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SPECIAL FEATURE

FROM THE OBVIOUS TO THE UNKNOWN

A NEW ERA FOR MOBILE APPS

INTERVIEW

TESTING YOUR FOOD BEFORE YOU EAT IT

Whilst globalisation allows us to find food from pretty much anywhere in the world in the nearest supermarket, this comfort has a major flaw: it is becoming very difficult to ensure food safety before it ends up on our plates. FOODSNIFFER — a food testing device to be integrated directly in our smartphones — might be the solution.

European citizens are increasingly concerned with food safety. And who could blame them? In spite of drastic regulations and control methods, Europe has faced multiple food-related crises over the years. The main reason for this is well known: current food analysis technologies are expensive and laboratory-bound, which means only a small fraction of the food ending up on EU shelves — a little more than 1 % — gets tested beforehand. The problem is even more evident with food coming from overseas. According to FAO, surveillance is weak or non-existent in most food-producing countries.

The FOODSNIFFER (FOOD Safety at the point-of-Need via monolithic spectroscopic chip identiFying harmFul substances in frEsh pRoduce) project was born from a double observation. First, that answering food concerns requires a new device that would be both widespread and cost-effective. Then, that the latest high tech trend — sensors integrated in smartphones — provides a unique opportunity to hit two birds with one stone. With its new technology, the project aims to acquire the data needed to reverse permanently the negative trend in food safety anywhere, at any time and by anyone, all with great precision, rapidly and at low cost.

The EUR 4 million project, which brings together 10 European partners including four SMEs, brings together researchers from various disciplines and key partners from the industrial sector. Ioannis Raptis and Eric Smith, who are project coordinator and exploitation leader respectively, told us more about their smartphone-controlled system and how the consortium aims to bring about a revolution in food safety testing.

★ **What are the main objectives of the project?**

FOODSNIFFER consortium: The FOODSNIFFER technology is a great step forward in that it would enable us, for the first time, to achieve reliable food surveillance down to *the source* of production, from the safety of irrigation water to controlling the use of only permitted pesticides. This means we will be able to solve the problem where it starts — deep at the source or in the *distribution chain.*

The smartphone application we are developing, which everyone will be able to use, will not only trace harmful substances in our food but also transmit these on-the-spot analytical test results along with the metadata — identity of the user, time and date, location and nature of the sample — to the internet cloud. It will also be possible to compare the results

available in the database and instantly create or update charts/maps that would be useful for the producer, trader, retailer or even consumer.

★ What is new or innovative about the project's approach to food safety?

The FOODSNIFFER consortium is developing a solution that is suitable for laboratory-quality molecular analysis of the entire food chain by anyone, at any time and targeting several threatening food contaminants. The system will be based on an easy to use, robust and low-cost solution for the detection of harmful substances such as pesticides, mycotoxins and allergens, for example on a sample taken from a jar of baby food prior to feeding. This contrasts with current laboratory practice, which requires delivery of samples to remote locations and a delay before receiving results. With the FOODSNIFFER solution, real-time operational decisions and choices may be driven by analytical results in a profoundly different way to the current state of art.

★ How will this work exactly?

The heart of the envisioned solution is an all-silicon optoelectronic platform that integrates all essential components of an optical biosensor, namely the light sources, the sensing elements and the detectors, on a single chip of a few tens of mm^2. This chip is fabricated using standard silicon technologies, which makes it ideal for mass production at low cost.

"FOODSNIFFER will empower us to identify potential dangers along the entire food supply chain."

Due to its radical design, this optoelectronic platform is capable of analysing simultaneously, in real time, several samples.

★ Were you able to rely on previous research for your work?

In the initial stages of development and over the course of the EU-funded PYTHIA project, the optoelectronic platform was tested in the detection of biomarkers related to healthcare. These results proved the analytical capabilities and the advantages of the platform and they inspired us to explore its potential in the food safety sector, which has a great impact not only on public health and quality of life, but also on the food industry itself. The biosensor market for applications in the food industry is complementary to the healthcare one, with additional advantages for the developers and a potential for commercialisation of a much lower regulatory approval barrier.

FOODSNIFFER consortium

★ What were the main difficulties you faced and how did you solve them?

The challenges that we face are mainly of a technological nature. FOODSNIFFER is attempting to achieve the ultimate level of on-chip integration by adding a spectrum analyser to the optoelectronic platform, which would make our device the first all-silicon spectroscopic circuit. To our knowledge this has never been attempted before and we had to build on radical photonic engineering approaches.

From a biochemistry point of view, we need to develop specific assays that would function on our micro-chip that would provide a detection sensitivity exceeding the maximum levels authorised by the EU for each targeted contaminant.

In addition, we need to ensure that the sample preparation per application is as simple and low cost as possible so that the FOODSNIFFER system could be widely and easily used.

In addition to these technological challenges the FOODSNIFFER solution should be able to compete with the currently used analytical methods. It has to prove itself comparable to established analytical laboratories in terms of sensitivity and reliability.

★ What are the next steps for the project?

Over the previous period we obtained some promising preliminary results in the detection of certain allergens with an intermediate chip version. FOODSNIFFER is now working towards the development of proof-of-concept sensing chips and their evaluation with the available assays on mycotoxins and pesticides, along with a comparison with standard methods.

In addition, a prototype bench-top measuring apparatus is being developed which will be used in the preliminary evaluation of the analytical performance of the FOODSNIFFER system. This is being performed as a preliminary step towards the development of the hand-held system for controlling and reading the response of the chip.

★ How do you expect this technology to help EU citizens?

The industrial revolution and our modern lifestyle have changed our perception of food. Previous generations used to buy a product based on a long-time trust relationship with the food producer but this is not the case anymore. The complexity and geographical spread of the modern food supply chain may also hide far greater dangers than we may have anticipated, and the ease of distribution of large quantities of

potentially unsafe food to many countries within short timeframes may have a snowball effect worldwide and makes tracing of the suspect product difficult.

We expect FOODSNIFFER to bring about a change in how we approach food by empowering us to identify potential dangers along the entire food supply chain.

It is important to stress that several human infections are foodborne. Cutting-edge medical research is now showing that short-lived infections are not harmless. In fact, they may often cause permanent damage to the physiology of many otherwise-healthy people with an untold cost — both financially and in terms of quality of life — resulting from chronic health conditions. This can consist of, for example, disturbance in the immune system.

★ When do you expect the FOODSNIFFER technology to be commercialised?

It should be available within the three years following completion of the project. However, the development of the technology and system is only the beginning of the process. Commercialisation requires a validation which may prove even more time consuming.

FOODSNIFFER

★ Coordinated by the National Center for Scientific Research 'Demokritos' in Greece.
★ Funded under FP7 ICT.
★ http://cordis.europa.eu/projects/rcn/104782_en.html
★ Project website: http://www.foodsniffer.eu
★ http://bit.ly/1cTnmeZ

A REVOLUTIONARY PORTABLE LAB FOR RAPID AND LOW-COST DIAGNOSIS

Do you remember the James Bond film *Casino Royale*? After being poisoned, the agent uses a portable diagnostic kit to identify the toxic substance and alert his HQ in London. Such technology is no longer fiction.

European researchers have developed a ground-breaking diagnostic system based on smartcards and skin patches combined with a portable reader. Test results can directly be sent to a remote computer, tablet or smartphone through a wireless connection. This small lab can already detect cocaine consumption, monitor colon cancer, identify bacteria in food and analyse environmental contamination. Many other useful applications can be foreseen. Companies in Spain, Ireland and Denmark will soon commercialise this innovative diagnostic system.

'Thirteen partners in eight countries worked for four years on the LABONFOIL (Laboratory skin patches and smartcards based on foils and compatible with a smartphone) project. They combined their skills in microtechnology, molecular biology, materials and electronics to develop this novel technology for rapid and low-cost diagnosis. All this was made possible thanks to EUR 5.3 million of funding from the European Union,' explains Dr Ruano-López, the project coordinator based at the Basque research centre IK4-IKERLAN.

The team focused more specifically on three smartcards and a skin patch. Each of them includes a very sophisticated electronic circuit and different chemical components that react to defined substances. The cards and the patch are analysed by a portable reader.

The cocaine detection patch can identify drugs in human sweat, which it samples straight through the skin. The patch collects data which can be examined in real time by a portable reader, or stored for later analysis — from 24 hours to 10 days. It could be used, for example, to test drivers, as drug consumption is related to around 25 % of fatal road accidents in Europe, the USA and Australia.

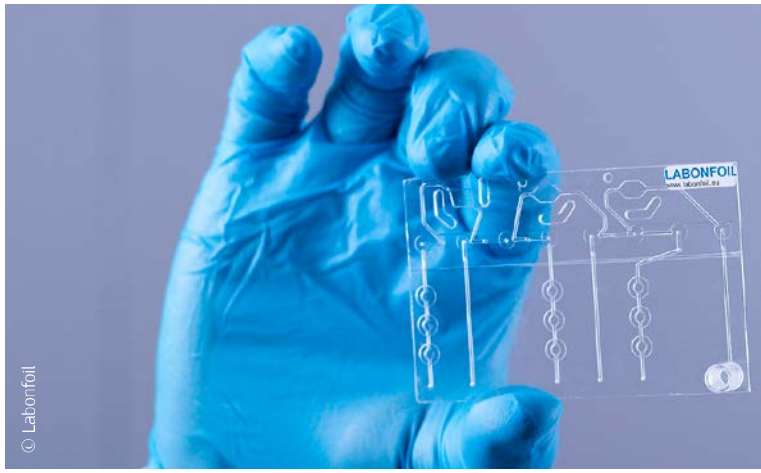
A smartcard has been developed to monitor colon cancer. It is inserted in the reader with a few drops of a patient's blood. The card can identify a specific protein which increases in the case of recurrence of the disease. The technique is not invasive and enables patients to be closely monitored at reduced costs.

Another smartcard developed by the research team can detect pathogens — infectious agents such as bacteria or viruses — in food. It focuses on 'Campylobacter' and 'Salmonella' — the most common bacterial infections in Europe. It could be used in farms and in food processing establishments to ensure food safety and protect consumers.

The water contamination card analyses phytoplankton concentration in a sample of sea water. Excessive concentrations of these microscopic algae can signal toxins or pollution which may be harmful to humans.

The portable reader can connect to computers, tablets or smartphones through a wireless network. The data obtained by the small lab on a poultry farm could be immediately inspected by a vet located anywhere in the world. Such a diagnostic system could enable rapid reactions in the event of a health or environmental crisis, and ultimately save lives.

Researchers used foils, instead of traditional wafers, to create the cards and the patch, drastically reducing production costs. After extensive validation tests — involving more than 600 samples — the devices were shown to be robust and reliable; they are now ready to be used by the market. 'With team spirit, dedication and a rigorous approach, we created a diagnostic system with major social and economic potential. The four applications that we developed present a real added value and they can be adapted in different scenarios, faster



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