Comparison of Simulated and Measured Results of Non-contact Capacitive Electrodes for Biomedical Applications

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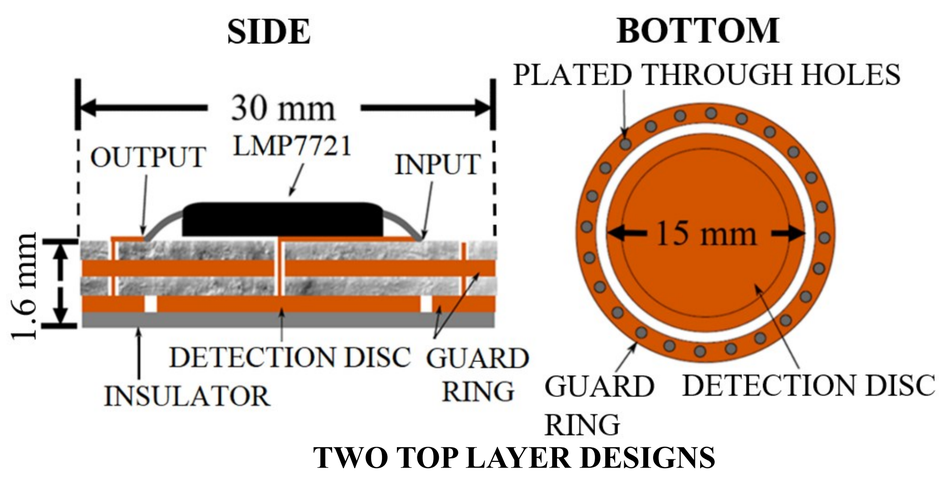
1. Introduction

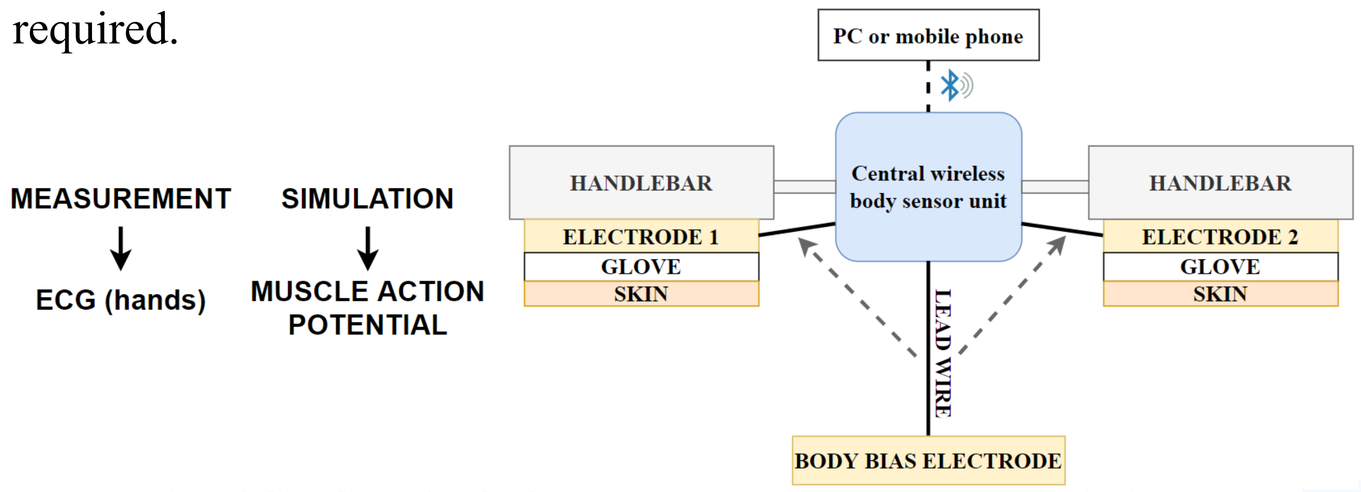
Unlike wet and gel **surface electrodes**, dry electrodes do not require the presence of electrolytic gel. **Capacitive dry electrodes** are contactless i.e., they can be applied over clothing, which makes their application easier, faster, less intrusive, and less painful. The analysis of the geometry and electronic design is one of the first steps in the process of increasing the immunity against environmental noise and motion artifacts. For this purpose, simulation models have been found to be particularly useful because they allow analysis without physical implementation.

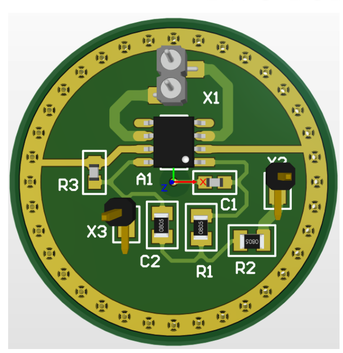
The goal of this research is to explore the reliability of the developed electromagnetic behavioral simulation model of the four-layered capacitive electrode via a comparison of the simulated and measured results.

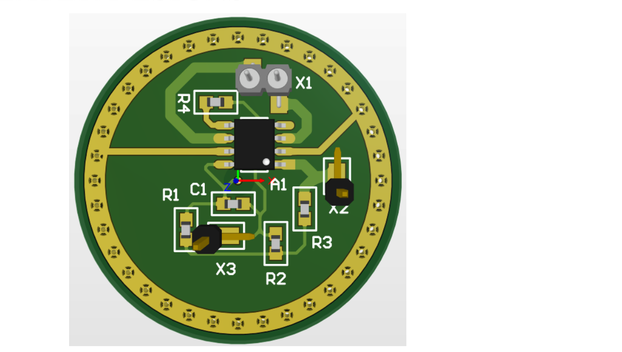
2. Method

The electrodes were implemented in **Altium Designer** software and used in the acquisition of myoelectric (**EMG**) and cardioelectric (**ECG**) signals. The ECG measurements were performed on a ***Greyp Bikes* electric bicycle**: the electrodes were placed on handlebars, whereas the subject was wearing cycling gloves while pedaling in place. To receive a good quality signal, a body bias electrode was required.







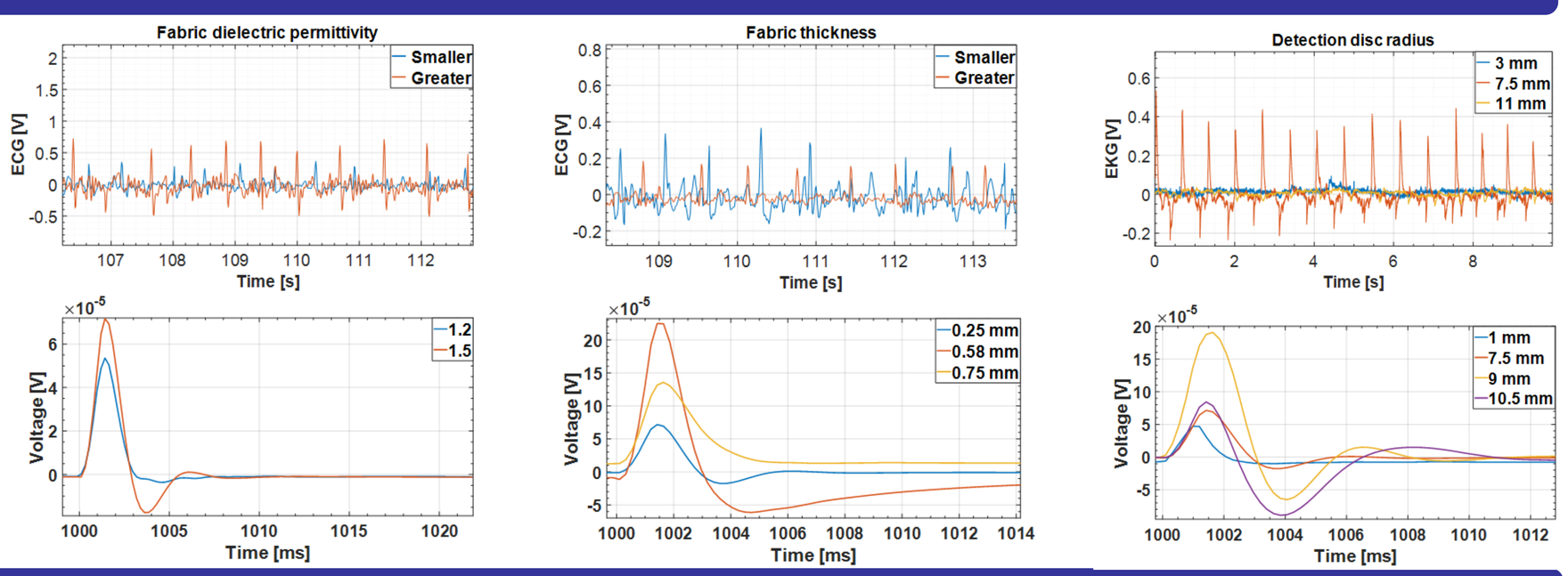


Within the **CST Studio Suite**, the upper arm was modelled as a concentric cylinder, along with the line action potential source. The preprocessing circuit is connected with the geometry via Schematic interface.

For comparison of simulated EMG with the measured ECG signals, the influence of detection disc radius and fabric (insulator) on the quality of capacitive coupling is observed.

3. Results

The measured ECG signals are shown in the first row, whereas the equivalent simulation results of the muscle action potential excitation, approximated with the exponential rising and falling function, are shown in the second row.



4. Conclusion

The results have confirmed the possibility of using simulation for qualitative system analysis. The drawn conclusions could be used as guidelines for more efficient prototype design in order to accelerate development, as well as save time and resources.

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