

## IT brings more than 20 demonstrators to Techdays 2019



Held between October 10-12 in the Parque de Feiras e Exposições, the city of Aveiro welcomed another edition of Techdays, one of the biggest national technology forums. The event is jointly organized by the Aveiro Municipality, University of Aveiro, IT, INOVARIA, tice.pt, CentroHabitat, Fórum Oceano and Mobinov.

With the aim to facilitate potential collaborations with the industry, IT had a strong presence in the event, bringing more than 20 demonstrators distributed within a 70 m2 area. From eHealth to smart cities, from intelligent mobility solutions to virtual and augmented reality serious games for physical rehabilitation, and a lot more, this was also an opportunity for visitors to get in touch with some of the research and technology developed in the institute.

Also within Techdays, this year was the first edition of the Aveiro Urban Challenges and Aveiro 5G Challenges. Intended for Startups, Scaleups or R&D Institutions, these challenges will reward the best ideas and solutions to respond to urban challenges, in the areas of environment, energy or mobility, and the best ideas and solutions that use 5G technology. With this initiative, the Aveiro Municipality aims to promote and leverage local policies that contribute to the development of employment-friendly ecosystems that allow the creation of differentiating goods and services that can add value to the market.

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IT is a private non-profit association of Universities (UA, UC, IST, UBI, UP, ISCTE-IUL), Polytechnic of Leiria, Altice Labs and Nokia, with a mission to create and disseminate scientific knowledge in telecommunications. IT hosts and tutors graduate and postgraduate students.

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# IT demonstrators in Techdays Aveiro 2019

## AR and VR serious games for physical rehabilitation

Augmented Reality (AR) is a technique used to impose digital content on top of the physical world, giving the user a different perception on the subject in which AR is being applied. If combined with a carefully designed form of feedback for the patient, AR can be of great use in the rehabilitation of a person.

From IT in ISCTE-IUL, João Monge presented us a project where, under the coordination of Octavian Postolache, a research team as developed a extended reality serious game to aid patients in gait rehabilitation. Through the use of a tablet or virtual reality glasses, the patient interacts with objects placed in a real environment, with the patient following a route previously defined. To help motivate the patients, points are added each time he/she catches an object. Through the use of sensors it is possible to keep track of the patient's equilibrium and heart beat.

Also coordinated by Octavian Postolache, a multidisciplinary research team developed a series of serious games virtual reality applications for evaluation of self or supervised physiotherapy sessions. These games were designed for the training of upper and lower limbs functional movements, and allow the configurations to be tailored to measure the patient's balance and functional movements during their physiotherapy sessions.



## Smart and mobile health

Project SmartHeart joined the Computer graphics and interactive multimedia-Po, the Network Architectures and Protocols-Cv, and the Pattern and Image Analysis-Lx groups – which have independently created state-of-the-art technologies and accumulated knowledge in the field of cardiac sensing and signal processing. The demonstrator presented a prototype of an augmented stethoscope that enables simultaneous PCG & ECG synchronized data acquisition, while still preserving the acoustic and usability characteristics of a conventional stethoscope.

With studies indicating that about 2.5% of casualties in road accidents are due to driving in a lethargic state, the Pattern and Image Analysis group of IT in Lisbon (PIA-Lx), developed a proof of concept, composed by hardware and software to monitor the attitude and vital signs of professional drivers, allowing the early identification of fatigue and pathology situations. On display there was a steering wheel instrumented with textile electrodes, Electrocardiographic (ECG) sensor and Visual Analogic Scale (VAS). The device can be applied in every vehicle and was already successfully tested by transportation companies in Portugal and Saudi Arabia, being highlighted by Nokia as a reference case.



The PIA-Lx group also presented a prototype of a Biomedical Innovation Toolkit (BIT), which is composed of a low-cost modular hardware for biosignal acquisition (BITalino) and the open source software SignalBit, for instant data visualization and recording. The goal is to overcome some barriers associated with the use of conventional equipments, notably the high cost and proprietary nature, through a DIY approach. Being used by

thousands of people worldwide, BIT is already a technology transfer success case, having won the "Innovation Radar Prize 2017" for the best "Industrial & Enabling Tech".

From IT in Aveiro, Ricardo Torres presented us a chair that acts as a scale, able to measure, with some reliability, a person's weight, without the need of an active collaboration. It can, for instance within the context of accessing an intervention's effectiveness, obtain quantitative and regular weight measurements of that patient to show his/her progress. The chair can be at the patient's home, with the data being sent via Bluetooth to the clinician.

Finally, from IT in Porto, a technology that was already on display in previous editions of Techdays, the Health Kiosk. This self-service unit allows patients to measure some of their vital signs on a routine basis, before going to a consultation. Health professionals have access to an electronic health record with the measured data, which they analyse to show patients their progress.

## Smart and safe coat



The E-caption 2.0 is a coat that protects and informs those responsible for the maintenance of the radio base stations about their level of exposure to radiation. Textile antennas, electromagnetic shielding and wireless power transfer are all combined in one single product, creating an application that can alert and protect the tower climber, while boosting the industrial fabrication process of textile antennas and their mass production, guiding future developments of smart clothing and wearables.

The E-caption 2.0 was developed in collaboration between researchers from UBI (Caroline Loss and Rita Salvado) and IT in Aveiro (Pedro Pinho and Daniel Belo).

## SheepIT - Virtual shepard



The main goal of the project SheepIT is to improve an ancient and ecological weeding practice, consisting in the use of animals, usually ovines, to graze the vineyards, eliminating the unwanted weeds and fertilizing the soil. Relying on IoT concepts, researchers have developed a solution for monitoring and controlling grazing sheep in vineyards and similar cultures.

## The 5G driving revolution is underway

IT is one of the 58 partners from European and Asian countries that are involved in a project that will examine the implications of 5G and its role in the future of autonomous driving.

Co-financed by the European Commission through the Horizon 2020 programme, the 5G-MOBIX project will develop and test automated vehicle functionalities using 5G core technological innovations along multiple cross-border corridors and urban trial sites. Tests will be done under conditions of vehicular traffic, network coverage, service demand, as well as consider the inherently distinct legal, business and social local aspects. The 5G-MOBIX aims to validate 5G technologies for CCAM (Cooperative, Connected and Automated Mobility) use-cases, in seven different European and Asian trial sites, including a Portugal-Spain corridor connecting the cities of Porto and Vigo.

A crucial aspect in increasing the safety of future automated vehicles and their full integration in the overall transport system is the communication between vehicles, infrastructures and other road users. This interaction is the domain of Cooperative Intelligent Transport Systems (C-ITS), which will allow road users and traffic managers to share information and use it to coordinate their actions.

SCOOP@F is a Cooperative ITS pilot deployment project that intends to connect approximately 3,000 vehicles with 2,000 kilometres of roads. It consists of five specific sites with different types of roads: Ile-de-France, "East Corridor" between Paris and Strasbourg, Brittany, Bordeaux and Isère. SCOOP@F is composed of SCOOP@F Part 1, from 2014-2015 and SCOOP@F Part 2, from 2016-2019. Its main objective is to improve the safety of road transport and road operating staff during road works or maintenance.

SCOOP@F Part 2, in which IT is involved, includes the validations of C-ITS services in open roads, cross border tests with other EU Member States (Spain, Portugal and Austria) and development of a hybrid communication solution (3G-4G/ITS G5). SCOOP@F Part 2 will cooperate with ongoing European pilot projects and the EU C-ITS platform. The project aims at reaching a critical mass in the number of tested vehicles, roads and services, to provide a representative evaluation of C-ITS. It also stimulates collaboration between automotive manufacturers and road operators, the exchange of best practice and innovation in solving common problems.

Also within the topic of cooperative ITS, PASMO is a Platform for the Development of Intelligent Mobility Solutions. Developed by researchers of the Embedded Systems group and the Telecommunications and Networking group, both from IT in Aveiro, PASMO consists of three subsystems that mirror the different layers of intelligent transport systems: data collection (roads, railways and vehicular resources), data transfer (telecommunications and data infrastructure), and applications.



## Smart cities and IoT

Magnetometer data, frequently used for orientation and navigation, includes some occasional strong local magnetic fields due to road structures (e.g. tunnels), that add to the geomagnetic field, creating anomalies. Susana Belas, from IT in Porto, under the coordination of Ana Aguiar, developed a technology that maps the precise location of these anomalies, using magnetic landmarks to complement already existing vehicle tracking systems.

From IT in Aveiro, Marina Jordão walked us through a smart crosswalk, an awareness system that alerts vehicles for the presence of pedestrians on the crosswalk. The technology uses backscatter communication and network vehicles, and has both immediate utility for boosting current drivers crosswalk awareness, as well as application in future autonomous driving.

Also from IT in Aveiro, André Mourato presented a IoT platform called City Zoom, which gathers data such as temperature, humidity, CO2 concentration levels, as well as concentration levels

of p10 and p50 particles, which can represent a risk to public health. The structure covers the entire Aveiro municipality, using external APIs (Application Programming Interfaces), which allow exchanging information between two or more systems. The platform keeps a data record, making it possible to access the evolution of these indicators along different time periods. Other functionality of the Cityzoom platform is the possibility to set alarms that inform when these indicators are above the pre-defined threshold, representing a possible risk to the public health and/or the environment.

From the Network Architectures and Protocols group of IT in Aveiro, two projects that use unmanned vehicle networks where drones work collaboratively in accomplishing complex missions across different sites. One of these projects uses fleets of aerial drones that work in collaboration to respond to emergency situations. Possible use cases are: monitoring forest fires and assist firefighters; inspect and monitor areas of nuclear accidents; providing cellular network coverage in natural disasters; assisting police forces in patrolling problematic areas and surveying crime scenes. Finally, also focused on unmanned vehicular networks, Carlos Senna, a Post-Doc researcher, presented us a heterogeneous environmental sensing platform allied with a low-cost infrastructure for aquatic monitoring. Using aquatic drones the focus is on monitoring the water quality regarding its colour, pH, humidity and pressure.





## A sensor to monitor an invisible, odourless and tasteless enemy

Radon is a naturally occurring radioactive gas which may be found in indoor environments, where greater exposure occurs. Existing in the subsoil of granitic compositions, in Portugal it is particularly concentrated in the subsoil of the northern and central interior regions. Outdoors, radon quickly dilutes to very low concentrations and is generally not a problem.

According to the World Health Organization (WHO), "Radon is the most important cause of lung cancer after smoking". So, to tackle this public health risk, researchers from IT, BMViV, S. A., the Polytechnic Institute of Viana do Castelo and the Polytechnic Institute of Cavado e do Ave work together on the design of a Cyber-Physical System (CPS) for online monitoring and active mitigation of radon gas concentration inside granitic public buildings. This radon sensor, with an indication of humidity, temperature and CO<sub>2</sub>, is placed inside a building or a house to monitor the level of radon. Through LoRa communication (radio frequency

technology that enables long distance communications with minimal power consumption), and by placing multiple radon sensors in several buildings, with just one gateway, it is possible to cover an area of approximately 4km<sup>2</sup>. A pilot study was already conducted in Vila Real, where Radon levels are much above the reference levels.

## Photonic "chip" for new generation satellites

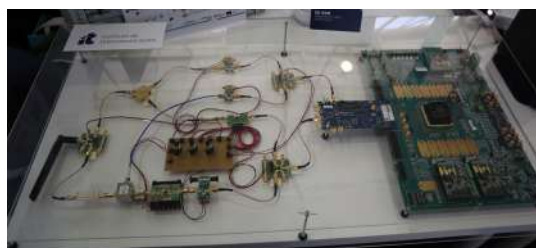


Researchers from IT in Aveiro have developed a photonic processor to improve satellite communications through an "individualized" network coverage system.

Envisaged for the new generation of telecommunications satellites, this photonic processor should allow accessing the internet even in

the most remote areas of the planet. Besides having a lower weight, as well as a much smaller cost and energy consumption, compared to the current processors, it can increase the capacity of data transmission and, highly important, give the satellite flexible coverage. This innovation also opens the way for the introduction of emerging technologies in satellite communication services, namely 5G and IoT services.

## 5G C-RAN over PON



IT is one of the 14 partners of Altice in the project 5GO.PT, which will allow the design and integrated validation of a new set of products, able to become part and give services within the future 5G networks. Within this context, IT in Aveiro, together with Altice Labs, have developed a 5G centralized

Radio Access Network (C-RAN, also known as cloud RAN) supported on Passive Optical Network (PON) technologies.

The deployment of 5G will enable ultra-high speed systems, connecting millions of low-bandwidth demand devices and support extremely low latency transmission. As the antenna throughput need increases, smaller is the cell size, and, consequently, more cells need to be deployed to cover for the same geographical area. Different fiber based approaches for network and RAN convergence may be addressed, covering the mobile Backhaul, Midhaul and Fronthaul alternatives. The new 5G radio architecture facilitates RAN virtualization (a centralized pool of baseband units, virtualized RAN control functions and service delivery optimization) and also allows for decreased Fronthaul/Midhaul line rates, while meeting latency demands.

PON technologies will play a significant role on 5G rapid development, specially for mass deployment of small cells and macro coverage scenarios.

## IoT Potentiostat for food quality assessment



Potentiostats are used in electrochemical analysis to identify different composites. From IT in ISCTE-IUL, João Monge is working on developing a potentiostat for food quality assessment. Assembled in a RF Duino board, the potentiostat is equipped with biosensors that react to different chemical composites. The technology was already tested several times in laboratory, for instance in sweat, to detect the level of glucose. The developed

prototype uses cloud based IoT architecture where the recorded data is sent via Bluetooth to a tablet or a computer, allowing for remote operation.

## ORCIP: A testbed for future optical and radio systems

Resulting from a collaboration between the branches of IT in Aveiro, Coimbra and Covilhã, ORCIP offers a wide variety of services, such as access to an optical-radio convergence testbed infrastructure, optical and wireless simulation tools, test equipment and FPGA development platforms for wireless and optical communications.



ORCIP is expected to have impact on education both at the undergraduate and graduate levels, as well as industry training.

The infrastructure will also contribute to lowering the entry barrier of regional and national SMEs in research and innovation activities through the availability of a powerful testbed remotely accessible with capacity to cover device to application testing, overcoming significant capital expenses for SMEs in equipment and providing continuity in the innovation chain.

## IPT technology for Electric mobility

The scarce supply of fossil fuel in the near future has driven the development of electric vehicles (EV) worldwide. Plug-in connectors have been commonly proposed for EV charging, however, these systems have disadvantages such as safety, esthete, and operation in snow.



As an alternative to the Plug-in, the Power Systems group of IT in Coimbra, brought to Techdays a fully functional electric car, that

is charged using an Inductive Power Transfer (IPT) technology (also known as Wireless Power Transfer). To optimize the efficiency of the IPT system under misalignment conditions, the research team developed a new controller that digitally regulates the power of the synchronous reluctance motor.