GWAPO–Generic Wireless Autonomous Conformable Patch with Display

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With the GWAPO platform, CSEM is offering a thin, miniature, flexible, and rechargeable wireless interactive sensor system, i.e. a smart patch. It combines energy sources (e.g. PV/OPV), with pressure and temperature sensors, electronics, displays, interactive components and antennas.

Wearable technologies are proliferating, from smartwatches and activity trackers to hearing aids, virtual reality devices and implantable sensors. While the first wave of wearables borrowed technologies from the mobile industry and was consequently limited to rigid devices such as headsets and smartwatches, the second wave is more focused on technologies for sensors that may be worn almost anywhere on the body [1]. Current technologies are limited, in particular with regards to their wearability and ease of use. Moreover, most of the current products use bulky disposable batteries offering limited autonomy.

To address these challenges, CSEM has developed the generic wireless autonomous conformable patch with display (GWAPO), which consists of an autonomous, flexible and wearable platform with embedded sensors, electronics for computation, display, rechargeable battery and renewable power source (photovoltaic), and wireless connectivity, including the antenna. The main goals of the project are to optimally combine the building blocks, to develop the necessary interconnection techniques and to integrate all components into a single thin "patch". The resulting solution is a disruptive platform for thin, miniature, flexible and rechargeable wireless interactive sensors and actuators that can be placed on body, as well as, on everyday objects or sports equipment.

The current GWAPO prototype patch (Figure 1) is comprised of 3 layers: The electronic layer, incl. pressure and temperature sensors, energy management, processing and communication; the PV cell and display layer; and the flexible battery layer. The electronic layer is optimized for 3D flexibility using flexible PCB technology on which the integrated circuits are placed on “rigidified” tiles in order to reduce the chance of breakage. Several concepts for electrical interconnection have been studied, from conventional to hybrid integration techniques, where sensors and energy harvesters are printed and integrated into the GWAPO thin patch.

Figure 1: Generic and autonomous wireless patch.

The energy source of the GWAPO prototype can be either a thin film silicon-based PV cell or an organic solar cell (both developed by CSEM). Both energy sources are able to provide typically 150 μW with an active area of 2.5 cm^2 and under 1000 lux. An ultra-low power processor provides the necessary processing capability for sensor acquisition including user interaction, wireless communication using the CSEM icyTRx radio chip, and display on the low power thin, flexible display.

A thin-film pressure sensor was made with an ultra-soft PDMS layer which was structured by imprinting on Ag-electrode PET-foil using an inkjet printer. Static pressures from 1 mN/cm^2 up to 400 mN/cm^2 were recorded. This corresponds to pressures from 0.15 mmHg to about 30 mmHg. The response of the sensor to physiologic pressure levels is linear in the range. A glucose sensor was also adapted with an expanded concentration range from 0.1 mmol to 30 mmol.

The antenna and the pressure sensors were printed on a flexible substrate and integrated with the patch. Figure 2 provides a 3D view of the GWAPO patch before packaging. Then, a specific waterproof coating, extremely robust against tearing and bending, is applied.

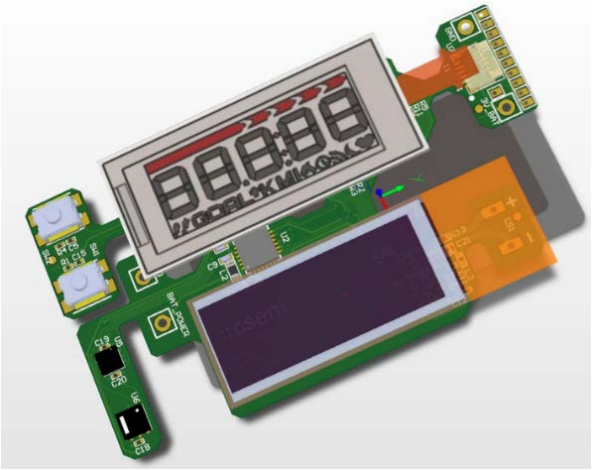

Figure 2: 3D view of the assembled patch.

Flexible and wearable solutions such as GWAPO can support a wide range of applications such as the monitoring of wounds, the direct display of vital signs, and more generally, applications requiring embedded sensing and display. Additionally, the GWAPO platform can actually provide "real-time feedback loops capable of influencing our life style in terms of physical and mental activity, nutrition, hydration, promoting healthy habits and, in general" [2], enabling long-term multi-parameter sensing systems expected by physicians and patients.

[1] IDtechEx 2016

[2] A. M. Ionescu, "Smart wearable technology: enabling future prevention-based healthcare", ASA/SVV Medinfo 2(2014) 30