**Electrical & Electronic Engineering, Software & Electronic Systems Engineering**

**Final Year Projects 2023-2024**

**Machine learning for electrode motion artefact removal in ECG signals**

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|  | Control | X | Embedded Systems |  | High Frequency Electronics |  | Microelectronics |
|  | Electric Power | X | Software | X | Connected Health |  | MEMS |
|  | Cyber-Security |  | Wireless Communications | X | Signal/Image Processing | X | Intelligent Systems |
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The electrocardiogram (ECG) is a non-invasive method to measure the electrical activity of the heart and can be used to diagnose heart disease. According to the World Health Organisation (WHO), chronic heart disease was the number one cause of death from 2000 – 2019. Long term ECG monitoring is currently the gold standard for diagnosing cardiovascular diseases (CVDs), however obtaining reliable long-term measurements of the ECG signal is challenging because patients are required to collect their ECG signal remotely on a wearable device. Wearable devices are inherently contaminated with noise which can supress the essential pathological biomarkers and, in some cases, render the ECG completely unusable. ECG signals can be contaminated by many types of noise including: 1) Baseline Wander, 2) Powerline Interference, 3) Electromyographic and 4) Electrode Motion artefacts. Most of these noise sources can be reduced through the use of time and frequency domain digital filters. However, the frequency spectrum of electrode motion noise overlaps with the frequency spectrum of a typical ECG signal making it very difficult to remove in the time and frequency domain. The objective of this project is to explore if AI/ machine learning can be used to learn the characteristics of, and correct for, electrode motion induced noise on ECG signals.

**Objectives**

1. Conduct a literature review on ECG motion artefact removal algorithms to identify the different approaches that exist, and the challenges involved in developing effective methods and assessing their performance.
2. Using available online sources (e.g. Physionet1) compile an ECG dataset which can be used to investigate and assess ECG motion artifact removal algorithms.
3. Develop a model for generating synthetic motion artefacts in clean ECG signals and use it to create a reference dataset for ground truth comparisons.
4. Investigate machine learning approaches to reducing electrode motion noise on ECG signals.
5. Develop and implement a candidate approach using Python or Matlab and validate its performance on the datasets from (2) and (3).
6. Compare the performance of the developed algorithm against alternative baseline algorithms from the literature.

**MEng Extension**

1. Explore advanced deep learning concepts (e.g., transfer learning, data augmentation) to enhance the performance of models and/or develop and evaluate alternative machine approaches for motion artefact removal.
2. Provide a rigorous assessment of all approaches developed with regard to real-time/embedded system implementation constraints.

**Learning Outcomes**

At the end of the project the student will be able to demonstrate:

1. A good understanding of ECG denoising algorithms.
2. A working knowledge of machine learning/ deep learning models and associated development tools
3. Enhanced programming skills in Python or Matlab, particularly with regard to algorithm development and signal processing.

**1https://archive.physionet.org/physiobank/database/macecgdb/**