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Using Biomodule for Vital Parameters Measurement in Hospital Environment

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***Abstract*—Trauma surgeons at emergency departments in hospitals consider the wireless biomodules as valuable information source about the patients health state. Doctors point of view is very important in designing solution for software support for these biomodules. We have designed and developed a software solution for using Zephyr Bioharness biomodule for patients in hospitals, developing features regarding the vital parameter signal processing and visualization. This solution provides live monitoring of ECG, heart rate, respiratory rate, posture and acceleration. The vital parameters measurements are also stored remotely and used for history and further analysis of the patient health state. As a case study, the solution is set and currently under testing in General Hospital in Celje, Slovenia.**

***Index Terms*—Vital Parameters, Zephyr, Android Application, Hospital.**

I. Introduction

Wearable biosensors can aid the standard procedure of measuring vital parameters in a hospital environment. The data from the biosensors can be collected by a portable electronic device that is located close to the biosensor, for example, a mobile phone or tablet. These biosensors are usually light weighted, long lasting and use low power protocols for sending data. The data received on the electronic device is initially processed and then transferred to the remote server or Cloud for further analysis of the patient health state. The low-cost biosensors have no or low memory capacity and vital parameters streaming starts immediately after the sensors are placed on the patients body. The biosensors data is usually streamed at a frequency of 100 to 1000 Hz. In order to keep the streamed data, we need an external software that will process and store the data. In this paper we present a software solution for using the Zephyr Bioharness biosensor for collecting data from the patients in hospital. Zephyr Bioharness biosensor [1] collects different vital parameters: ECG (electrical activity all over the heart), Heart Rate (number of heartbeats per minute), Respiratory Rate (number of breaths per minute), Temperature (skin temperature), Posture (body position), Activity Level (acceleration), Subject Status as well as the battery level of the device. The data are streamed at a frequency of 250 Hz.

Zephyr BioHarness is widely used for developing eHealth applications. In [2] BioHarness has been tested for validity and has shown to be reliable for determining respiratory rate and respiratory breakpoint during exercise of varying intensity. In [3] the authors present an application developed for usage in fire fighting and sports that includes Zephyr BioHarness sensor. The application has been designed for smart phones, smart watches and tablets. An IoT-enabled mHealth application is presented in [4] to aid the personalized health care services. The application is developed for both Android and Windows phone platforms and the proposed architecture uses Zephyr BioHarness sensor. Another application of Zephyr Bioharness is in a cross-domain application for ambient and health monitoring with the aim to provide a complete picture to the information users (e.g. doctors) [6]. In [7], the authors present a platform that supports a variety of biosensor add-ons and it is used as a pilot project in Washington Hospital .

In this paper we confirm the usefulness of the Zephyr Bioharness in a hospital environment by providing remote patient vital parameter monitoring. Our software solution is set and tested in General Hospital in Celje, Slovenia.

II. Software Solution for Using Zephyr Bioharness Biomodule

The provided software system is intended for remote monitoring of human vital parameters and enables constant monitoring of patients health state in hospitals. The solution is developed under Android platform and supports Android devices with operating system Android 4.4 (and higher). The data gathering from the sensor is performed by using the Bioharness 3 SDK for Android platform. As shown in Fig. 1, the communication between Android device and Zephyr Bioharness 3 sensor is achieved by using the Bluetooth protocol. The application can be also installed on the patient android devices.

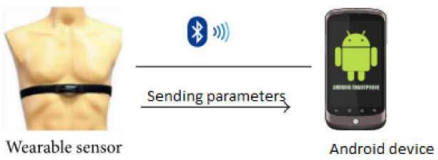

Fig. 1. Patient Monitoring System.

The vital parameter measurements are streamed in real time at a frequency of 250 Hz. Received data are stored locally on

the device as .csv files. If Internet connection is available, the data is sent to the remote SQL database hosted on a Windows server machine by using the android ksoap library and web services developed in C# which provide the communication between the android device and the SQL server.

Our solution enables simultaneous monitoring of five parameters: ECG, heart rate, respiratory rate, posture and peak acceleration. Fig. 2 presents a screen of the proposed solution. Heart rate (HR), respiratory rate (RR), posture and peak acceleration are shown in the upper table. There is also information (MAC Address) for the connected sensor and two buttons for connecting/disconnecting from the sensor.

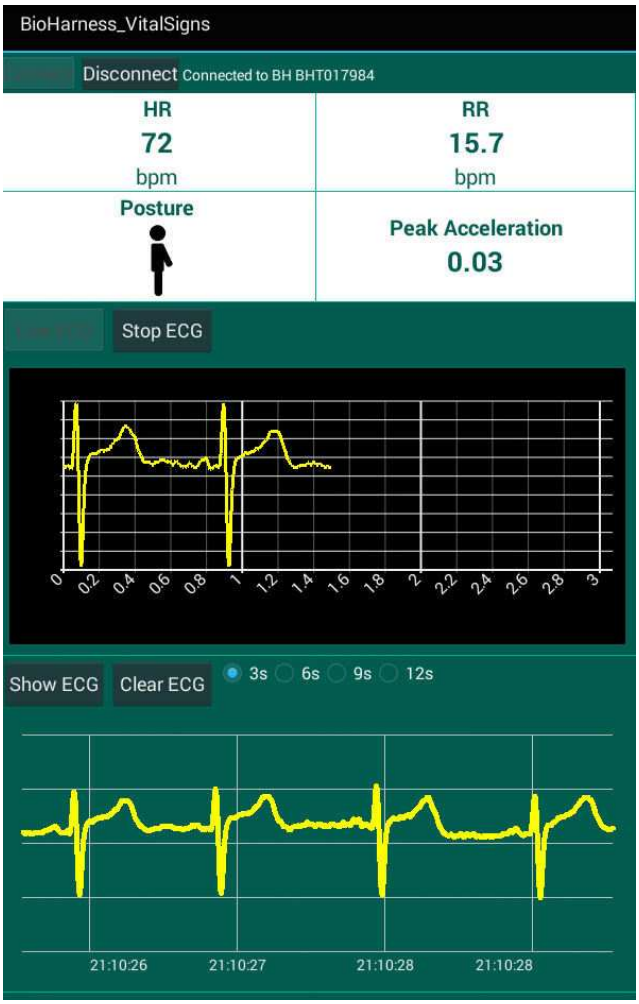

Fig. 2. Monitored Parameters.

As a very important feature requested by the trauma doctors, the application provides live monitoring and history of the electrocardiogram (ECG), and in both cases ECG is graphically represented by using the GraphView component. The live ECG monitoring is shown for three seconds. ECG history is gathered from the .csv files saved in the Android device. The history graph shows ECG data of the paired sensor from the last hour and according to the doctors' requirements there is an option for showing history of 3, 6, 9 and 12 seconds. The time of measurement is presented on the x axis. The graph is also scrollable and zoomable which provides easy detection of ECG signal abnormalities.

The benefits of the application are multi-fold. It provides an alternative opportunity for the doctors to monitor the vital patient parameters at a time without using a few different machines for obtaining each of the parameters. Another advantage is that the solution is wireless. This is very beneficial for the doctors in terms of the space available in the hospital units - too much cables cause lots of problems when treating the patients. The option to zoom and scroll included in the ECG window is also an advantage. Disadvantages considering the reliability of the application are not reported.

III. Conclusion

In this paper we have presented a software for wireless vital parameters monitoring by using the Zephyr Bioharness 3 sensor. The application is developed according to the doctors demands in the General Hospital in Celje, Slovenia where it is tested and confirmed to be reliable. The application provides the ability to monitor the patient's HR, RR, peak acceleration, posture and ECG. The module showing the ECG is more advanced providing the opportunity to show history and also to zoom the signal for making deeper visual analysis by the doctors. The application is modular and easy to use, thus new features can be added easily. The database records created from the patitent's data (ECG, HR, RR) processed by the software solution are very important for further research, especially in biosignal processing domain.

Acknowledgment

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