INEXPENSIVE EKG SYSTEM WITH NOISE SUPPRESSION

Madhu V [1] ,Prakruthi M C [2] , Prapulla M S [3] , Radhika S N [4] ,
Sri Ramu D S [5] , Shobha B N [6] .
[1,2,3,4]students, Dept. of ECE, SJC institute of technology, chickballapur, Karnataka, India.
[5] Project guide, Dept. of ECE, SJC institute of technology, chickballapur, Karnataka, India.
[4] HOD, Dept. of ECE, SJC institute of technology, chickballapur, Karnataka, India.

Abstract: An electrocardiogram (EKG) records the electrical signal from the heart to check for different heart conditions, but it is susceptible to noises. Denoising of EKG (Electrocardiogram) signals, usually contaminated from different noise sources is decisive for correct parameter extraction. The purpose of this project is to model the developed circuit analysis on EKG signal extraction using the analog circuits. The electrodes sense the EKG signals which are very weak.

The weak EKG signals are amplified using precision amplifiers. The low-noise filter circuits are used to remove the noise that is present in the signal. The aim of this work is to provide a user-friendly support for the existing EKG in order to make the operation reliable and more accurate in order to reduce health risks. For base-line wander, and electrode motion artifacts removal, GAN1 is the best denoising option.

Keywords: Non-invasive EKG, Electrocardiogram,
Precision amplifiers, Notch filter, Band-pass filter

I. INTRODUCTION

An electrocardiogram (EKG) is a recording of the electrical activity of the heart on body surface. It's a test used to quickly detect heart problems and monitor heart's condition. EKG machines are standard equipment in labs and in ambulances. The noise is due to the electromyography signals caused by muscle contractions. Noise sources affect the EKG signal, these types of interference could be significantly reduced by a careful choice of high quality components.

In general, EKG contaminants can be classified into different categories, including power line interference, electrode pop or contact noise, patient-electrode motion artifacts, electromyography (EMG) noise, and baseline wandering.

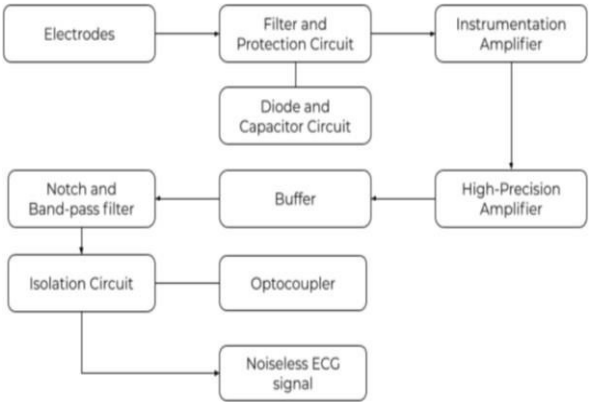
Among these noises, the power line interference and the baseline wandering (BW) are the most significant and can strongly affect EKG signal analysis. The power line interference is narrow-band noise centered at 50Hz or 60Hz with a bandwidth of less than 1Hz. EKG measurement Information is collected by skin electrodes placed at designated locations on the body. The cardiovascular diseases are measured from the ECG based on the abnormality in the parameters of that graph. Different parameters denote different level of cardiac problems.

It is necessary to pass the ECG data to a specialist person. As this data is so sensitive in patient's perspective, in wrong hand it can be devastating for them. Electrode leads, attached to the surface of the skin, pick up electrical signals that represent the heart electrical activity. These are analog signals and are transmitted to electronics equipment that filters, amplifies, and digitizes them.

A computer then analyses the digital wave and outputs it to a monitor or prints it onto graph paper. The results are then interpreted by a doctor who determines the patient cardiovascular health. The ECG wave is comprised of many parts, each indicating something important about the patient heart.

II. PROPOSED SYSTEM ARCHITECTURE

Figure II-1 architecture shows the inexpensive ecg system with noise suppression followed in our project.



The signal is taken from the heart through the electrode, checked for the noise which is generated due to the detecting device. The ECG electrode gives the output that may contain noise signals which are of different types like noise filtered with the capacitor circuit called the white noise. The protection of the pre-amplifier against high-voltage fluctuations is by the protection circuit. The signal is then received by the instrumentation amplifier. The instrumentation amplifier has high input impedance also provides High-precision voltage.

Instrumentation amplifier output is buffered before applying to the filter which avoids loading. The notch filter and the band pass filter are at the filtering stage.

The band pass filter is usually designed to have a bandwidth of 0.5Hz-150 Hz and the notch filter eliminates the 50Hz caused by power lines in the project proposed. An optocoupler in isolation circuit separates the patient with the output signals. Noiseless EKG signal is obtained at the output stage.

III. MATERIALS

A. Resistor and Capacitor

Both are energy storage components, but they differ in the way they store energy. A resistor is an electronic component used to resist the flow of current in a circuit. It's more like a friction which restricts energy. A capacitor, on the other hand, is an electronic component used to store electrical charge.

B. Diode – 1N1183

The use of Diode means to convert AC power into DC power. There are other cases where a time varying signal might need to be converted into a DC signal.

C. Operational Amplifier – LM324

The LM324 series are low-cost, quad op-amps with true differential inputs. They are other cases where a time varying signal might need to be converted into a DC signal.

D. Optocoupler – 4N324

An optocoupler is used to break the connection between signal source and signal receiver, so as to stop electrical interference.

IV. METHODS

EKG methodology is an extensive interdisciplinary science. EKG methodology includes three aspects: hardware platform (data acquisition or communication), software application(signal processing or monitoring).

Hardware platform:

Typically, ECG signal that detected by the electrode is very weak with amplitude of 1mv to 3mv. Its frequency spectrum lies between 0.05Hz to 150Hz. According to the technical requirements, this Bluetooth- enabled hardware platform basically could be divided to six parts: Analog circuit, Digital Circuit, Signal Condition Circuit, Communication Interface and Power management Circuit.

As most of the energy of ECG waveforms is concentrated in frequency up to 40Hz only, the cut off frequency of 5 th order Butterworth low-pass filter has set to 40Hz. This not only simplified the analog circuit, but also removed high frequency noise and power line noise, the total amplifier gain was about 60dB and the Common Mode Rejection Ratio (CMRR) was adjusted to 120dB by introducing Right leg Driver(RLD) circuit.

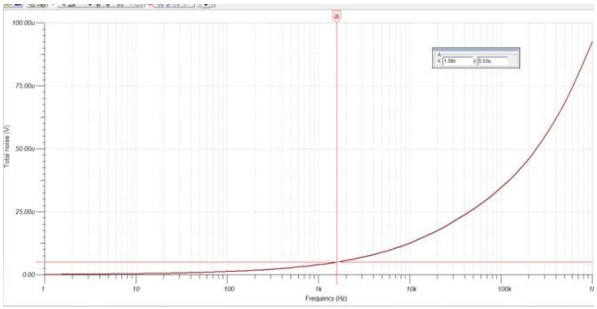
Software Application:

The application realized basic functions include ECG data receive/decoding, Control Command (start/stop control, time control), Real-time monitoring, raw data pre-processing, ECG data storage/Playback and data post- processing. It was well accepted that ECG signal was susceptible to artifacts due to power-line inference, Electrode motion, baseline wander, high frequency contents and myoelectric interference. So it was necessary to integrate a 60Hz notch filter for minimizing the power line interference in real time.

This digital filter is a Finite Impulse Response (FIR)band- pass filter with hamming windows. The cut-off frequency was set between 3 Hz to 40 Hz, which is screen out other components such as P wave, T wave, and baseline drift from human motion.

Figure IV-1 Hardware Circuit Prototype

V. RESULTS



As per the block diagram shown in the figure II-1 the project“Inexpensive EKG System with Noise Suppression” has been fabricated and final testing has been done using analog signals. In the testing mode, we have applied the sine wave.

The filter has successfully removed the noise from the signal. The bandwidth was also in the required range that is approximately 100Hz.

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