

Portable ECG with Monitoring Parameters

Prof. Varsha.V.Gaikwad¹ Palak Bardia² Suvidya Cherkar³ Sanyukta Jadhav⁴

¹Assistant Professor ^{2,3,4}U.G. Student

^{1,2,3,4}Department of Electronic & Telecommunication Engineering

^{1,2,3,4}BVCOEW, PUNE

Abstract— The paper explains the electrocardiographic information which can be share with the doctor so doctor can use that information for monitoring patient’s health. The electrocardiogram (ECG) is widely used for diagnosis of heart diseases. It is very difficult for the patient to tell the difference between angina symptoms and heart attack symptoms, so it is very important to identify the symptoms of heart attack and immediately seek medical attention. The design of portable ECG system is for monitoring parameters like blood pressure, ECG acquisition, body temperature, critical impacts and heart rate measurement. In this paper we present a low cost, portable system for real time ECG acquisition, archiving and visualization. Successfully implemented the acquisition module and the visualization tool for the ECG by making it user friendly and additionally sharing the same with doctor by using GSM module. A practical case of this type of remote consultation is examined in this paper. Good quality ECG is utilized by physicians for interpretation and identification of physiological and pathological phenomena. To deal with the huge amount of electrocardiogram (ECG) data for analysis, displaying and transmitting. An effective ECG compression technique is needed to reduce the amount of data as much as possible, while acquiring the clinical significant signal for cardiac diagnosis. Here the ECG signal is analysed for various parameters such as heart rate, QRS-width; etc hardware implementation will be detailed in this paper.

Key words: ATMEGA 32, ECG, TFT LCD, repository system

I. INTRODUCTION

Nowadays, as the number of people suffering from heart diseases are increasing. The ECG is one of the medical equipment that measures the heart impacts, converts it into a signal and presents the data on a piece of paper or on a monitor. Human body consist of cells which resembles small batteries. These cells have different ion concentrations which results into minute electric potentials which are referred as biopotentials. An action potential is generated when there is disturbance in a biopotential which is the depolarization and repolarisation of the cell. Due to this action potentials from different nodes in the heart electrocardiograph (ECG) signals are generated. To examine the electrocardiograph (ECG), electrodes are placed at designated locations on the body to collect ECG measurement information. The proposed system is best way to measure and diagnose abnormalities which occurs in the heart. For measuring the heart rate Electro-cardiogram (ECG) is the most accurate method. These devices can give precise measurements but their cost is uneconomical. This paper describes the design of an low cost monitoring system which monitors ECG, heart rate, body temperature and critical impacts. System which measures the heart rate of the subject by sticking electrode on the arms and then displaying the ECG and other parameters on a TFT LCD.

Additionally a GSM module is introduced for ease of medical consultation in case of emergency. While monitoring the patient, if abnormality is encountered then the status of patient will be directed to the cardiologist to whom patient has been consulting. An advantage of such a design is that it can be flexible and can easily be connected to a PC or recording instrument to collect and examine the data over a period of time.

II. METHODOLOGY

Cells in human body act like little batteries. A small electric potential is created due to different ion concentrations inside and outside of membranes of the cells which is known as biopotential. The disturbance in these biopotentials gives rise to an action which is the depolarization and repolarization of the cell as shown in Figure 1.

Electrocardiograph (ECG) signals are created by these action potentials from different nodes in the heart. ECG signals are made up of the superposition of the distinct action potentials from the heart beating as shown in Figure 2.

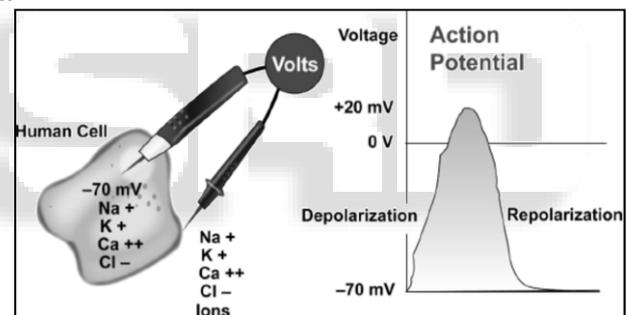


Fig. 1: Each living cell acts as a small battery

The ionic signals from the body are converted into electrical signals using electrodes by ECG systems. These signals are displayed and used for data analysis. ECG requires amplification and filtering to produce high quality signals because of the size of the signals and outside noise.

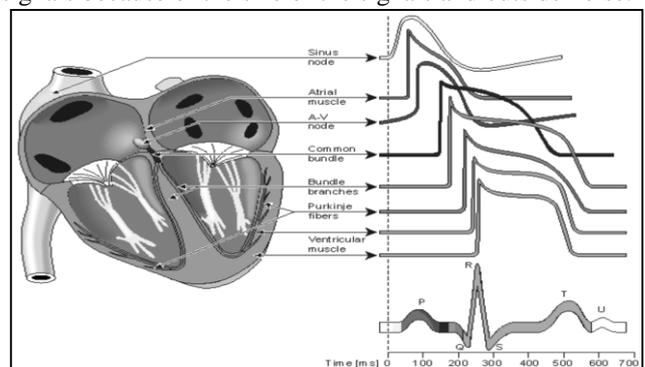


Fig. 2: Superposition of all the action potentials produces the ECG signal

Thus ECG system amplifies the small signal measured from the heart as well as to filters outside and internal noise. This amplification is carried out using

differential amplifier and filtering is done using common and differential mode filtering.

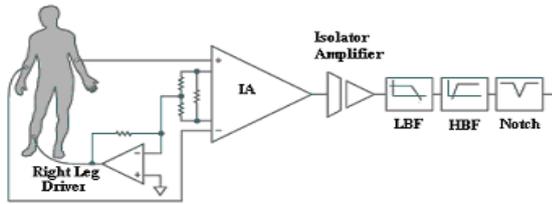


Fig. 3: Simplified ECG recording system

A. Block Diagram

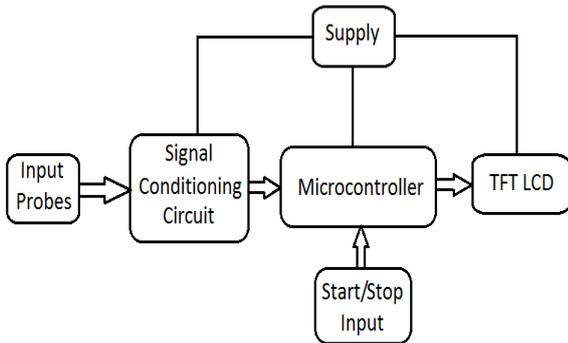


Fig. 4: Block diagram

In the figure 4, block diagram of portable ECG system is shown. The main part of the system is signal conditioning which includes amplifier and filter.

1) Amplifier

ECG signals are highly varying signals and are need to be amplified in order to be better interpreted. The input impedance of Biopotential amplifiers is high and thus they are designed for safety first. Preventive measures are taken as the signal which is to be amplified is taken from the living organism to avoid possibilities of shock. To limit the current through electrodes isolation and protection circuitry are used. In order to drive external load with minimal distortion output impedance of amplifier must be very low. Further the gain should be large as the size of the signal is very small. Biopotential amplifier circuits are implemented with gain of about 1000. Amplifiers with high common mode rejection ratio are needed in order to eliminate large offset signals. Differential amplifiers are mainly preferred. The main role of differential amplifier is to gain high integrity signal. Here differential amplifiers must not amplify noise from the input. Differential amplifiers with such feature are difficult to find. Hence combination of differential amplifiers are used which is instrumentation amplifier.

A three stage instrumentation amplifier is shown in Figure 4. Instrumentation stage comprises of two stages that are useful in meeting various features of an ideal Biopotential amplifier. Out of the two stages the first stage is the input stage of the amplifier which ideally supplies no common mode gain thus eliminating common mode noise. The second stage is gain stage. High input impedance is provided by the three op-amps and their configuration gives the gain.

$$Gd = \frac{v_3 - v_4}{v_1 - v_2} = \frac{2R_2 - R_1}{R_1}$$

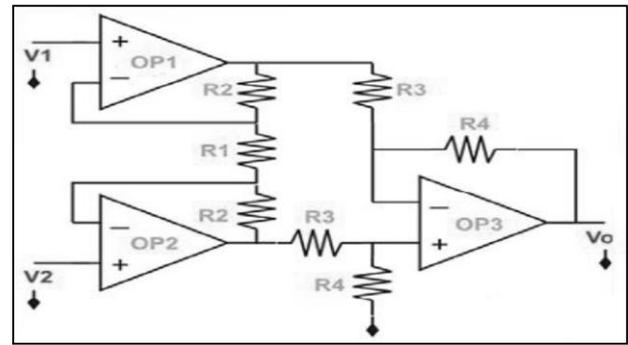


Fig. 5: Basic Instrumentation Amplifier

The input stage buffers the gain stage. The gain stage has the input from output of the input stage. The gain stage gives differential gain and has low impedance. Overall differential component gain is given by

$$Gd = \frac{2R_2 - R_1}{R_1} * \frac{R_4}{R_3}$$

And also it provides a high common mode rejection ratio.

2) Filtering

ECGs contain different types of noise. To eliminate the noise and to acquire only ECG components of the signal, filtering is needed. For ECG circuits however, typically low pass filters are suitable to eliminate outside noise due to the frequency of a heartbeat.

Filtering is the stage which limits the bandwidth to reject interference signals and noises. Lots of interferences and noise are induced, such as DC potentials arising at the interface of electrode-skin, potentials of amplifier offset, interference of radio frequencies (RF), interference of muscle signal, and interference at 50 Hz of power line. To filter out all the interferences and noises a filter with bandwidth of 0.1 Hz to 150 Hz is used. A 50 Hz low pass filter (ICF121) is used to remove the power line interference. Moreover, high-pass filter is recommended to be used in the early stages of circuit, because the DC potential must be blocked well before the ECG signal is amplified greatly to prevent the amplifier from saturation and the resultant signal is displayed on the TFT display.

B. Gsm Module

This ECG system has GSM module along with it. When the system finds the abnormal ECG of the patient, it immediately informs the doctor through message whose mobile number is fed in the module. This system is thus very useful in case of emergency which can save the lives.

III. RESULTS

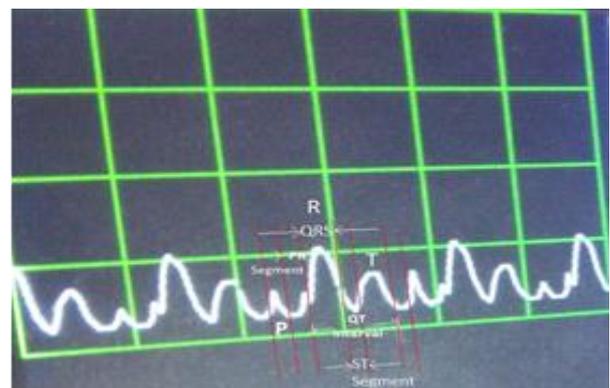


Fig. 6:

IV. CONCLUSION

This paper presents the implementation of portable ECG system with Monitoring parameters involving low cost amplifier, filter components coupled with a sophisticated microcontroller and LCD screen using the available resources.

REFERENCES

- [1] National Coalition on Health Care, in: <<http://www.nchc.org/facts/cost.shtml/>>, Accessed: June 2005.
- [2] Braunwald E. (Editor), Heart Disease: A Textbook of Cardiovascular Medicine, Fifth Edition, p. 108, Philadelphia, W.B. Saunders Co., 1997. ISBN 0-7216-5666-8.
- [3] Van Mieghem, C; Sabbe, M; Knockaert, D (2004). "The clinical value of the ECG in no cardiac conditions" *Chest* 125(4):1561–76. Doi:10.1378/chest.125.4.1561. PMID 15078775.
- [4] "2005 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care - Part 8: Stabilization of the Patient With Acute Coronary Syndromes." *Circulation* 2005; 112: IV-89-IV-110.
- [5] A. R. Houghton and D. Gray., "Making sense of the ECG", Hodder Arnold Publishing's 2003.
- [6] Forerunner 201/301 User Guide, web site: <http://www.grmin.com>.
- [7] Pulsar heart rate monitors, web site: <http://www.heartratemonitor.co.uk>.
- [8] A precision low-level DAS/ECG Cardiometer Demo Board, a Texas Instruments technical presentation created by John Brown. Analog Fundamentals of the ECG Signal Chain, a Texas Instruments technical presentation prepared by Matthew Hann.