WEARABLE SENSORS FOR BIOPOTENTIAL MONITORING

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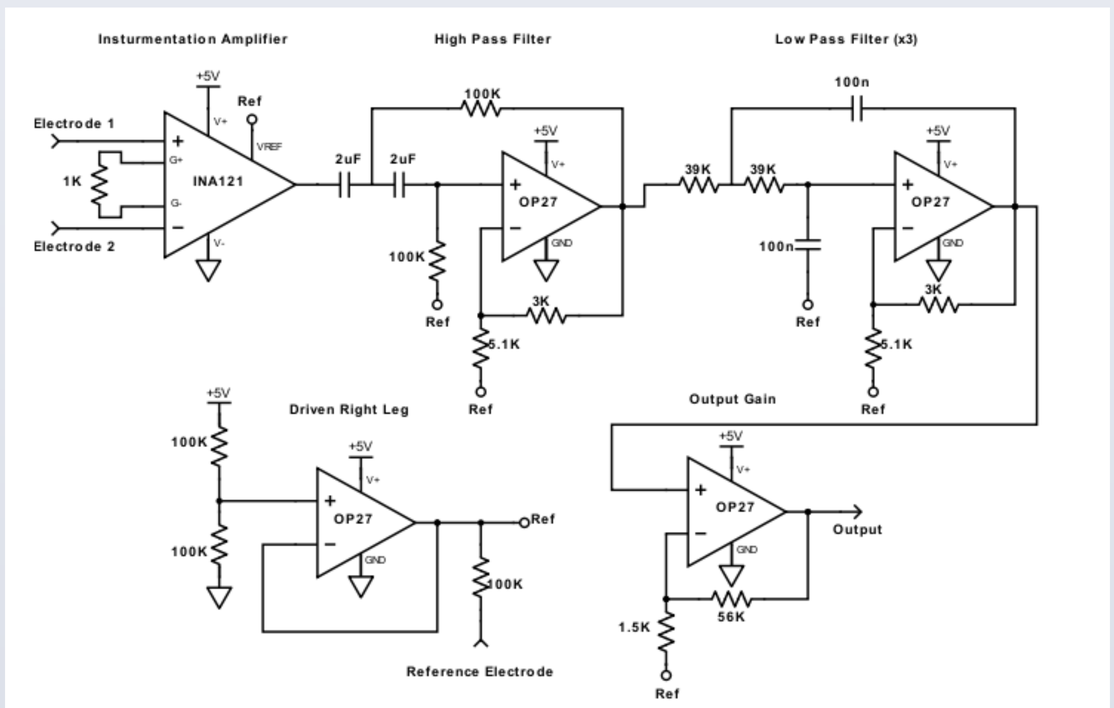
Abstract

Electrocardiogram(ECG) is a diagnostic tool for recording the electrical activity of the heart using electrodes placed on the skin. In this study, rather than using traditional Ag/AgCl wet electrodes, graphene-coated dry textile electrodes are used to eliminate the need for skin preparation and provide the user with comfortable, wearable sensors. A low-cost circuit is designed and printed on a circuit board so it can be used with an armband, for the user to wear it anytime without any preparation. Signals are sent via Bluetooth to a PC or a smartphone to monitor the ECG signals.

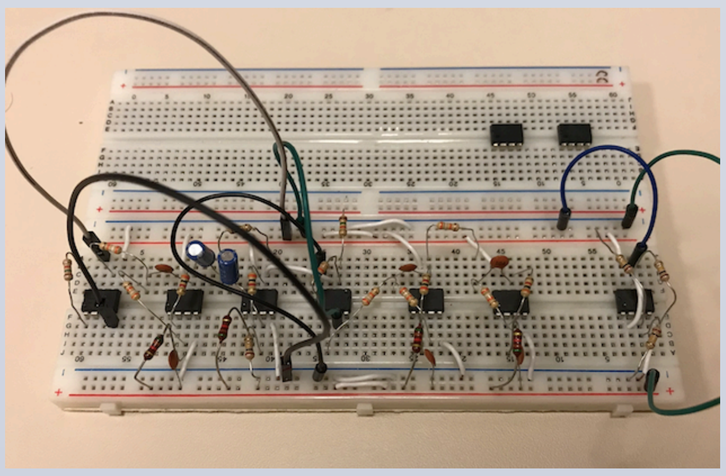
Objectives

Designing a electrocardiogram (ECG) circuit which uses flexible conductive substrates as sensor elements, it should work with a battery, transmit data to PC and measurements should be performed from one arm.

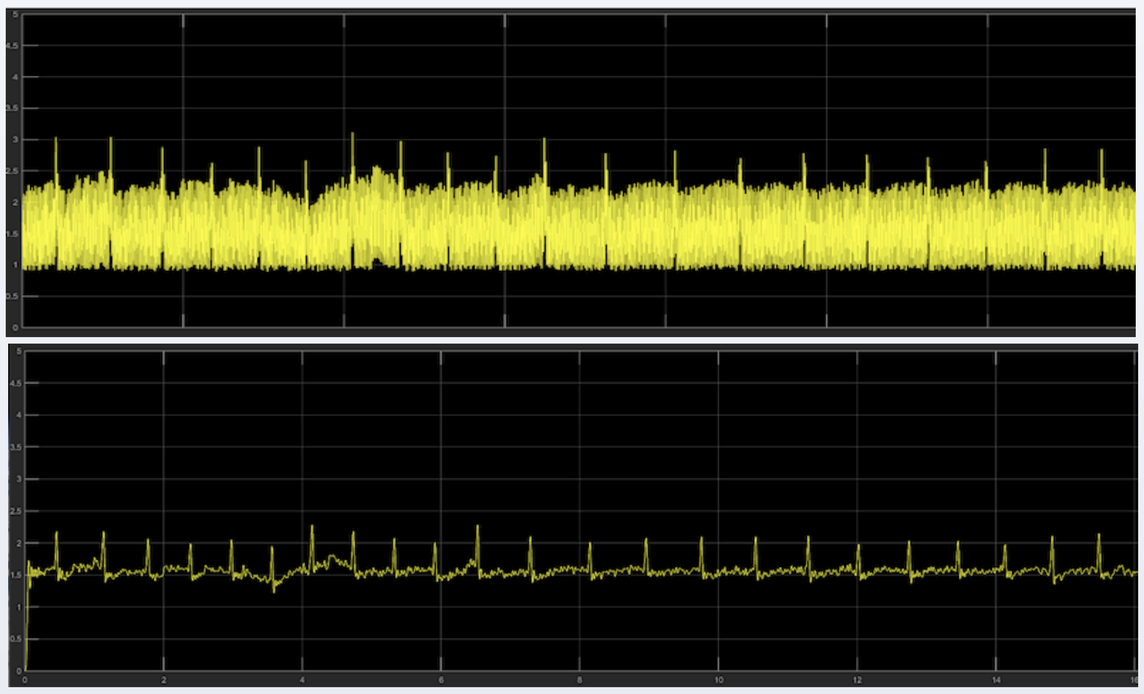
Circuit Schematic



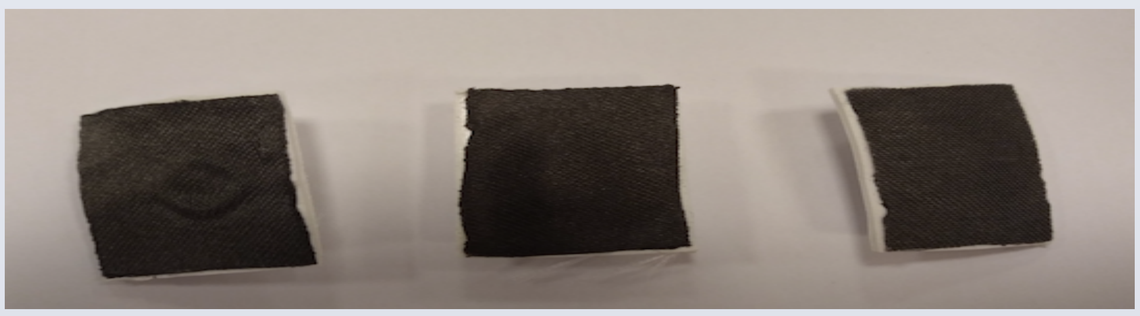
To obtain ECG signals from one arm, aggressive filtering and more gain is needed. With all three electrodes placed on the same arm, heart and muscle signals interfere with each other and the most obvious interference is the powerline noise at 50 Hz. It's disturbing because ECG signals are at the range of 10 to 50 Hz. For filtering, 2nd order high-pass filter and 6th order low-pass filters are used with cutoffs 0.8 and 40 Hz respectively. In addition to the instrumentation amplifier, another output stage amplifier is designed so that the total gain of the circuit is around 73 dB. Driven Right Leg circuit with a voltage divider is implemented for a single power supply and an enhanced CMRR.



Results

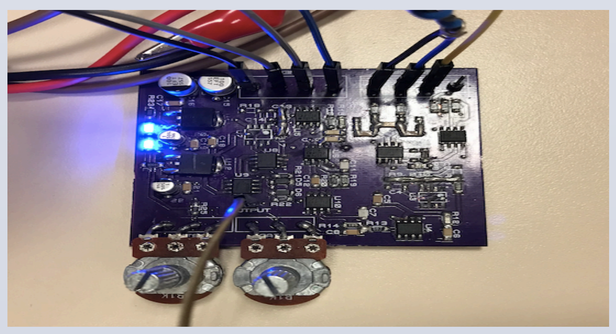


Arduino Uno is used for A/D converter and MATLAB is used for processing the data in PC. The raw data from the circuit at the top image is very noisy. To clear the noise, a digital Notch filter at 50 Hz is applied. The second image is the filtered signal and QRS complex of the heart is clearly visible. Also P-T waves are distinguished in a close look but they're noisy. Graphene-coated textile electrodes are shown in the figure below and similar results are obtained using them.



Conclusion

ECG from one arm with wearable textile electrodes and a low-cost printed circuit board (PCB) can make biopotential monitoring easy because there is no need for skin preparation. An armband with a PCB on it can measure ECG signals and give the heart rate as well as the signals which can be enough to diagnose an abnormal activity of the heart.



Acknowledgements

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References

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