Biometric Data Capture as a Way to Identify Lack of Physical Activity in Daily Life

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Abstract. Given the impact of the pandemic era, it is important the effects of physical activity on human beings, physically and mentally. The significant advance in the technology industry of biomedical sensors and mobile devices allowed the arrival of new health monitoring prototypes to improve people's lives. This work implements a data capture system, using an electrocardiogram (ECG) and accelerometer (ACC) type sensor to collect a large volume of data for further analysis to obtain metrics to assess the activity level during this pandemic phase. Using a BITalino device that allows us to collect a large amount of information from various sensors, we, therefore, chose to use it as a platform to capture data from the sensors mentioned above. In the first phase, we will capture the largest possible amount of data from the subject in the test phase. Then, the collected data will be sent to a web server, where it will be processed. Finally, in a third phase, the data will be presented in a more summarized and graphical way. In this way, we will analyze the impact of movement/inactivity on the test subjects' daily life with the referred sensors' biometric data.

Keywords: Biometric · Data capture · ECG · Accelerometer · BITalino

1 Introduction

Interest in biometrics has gained momentum in the last years, mostly due to the massive use of daily life devices like smartwatches, smartphones, and laptops [10,11]. From a technical perspective, biometrics can be classified into two

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main groups depending on whether they use physiological or behavioral signals. Examples of physiological signals include fingerprints, iris, retina, heart, and brain signals, whereas voice, signature analysis, or keystroke dynamics are behavioral signals [8].

The research outcome in this area is that most gadgets, such as smartphones, tablets, wearables, and Implantable Medical Devices (IMDs), have been equipped with one or more embedded sensors to measure biometric parameters from the bearer. Besides having biometrics sensors, most (if not all) of these devices are enhanced with some wireless communication technology, e.g., Bluetooth, WiFi, or Radio Frequency(RF), allowing them to share data and to perform remote reconfiguration [6].

Nowadays, mobile devices have increased, and this trend will continue in the coming years. Due to their widespread integration with the users' lifestyles, mobile devices can support personal activities anywhere at any time. Also, these devices integrate numerous sensors that allow signal acquisition related to different aspects of medical or assisted living purposes in different environments [13].

Mobile devices integrate sensors and features that help healthcare professionals treat their patients with permanent connectivity. Mobile applications help collect data related to physical activity, human body images, and other aspects related to healthcare [13].

Although mobile devices integrate many sensors, over recent years, the Do-it-Yourself (DiY) community has been contributing to the development of low-cost, easy-to-use hardware platforms targeting biomedical engineering and equipped with multiple sensors useful for a wide range of applications [4]. One of these hardware platforms, explicitly designed to suit the needs of the physiological computing community, is BITalino device [14].

BITalino device a low-cost and highly versatile hardware framework designed to allow anyone, from students to professional app developers, to create projects and applications with physiological sensors [14].

Jupyter notebooks provide an environment where you can freely combine human-readable narrative with computer-readable code. This lesson describes how to install the Jupyter Notebook software, run and create Jupyter notebook files, and contexts where Jupyter notebooks can be particularly helpful [7].

In our daily life, we have continuous access to a plethora of sensors in our mobile devices. With the use of specialized sensors such as the ones provided by the BITalino platform, the information captured with these sensors can give us many data to analyze. In this study, we intend to correlate some of these sensors data in daily life to detect lack or not of physical activity.

This document is organized into five sections. In Sect. 2, we identify related work. Section 3, presents the method applied in study. Section 4, shows the obtained results. Finally, in Sect. 5 conclusions are drawn, followed by future work guidelines.

2 Related Work

This section's overall goal is to describe the related research areas and place the method's contributions in this context. This chapter surveys previous work in biometric data capture to identify a lack of physical activity in daily life. In general terms, the biometric data will be captured through a device called BITalino and its sensors, such as an ECG sensor to measure the heartbeat of the subject and accelerometer sensors to measure subject movement, respectively. The biometric data will be sent to a server, processed the signals, and finally, the information will be displayed graphically and resumed to be better visualized. This process aims to understand the lack of physical activity and the relation with this critical phase that we are trying to pass through.

A device and an ECG sensor will do this process, but first a little bit of history about it, this device was designed in Portugal and is one of the ten main European innovations in the Industrial & Enabling Tech category of the Innovations Radar Prize 2017 [3].

Nowadays, biometric data is a subject in vogue by the general public and not only by the people who work in medicine. Thus, portable devices such as smartwatches and smart fitness bands play a crucial role in evolving how it diagnoses several health disorders before they step into a high-risk medical field. It is significantly accessible to recording data. There is a tremendous interest in devices that can help people control or measure their physical condition or health and well-being. Furthermore, biometric data has become a critical topic of study for the global engineering community and, as a consequence, shows that biometric data is a topic of growing interest [9,12,14].

In this project, it will be captured biometric data from three or four subjects. For this purpose, a BITalino device will be used with the respective sensors to capture biometric data. This equipment will be described in the following topic to understand better this technology [15].

Currently, there is a need to create innovative hardware at a low cost. In this specific case, we are talking about BITalino devices. It is a versatile hardware structure designed with good raw material at a reduced price, allowing anyone to create projects and applications with physiological sensors. This device is probably the most well-established and recognized system for biomedical research and education. Although BITalino device has a variety of sensors and functionalities, we chose to use the sensor because, for the intended purpose, it is the most suitable sensor. This sensor analyzes four different activities: spine, seated, deep breathing, and recovery after exercise [1,2,5].

3 Experimental Work

At this stage, our project's first step was to obtain the data from a BITalino device from the two sensors used in this study, in this case, an ECG and accelerometer sensors. The procedure was to establish a connection between the BITalino device and an Android smartphone using the OpenSignals application to collect this data. OpenSignals, from the creators of the BITalino device, allow to capture data from the sensors and save it to a text file with the sensors' outcome results. After the capture is done, the same data text file is sent to an FTP server. The server folder, where the data files are received, is constantly monitored for new files. When a new file arrives, the server processes it and creates a new Jupyter Notebook file from a template and the received file data. These generated files can then be opened in Jupyter Server or Jupyter Lab, where we can visualize charts with the sensors' metrics. This process's architecture is demonstrated in the picture Fig. 1 presented below. Firstly, on the Android side, the OpenSignals app looks like the following pictures presented in Fig. 5. Secondly, on the server-side, the stack consisted of an File Transfer Protocol (FTP) server receiving the data collected from Android application to a folder (see Figs. 2 and 3), and the server monitoring these folders for processing the received data files. Finally, in Fig. 4, the Jupyter Lab server with a processed notebook is presented.

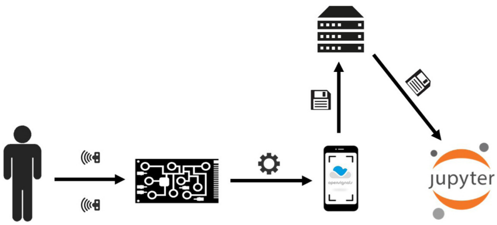


Fig. 1. Schema of the proposed system.

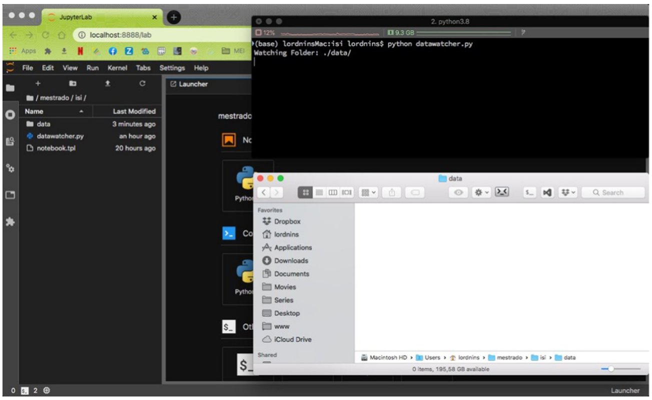


Fig. 2. Server Stack

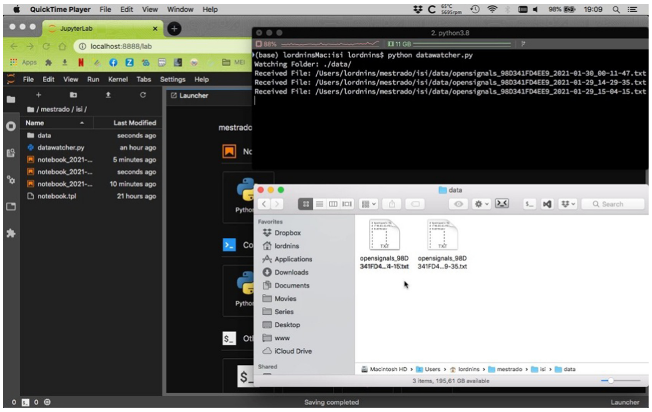


Fig. 3. Server Stack 1

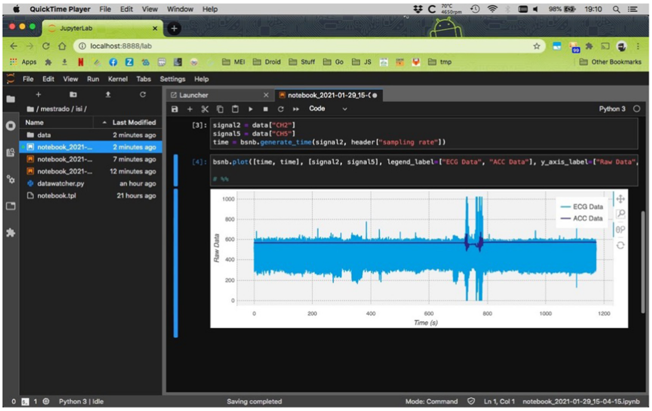
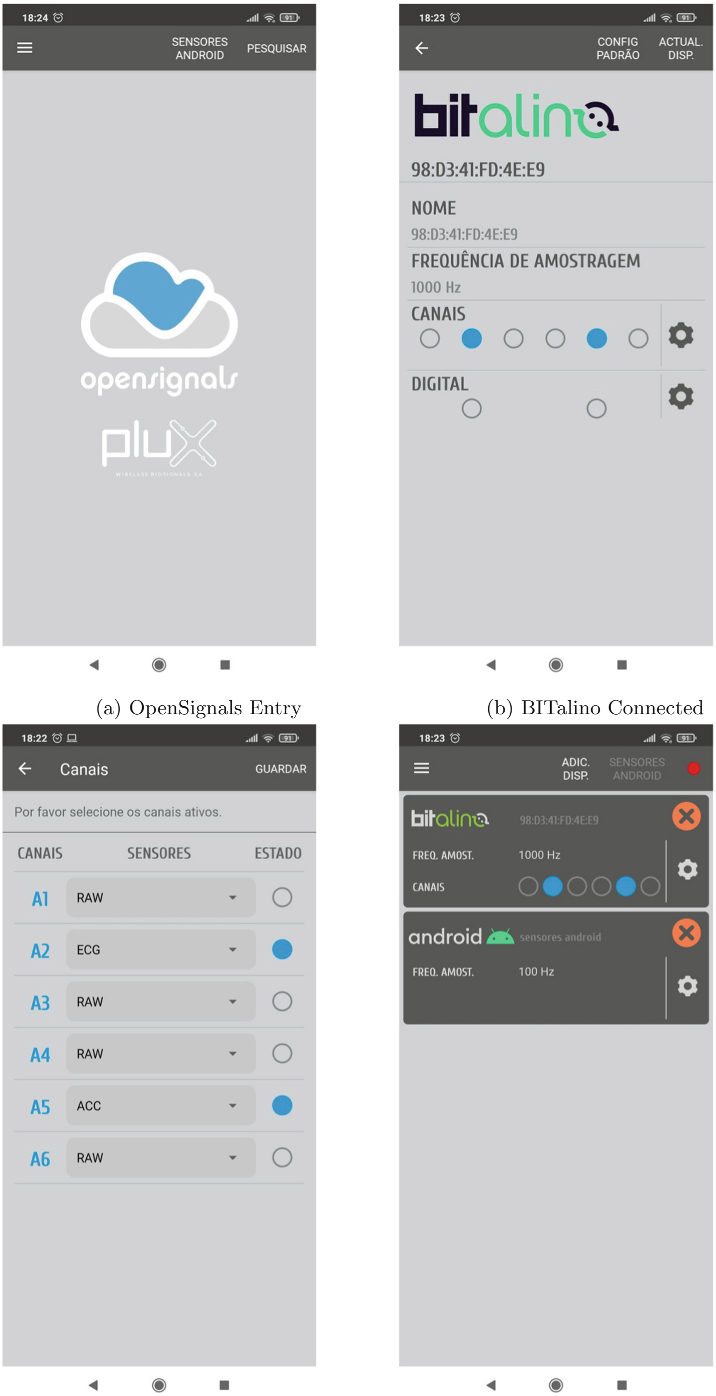


Fig. 4. Jupyter Notebook Processed Data

4 Preliminary Results

From the captured data collected from a single subject, the results obtained from the sensors can be seen in the chart presented in Fig. 6 or 7. The result data serves as an example for a small part of a day. The Fig. 6 represents a portion of roughly 18 min and Fig. 7 represents a portion of roughly 2 h and 18 min. The data had to be collected in chunks due to the large volume of data captured, making it much more difficult to handle in devices like mobile phones and even transform it into a simple laptop computer.

As shown in both charts, the data collected induce us to a correlation between spikes in ECG signal and spikes in the accelerometer signal, representing periods of movement from the subject. Although the periods described in charts are not from a full day from continuous measurements, we observed the same pattern of



(a) OpenSignals Entry

(b) BITalino Connected

(c) BITalino Channels

(d) Capture Devices

Fig. 5. OpenSignals

motion, or lack of movement in this case of the subject, as we suspected from the beginning of this work.

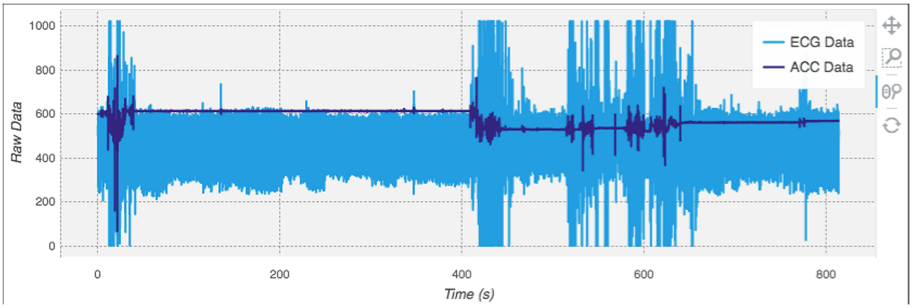


Fig. 6. ECC and accelerometer signals

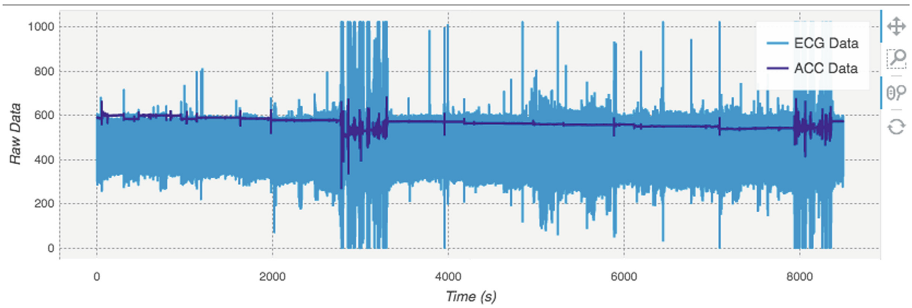


Fig. 7. ECC and accelerometer signals

5 Conclusion

The purpose of this work was to implement a system that would capture, process, and display biometric data collected from sensors for individuals to try to make a correlation between lack or not of movement and the sensors data, due to the confinements times that the population is facing. Two sensors were used to achieve the proposed goal, ECG and accelerometer adequately integrated in a single-board computer (i.e., BITalino device). It could make the capture, and then the data collected is sent to an FTP server then further processes to a Jupyter Notebooks where data is rendered in carts. The conclusion is that the implementation of this system was an excellent means for learning purposes. Finally, it was helpful being the population tends to be more sedentary in the pandemic time. In the future, can be considered additional sensors in the monitoring and analysis of metrics and indicators related to the well-being of individuals. Finally, can be explored machine learning algorithms on processing the data to get new insights.

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