PRESS RELEASE

PHOTONICS IN CORONAVIRUS DETECTION

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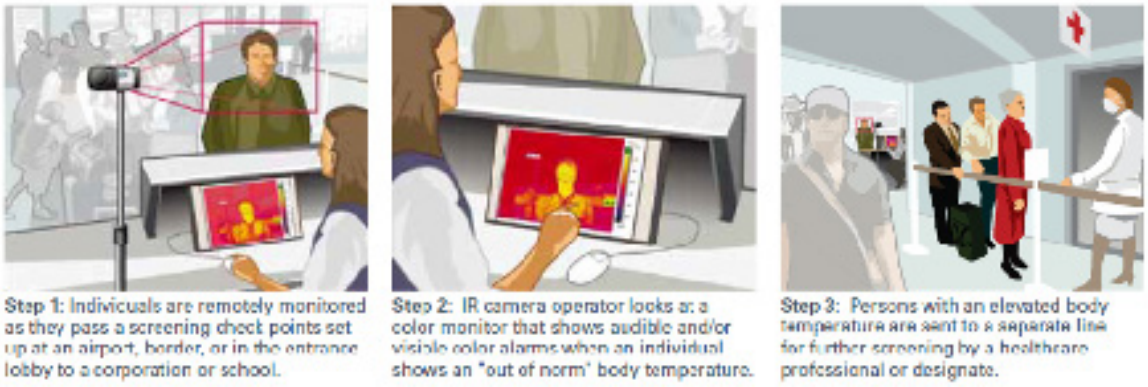
PHOTONIC TECHNOLOGIES IN THE DIAGNOSIS OF THE CORONAVIRUS SYMPTOMS

In the face of the coronavirus (COVID-19) alarm situation, photonic technologies can provide fast and accurate diagnostic solutions. These include:

Infrared thermography. Through a camera with infrared sensors it is possible to generate a thermal map of the skin in real time. Coupled with appropriate software, such as the bcbMonitor of the company **BCB Informática y Control** or those of **FLIR Systems** distributed also by **Álava Ingenieros**, allows to generate alarms if the established temperature threshold is exceeded. It is a technology that allows rapid screening of large groups of individuals or points high transit of persons and which has already proven to be effective in the past in curbing other viral outbreaks such as swine flu, avian flu, Ebola or SARS.

Computer Vision. The combination of an infrared image library and behavioural study could be used in high traffic locations without the need for citizens to pass through a particular checkpoint. The **TECNALIA** research centre has developed a library of infrared images to monitor temperature that could be combined with the study of people's posture to detect behaviour that is outside what is considered normal. In other words, by analysing an individual's position, the algorithm can detect whether the subject is feeling dizzy or confused.

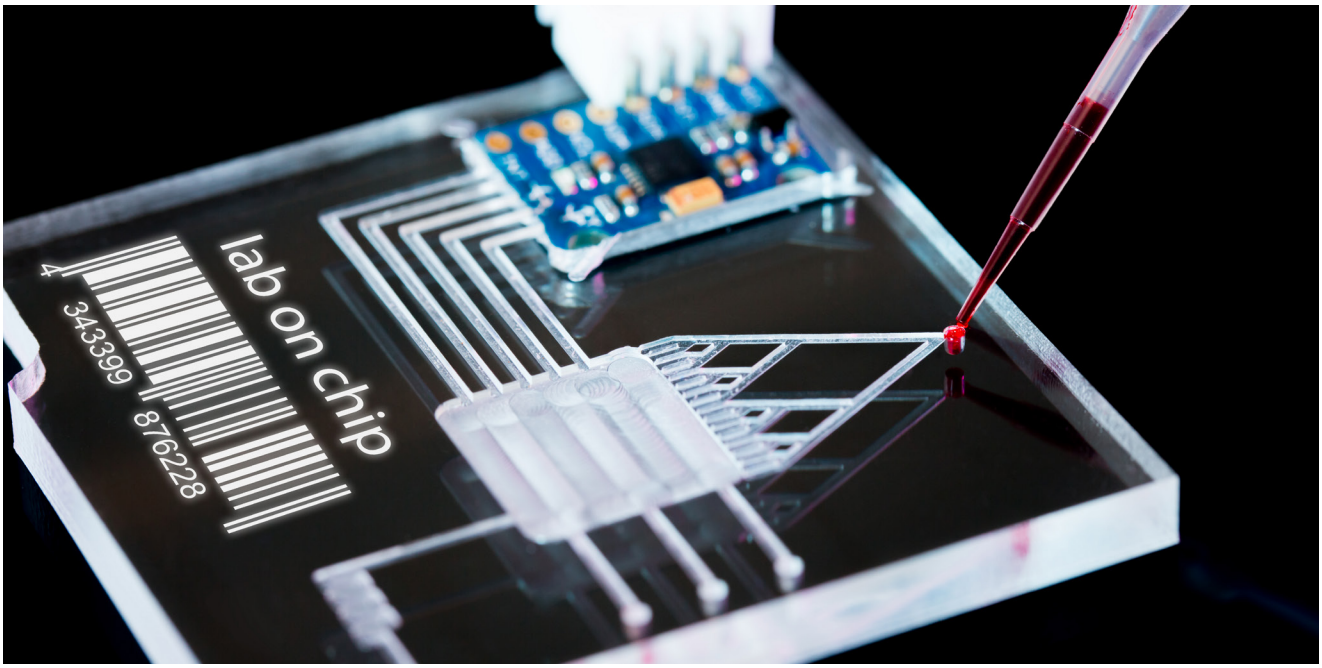


Images courtesy of FLIR Systems and BCB Informatica y Control

Infrared Thermography + Computer Vision + Machine Learning. The Medical Technology team of the **Instituto de Astrofísica de Canarias (IACTEC)** is developing the first prototype of a portable, low-cost, multi-channel sensor with free software for the detection of anomalous surface temperature patterns, which combines an infrared camera and Machine Learning algorithms that allow the recording and segmentation of body areas of interest. When this technique is applied to facial recognition, people with altered temperature patterns can be automatically identified.

Virus sensors. The **IMDEA Nanociencia Institute** develops sensors based on gold nanoparticles in which a control changes colour when it comes into contact with samples of a given virus. Taking a photograph of the core with a mobile phone would determine the status of the infection. The development of this test for the new described variant of coronavirus could be applied to their detection.

(The following pages detail the characteristics of the applications described).



What is photonics?

Photonics is the science that studies the generation, control and detection of light and photons, which are the particles of light. From it derives several technologies, considered **Deep Tech**, among which we can find **laser systems, sensors optical, scanning and imaging systems, advanced lighting or communications optics**, among others. These key enabling technologies in areas such as **Telemedicine, Industry 4.0, Internet of Things, Smart Cities, Autonomous Vehicle, Cybersecurity** or **development of new materials.**

About secpho

secpho is a cluster formed by 125 companies, technology centres and research groups experts in innovation technology through the application of Deep Tech, mainly photonic technologies, to all kinds of sectors of our economy. In this sense, **secpho** is a **bridge between research talent and innovative companie**s, on the one hand, and the **opportunities appearing on the market**, on the other.

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TECNALIA
Computer Vision

The **TECNALIA** team, one of the centres of reference in applied research and development technology, has created an **infrared library image processing system** which provides powerful tools for analysis. This new system allows you to customize the solution of the application (from algorithms simple to the most sophisticated), the interface, processing and communication of results of thermal control applications. This image processing library Infrared has been developed for **LAND INSTRUMENTS** equipment manufacturer for thermography.

Another technology applicable to this case is the **study of behavior through visible image** to detect outgoing attittudes of what is considered normal. Analyzing the position of the person, the algorithm can estimate the gestures and detect if the individual feels dizzy or confused..

The combination of the image library infrared and image behaviour visible could be used in contexts of large surfaces, such as airports and supermarkets, without the need for citizens must pass through a point of control determined. In this case, it would create a Deep Learning Multimodal network with much more efficient detection results.

TECNALIA is a research centre applied and technological development. Its activities in the field of photonics, including in the ICT division, pursue the development of micro and nanophotonic devices: from fundamental studies up to the stage of micro and nanofabrication, through the design rigorous and intensive simulation.

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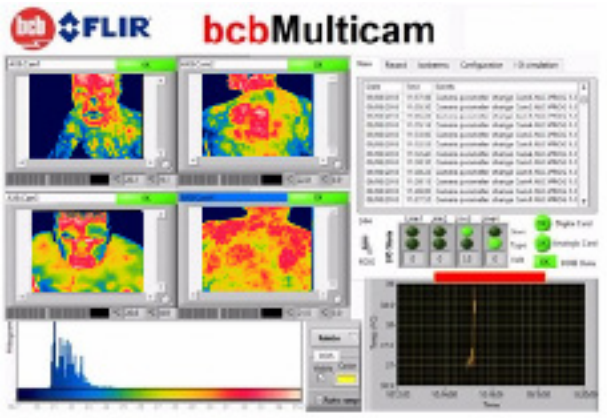
BCB
Infrared Thermography



Infrared thermography is a fast, simple, non-invasive and reliable method, that has already been used in the past to stop other viral outbreaks like swine flu, bird flu, Ebola or SARS.

Infrared thermography provides a **thermal map of the skin**, quickly and in real time. Being linked to an appropriate software, as the **bcbMonitor** that has developed **BCB Informática y Control,** it allows generating visual and/or audible alarms if the person exceeds a set temperature threshold. It also allows the storage of radiometric images for later traceability and analysis. This technology allows rapid screening of large groups of individuals, facilitating the isolation of those persons who have allegedly contracted a viral infection, to be diagnosed more precisely by a medical team.
This makes infrared thermography a useful ally against the spread of possible infections, in high passenger traffic points.

FLIR, the world's leading manufacturer of cameras products, has products specially designed for this application, with high sensitivity, functions and advanced technologies such as ATC (Automatic Ambient temperature) and an automatic recalibration, which have already proved their effectiveness in international airports, terminals and companies from multiple countries.

BCB Informática y Control is an engineering technology that operates in Spain, Portugal and Mexico. It is an official distributor and integrator of FLIR and has software solutions specific for thermographic monitoring in industrial, scientific applications, and in the health field, in addition to an extensive experience in R+D+i projects and has won the SME Innovation Award.

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ÁLAVA INGENIEROS

Infrared Thermography

Thermographic cameras have a similar function to ancient thermometers, but do not require contact with the patient and have replaced mercury with **infrared sensors**.

Its size is like a video camera, or even less, and they are able to warn automatic "alarm" of fever thanks to their infrared sensors, that measure the energy that bodies radiate, from which the device automatically calculates the temperature. **Each strip of temperature corresponds to one color**. If the display shows the color red, it corresponds usually to high temperature, and therefore fever. With this system one can gain a lot of time and effectiveness, since detection takes only 1 second. And it's enough for the subject to pass a distance of a few meters so that the thermographic camera detects the temperature.

Used in diagnostics for over 40 years, thermography is not only the new boom in alternative medicine, it is a proven method of diagnosis and helps treatment with an application in a wide range of diseases and treatments like flu or fever, pressure ulcers, trauma, surgery, oncology, psychology, physiotherapy, etc.

ÁLAVA INGENIEROS is a company that offers high-tech solutions in Fields of Testing, Measurement, Communications, Security, Defense, Predictive Maintenance and Civil Engineering.

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IMDEA NANOCIENCIA
Virus Sensors

The **IMDEA Nanoscience Institute** team has developed sensors of different nucleic acids, that can facilitate the detection of various pathologies and infectious agents that "pour" specific markers into the blood. In recent years, systems have focused in the detection of different tumors or diseases like Muscular Dystrophy Duchenne; but it has also been explored its use in detecting the Ebola virus. The system can be easily adapted to the detection of other viruses, how can be the newly described variant of coronavirus(COVID-19).

For get this, the **gold nanoparticles** ("Gold NP") have to be **modified with short DNA strands** (oligonucleotides) that include complementary sequences to the target to detect. These molecules are modified in their ends with a group with great affinity for gold and with a **hydrophobic molecule** (like cholesterol), respectively. By combining these oligonucleotides with the gold nanoparticles you get structures where the oligonucleotides are folded fork-shaped "hiding" cholesterol, being in this conformation completely soluble in water (Figure 1A).

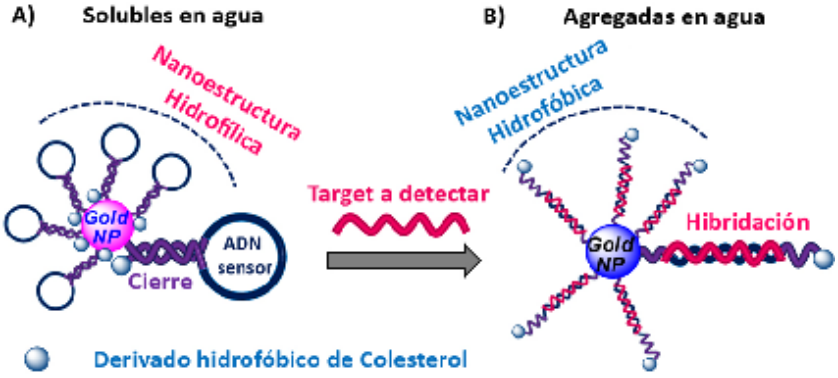

Figure 1. Schematic representation of the operation of the nucleic acids based on gold nanoparticles. The system is soluble in water, but in the presence of the target to be detected, it changes of conformation by exposing cholesterol to the outside, becoming water-insoluble.

Given the **optical properties of gold**, what we may see is a pink solution, where the nanoparticles are in a very low concentration (10 nanomolar). This nanostructure can be designed to that, in the presence of specific fragments of the virus genome, changes to an open form, by complementary union(hybridization) of the viral target with
the short DNA strand (Figure 1B). In this conformation, cholesterol is exposed to the dissolution and the nanostructure, that is not soluble in water, starts to deposit deep down and the dissolution gets clear. **This change can be seen with at first sight without any sophisticated equipment and in a matter of hours.**

The purpose of these nanoparticle-based sensors is to get a **diagnostic specific system, fast, disposable, portable, easy to and profitable.** The colorimetric detection method is very interesting because it doesn't need any equipment for qualitative analysis. The presence of the target group results in a **change in color**, indicating if the test is positive or negative. For a more extensive analysis of the signal obtained, a device such as a telephone is enough to capture the visual signal and mediate its transformation into quantitative data.

The **IMDEA Nanoscience Institute** has a long experience in the design and adjustment of this type of sensor and is prepared to extrapolate its use to the urgent detection of viruses emerging and of great interest to public Health as the current COVID-19.

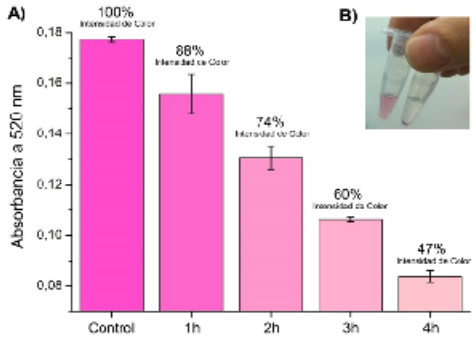

Figure 2. Detection of related nucleic acids (microRNAs) with the Ebola virus. (A) During the first few hours a drop in the absorbance of the solution is observed, that can be seen with the naked eye. (B) After 8 hours the change is dramatic, resulting in a colourless dissolution due to the total precipitation of the nanoparticles.

https://www.nanociencia.imdea.org
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IACTEC

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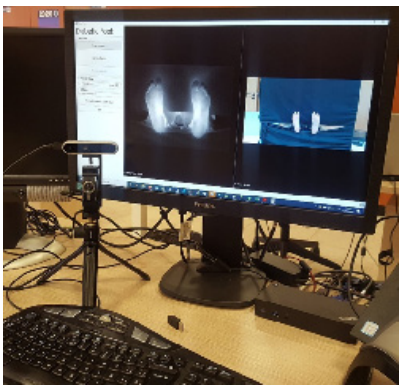
Computer Vision
Machine Learning



The **Instituto de Astrofísica de Canarias (IAC)** has an intensive transfer policy of technology to the industry in several areas and it has decades of experience in advanced techniques and devices. Image processing is, by nature of astrophysical research, one of those areas of excellence of the IAC, in which researchers and engineers of the institute have been working over 40 years. In line with this policy of corporate social responsibility, since 2016 IACTEC, the space for technological cooperation The IAC's business team, with a specific (6 people at present) dedicated to investigating the use of image processing and the development of new devices, to medical applications.

IACTEC's **Medical Technology** team is developing a first **prototype of low-cost multi-channel sensor and open software for the detection of abnormal patterns of skin surface temperature** and that in a first version tries to improve the early diagnosis and treatment in patients with diabetic foot.

Regarding to image acquisition for the **evaluation of pathologies through thermography, 3 low cost sensors have been used to obtain images in the infrared and visible spectrum, as well as microwave depth imaging.** The aim is to be able to record the images acquired with the different sensors and segment the areas of interest for the evaluation using free software tools. In parallel, has been carried out a training of neural networks (Convolutional Neural Network - CNN) from RGB images and depth, which allows the segmentation of the area of interest.

Infectious diseases lead to increase body temperature, and this is an indicator of the viral process in advanced stages. One of the measures used at airports for sanitary control on entry of passengers is the infrared thermography analysis of their faces.

This is carried out usually with high-cost stationary equipment.

IACTEC proposes to extend the research that have been made in the last years, to develop a combination of a portable **camera of RGB surveillance and an infrared low-cost camera**, that merge the detection of abnormal temperature patterns that can be applied in groups of people simultaneously with algorithms for **facial recognition ("computer vision")** that allow the extraction of regions of interest (ROI) for collective temperature control. **This proposal is based on implementing in its multi-channel sensor a portable prototype Machine Learning algorithms** (automatic learning) in order to detect anomalies between people. and to make possible to automatically identify people that have altered temperature patterns and quantify the degree of anomaly that these individuals present on the basis of the facial temperature they present.

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