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Non-conventional Energy Operated ECG System

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Abstract *- Electrocardiography (ECG) is the interpretation of the electrical activity of one's heart over a period of time. ECG equipment is vital for diagnosis of cardiac problems. The detailed design of a solar powered PC based ECG equipment is presented here where optimized choice of components and of the design have been made keeping the cost and maintenance in view but not sacrificing the quality. Actually, the circuit is simulated in simulation software to sure that the circuit can work practically and the circuit is designed that detect any failure in the electrodes connection. The purpose of the Evaluating ECG capturing using sound-card of PC/Laptop is provided portable and low cost ECG monitoring system using laptop and mobile phones. There is no need to interface microcontroller or any other device to transmit ECG data. Hybrid power (solar or wind) is used for rural areas where mass people are living without facility of electricity.*

Key Words: **ECG, Instrumentation Amplifier, PC Based ECG, Solar Powered ECG.**

1. INTRODUCTION

World Health Organization (WHO) has confirmed that heart related diseases are on the rise today after conducting World-wide survey. many of these cardiac problems are created due to modern lifestyle, food habits, obesity, smoking, lack of physical exercise, etc [1]. An electrocardiogram (ECG) is a recording of the electrical activity on the body surface generated by the heart. ECG measurement information is collected by skin electrodes placed at designated locations on the body. The ECG signal is characterized by six peaks and valleys which are labeled with successive letters of the alphabet P, Q, R, S, T and U that is shown in Figure-1 [2].

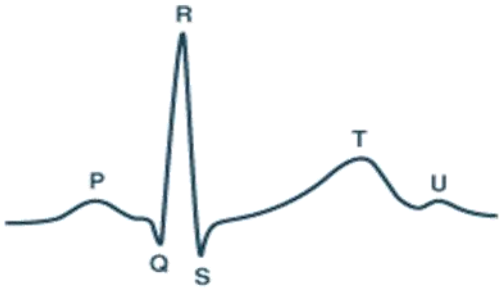

Figure 1: Form of ECG Signal.

This is a list of events that occur in the heart on each heartbeat.

Also known as QRS complex:

1. Atrium begins to depolarize.
2. Atrium depolarizes.
3. Ventricles begin to depolarize at apex. Atrium re polarizes.
4. Ventricles depolarize.
5. Ventricles begin to re polarize at apex.
6. Ventricles re polarize [3].

Figure 2 shows heart behavior and part of the generated signal.

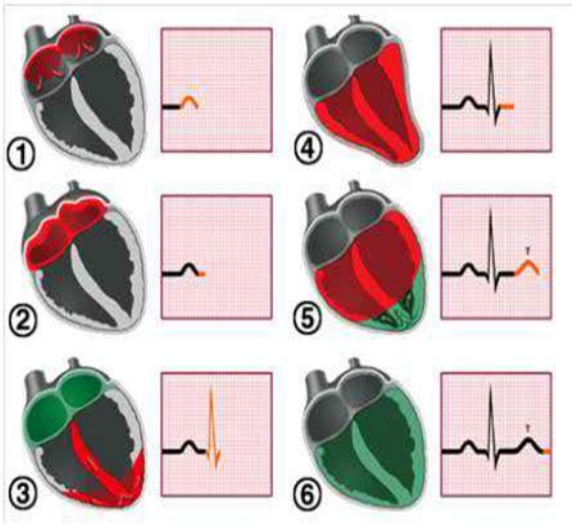

Figure 2: Electrical Activity of the Heart [4].

The power line interference is the main noise from the transformer used. To overcome this, hybrid power supply is used by using solar and wind because only solar power-driven system will have some drawbacks like quick discharge of battery. When it is rainy season, there will not be any availability of the solar energy. Therefore, the battery discharges and we finally tend to use commercial power

2. OBJECTIVES

To make a low cost portable ECG machine is the objective of this proposed model. This is very helpful for the poor people. Another important objective is to minimize the electricity problem. Here, hybrid power system is used instead of electricity. So, it can be used where electricity is absent. Our model offers a special functionality and that is an indicator. The indicators make response if any electrode is displaced. Our proposed model also offers portability which

is very important. Our proposed model will bring a revolutionary change to provide the medical support to the rural people.

3. METHODOLOGY

The first stage of the ECG circuit includes instrumentation amplifier is the most important part in the circuit. It should provide high gain to amplify the weak ECG signal and be able to immunize the noise (common mode signal) and other signal in electromagnetic spectrum. To address the issues above, the following measure will be taken. A high gain instrumentation amplifier with a high Common Mode Rejection Ratio (CMRR) will be used to receive the desired signal. To remove the noise, a band pass filter will be implemented. Since, most of the noise types discussed are of high frequency while the desired signal is relatively low. Peak detection circuit is used to detect the failure in electrodes connection. Oscillator generates signal with frequency approximately 50khz that pass through the instrumentation amplifier when the loss connection is occurred. Analog to digital circuit is used to processing the signal using computer techniques. There is another important problem that the doctor needed to know if there is any loss in electrode connection to solve it and to take the best measurements from devices. That's why an indicator circuit is implemented which will be very helpful for a doctor to understand the loose connection of electrode. Generally, ECG machine is connected with the main AC line that produces some noise which is not expected. So, a hybrid power source is implemented that is not connected with the main line. The hybrid power source will be generated from the combination of the solar and wind. Laptop is also used to see the output of ECG which will provide the facility of the portability. This can be done by using the sound card of a laptop.

4. PROPOSED MODEL

A. *Basic block diagram of ECG:*

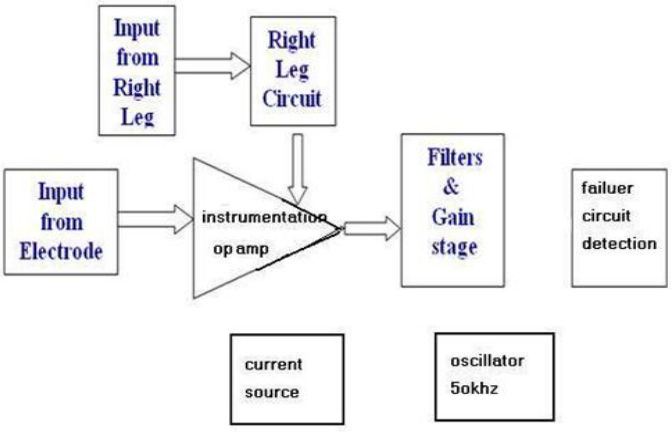

Figure 3: Block Diagram of the Circuit

The input signal will be taken by using some electrodes. The electrode will be placed on the chest. Input signal from the leg will also be taken. The input signals will be amplified through the instrumentation amplifier. Then, the amplified signal will be passed through the filtering stage. The hybrid power source is connected to the current source for getting sufficient power to operate our device properly. To see the output, laptop is used. The failure circuit detection is used to check the proper connection of the electrodes.

B. *Hardware implementation*

1) Instrumentation amplifier (INA 126): The INA126 and INA2126 are precision instrumentation amplifiers used for accurate, low noise differential signal acquisition [4]. The signal acquisition is the first consideration when an HRM is implemented. But, the signal is too small and contains a lot of added noise. As we said above the signal extracted from the heart has amplitude of approximately 0.5 mV. Since, it is necessary to amplify the signal and to filter the noise and then to extract the QRS complex. An instrumentation amplifier is usually the very first stage in an instrumentation system. This is because of the very small voltages usually received from the probes need to be amplified significantly to be proceeding stages.

The reasons to use instrumentation amplifier are:

1- Get differential signal.

2- High input impedance.

3- High CMRR.

2) Filtering Stage: The required band width for ECG signal (0.5 hz- 30 Hz) for normal heart human, the bandwidth of the circuit is selected near to this range. Now, the bandwidth (0.5-120Hz) is selected notching filter required in design to remove 50hz noise from power line grid [3].

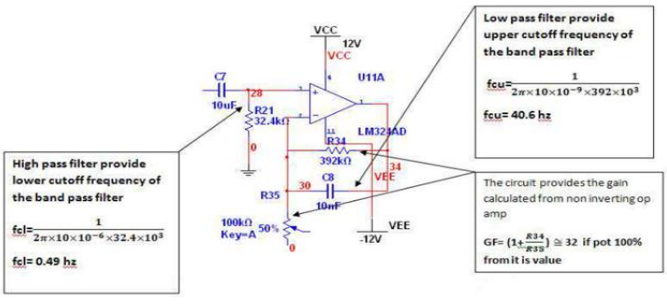

Figure 4: Band Pass filter

3) Hybrid power supply: Hybrid power are combinations between different technologies to produce power [5]. This system consists of two energy source i.e., wind and solar for voltage source. For wind energy, low turbines made up of D.C generators are used with mechanical model. To acquire solar energy, photo-voltaic cell made up of amorphous silicon module is used that is very rigid, high thermal

stability. The voltage acquired from both the sources is given to a high end high frequency charge controller to charge the battery by trickle pulse method. Multilevel charging system enhances to high end usage. This helps to avoid AC interference in the ECG signal [6].

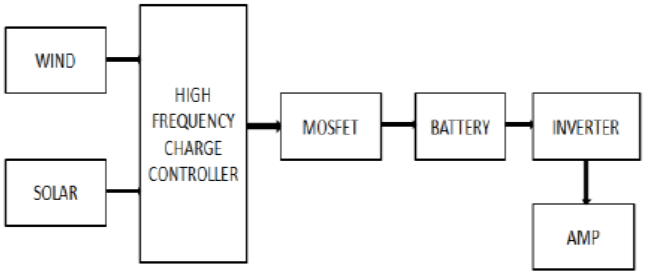

Figure 5: Block Diagram of Hybrid Supply.

The combination of both wind and solar can provide an effective power source. The generated voltage is then passed through the high frequency charge controller which will maintain the same frequency from different sources. Then, the same frequency voltage is stored into a battery. The inverter and amplifier are also used to amplify the power signal. In the remote area where electricity is still absent, our ECG can be used due to this hybrid power source.

4) ECG Electrodes: Disposable sensor electrodes are used for testing purpose. They are pre-loaded with a low impedance wet Ag/Cl gel which is better than solid gels at reducing skin impedance that is important for obtaining a clean signal. A tab connector allows for the cable to move around without disturbing the electrode-skin contact, which highly reduces the motion artifacts. Figure 6 shows the picture of electrodes used for this purpose. These electrodes are used for RA, LA and LL position [1].

Figure 6: Disposable Sensor Electrode Used for Testing.

5) Testing the Circuit in Failure Connection of Electrodes: According to the impotency of the circuit in medical application, it is needed to detect any failure may occur during diagnostic. The major problem is that the doctor needed to know if there is any loss in electrode connection to solve it and to take the best measurements from devices.

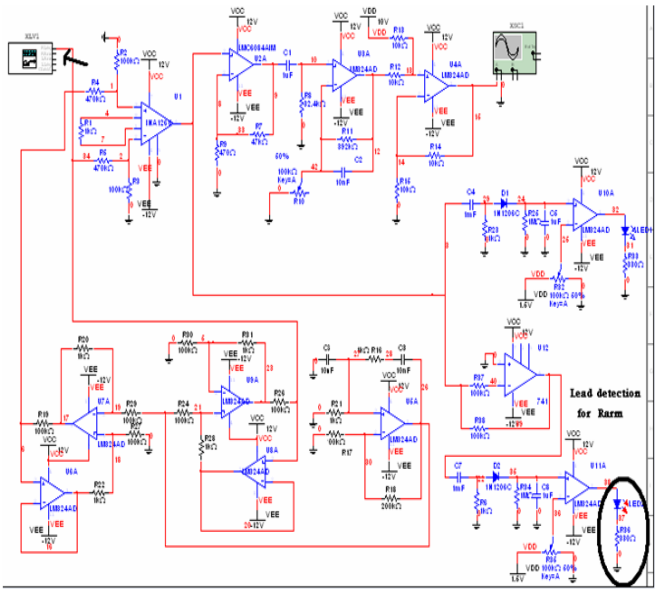

Figure 7: Failure Connection in Right Arm.

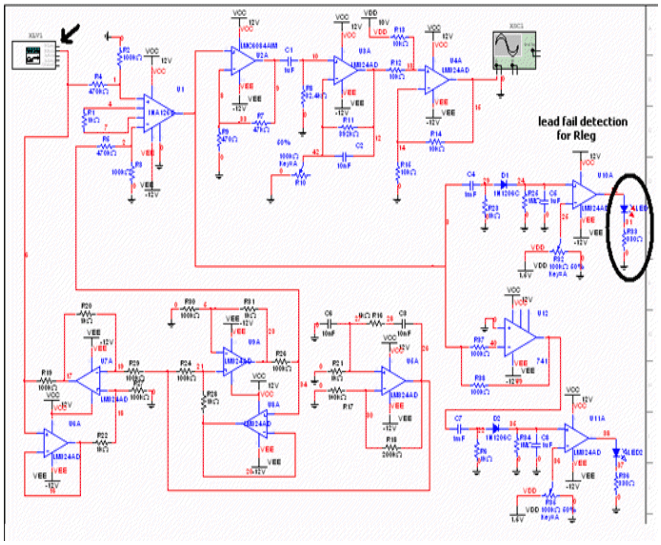

Figure 8: Failure Connection in Right Leg.

5. ECG SIGNAL SIMULATION

SPICE simulation, the language by which Multisim emulates circuit design behavior. It does not run in real-time. This means that if a real-world signal is acquired by a Lab VIEW instrument, it cannot be directly injected into simulation, since the measurements will be running at different rates (real time vs. simulated time) [7]. In the growing world of Biomedical Engineering, the need to be able to design circuit quickly which interfaces to a human signal is a common design problem. An amplifier for example can be designed in a circuit simulation package, however the signals which will interface to that particular circuit will be simple simulation stimuli (such as a sine wave, square wave etc.). To truly test a biomedical amplifier, you need to be able to interface the design to a real signal. Using this unique Lab

VIEW instrument, one can define a human electrocardiogram (ECG) signal and have amplified it through a circuit created in Multisim.

6. ECG CIRCUIT DIAGRAM

This the ECG circuit diagram of our proposed model.

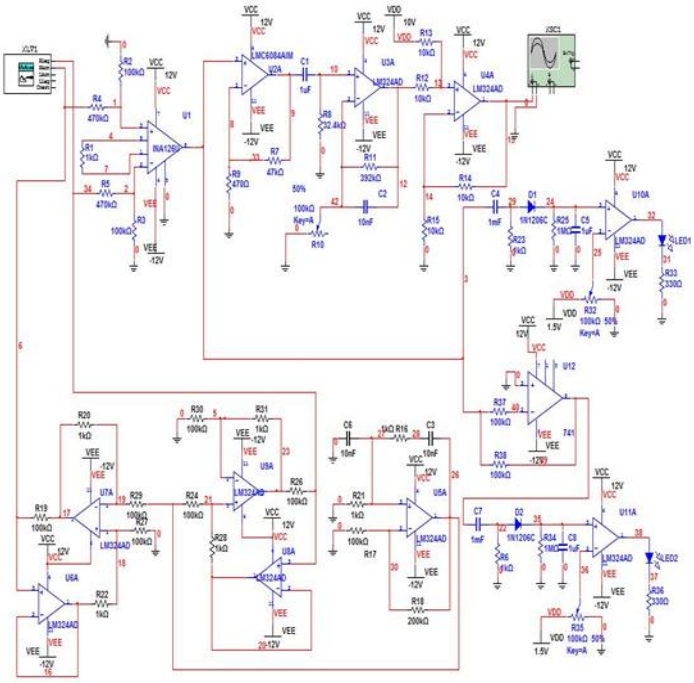

Figure 9: ECG circuit diagram

Output of ECG:

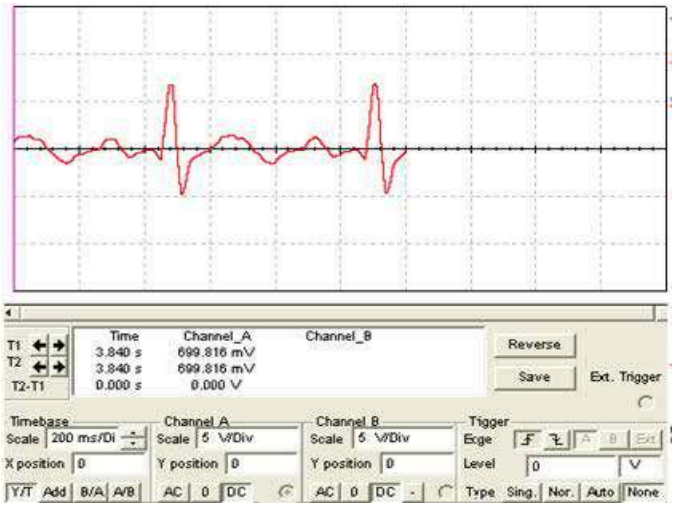

Figure 10: Output of ECG

7. OUTPUT FROM LAPTOP/PC

Output of ECG circuit diagram can be taken by using laptop/pc. This will help to create a portable ECG unit. This is a simple technique and sound card may be used for this purpose.

1) Soundcard of Laptop: A sound card which is also known as an audio card has facilitated the input and output of audio signals to and from a computer. It is under the control of computer programs. Typical uses of sound cards include providing the audio component for multimedia applications such as music composition, editing video or audio, presentation, education and entertainment (games) [8]. Many computers have in built sound capabilities, while others require further soundcard expansion cards to provide for audio potentiality.

Figure 11: Soundcard Hardware

Sound card has usually functioned of analog-to-digital converter (ADC), which converts recorded or generated analog data into a digital format. The output signal is connected to an amplifier, headphones or external device using standard interconnects. For higher data rates and multiple functions, there is more advanced card commonly include more than one chip.

8. OVERALL BLOCK DIAGRAM OF ECG

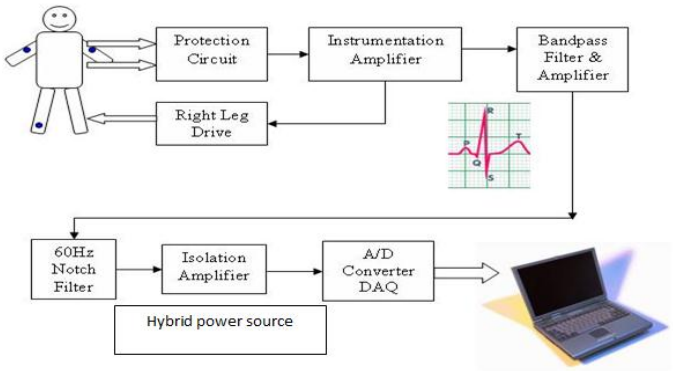

Figure 12: Overall block diagram of ECG

9. RESULT

Hybrid low power ECG has a very easy acquisition. It is suited for the energy constrained portable healthcare applications. Through the hybrid supply the power line interference noise is removed. With good signal conditioning circuit IC noises are removed. It can also be continuously monitored for critical patients and it can be interfaced simultaneously with PC and stored in Excel. This circuit will also indicate the misconnection of electrodes.

10. PROBLEMS & TROUBLESHOOTING

The harder part is to take the very low frequencies pulses and chose the proper amplifier to amplify it. The laptop/pc interfacing with the ECG circuit was another great deal for us. So, it is needed to make interface between pc and circuit very carefully.

11. CONCLUSION

Power cuts play a major hurdle now a days. In villages, it is more common for 8-10 hours. All the peripheral health centres are affected due to this. By using renewable energy sources, this problem can be solved by producing power through solar and wind energy. This helps to work ECG machine smoothly. Dry metal electrode acquisition makes patient feel comfortable. The digital values of ECG can be given into any ECG analysing software for processing.

12. FUTURE WORK

A medical module kit can be implemented which includes our proposed ECG module, heart rate measuring instrument, BP (blood pressure) measuring device, Blood glucose measuring device, respiratory measuring device etc. The combination of all of these may be implemented as an integrated device which will be portable. This medical module kit can be used anywhere especially where the medical support is not enough such as rural areas. The medical module kit will bring a new dimension of medication service.

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