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Real -Time Ambulatory Monitoring System

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Abstract - *This paper presents the design of a cardiovascular monitoring system, for implementation on an embedded device. An electrocardiogram is one of the major biomedical waveforms been commonly used for a prognostic of heart-related diseases. ECG is acquired simultaneously from different systematic points of the body. A heart is an electromechanical unit. To know the proper functioning of heart we are monitoring both heart rate and pulse rate. A pulse oximeter is a medical device that monitors both pulse rate and oxygen saturation in the patient's blood. In this work, we propose a wearable device that a patient can use in his body and system can monitor the heartbeat of the patient and pulse rate. This paper mainly explains about real-time monitoring of heart rate, pulse rate and relative Blood Pressure through specially designed ECG circuit and transmission of data to a smartphone via Bluetooth.*

In wearable bio-signal monitoring systems, various noises increase incidences of misdetection or false detection. To prevent incorrect detection we use a robust method called autocorrelation. Autocorrelation method improves Instantaneous Heart Rate (IHR) accuracy despite its use in noisy conditions. Proposed method can contribute to the power and area reduction of the wearable bio-signal monitoring system

Key Words: **ECG, Pulse Oximeter, Bluetooth, Android Bluetooth App.**

1. INTRODUCTION

The Internet of Things (IoT) is basically a cloud of interconnected devices where thing refers to the physical entity it could be a microcontroller or sensor or could be an actuator. Technology plays a major role in not only monitoring health care parameters but also transmitting data and displaying it. The process of recording the electrical activity of the heart over a period of time by means of electrodes located on the surface of the skin is known as Electrocardiography (ECG). When heart contracts or relaxes the voltage in different ways changes this Voltage is required as an ECG Signal. Every reference point at which we take this voltage is known as a lead there are totally 12 ECG leads, 10 electrodes are placed on the patient's limbs and on the surface of the chest from which we acquire signal simultaneously. Whenever we plot a graph of voltage against time using this medical practice is mentioned as an electrocardiogram. The group of three graphical deflections seen on a typical electrocardiogram is nothing but a QRS complex.

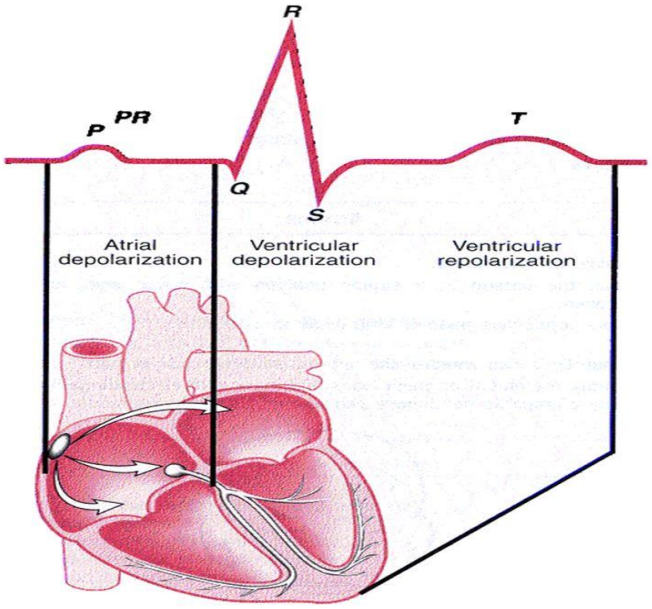

Fig-1: QRS complex

It corresponds to the depolarization of the right and left ventricles of the human heart. Q wave is any downward deflection after the P wave an R-wave follows as an upward deflection, and the S wave is any downward deflection after the R wave. After S wave we have T wave and in some cases, an extra U wave follows the T wave. Pulse oximeters were first used for vital sign monitoring during operations. A pulse oximeter is a device proposed for the non-invasive quantity of arterial blood oxygen saturation (SpO2) and pulse rate. In pulse oximeter normally two types of lights are used, red and infra-red light are passed through the finger.

Fig- 2: Pulse Oximeter

The pulse oximeter can be used for vital sign monitoring during operations. The common places where we find oximeters are in emergency rooms or ICU where it is used to keep an eye on the body condition of the patients.

Organization of paper: 1.Introduction, 2.Related work, 3.Proposed Work, 4. Implementation and Results, 5.Conclusion and future work.

2. RELATED WORK

The IHR is an important bio signal that is useful for heart rate variation (HRV) analysis, heart disease detection and exercises intensity estimation [1]. ECG represents the electrical activity of the heart. It is not possible for common people to put an ECG device and to be under observation bedridden for over 24 hours.

Therefore mobile healthcare system is of extremely important [2, 3]. Many single-chips ECG monitoring system [4] have been developed by different vendors which claim to monitor the heartbeat. ECG represents the electrical activity of the heart and it leads to the mechanical activity [5] so to understand proper functioning of the heart we are using a pulse oximeter. It is important to know arterial hemoglobin saturation (SpO2) [6] to help to save life by saying the oxygen level in blood and also provide the ambulatory monitoring to measure the various parameters [7].

The analog front-end of the ECG monitoring system comprises analog filters, amplifiers and an analog to digital converter (ADC). The battery weight is main in the wearable system. Battery capacity and power consumption must be reduced for weight reduction [8].

Our work is mainly focused on providing real-time monitoring and remote monitoring [9, 10] of health care parameters and explains in brief how IoT functions and how it is used in concurrence with wireless and sensing procedures to implement the desired healthcare applications.

3. PROPOSED WORK

The approach is designed for continuous monitoring of ECG and pulse signals and data transfer via Bluetooth to mobile. The advantage of implementing this work is that it provides a significant autonomous decision-making system. Signals can be acquired using ECG (AD8232) sensor and pulse sensor. ECG data can be acquired by placing electrodes on a surface of the skin. Mainly there are two types of leads through which we can take ECG data i.e., through limbs and through the chest. The L2 lead gives accurate value as compared to other leads. In L2 lead we are placing the positive electrode on left leg, the negative electrode on right leg and the third electrode can be placed on the right hand. By placing index finger on the pulse sensor we can get pulse data. Acquired data is processed by STM32 an IoT node and it can be transmitted to mobile using Bluetooth. One can make use of ThingSpeak for real-time monitoring of the health care parameters. And the main advantage of using ThingSpeak is that it provides remote monitoring. So it is useful to help the patient with this type of monitoring. As we are using wearable bio-signal monitoring system there is a chance of false detection or misdetection due to the various noises. To avoid this we are using a robust method called autocorrelation to prevent the signals from noises. Autocorrelation is the association of a signal with a late copy of itself as a function of delay. It is also known as serial correlation. The main advantage of autocorrelation is that the peaks will be much greater than the signal itself. Figure 3 shows the comparison of correlation and convolution. If we take the autocorrelation of the signal, the values which are high will be maximized and the values which are small will keep on becoming smaller. So we can get the accurate R peak by removing the noises. Further, we are using a median filter and average moving filter for signal filtering which removes noise from ECG and Pulse signal respectively. We are using a wearable device which is small in size and portable and efficient with low power consumption capability, easy setup, high performance and time to time response.

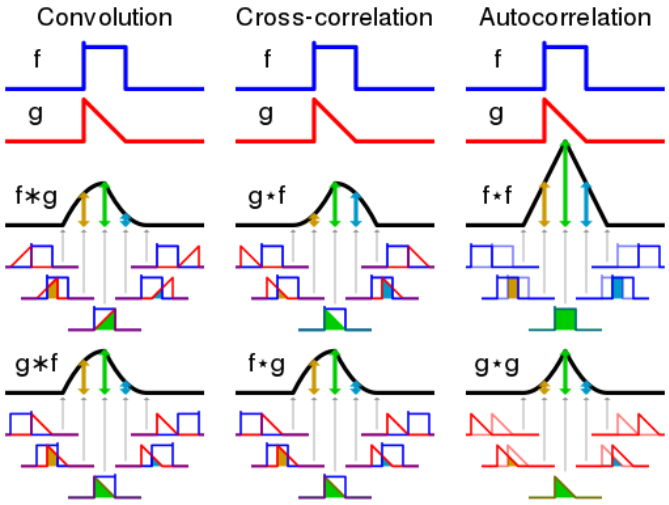

Fig-3: Comparison of convolution and correlation

4. IMPLEMENTATION AND RESULTS

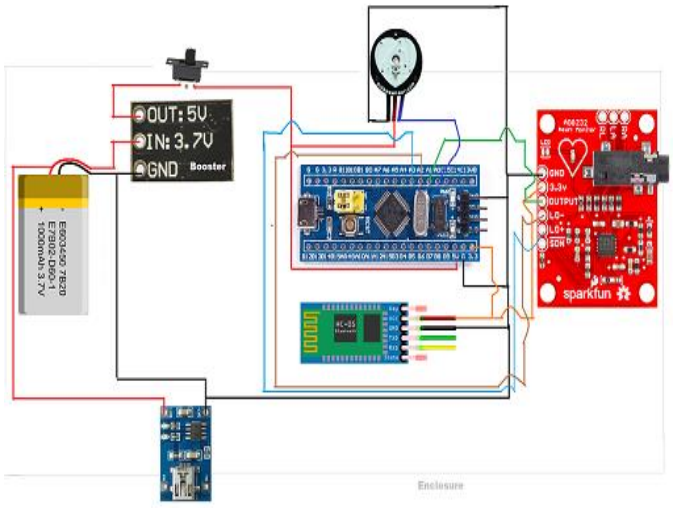

Fig-4: Circuit Diagram

The overall setup is shown in figure 4. The objective is to develop an ECG acquisition system where we use hardware sensors to acquire ECG signals and pulse rate.

Two types of sensors are used namely ECG sensor and Pulse sensor.STM32 is used as a gateway to communicate and pick the data from sensors and transmit it to the mobile using Bluetooth. Pulse and ECG sensors acquire the data and the output of these goes to the analog pins A0 and A1 respectively. The signals or data captured by STM32 is then sent to the mobile with the help of Bluetooth module HC-09. There is a serial communication between the STM32 and HC-09 modules. Finally, a Lipo battery along with booster is used. There is a switch which completes the overall circuit.

ECG Analytics is a unique mobile application. It is intended to help health expert, medical students, common practitioners, interns, citizens, and medical professional to improve their abilities in reading electrocardiogram (ECG). ECG Analytics has used for fast and simple monitoring of the heart- related parameters. It operates via Bluetooth. The application is developed using Android Studio. It receives data from the stm32 via serial communication using Bluetooth.

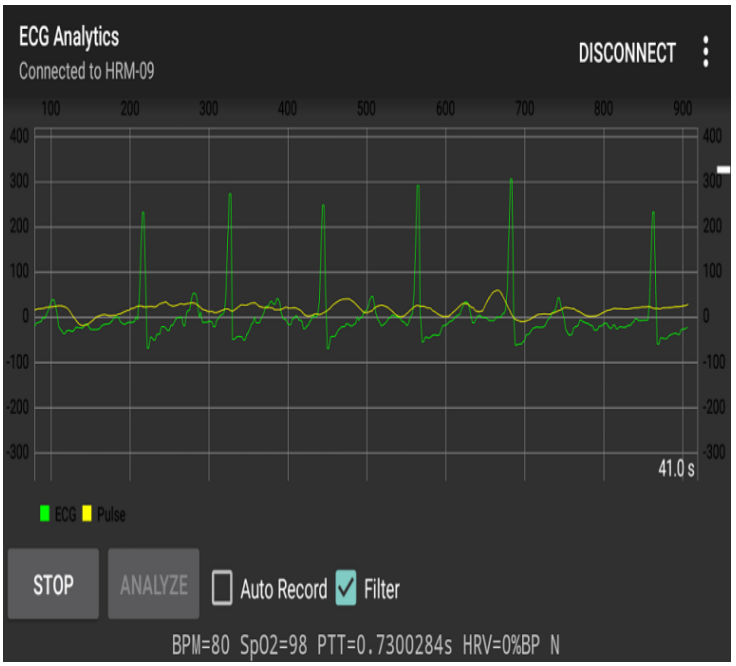

Fig- 5: Application showing ECG and Pulse signals

Once the patient installs the App, it requires the Bluetooth connection. The nearby devices are detected and the Bluetooth module HC-09 can be thus wirelessly connected using this app. Further communication may be carried out once the two devices are paired successfully. And one can easily monitor the parameters and its values through this app.Once the functionality is over, the patient may turn off the Bluetooth connection and disconnect. Figure 5 shows the ECG signal and pulse signal. With the help of the App, the patient can identify the problem and report the same to the doctor for medical advice. This approach is not only quick but also economical and efficient.

Fig- 6: Real-time monitoring of Heart Rate

Thing Speak is a freely available or open source Internet of Things (IoT) application and API to collect and fetch retrieve data from things using the HTTP protocol over Local Area Network or the Internet. It provides easy storage and retrieval of data. One can monitor the various parameters using things peak in real time. Figure 6 shows the real- time monitoring of heart rate.

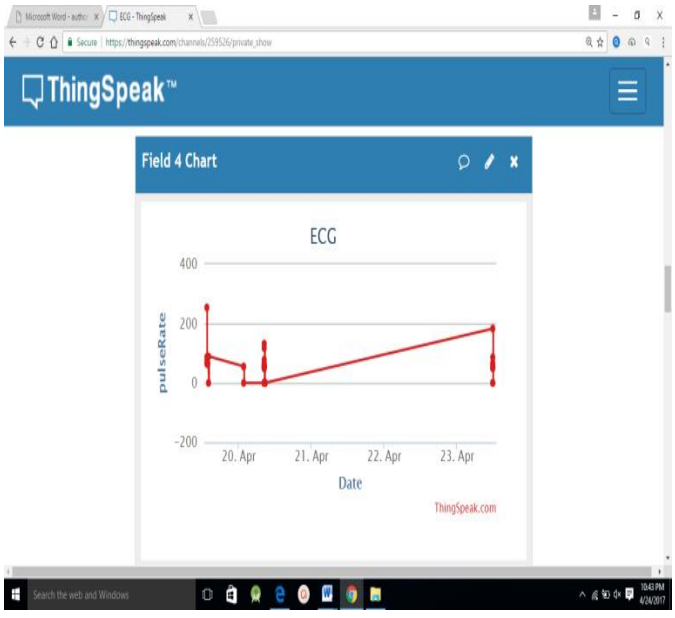

Fig-7: Real-time monitoring of Pulse Rate

We can also go for remote monitoring this is another facility provided by thing Speak. By providing the channel id one can monitor the parameters remotely. It also provides an option to store and retrieve the data at anytime from anywhere. Real-time monitoring of the pulse rate is shown in figure 7.

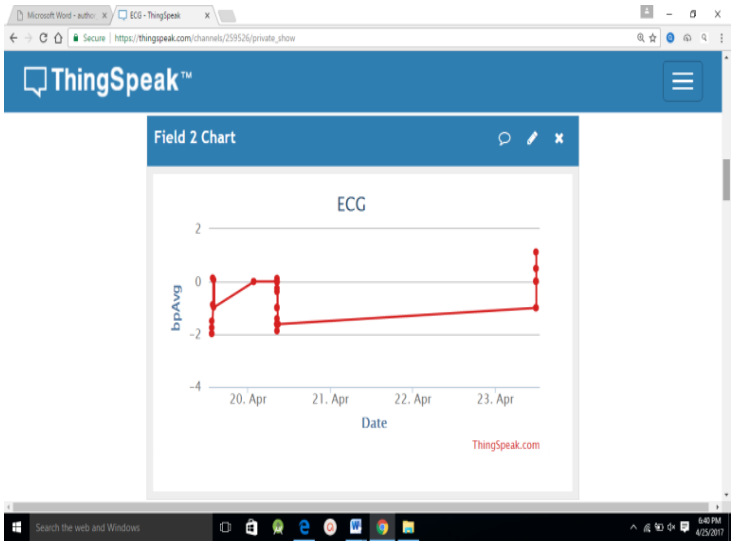

Fig- 8: Real-time monitoring of Blood Pressure

Depending on the pulse transit time (PTT) we can say a person is having low BP or high BP.

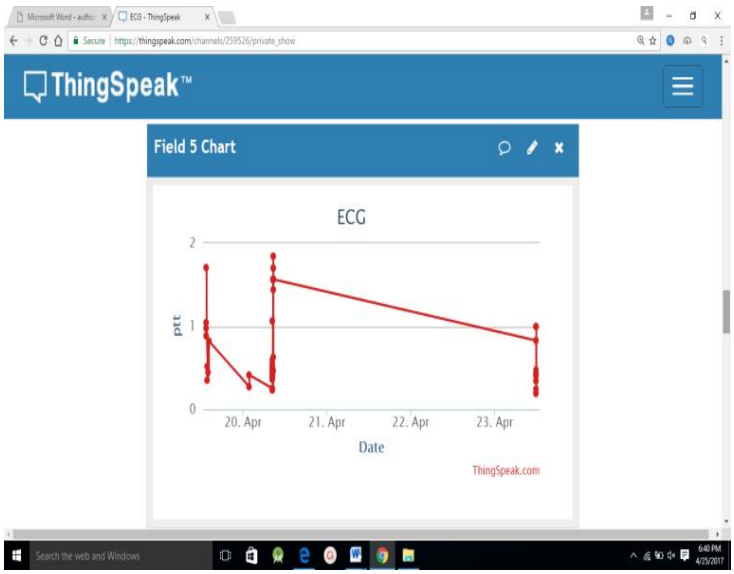

Fig-9: Real-time monitoring of pulse transit time

PTT is the difference between first R peak to the first pulse. PTT is a virtual measure of the relative blood pressure. Through the alert message, we can display whenever BP is high or low in the app. Figure 8 shows the average blood pressure value.

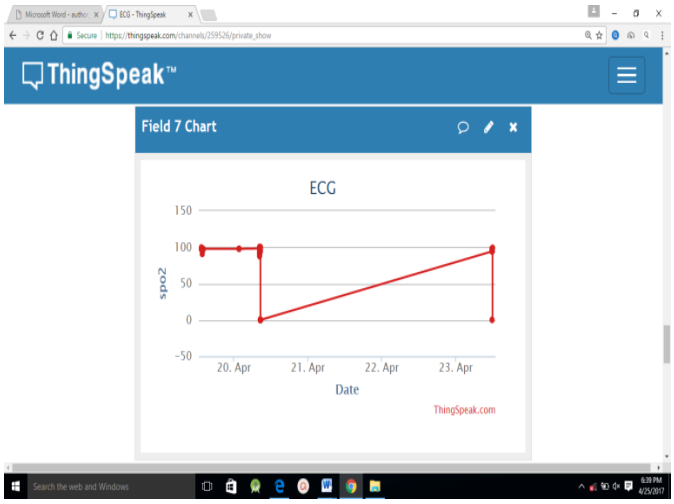

Fig-10: Real-time monitoring of SPo2

Figure 10 shows the amount of oxygen which is saturated in the blood which is nothing but arterial hemoglobin saturation.

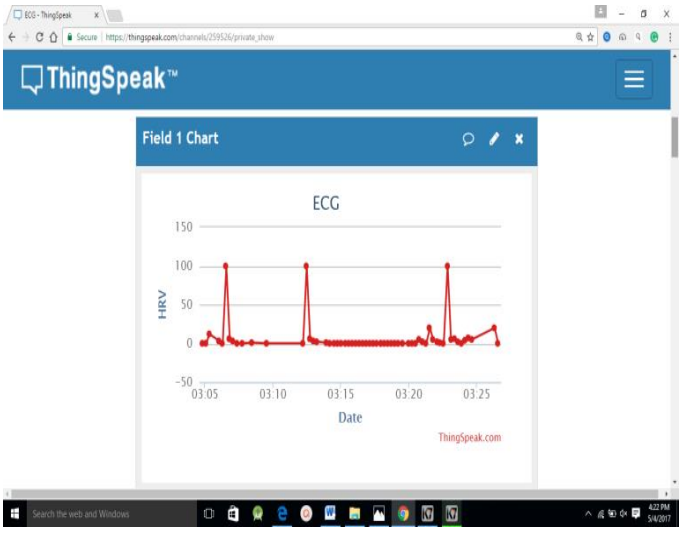

Fig-11: Real-time monitoring of Heart Rate Variability(HRV)

HRV is variation in the time interval between heart beats. It can be measured as the variation in the beat-to-beat interval.

5. CONCLUSION AND FUTURE WORK

In our proposed and implemented system, we focus on monitoring the health care parameters like heart rate, pulse rate, relative blood pressure, oxygen level, pulse transit time etc.,

The real-time monitoring application was successfully implemented using Integrated Development Environment (IDE) Android Studio.

This tool can be used for Android Development which makes the process faster and more productive. ECG Analytics is the application which is developed for monitoring the signals. We proposed a robust IHR detection algorithm using autocorrelation which is useful to remove the noises or prevents from false detection or misdetection. The proposed project is a novel idea. It provides the real-time monitoring of the health care parameters for doctors and caretakers where data can be accessed from anywhere at any time.

The advantages of implementing this work are that it reduces the manual labor involved in performing cardiac related tests. Also, it saves precious time that could be used for treatment. The system is efficient with low power consumption capability, easy setup, high performance and time to time response. Autocorrelation method improves IHR accuracy despite its use in noisy conditions. Proposed method can contribute to the power and area reduction of the wearable bio-signal monitoring system.

The major advantage of this work is that it offers,

Both electrical as well as the mechanical overview of the heart. The Mechanical view is provided through an approximation of pulse, whereas electrical activity is provided through ECG signal. The system provides saturated oxygen percentage in the blood which gives the synchronization between heart and lungs. Therefore proposed system can also be used to understand respiratory disorders. By combining ECG and pulse signal the proposed system derives pulse transit time (PTT) which is a virtual measure of the relative blood pressure. Therefore the system can also be used to monitor continuous blood pressure (NIBP). The system can be used to remotely monitor the patient. Cloud-based integration allows doctors or concern authorities to monitor patients continuously and also to obtain real-time analytics of the data.

The system can be further improved by incorporating other parameters like temperature, respiratory rate. The system can also be improved by incorporating automated diagnosis system by means of which different diseases could be identified in real-time through the monitored parameters. The system can also be improved by

incorporating security techniques for data exchange between the ECG device and IoT gateway.

REFERENCES

[1] Syunji Yazaki, Toshio Matsunaga "Evaluation of activity level of daily life based on heart rate and acceleration",2010.

[2] Hiroshi Nakajima, Yutaka Hata, Toshikazu Shiga "Systems Health Care",IEEE 2011.

[3] Shu-Yu Hsu, Yao-Lin Chen, Po-Yao Chang, Jui-Yuan Yu, Ten-Fang Yang, Ray-Jade Chen, Chen-Yi Lee "A micropower biomedical signal processor for mobile healthcare applications". November 14-16, 2011

[4] H. Kim, R. F. Yazicioglu, S.Kim, et al., "A configurable and low-power mixed signal SoC for portable ECG monitoring applications," VLSI Symp., pp.142-143, Jun. 2011.

[5] Christoph Bruser, Kurt Stadlthanner, Stijn de Waele, Steffen Leonhardt "Adaptive beat-to-beat heart rate estimation in ballistocardiograms".IEEE Trans,Biomed. vol. 15, no. 5, september 2011.

[6] L Storme, R Logie, Y Riou, MO Jaffrk, and P Lequien "Hemodynamic monitoring by continuous analysis of pulse oxymeter plethysmographic waveform in newborn infants", IEEE/EMBS Oct. 30 - Nov. 2.

[7] Young-Dong Lee, Sang-Joong Jung, Yong-Su Seo and Wan-Young Chung" Measurement of Motion Activity during Ambulatory Using Pulse Oximeter and Triaxial Accelerometer", 2008

[8] Shu-Yu Hsu, Yao-Lin Chen, Po-Yao Chang, Jui-Yuan Yu, Ten-Fang Yang, Ray-Jade Chen, Chen-Yi Lee "A micropower biomedical signal processor for mobile healthcare applications". November 14-16, 2011

[9] Reza S. Dilmaghani, Hossein Bobarshad, M. Ghavami, Sabrieh Choobkar, and Charles Wolfe "Wireless sensor networks for monitoring physiological signals of multiple patients", IEEE 2011.

[10] Krishna Bharadwaj Chivukula, Naresh Vemishetty, Agathya Jagirdar, and Amit Acharyya, "A low-complexity onchip real-time automated ECG frame identification methodology targeting remote heath care", IEEE 2014.

[11]Qiuzhen Xue, Yu Hen Hu ,Willis J. Tompkins "Neural network based adaptive matched filtering for QRS detection"

[12]Masatoshi Sekine and Kurato Maeno "Non-contact heart rate detection using periodic variation in Doppler frequency", IEEE 2011.

[13] Juan Pablo Martinez, Rute Almeida, Salvador Olmos Ana Paula Rocha, and Pablo Laguna "A wavelet based ECG delineator: Evaluation on standard databases", IEEE 2004.

[14] Kai Yang, Hanjun Jiang, Jingjing Dong, Chun Zhang, Zhihua Wang "An adaptive real time method for fetal heart rate extraction based on phonocardiography"

[15] Christoph Bruser, Stefan Winter and Steffen Leonhardt "How speech processing can help with beat-to-beat heart rate estimation in ballistocardiograms",IEEE 2013.

[16] Diptee C. Pandhe , H. T. Patil , "ECG Data Compression for a Portable ECG
Recorder and Transmitter" IEEE 2014.

[17] Yangdong (Jack) Liao, Ru-Xin (Tony) Na, and Derek Rayside, "Accurate ECG R-peak detection for telemedicine" , IEEE 2014.

[18] G. Warmerdam, R. Vullings, C. Van Pul, P. Andriessen, S.G. Oei, P. Wijn "QRS classification and spatial combination for robust heart rate detection in low-quality fetal ECG recordings" , IEEE July 2013

[19] Seain Finn, Edward Jones, Martin Glavin, "Design of a Personal Cardiovascular Monitoring System with ECG and Stethoscopic Analysis", IEEE 2008.

[20] A. Benharref and M. Serhani, "Novel cloud and SOA-based framework for E-Health monitoring using wireless biosensors,"
IEEE Journal of Biomed. and Health Inf., vol. 18, no. 1, pp. 46– 55, Jan 2014

BIOGRAPHIES

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