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Study on Low-Cost Portable ECG Device

Nayana Tomson[1], Savio Joseph[2], Agi Joseph George[3], Jacob George[4]
[1, 2, 4]*UG Student,* [3]*Asst. Professor, Department of Electronics and Communication Engineering Amal Jyothi College of Engineering Kottayam, India*

Abstract: Portable Electrocardiographic (ECG) device becomes inevitable as the cardiovascular disease rises. To reach the race of technological advancement a flexible mobile ECG monitoring system with cloud computing is discussed here.
In the system ECG pulses are taken from the patient through ECG monitoring device and obtained in either laptop or mobile and is further transmitted to health care platform from where the doctors can access the data and if the doctor is not available then as an alternative, we can process the data from cloud computing [1-6].
Keywords: low-cost ECG device, ECG system design

I. INTRODUCTION

According to the 2020 census taken by Centers for Disease Control and Prevention (CDC) it was reported that heart diseases is the leading cause of death for men and woman. It was also found that one person dies in every 36 seconds in US from cardiovascular disease.[15] Implementing a portable ECG device on a large scale will show a remarkable cease in death rate caused by heart related disease. In such a scenario portable ECG device can make things simpler by doing the ECG test at home and saving the time. There are various methods to determine cardiovascular disease like cardiac magnetic resonance imaging (MRI), cardiac computed tomography (CT) scan, angiogram etc. But the most widely used is ECG as it can scrutinize various case condition. One cardiac cycle will have P, Q, R, S, T and U wave which makes one ECG beat and ECG signal is the combination of such beats. [11]

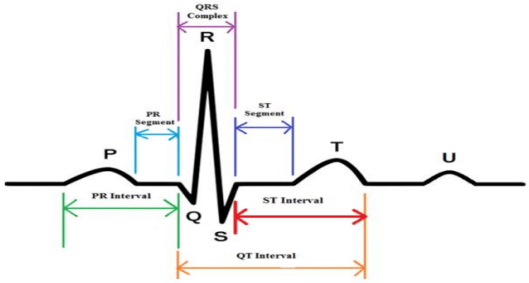


Figure 1 ECG waveform of a healthy person

Feature	Description	Duration
RR	Interval between R wave and the next R wave	0.6-1.2s
P	Measured from the originating point of the P wave to the originating point of the QRS wave	80 ms
PR	Normally begins with a downward deflection Q, a larger upwards deflection Rand ends with a downward S wave	120-200 ms
QRS	Connects the P wave and the QRS complex	80-120 ms
J-point	The point at which the QRS complex concludes and the ST segment begins is called J-point	50-120 ms
ST	Connects the QRS Complex and the T wave	Not applicable
T	Normally a modest upward waveform	80-120 ms
ST	Measured from J point to the end of the T wave	160 ms
QT	Measured from the beginning of the QRS complex to the concluding point of the T wave	420 ms
U	Normally shows low amplitude and is most often completely absent	Not mentioned

ECG features and its normal Duration is shown in the above table [11]

There has been researched in measuring Heart Rate Variability (HRV) to predict the myocardial infarction, this is done finding out the R-wave at every beat and processing it and converting to R-R Intervals Graph [5-6]. Conventionally the study of ORS wave talks about arrhythmia condition and it is analyzed generally by wavelet analysis and neural network method. Studies have now proposed much simple approach with real time processing by establishing two data buffers [10] and machine learning techniques known as Echo State Network for Arrhythmia [14] and pseudo-ECG biomarker technique to detect Ischemia [15].

There are many factors do be taken in mind while designing a portable ECG system like the choosing of electrodes, accuracy of the processed data, weight of the system, storage space to keep the data record of the patient and compatibility of components with each other.

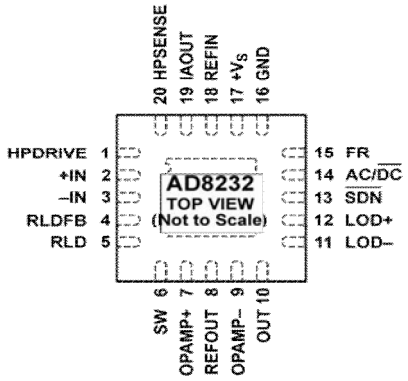
There are various types of electrodes, and researchers use electrodes depending upon their needs. In conventional ECG system, Ag/AgCl electrodes are used with conductive gel at the electrode-skin interface. These conductive gels are found to be toxic if used for longer period and can cause skin allergies. So, there have been studies on alternative electrodes. Textile electrode is one such electrode which has got minimal effect on human and is reliable of ECG acquisition [7-9]. In terms of electrodes lead there are 3-lead electrode, 5-lead electrode, etc. Mostly available ones are 3- lead electrodes which are placed in right-hand wrist (R-Red), left-hand wrist (G-Green) and the right-leg ankle (Y-Yellow). Now there has been a development of wearable electrodes and one such is 12-lead electrode which is made up of fabrics. It monitors the heart with 10 electrodes attached on the surface of limbs and chest, therefore generating 12 group of signals. These types of ECG come in demand for vendor- specific algorithm [13].

Measurement of entropy of ECG has led to result that both fabric and metal electrodes provide similar result which gives a future shoot to the usage of fabric electrodes. This discovery also ends the worry of patience about the use of uncomfortable conductive gel to their skin [1].

II. SYSTEM DESIGN

A. Hardware System

The hardware system mainly comprises of ECG electrodes, ECG sensor, amplifier, sampler and filter circuit, Arduino Uno microcontroller, Laptop, mobile, power supply, etc. We use bandpass filter to remove the baseline interference and frequency interference. The heart generates low amplitude electrical current and voltage signals which is sensed by the ECG sensor (AD8232IC). The internal structure of AD8232 consist of instrumentational amplifier, a right- driven amplifier which is also known as biological signal amplifier, a mid-supply reference buffer and an automatic fast reinstate circuit which is used to regain the signal when the lead is reconnected [3]. The pin configuration of ECG sensor is shown below.



20-LEAD LEAD FRAME CHIP SCALE PACKAGE [LFCSP]
4mm × 4mm BODY AND 0.75mm PACKAGE HEIGHT
(CP-20-8)

Figure 2.1 Pin configuration of sensor AD8232

For the microcontroller to sense the signal from the sensor, the signal output from the ECG sensor should be amplified, filtered as well as sampled. Thus, the input of the Arduino will be Pulse Amplitude Modulated signal and the output will be a digital signal obtained from its processing algorithm. This is further given to a Graphical User Interface (GUI) which is a software loaded in laptop or in mobile phone. Two level DC voltage is used as power supply (5V and 9V) for ECG sensor and microcontroller.

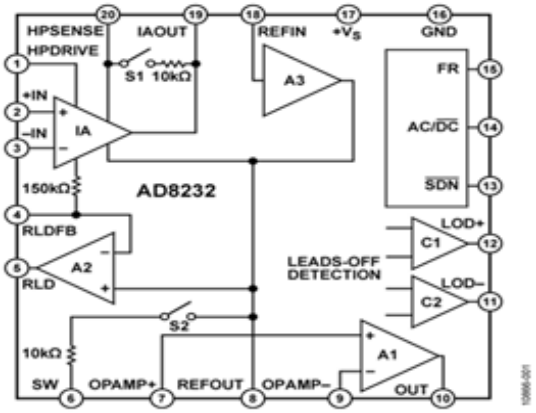


Figure 2.2 Internal structure of sensor AD8232

Arduino Uno R3 is used for its features like low power consumption, high efficiency, an in-build ADC is used to convert the PAM signal to digital. To connect the Arduino with mobile HC06 Bluetooth module is used and for that of laptop USB cable is enough. We would also require an additional circuit for the electrodes acquisition of signal as the ECG signal can get vulnerable due to the interface of electrode and connecting leads of amplifier [1].

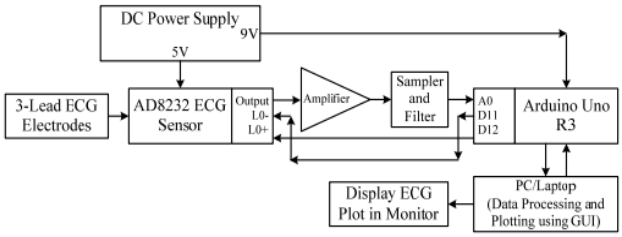


Figure 2.3 Block diagram of designed ECG machine

Well, another approachable method is designing of ECG monitoring system [2]. A monitoring terminal is designed from MSP430 which has the feature of upper low power consumption and high integration. The MSP430 module is responsible for signal collection, amplification, analog to digital conversion and wireless communication module. The signal is passed to a preamplifier which is made of CMOS instrumentational amplifier INA321 with gain of 5. A filter is followed by an amplifier to eliminate the interference.

We have not been able to design a hardware system optimizing the power consumption, the main focus was on given to flexibility and compatibility of device with other one. But when it comes to software, Blackfin BF533 DSP processor is selected to get the power optimization. It consists of M25P10-A serial 1MBIT data flash and Secure Digital (SD) car. This is a high-performance processor with 600MHz clock speed. It is 16bit Multiply and Accumulate (MAC) units allowing two 16-bit precision multiplication to perform parallelly. It can also transfer the data to the SD-card by Serial Peripheral Interface (SPI) bus [4]. Some researchers have also used ARM Cortex-M3 as core processor. It has the feature of real time and effective detection of ECG signal as well as it has to large capacity SD card as storage. Ones the signal is obtained it is stored in the TXT file so that it is easy for further transmission [10].

B. Software Design

The key motive is to make a portable device which brings the need of a mobile application which will allow the users to get their real-time data. In each user's mobile an application will be installed which will relate to all the nearby hospitals. The patient will be assigned to a doctor and the acquired ECG signal will be passed to doctor via cloud along with his past reports. Doctor can send the prescription and comments directly to patient's mobile through SMS and one message a duplicate message will be send to a person whose name will be taken from the patient before the checkup so that if any care is to be taken then there is someone.

III. CHALLENGES

A. ECG of different patients would be different and even different diseases may cause the ECG wave to differ from the normal ECG signal which makes the study difficult.

B. There are proper classification rules to classify the ECG signal.

C. Exercise or stress can cause change in the ECG features like on RR interval, QT interval. So, the impact of heartbeat cause by such action should be eliminated.

D. There are no proper standards on the amplitude of ECG waves so small misinterpretation of its feature can lead to wrong information.

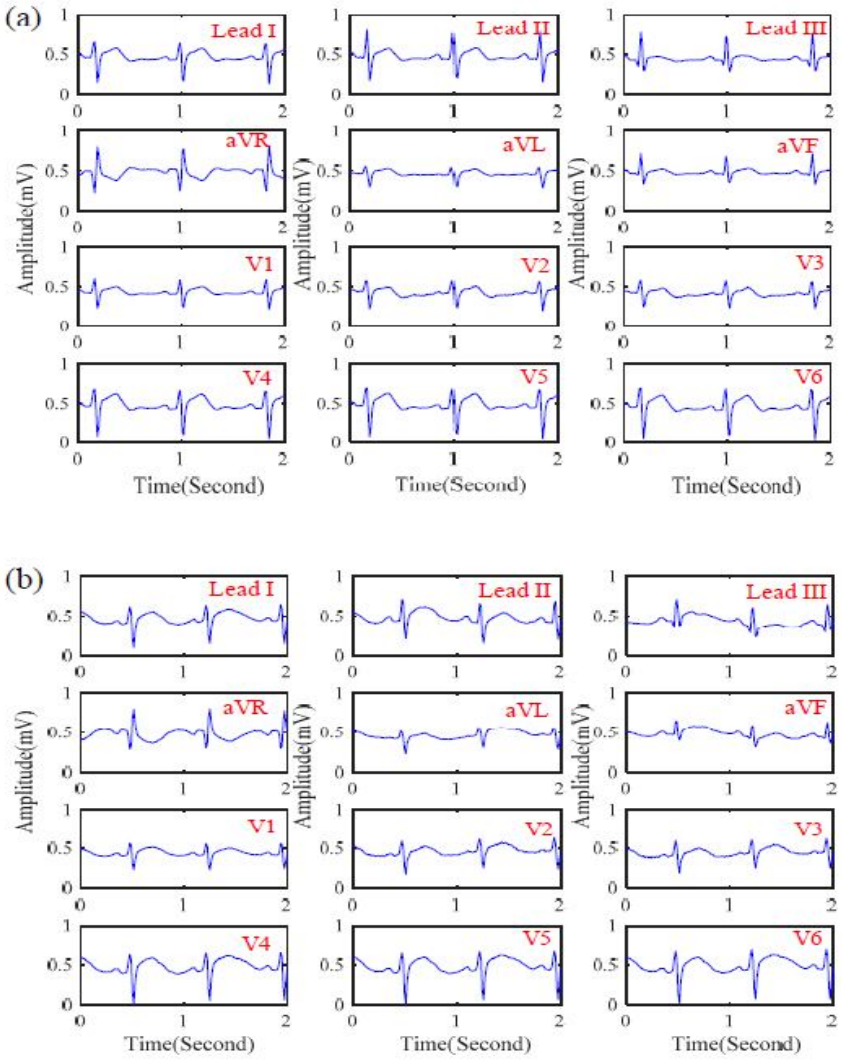


Figure 3 Block diagram of designed ECG machine

REFERENCES

[1] Bhuyan, Muhibul. (2020). Low-Cost Microcontroller Based ECG Machine.

[2] Jihong Chai, "The design of mobile ECG monitoring system," 2013 IEEE 4th International Conference on Electronics Information and Emergency Communication, Beijing, China, 2013, pp. 148-151, doi: 10.1109/ICEIEC.2013.6835474.

[3] A. S. Prasad and N. Kavanashree, "ECG Monitoring System Using AD8232 Sensor," 2019 International Conference on Communication and Electronics Systems (ICCES), Coimbatore, India, 2019, pp. 976-980, doi: 10.1109/ICCES45898.2019.9002540.

[4] Justesen, Jakob & Madsen, Soren. (2009). Wearable wireless ECG monitoring - Hardware prototype for use in patients own home. 1 - 3. 10.4108/ICST.PERVASIVEHEALTH2009.6083.

[5] M. Wu, S. Shieh, Y. Liao and Y. Chen, "ECG Measurement System Based on Arduino and Android Devices," 2016 International Symposium on Computer, Consumer and Control (IS3C), Xi'an, China, 2016, pp. 690-693, doi: 10.1109/IS3C.2016.177.

[6] Yang, Zhe & Zhou, Qihao & Lei, Lei & Zheng, Kan & Xiang, Wei. (2016). "An IoT-cloud Based Wearable ECG Monitoring System for Smart Healthcare". Journal of Medical Systems. 40. 286. 10.1007/s10916-016-0644-9.

[7] H. Ozkan, O. Ozhan, Y. Karadana, M. Gulcu, S. Macit and F. Husain, "A Portable Wearable Tele-ECG Monitoring System," in IEEE Transactions on Instrumentation and Measurement, vol. 69, no. 1, pp. 173-182, Jan. 2020, doi: 10.1109/TIM.2019.2895484.

[8] B. Li and H. Li, "The Preliminary Exploration of Intelligent Private Pension Institutions - The Design of Portable ECG Monitor," 2014 Sixth International Conference on Intelligent Human-Machine Systems and Cybernetics, Hangzhou, China, 2014, pp. 8-11, doi: 10.1109/IHMSC.2014.105.

[9] S. H. Jambukia, V. K. Dabhi and H. B. Prajapati, "Classification of ECG signals using machine learning techniques: A survey," 2015 International Conference on Advances in Computer Engineering and Applications, Ghaziabad, India, 2015, pp. 714-721, doi: 10.1109/ICACEA.2015.7164783.

[10] Hsieh, Jui-Chien & Hsu, Meng-Wei. (2012). "A cloud computing based 12-lead ECG telemedicine service". BMC medical informatics and decision making. 12. 77. 10.1186/1472-6947-12-77.

[11] S. Deb, S. M. R. Islam, J. RobaiatMou and M. T. Islam, "Design and implementation of low-cost ECG monitoring system for the patient using smart device," 2017 International Conference on Electrical, Computer and Communication Engineering (ECCE), Cox's Bazar, Bangladesh, 2017, pp. 774-778, doi: 10.1109/ECACE.2017.7913007.

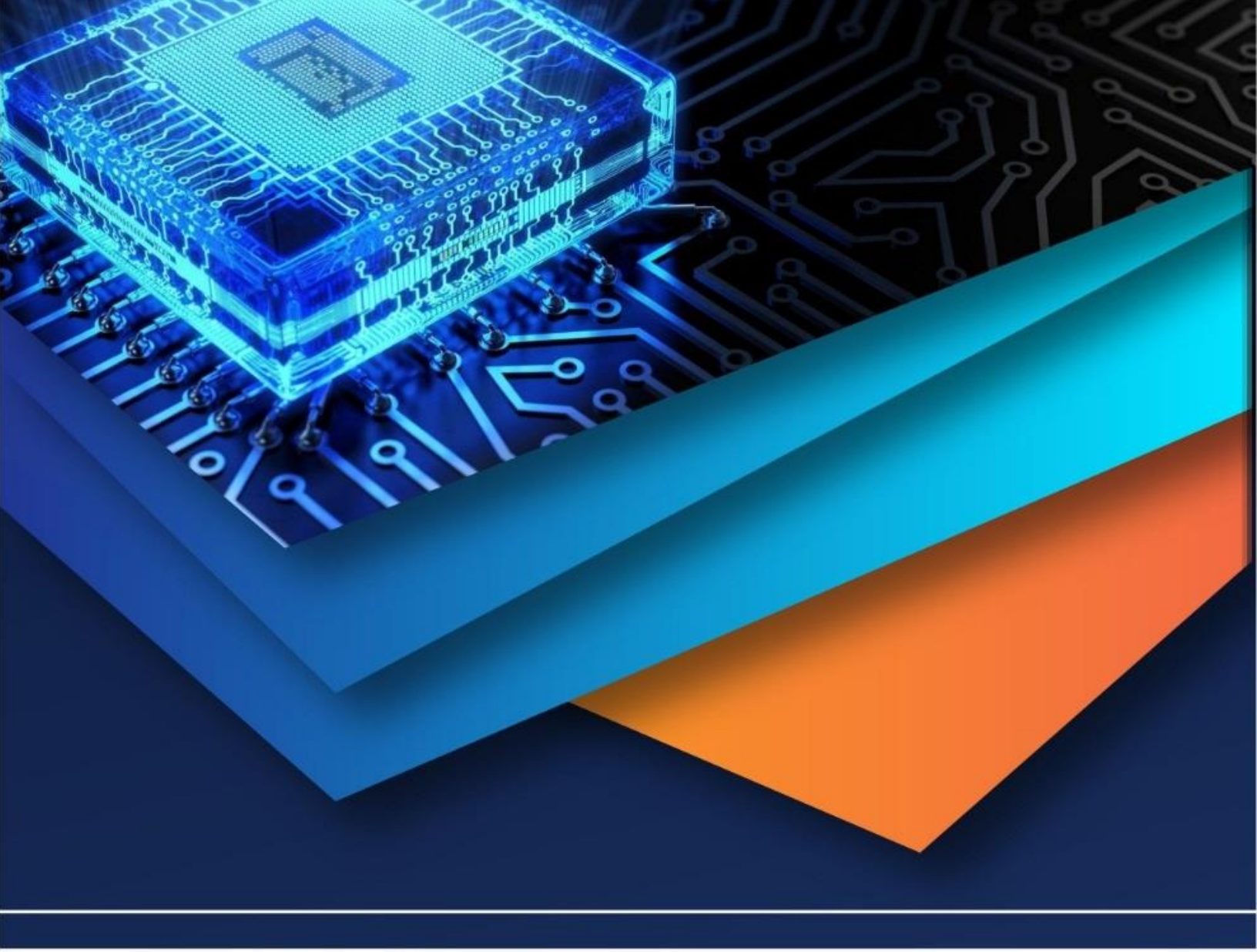
[12] Hsu, Chien-Chin & Lin, Bor-Shing & He, Ke-Yi. (2019). "Design of a Wearable 12-Lead Noncontact Electrocardiogram Monitoring System". Sensors (Switzerland). 19. 10.3390/s19071509.

[13] Shahzad, A., Lee, Y. S., Lee, M., Kim, Y.-G., & Xiong, N. (2018). Real-Time Cloud-Based Health Tracking and Monitoring System in Designed Boundary for Cardiology Patients. Journal of Sensors, 2018, 1–15. doi:10.1155/2018/3202787

[14] Alfaras, M., Soriano, M. C., & Ortín, S. (2019). A Fast Machine Learning Model for ECG-Based Heartbeat Classification and Arrhythmia Detection. Frontiers in Physics, 7. doi:10.3389/fphy.2019.00103

[15] Ledezma, C. A., Zhou, X., Rodríguez, B., Tan, P. J., & Díaz-Zuccarini, V. (2019). A modeling and machine learning approach to ECG feature engineering for the detection of ischemia using pseudo-ECG. PLOS ONE,14(8), e0220294. doi: 10.1371/journal.pone.0220294

[16] P. Singh and A. Jasuja, "IoT based low-cost distant patient ECG monitoring system," 2017 International Conference on Computing, Communication and Automation (ICCCA), Great Noida, India, 2017, pp.1330-1334, doi: 10.1109/CCAA.2017.8230003.



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