ABSTRACT

Improving public health using contactless ECG electrodes for long-term monitoring of arrhythmia

Matin Khalili

Keywords: Cardiovascular disease, CVD, ECG, Capacitive electrodes, Contactless electrodes, Motion artifacts, Long-term ECG monitoring

Cardiovascular disease (CVD) is the leading cause of death and disability worldwide, resulting in 17.3 million deaths annually. Thus, any CVD symptoms should be immediately diagnosed for effective treatments [1]. In this case, Electrocardiography (ECG) is widely considered for monitoring and diagnosing heart symptoms. The traditional wet Ag/AgCl electrodes can acquire high-quality ECG signals. However, they cause skin irritation and require careful skin preparation by a specialist. Therefore, they are not practical for efficient long-term ECG monitoring. To overcome these limitations, contactless capacitive electrodes are introduced as an alternative. But these electrodes suffer various shortfalls in collecting high-quality and clinically acceptable signals. As a coupling capacitor between the body and electrode is formed in these sensors and this capacitor changes due to the subject's physiological or body movements leading to Motion Artifacts (MAs). In addition, the variable skin potential across the capacitor forms an additive voltage that may distort the ECG signal adversely. This presentation aims to illustrate a comprehensive literature review and methodology used in my study. Regarding the methodology, I intend to simulate the equivalent model of the measurement system and implement it in the real world. Moreover, two issues will be addressed in my research questions. Firstly, I will extract the variable impedance between the sensor and the subject's skin, which has the highest correlation with MAs according to literature, by injecting a voltage with a known frequency into the circuit. Unlike many previous methods, the ECG signal, and impedance signal will be measured simultaneously. I will address the optimal frequency and impedance signal with maximum correlation with MAs, which are the gaps in previous works. Secondly, in past studies, the effects of skin potential on MAs have not been sufficiently investigated, which is aimed to be analyzed, estimated, and subtracted from the polluted ECG noise signal.

References

Jung, J., Shin, S., Kang, M., Kang, K. H. & Kim, Y. T. Development of Wearable Wireless Electrocardiogram Detection System using Bluetooth Low Energy. Electronics 10, 608 (2021).