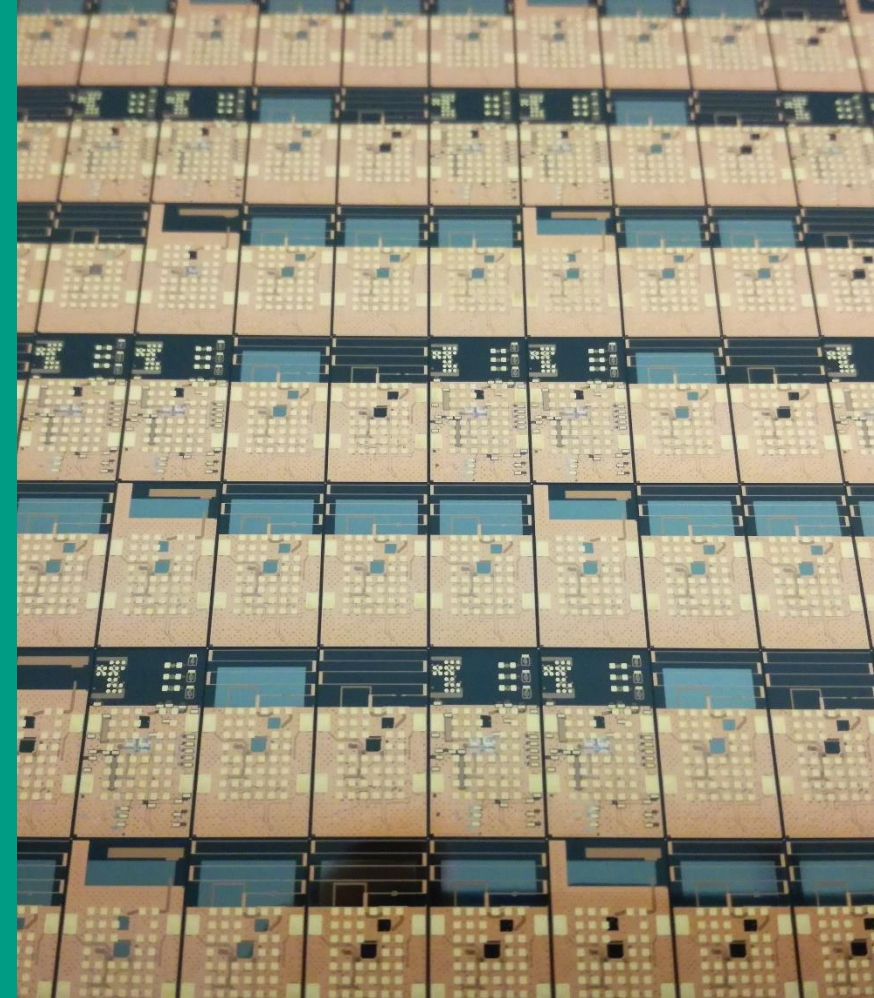
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Fraunhofer AICOS
Small, flexible, and modular cyber-physical systems

SENSE

Letting everything sense:
a small, easy deployable and
modular technology enabling
virtually any object to sense,
act and process data

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Network infrastructures for the unconnected

CONNECT

Connect unconnected communities and things using low-cost network equipment and opportunistic communications

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Crowd assisted services

COMMUNITY

Developing inclusive tools focused on citizen empowerment, participatory monitoring, urban service delivery, and social equity

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Fraunhofer AICOS
Understanding Human Movement

MOTION

Advanced inertial sensors data processing for recognizing human activities and characterizing movements

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Motion

Problem

- Physical inactivity and a sedentary lifestyle

  - Risk factor for chronic diseases and fragility fractures.

- Falls and fractures

  - Cost €25 billion[1] in EU and $31 billion[2] in USA per year;

  - Main causes for institutionalisation and loss of independence.

- Musculoskeletal disorders

  - Most common occupational disease in the EU;

  - Most important cause of long-term sickness absence[3].

[1] Hartholt, K, Falls and drugs in older population: medical and societal consequences, Erasmus University Rotterdam, 2011.

[2] Burns EB, Stevens JA, Lee RL. The direct costs of fatal and non-fatal falls among older adults - United States. J Safety Res 2016:58.
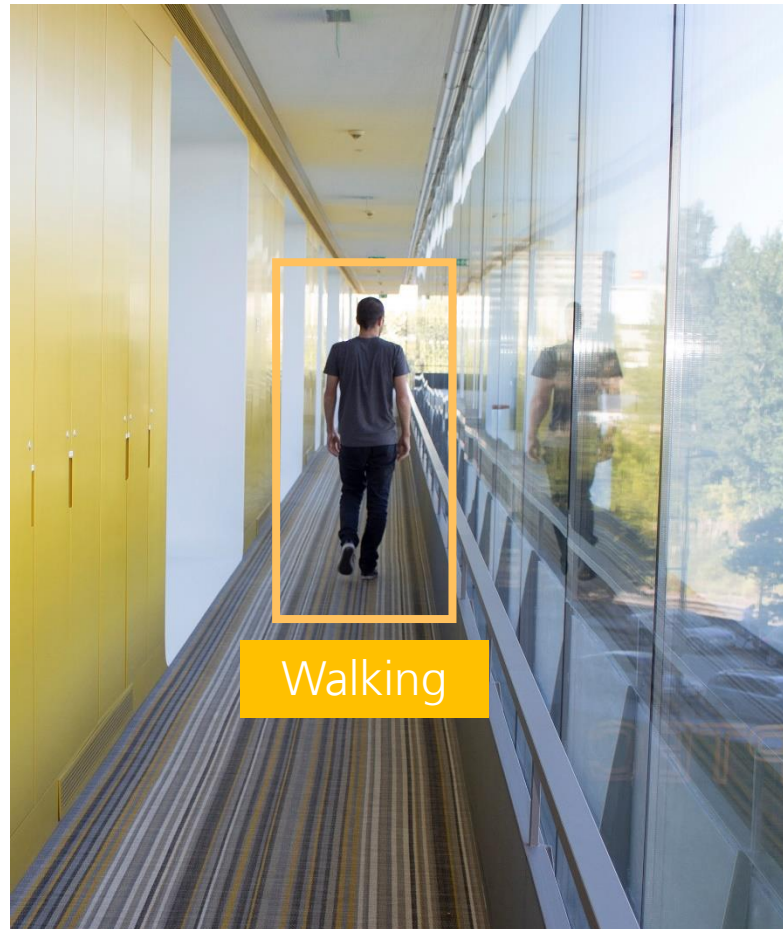
[3] European Agency for Safety and Health at Work. OSH in figures: Work-related musculoskeletal disorders in the EU - Facts and figures.
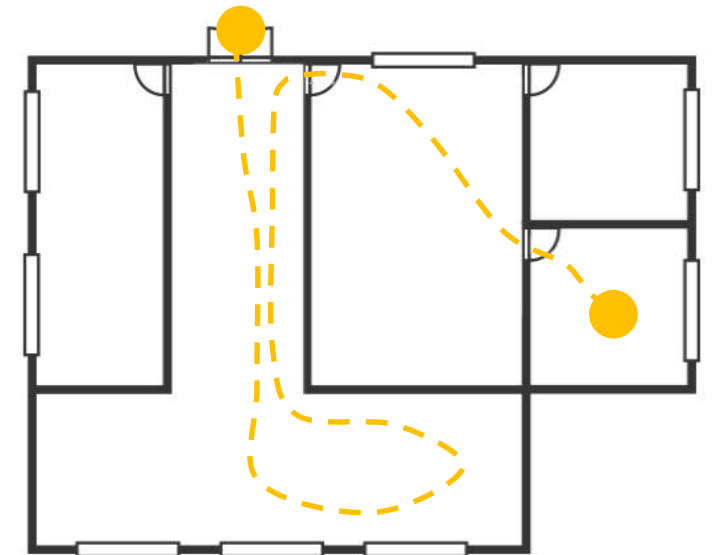
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Motion

Solution – Continuous monitoring
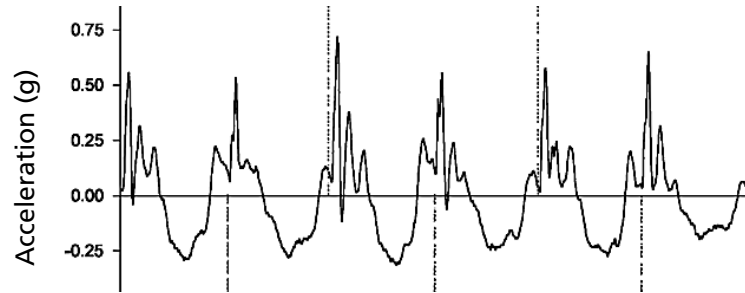
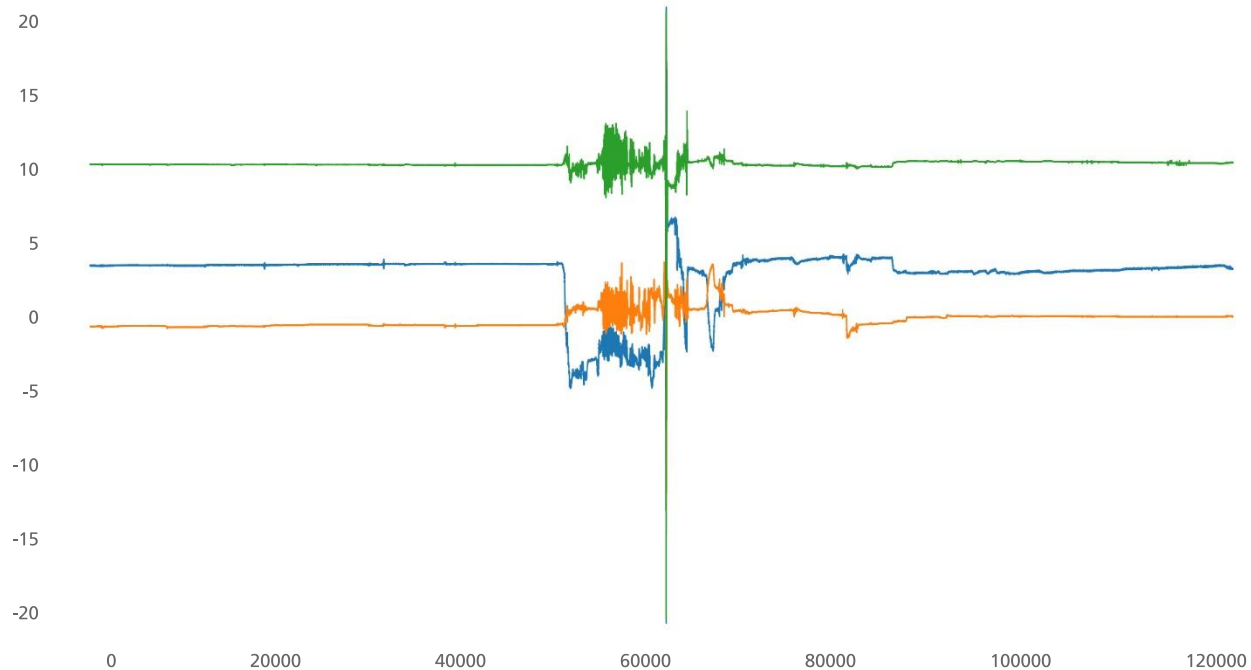

| Inertial measurement | Activity recognition/Events detection | Indoor tracking |

Motion

Solution – Continuous monitoring

Accuracy in 3,400 laboratory falls

97%[1,2]

(waist and pocket)

Accuracy in 23 real-world falls
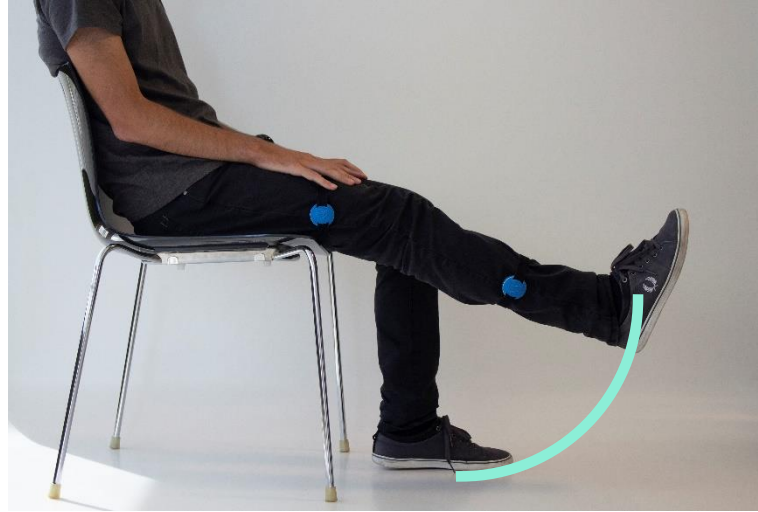
96%[3]

(waist)

[1] B. Aguiar, T. Rocha, J. Silva and I. Sousa, "Accelerometer-based fall detection for smartphones," MeMeA, 2014, pp. 1-6.

[2] J. Vermeulen, S. Willard, B. Aguiar, and L. P. de Witte, "Validity of a smartphone-based fall detection application on different phones worn on a belt or in a trouser pocket", Assistive Technology, vol. 27, no. 1, pp. 18–23, Aug. 2014.

[3] J. Silva, I. Sousa and J. Cardoso, Transfer learning approach for fall detection with the FARSEEING real-world dataset and simulated falls. 40th EMBC 2018.

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Motion

Solution – Movement evaluation

Rate	Direction	Matching	Axis
Plane	Profiling	Range-of-motion	Posture

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Motion

Solution – FallSensing

- Clinical Screening
- Clinical Intervention
- Portal
- FallSensing
- Mobile Apps
- Home
- Games

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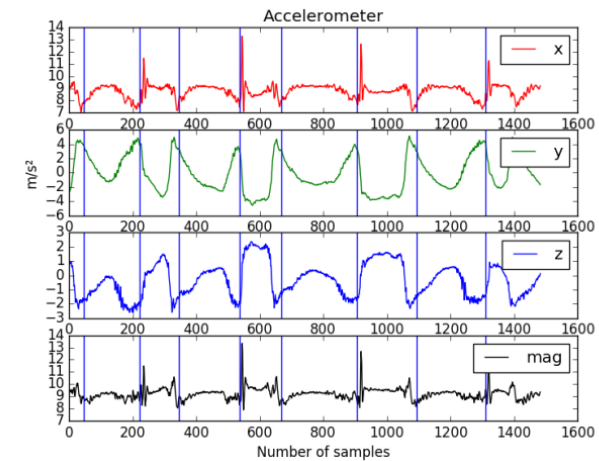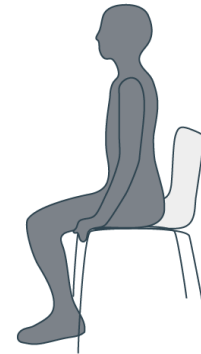
Motion

Solution – FallSensing

- **Inertial Sensors**

Inertial Sensors   Pressure Platform

Motion

Solution – FallSensing

- ■ **Inertial Sensors**

Inertial Sensors   Pressure Platform
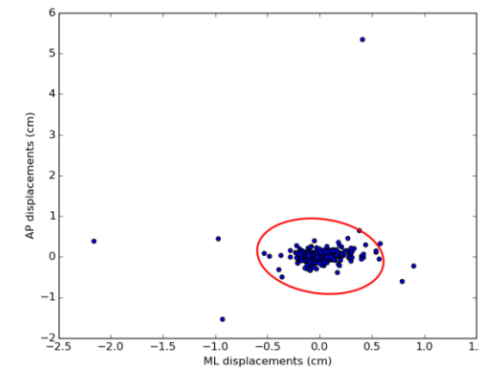
Motion

Solution – Preventive exercise

Interactive games

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Motion

Opportunities and Benefits

- **Rehabilitation Technology**

    - High accuracy algorithms for a variety of movements;

    - Improve adherence to long term plans.

- **Healthcare Technology and Equipment**

    - Metrics from continuous movements;

    - Assess diseases in free-living;

    - Quantify the effect of therapeutics.

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Understanding Human Movement

MOTION

Advanced inertial sensors data processing for recognizing human activities and characterizing movements

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PORTUGAL

Fraunhofer AICOS
Recommendation tools in nutrition

NUTRITION

Meal recommendations and shopping assistance balancing food preferences, nutrition and budget by combining information

360 CALS

Pr 45%

Ft 20%

Cb 45%

3,50 EUR

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Fraunhofer AICOS

Personalised technology for self-management of chronic disease and ageing

PERSONAL

Mobile devices connecting
your customers to your services,
backed by the science of how
humans interact with technology

Fraunhofer
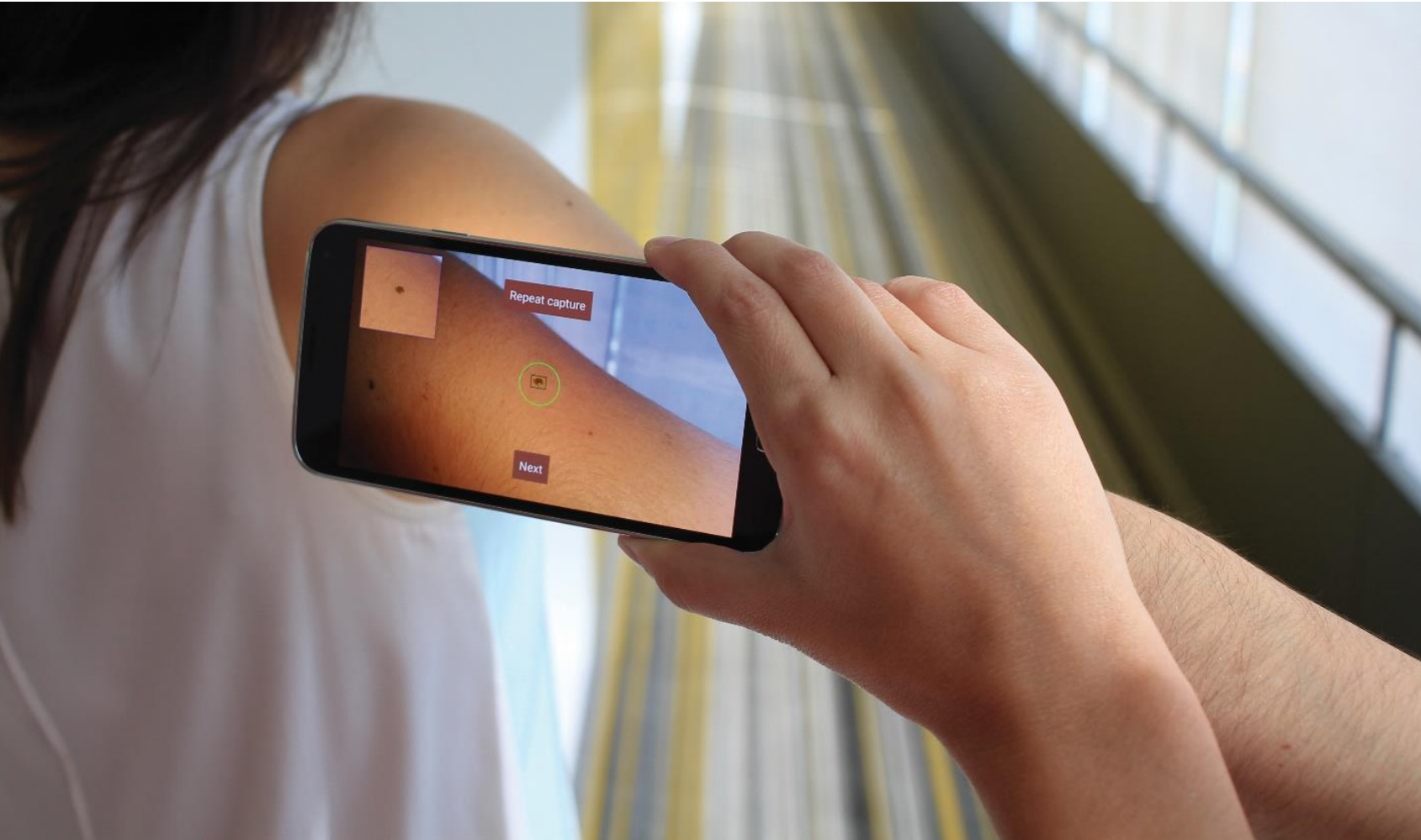**PORTUGAL**

Fraunhofer AICOS
Decentralised screening in dermatology

DERMA

Mobile technology for healthcare professionals, validated as monitoring or referral solution for skin lesions

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PORTUGAL

Fraunhofer AICOS
Decentralised screening in dermatology

DERMA

Mobile technology for healthcare professionals, validated as monitoring or referral solution for skin lesions

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Fraunhofer AICOS
Decentralised screening in ophthalmology

OPHTHA

A smartphone-based handheld optical device that captures retinal images automatically, with intelligent guidance during acquisition. A Computer-Aided Diagnosis of eye diseases is available on-device, as part of the fundus camera

Fraunhofer
PORTUGAL

Ophtha

Problem

- **Diabetic Retinopathy (DR)**

  - Main cause of avoidable blindness in the world;

  - No symptoms until late stages;

  - After 15 years with diabetes, approx. 2% of people will go blind from DR and 10% will develop severe vision impairment.

- **217 million people with moderate-severe vision impairment worldwide**

  - Age-related Macular Degeneration (AMD), Glaucoma and DR rank highest among the causes.

Normal vision

Diabetic Retinopathy

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PORTUGAL

Ophtha

Problem – Screening in ophthalmology

- Lack of resources + hard logistics to implement Screening Programmes

    - Expensive and stationary equipment for retinal imaging;

    - Critical shortage of trained professionals to operate the equipment;

    - Limited workforces for eye health is key to high prevalence of blindness;

    - Some portable solutions require pupil dilation.

- Diagnosis at the reading centre is done by ophthalmologists

    - Manual and time consuming.

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PORTUGAL

Ophtha

Solution

Handheld Affordable
Fundus Camera

Intelligent Acquisition Guidance

Computer Aided Diagnosis
(CADx)

Ophtha
Solution – Handheld fundus camera

- EyeFundusScope prototype
  - Retinal imaging with smartphone;
  - 45° field-of-view (FOV);
  - Non-invasive and non-dilated pupil;
  - 3D printed.

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Ophtha

Solution – Handheld fundus camera

25° FOV

40° FOV

Welch Allyn PanOptic
+ standard halogen lamp

Same ophthalmoscope
+ smartphone controlled LED

Mobile EyeFundusScope
developed by AICOS

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Ophtha

Solution – CADx Results in Diabetic Retinopathy

■ Extracted features

■ Microaneurysms;

■ Vessel regions;

■ Exudates.

■ CADx results with images by table-top fundus cameras

■ Check if each patient must be referred to treatment;

	Messidor		EyePACS	
	Classical	Deep Learning	Classical	Deep Learning
Accuracy	0.750	0.816	0.766	0.891
Precision	0.771	0.849	0.733	0.918
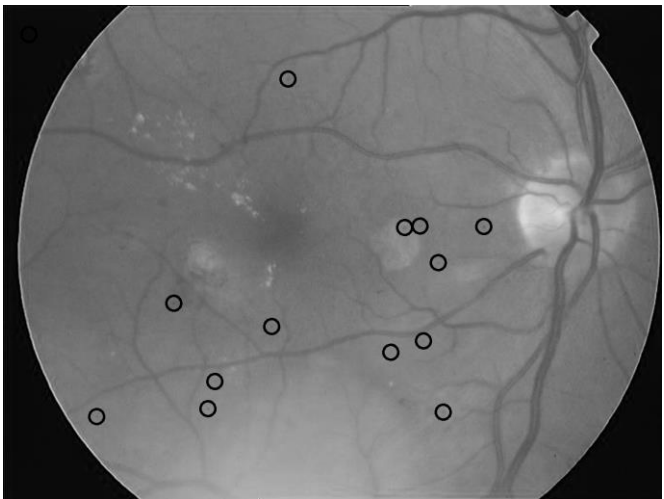
Ophtha

Class 1: **Mild DR**

Ophtha
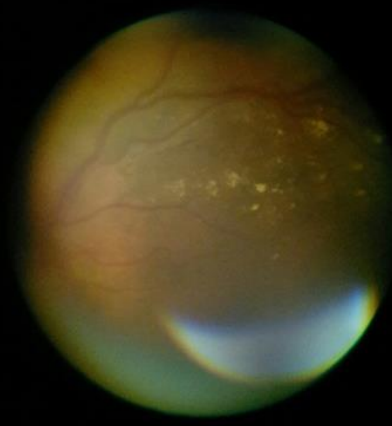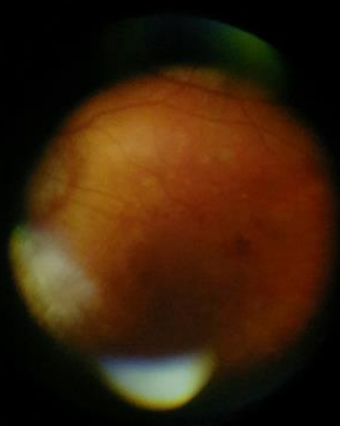Solution – CADx Results in Diabetic Retinopathy

Class 2: **Moderate DR**
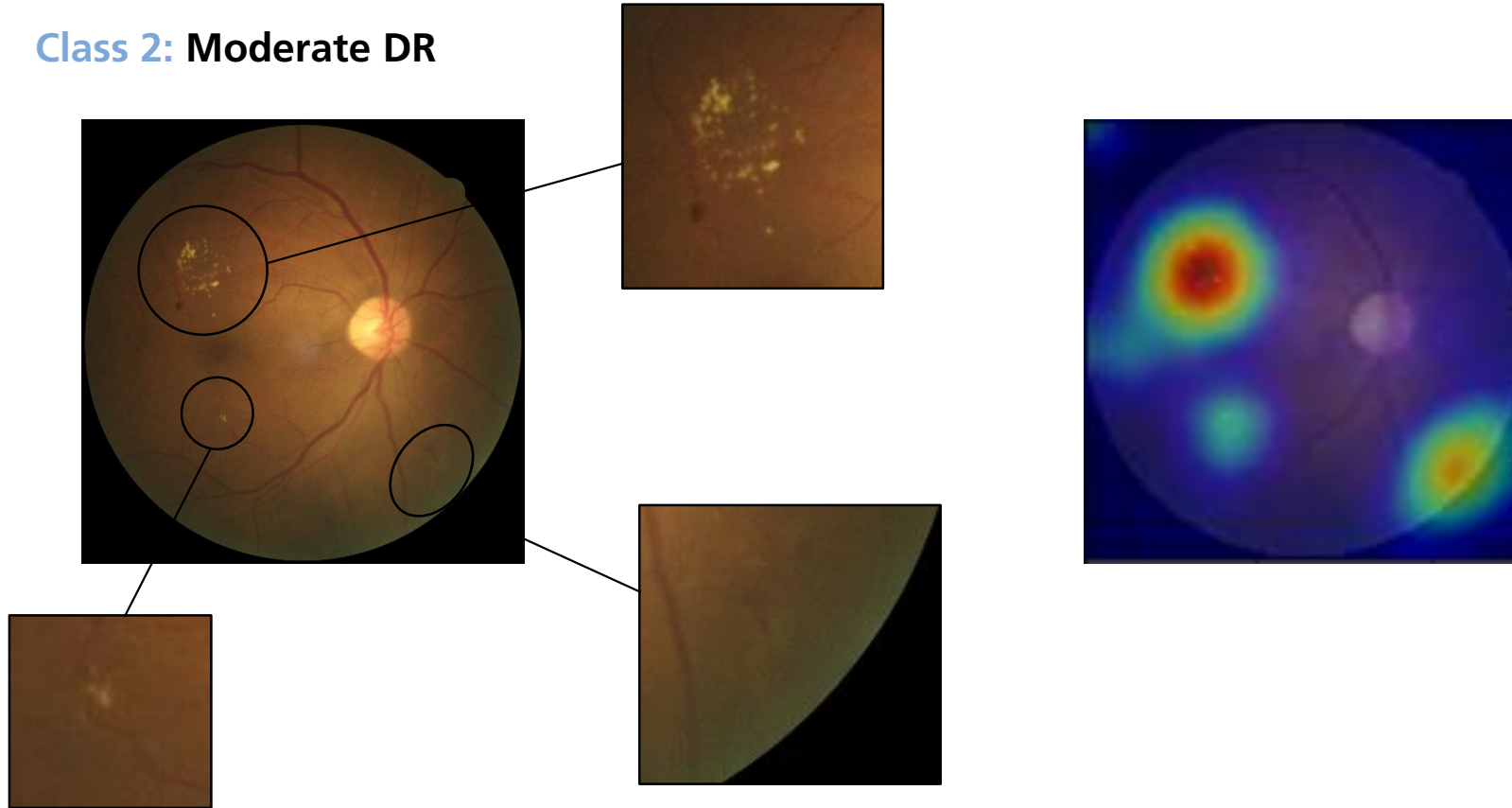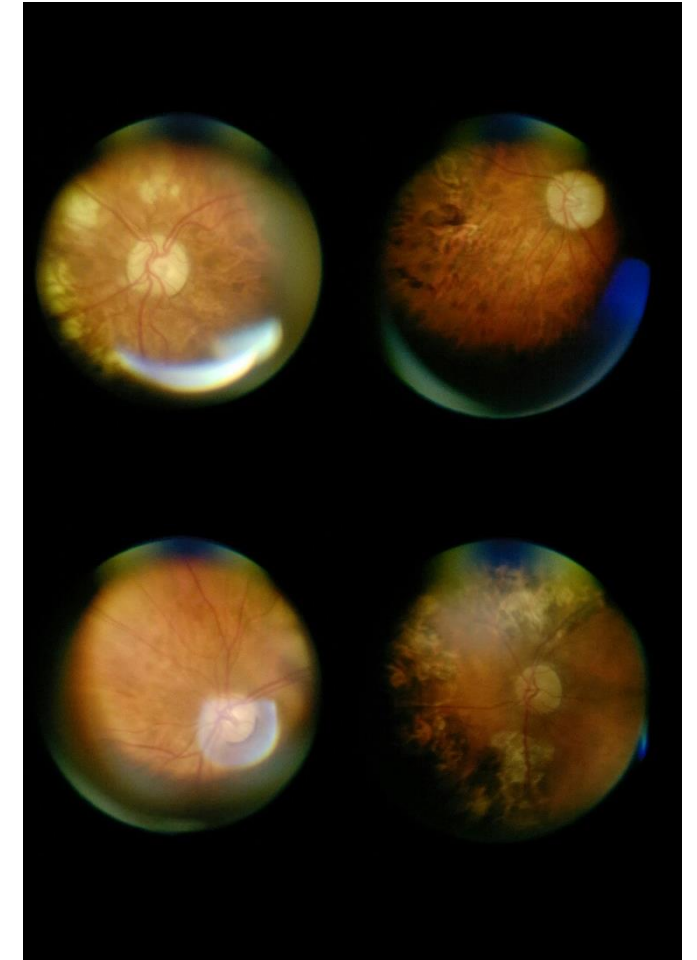
Ophtha

Class 3: Severe DR

Ophtha
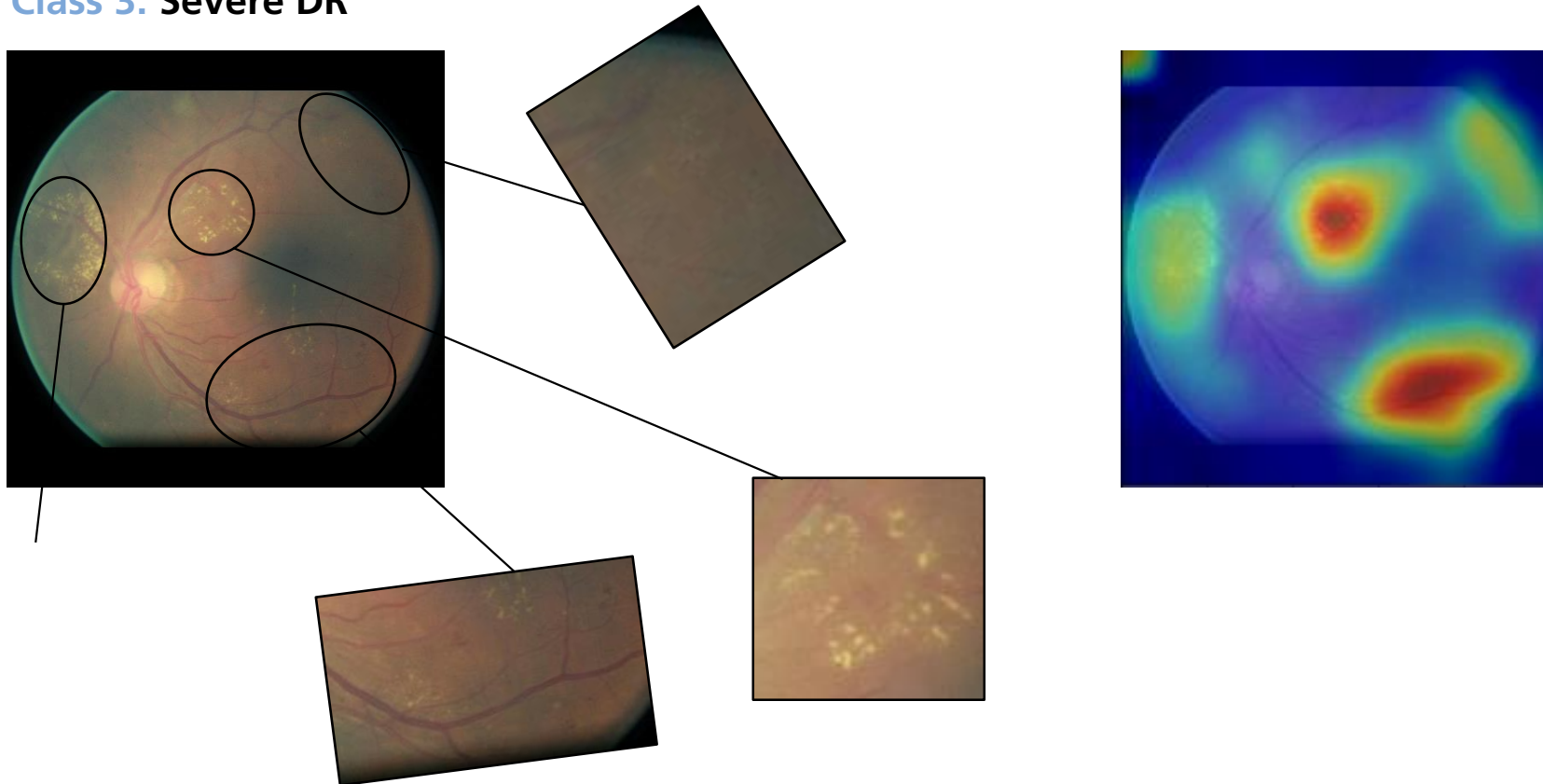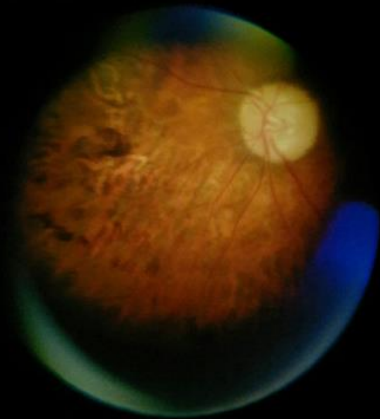
Solution – CADx Results in Diabetic Retinopathy

- Data collection with patients with diabetes using the mobile fundus camera prototype (25° FOV)

    - 80 patients in Centro Hospitalar do Porto;

    - Dedicated processing for exudates detection;

        - Total time with patient (both eyes): 5 minutes.

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Ophtha
Opportunities and Benefits

- Patients

  - Comfortable and near home exams;

  - Images acquired by General Practitioners.

- Public Health Systems

  - More population covered with less investment;

  - Less cases at the reading centre.

- National Health Norm 016/2018 points to annual screening for all patients with Diabetes

  - Over 1 million adults in Portugal and less than 15% of them are being screened.

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Decentralised screening in ophthalmology

OPHTHA

A smartphone-based handheld optical device that captures retinal images automatically, with intelligent guidance during acquisition. A Computer-Aided Diagnosis of eye diseases is available on-device, as part of the fundus camera
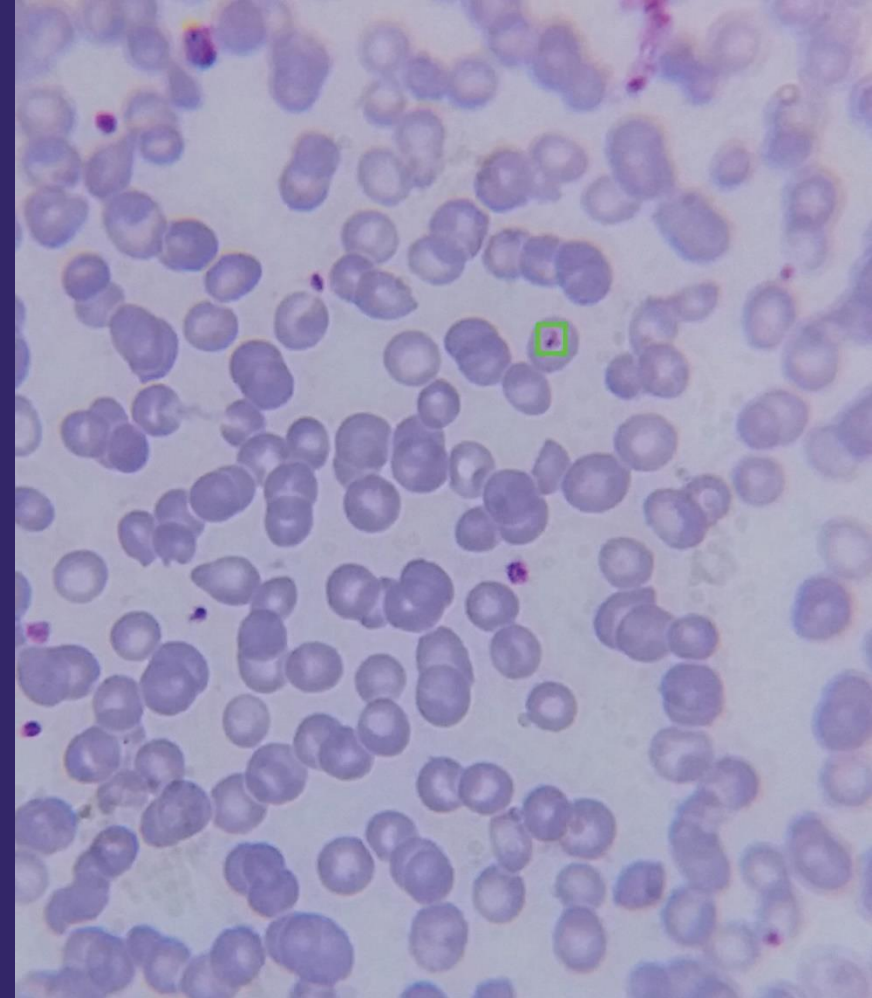
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Affordable and automated mobile-based microscopy
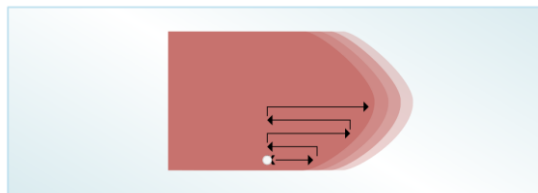
MICRON

A affordable and automated alternative to conventional microscopes, tailored to effectively support microscopy-based diagnosis in areas with limited access to healthcare services

**Fraunhofer**
PORTUGAL

Micron

Problem

- In medically underserved areas
  - Lack of trained personnel;
  - Lack of adequate equipment.

- In healthcare units with proper microscopy resources
  - Exhaustive and time consuming.

- Automated microscopy solutions commercially available
  - Have prohibitive prices;
  - There's lack of integration with health information systems.


Sample collection
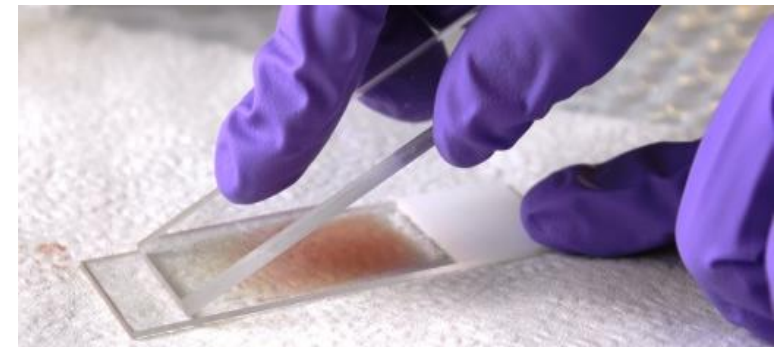
Slide preparation

Microscopy examination

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Micron

Solution – Affordable and Automated Mobile-based Microscopy

- **µSmartScope – a fully automated 3D-printed smartphone microscope**

    - Autonomous slide scanning: motorized stage fully powered and controlled by a smartphone.

- **Usage of Interpretable Artificial Intelligence**

    - 73.9~96.2% sensitivity and 92.6~99.3% specificity for malaria detection.

- **Easy integration with Health Information Systems**

Fraunhofer **PORTUGAL**
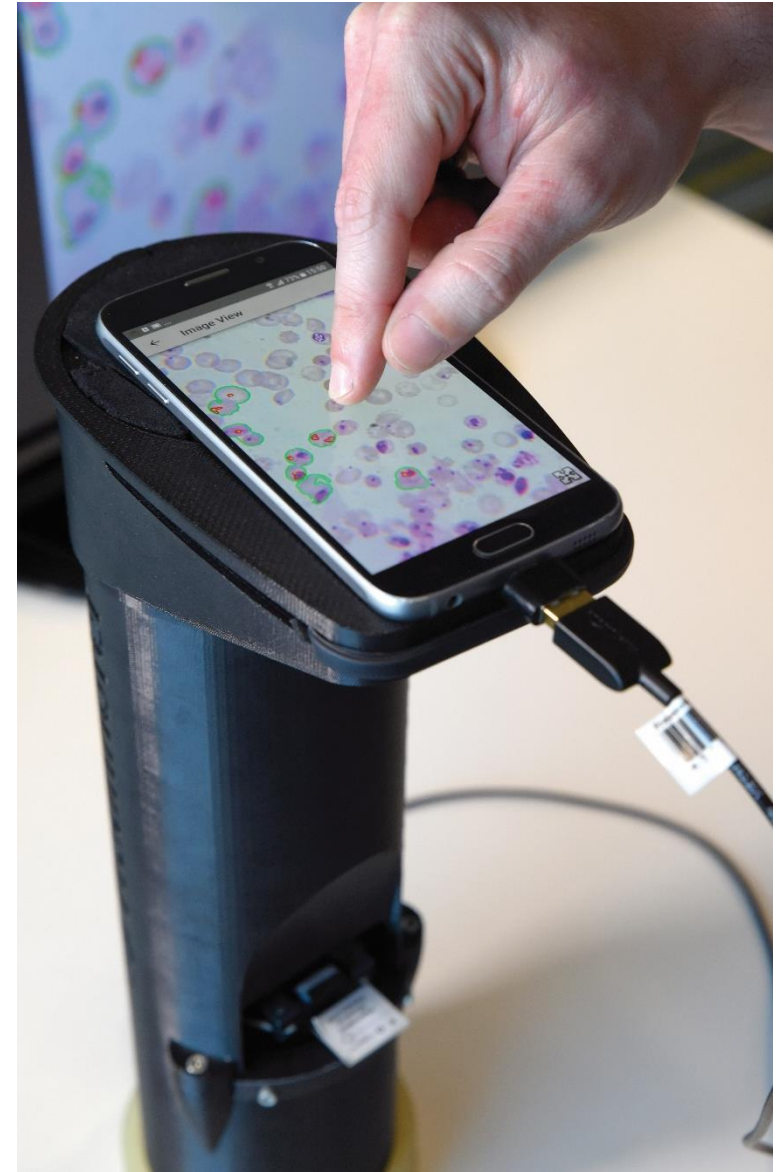
Micron

Opportunities and Benefits for Healthcare Professionals
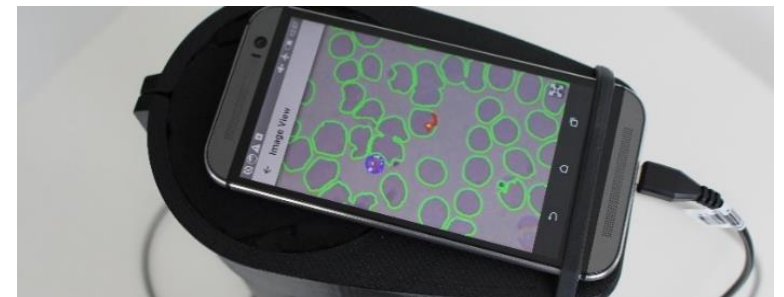
- **Improve microscopic-based diagnosis on site**

  - Reduce human dependence;

  - Trustworthy Decision Support System.

- **Improve microscopic-based diagnosis centrally**

  - Remote diagnosis;

  - Double-check;

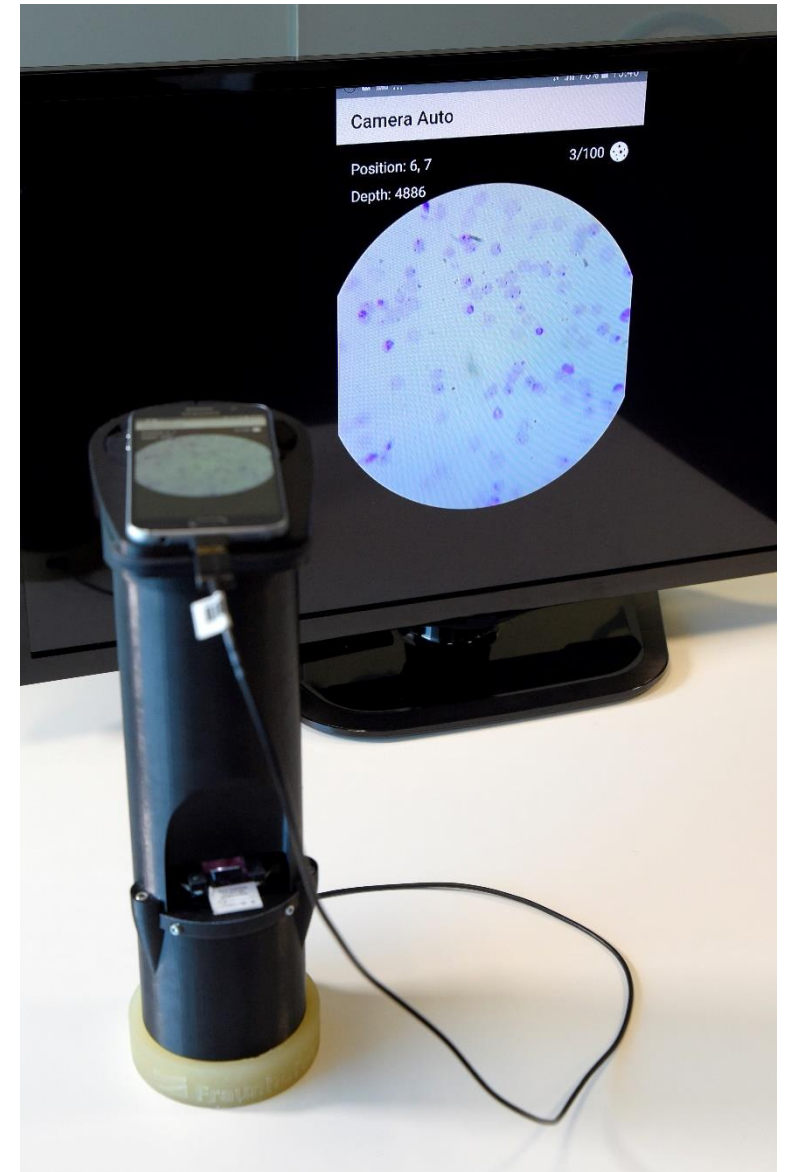 - Transparent data storage.

Insert Smear

Start Analysis

View Results

Fraunhofer PORTUGAL

Micron

Opportunities and Benefits

- **Affordable microscopy solutions**

- **Microscopy with straightforward integration with AI**

- **Automated samples digitalisation**

    - Transparent data storage;

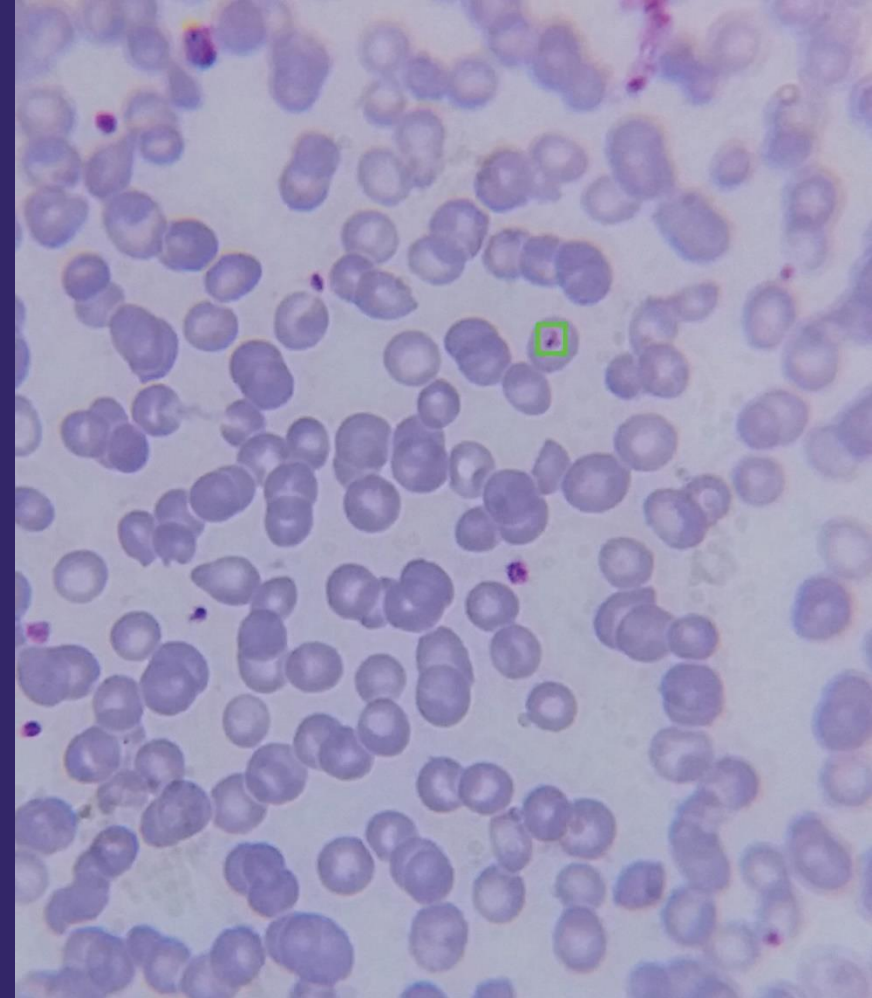   - Increase acceptance among healthcare professionals.

Fraunhofer AICOS

Affordable and automated mobile-based microscopy

MICRON

A affordable and automated alternative to conventional microscopes, tailored to effectively support microscopy-based diagnosis in areas with limited access to healthcare services

Fraunhofer AICOS
Automatic Visual Inspection and Validation

AUDIT

Computer Vision technology designed for high-level understanding of images or video frames, for quick, automated and recurrent auditing tasks, powered by Artificial Intelligence and Business Logic

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