Surface Enhancement of Dry Electrodes used in Prolonged ECG Recording

Background An increasing number of patients suffer from cardiac arrhythmias as the result of the aging population, making long-term (outpatient) ECG recording highly desirable. Today, disposable silver/silver chloride (Ag/AgCl)–gelled surface electrodes are most commonly used. Unfortunately, they suffer from limited ECG signal quality and recording capability because the electromechanical interface alters with time and they may irritate the skin; both reduce the patient compliance. As a promising alternative, ECG signals derived with dry electrodes may be used. Dry electrodes, in the form of a foam or fabric, make use of macroscopic surface areas or nano-particles to reduce the contact impedance without additional electrolytes. However, dry electrodes are more susceptible to baseline wandering and motion artifacts as compared to gelled electrodes, particularly during physical activity [1]. This behavior is mostly related to relative electrode-skin motions as present e.g. with ECG belts or vests inducing differential skin potentials and impedance imbalances between bipolar electrodes. The efficacy of such recordings is reduced, as well.
To overcome the limitations of belts / vests, our institute aims a flexible, cuff-integrated ECG amplifier with active dry electrodes (see prototype in Figure 1). To improve signal quality, dedicated surface enhancement for metal dry electrodes should be exploited.

Aim The focus of this master's thesis is to design, develop, and test a surface enhancement technique for dry electrodes used for prolonged ECG recording at the upper arm.

Tasks

- Familiarize with ECG signals, electrode characteristics and the existing prototype
- Investigate suitable contact surface modification possibilities
- Develop dedicated manufacturing processed for the surface enhancement
- Design and build prototype electrodes
- Test the novel electrodes under real conditions (*in vitro* and *in vivo*)

Nature of the Thesis
System analysis: 10%
Surface engineering: 60%
Electrode design & testing: 30%

Requirements
Basic understanding of biomedical instrumentation
Interest in surface engineering & biomaterials
Basic knowledge in electronics design

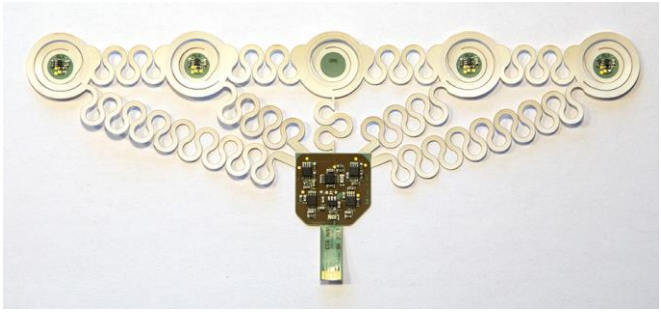

Figure: flexible amplifier circuit for upper arm ECG recording using dry electrodes

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Institute
Institute for Human Centered Engineering HuCE-microLab, Bern University of Applied Sciences
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What we offer
The candidate will work on a highly innovative and unique research project, in which creativity and interdisciplinarity are appreciated. The collaboration partners are dedicated providing highest class equipment / infrastructure enabling the transfer of cutting-edge technologies into novel cardiovascular devices.

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References:
[1] N. Meziane, J. G. Webster, M. Attari, and A. J. Nimunkar, "Dry electrodes for electrocardiography," *Physiol. Meas.*, vol. 34, no. 9, p. R47, Sep. 2013.