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SMART FABRICS HACKATHON 2017 accenture

Notes about smart fabrics

and available technologies for the hackathon

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Smart Fabrics or Smart Textiles is an emerging technology that covers a wide spectrum of sensing and actuating mechanisms, from detecting physiological signals, environmental conditions and interactions with others to displaying information or adapting color, shape or shrinkage as a response of a given stimulus. They can also include embedded or even printed electronics for control and communications and energy harvesting and storage. Two good reviews on the current state of this technology, with additional references, can be downloaded from open-access sources at:

- http://www.mdpi.com/1424-8220/14/7/11957
- https://www.semanticscholar.org/paper/Smart-Textiles-and-Wearable-Technology-A-study-of-Berglin/7a0b01c5aaec9fb2e66821abe5df688297e9888d

Examples of sensor-based wearables applied to e-health (left: MC10 electronic tattoos, self-positioning electrode harness (HB-KTH)), sports (center: Hexoskin Smart Shirt, Warm-X) and fashion (right:Electric Foxy Bar, Hug-Shirt Cute-Circuit)

The Smart Fabrics solutions based on mechanical or chemical properties of the textile materials (color, shape, strength) are not suitable for prototyping in a Hackathon frame because they need specialized facilities and long development times. On the other hand, solutions based on sensing physical variables, acquiring and processing them and displaying or exploiting derived estimators allows fast development of new products and services thanks to the availability of multiple IoT devices and data analytics tools.

The focus of 2018 Smart Fabrics Hackathon will then be the development of a solution using sensor-enabled smart fabrics in the health care, sport or fashion industries. In order to reduce the development time of the signal sensing, acquisition and communication, two different kits will be provided :

- The Plux Bitalino Revolution, open-source hardware for education, rapid prototyping and exploratory research in biomedical engineering, able to capture several physiological signals.
- The Adafruit Flora development kit, an Arduino-like platform tailored to develop wearable applications.

A short description with links to additional information and tutorial videos about both devices can be found in the following pages.

The kit Bitalino (r)evolution was developed by the company Plux Biosignals (Lisbon, Portugal) and is the third iteration of the Bitalino products line. The direct link to the kit is

http://bitalino.com/en/board-kit-bt

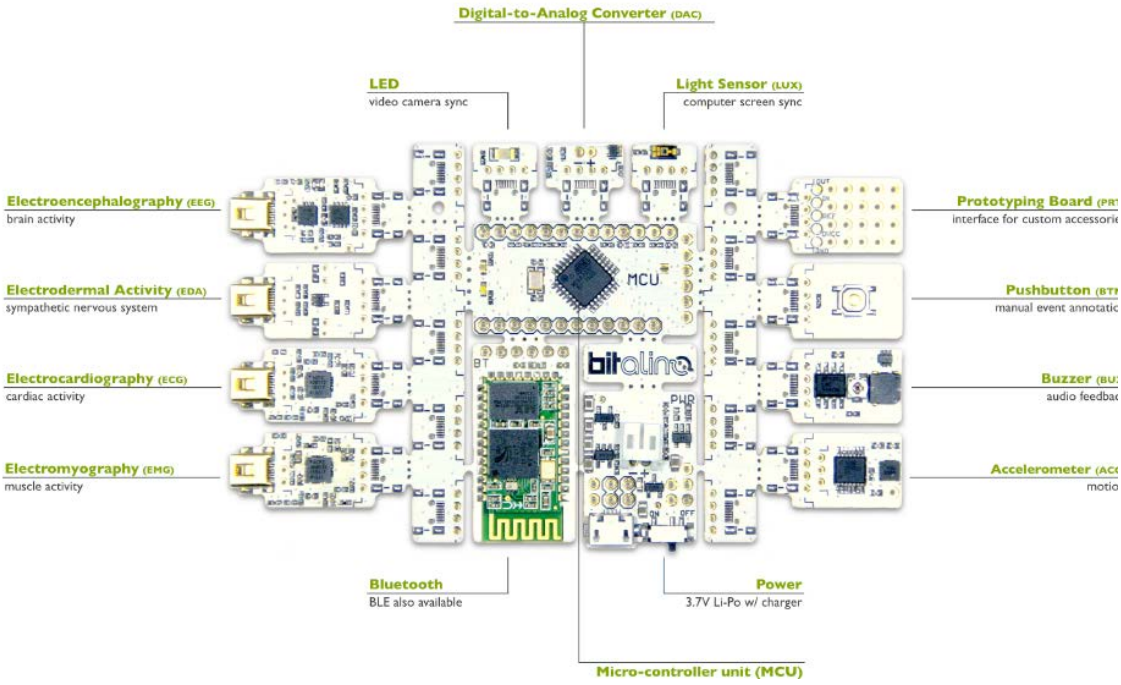
The board has a modular structure. All modules are initially attached and internally connected. The board allows splitting one or several modules, but then wires have to be used to connect the separated module with the main board. There are four channels for electrophysiological signals:

- Electromyography (EMG). Captures the electrical signals generated by the muscle activity. Additionally of detecting associated pathologies, it is useful as control signal for Human-Computer Interaction (HCI), Prosthesis control, Biofeedback, …
- Electrocardiography (ECG). Captures the electrical signals generated by the heart activity and detectable at the body surface. Additionally of being a diagnostic tool for cardiac pathologies, it is useful to determine Heart beat rhythm (HR) and its variability (HRV), which are indicators of effort, stress, awareness, drowsiness, among other states
- Electrodermal Activity (EDA). Reflects the electrical conductivity of the skin, which changes with blood irrigation and micro-sweating, which reflects the activity of the sympathetic nervous system (body's fight-or-flight response). Is one of the basis of liar detecting machines and is useful to build human-computer Interfaces, for affective computing, relaxation biofeedback, …
- Electroencephalography (EEG). Reflects the brain electrical activity as it can be detected in the skull surface. Although it has several applications, the detection and interpretation of EEG signals is complex.

There are also three additional inputs:

- Accelerometer (ACC). Activity monitoring through the movement of the accelerometer attached to the Bitalino board. Useful for activity monitoring, tilt detection, vibration measurement, human-Computer Interaction, posture detection, step counting, fall and shock detection,…
- Light (LUX). Ambient light monitoring, synchronization with other devices
- Pushbutton (BTN). Manual trigger, biofeedback.

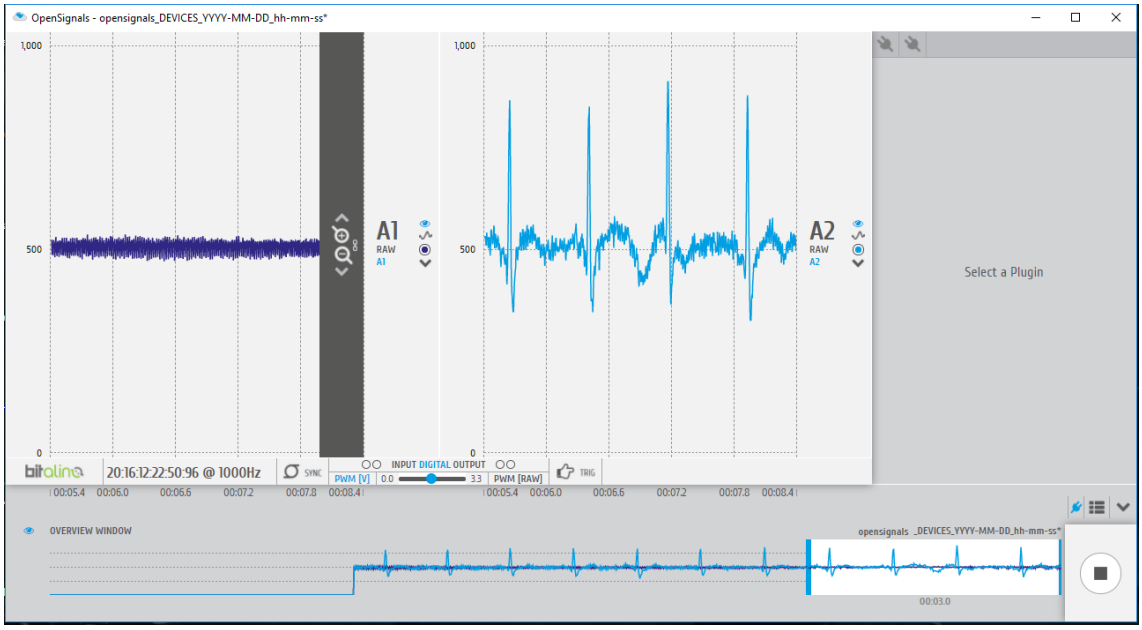
and three actuators: Light-Emitting Diode (LED), Buzzer (BUZ) and a 8 bit Digital-to-Analog Converter (DAC). The board also includes an Arduino-like microcontroller (ATMega 328P), a Bluetooth (BT) module, a Power (PWR) block, which allows charging a LiPo 3,7 V battery and regulates its output to provide the 3,3 V needed by all the modules.



The Bitalino module comes already programmed. The channels to be measured and the sampling rate (1, 10, 100 or 1000 samples/s) can be selected by parameters sent through the Bluetooth link. The datasheet of the board as well as the features of the different acquisition channels can be found at http://bitalino.com/en/learn/documentation .

The kit includes two cable arrangements, one with three leads, suitable for measuring EMG or ECG or EEG and one with two leads, suitable for EDA measurements.

About the software, there are applications (http://bitalino.com/en/software) to configure, acquire and visualize the Bitalino signals from a computer (Windows, Linux, Mac) or from a smartphone (Android).



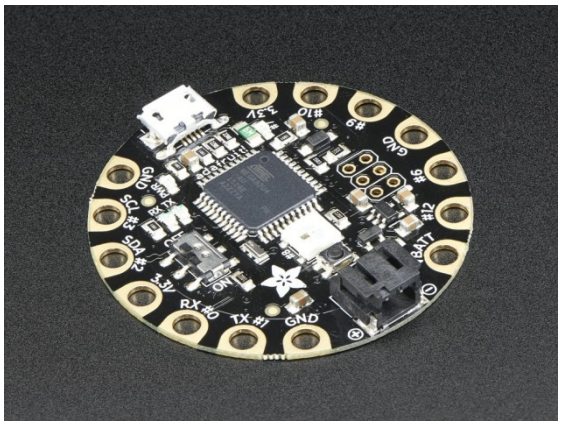
The quickstart guide to configure BlueTooth to communicate with Bitalino can be found at:

http://bitalino.com/downloads/quick_start_guide/quickstart-guide-1.0.0.3-print.pdf

There are also APIs (http://bitalino.com/en/development/apis) for the mainstream programming languages and development frameworks although most applications are developed in Python. There are a lot of public materials at the GitHub repository (https://github.com/BITalinoWorld). You can find video tutorials about the use of Bitalino at http://bitalino.com/en/learn/tutorials or at YouTube (https://www.youtube.com/watch?v=LOFUTNEgrv4) and also third-party video tutorials at YouTube. Most of them use the previous version of the hardware, but are also useful.

The kit Flora was developed by the company Adafruit Industries (New York, USA), which also sells a wide range of components for prototyping wearable systems.

The kit core is the Arduino-compatible board Flora (https://www.adafruit.com/product/659) which has a round shape and has been designed to be sewed to clothes, being suitable as the core of a wearable system (left figure). The kit Flora Sensor Pack (right) (https://www.adafruit.com/product/1458) includes the Flora board, USB cable, batteries and connectors, four RGB programmable NeoPixel LEDs, a color sensor, an accelerometer/compass sensor, a light (Lux) sensor, Woven Conductive Fabric (for capacitive touch sensing) sewable snaps and stainless steel conductive thread



This system is quite different than the Bitalino. It does not include amplifiers for biosignals. So it can only detect movement, contact, changes in ambient light and color, and provoke a response through changes in light and color of LEDs. On the other hand, it is fully programmable and can be the core of a standalone wearable system that gives a response after a set of stimuli or changes in the situation without the need of being connected to a computer or a mobile phone. For example, a suit that blinks when detecting a fall or when the user touches a given part. Flora can, however, stablish a communication with other systems through a UART connection or a Bluetooth accessory if needed.

There is a document describing the Flora features, that can be downloaded at http://www.mouser.com/ds/2/737/getting-started-with-flora-774780.pdf

But the easiest way of getting ideas of possible applications is watching the video tutorials that can be found at YouTube (searching Adafruit Flora) or at https://learn.adafruit.com/getting-started-with-flora/flora-projects

Some ideas about handcrafting wearable sensors can be found at:

https://cdn-shop.adafruit.com/datasheets/HandcraftingSensors.pdf