4.9. IncluSens

Project	IncluSens: Democratising progress in healthcare through the development of wearable, low-cost technological platforms
Organisation	Nanosensors Research Group, Universitat Rovira I Virgili
Research location	Tarragona, Spain
Cooperation partners	International university partners, local private organisations and the Hospital St. Joan de Déu Barcelona
Team	Four senior researchers
Funding sources	Universitat Rovira i Virgili, European Union (Marie Curie fellowship and European Institute of innovation and technology, EIT Health); Ramón y Cajal Programme, Ministry of Science and Innovation of Spain; Ministry of Economy and Competitiveness of Spain and the Fundación Recercaixa, La Caixa Capital Risc
Websites	http://www.quimica.urv.es/quimio/nanosensors/ http://www.caixaimpulse.com/projects/-/caixaimpulse/project/25412

ORGANISATIONAL BACKGROUND

The project is carried out by a project leader, a senior researcher and three post-doc researchers from Universitat Rovira i Virgili within the nanosensors research group in the department of Analytical and Organic Chemistry.

The project leader is Dr. Francisco Andrade, whose aim it is to expand the knowledge base (curiosity) but also to find new ways of arriving at innovative solutions that have high social practice and impact (necessity, i.e. as opposed to doing science and technology in the lab only). The idea is that in the lab knowledge is de-contextualised, but through innovation it must be re-contextualised again in order to be adopted by society.

The team collaborates closely with four partners. These partners are diverse and each contributes in a different way. Together with the University of California San Diego, the collaboration is on research into wearable technology. With two private partners, the collaboration concerns the design of prototypes and the use of RFID tags in portable applications. With the Hospital Sant Joan de Déu Barcelona – and other local hospitals and institutions – the focus of collaboration is on further development of the innovation concept, development of real scenarios for applications and acceptance of these innovations.

FUNDING

This research is supported by several public and private sources. Since the beginning of the project, financial support has been provided through national and international projects. Funding has been received for:

- EC FlexCare: electrochemical platforms for decentralised chemical measurements by both the Ministry of Economy and Competitiveness and the Ministry of Science and Education of Spain;
- FlexSens: chemical sensors for the 21st century by the European Union, Marie Curie starting grant and EIT Health;
- Sens-Age: smart sensors for healthy ageing by The Fundación "La Caixa" & Caixa Bank Capital Risc;
- Creatimeter by Universitat Rovira i Virgili.

PROBLEM BEING ADDRESSED

Knowing about one's own day-to-day health appears to be very challenging as the body often seems like a black box. Today's technology allows people to send messages and pictures and the same technology can also be used for health data, i.e. sending daily health data using the power of networking to allow people to obtain information about their daily state of health.

This research concerns the development of cloud-based platforms for wearable and affordable devices that can be used at home by patients at a very low cost. The devices measure and monitor biochemical parameters that are indicators for common chronic conditions – such as diabetes, chronic kidney disease, etc. IncluSens aims to create a more efficient and inclusive social healthcare system by developing telemedicine tools that are highly affordable, simple and robust.

RESEARCH DESIGN AND SOLUTION

The main research is carried out on chemical compounds in biological fluids, for instance creatinine, which is a biomarker for kidney function. These molecules can be measured almost continuously by wearable devices without much interference with a person's daily life. By drawing on and leveraging current progress in communications, materials and sensors, the team is developing new tools for the monitoring and management of chronic diseases that are extremely simple and affordable. The research is embedded in scientific research and tries to translate the research findings into devices that are affordable and comfortable to use for a wide audience. Implementation of the research into these devices receives considerable emphasis in the research project and to support that, the team collaborates at specific points with experts from the fashion industry on designing clothes and mannequins to model the prototypes, while the postdocs also take courses in the commercialisation of technology. The team has incorporated a senior industrial designer who works in the lab to help to visualise users' needs and provide tools for thinking about design.

GRAND CHALLENGE BEING ADDRESSED

Social inequality is one of the biggest challenges of the 21st century. Most of the wealth is concentrated among only a small fraction of the world population, while large numbers of people suffer from conditions that seriously compromise their life and well-being. Science cannot be indifferent to this problem since the incorporation of technology in society might become a source of inequality. In healthcare, for example, technological progress is creating unprecedented ways to detect and cure diseases early. At the same time, increasing numbers of people in both developed and developing nations cannot afford basic medical care. The World Health Organisation has recently admitted that technological progress is directly linked to the skyrocketing costs of healthcare. Treatment is better but accessed by fewer people. To avoid this, an understanding of progress that goes beyond improving current performance to include the extension of existing benefits to larger numbers of people is therefore required. Many challenges lack academic appeal because the focus is on the scientific challenge. Nevertheless, little is being done to allow the benefits to reach the whole population. New models of inclusive social progress are needed. IncluSens aims to create novel technological platforms for healthcare that are accessible on a mass scale. At the social level, this project aims to provide tools for home-based healthcare that are simple to operate, easy to access and highly affordable. People will therefore benefit from better and affordable control of their health and improved quality of life. Society will also benefit from effective tools that can help to redefine healthcare by leveraging progress in communication tools and channels. Another social challenge that is mentioned is the pressure the devices put on the interaction between patients and their doctors and the position adopted by doctors on the device.

RESPONSIBLE RESEARCH AND INNOVATION

To develop and design the wearable devices, the research group included, right from the outset, an industrial designer with a high level of expertise in design thinking and human-centred design. Through this collaboration, the team conducted observational research by testing the devices among patients and doctors. Ethnographic studies were carried out and the insights gained were discussed in focus groups to translate them into inputs for research. This helped to improve the development of useful, applicable solutions, since it highlights different layers of value, latent needs etc. The team also included two target groups: doctors and patients. Since the goal of the project is to provide tools to improve healthcare and well-being, these patients and doctors were included as co-developers of the project. For this reason, periodical review meetings were organised with them, at which progress was shared and their feedback and needs were captured in order to identify how to proceed or what the limitations are.

The research team has also participated in several results dissemination sessions, not only in healthcare and academic centres, but also through dissemination activities allowing the general public to learn about the goals and progress of the project and offer its opinions. The research team has communicated its vision and research progress to a wider audience through several mass-media channels (national TV, newspapers, radio). People from the audience have contacted the team afterwards on several occasions.

To reflect on the broader issues involved in implementing wearable devices, the team has set up a panel of experts from different areas (medical, legal, social, ethics, etc.), who are consulted periodically to evaluate the ethical and social implications of the results. The analysis of the project's impact used a matrix in which the different aspects (social, environmental, economic) were evaluated as a function of the time-frame (short, medium, long-term). The feedback captured

from the different panels (doctors, patients, stakeholders) and from the experts was classified accordingly. This matrix allowed the identification of previously unsuspected problems, and also the detection of many opportunities.

One point that is worth mentioning involves the use of information. The project aims to develop home-based devices that generate biochemical data. A system incorporated in the toilet, for example, produces information regarding urine composition. One unforeseen problem is how to manage this type of information. Doctors have raised concerns about the problems that could arise if people have frequent access to their biochemical parameters. Patients have mentioned that they might feel uneasy if biochemical measurements are carried out regularly. This information was captured at an early stage by the designers, and has been incorporated in the design of the user interface and information management system. Similar problems have been detected, for example, concerning confidentiality of the data generated. As a result of these findings during the research, the project aims to analyse risk at different levels.

EVALUATION AND DISSEMINATION

The research is carried out by a relative small research group. It is broadly embedded in terms of both the scientific literature and practical implementation. It seeks to incorporate human-centred design early in the research lab to balance scientific curiosity and social necessity. Design thinking tools help to find real challenges beyond the obvious problems and not only to develop cheaper tools, but to reshape the way doctors and patients engage with caring for their health.

The research team has provided eleven scientific journal publications since 2013 in journals such as: *Chemical Communications, Biosensors & Bioelectronics, Analytica Chimica Acta, Electroanalysis*, and the *Analyst*. Two of these were featured as cover articles. Two book contributions were provided.