Power spectral density estimation of non-equally spaced samples algorithm for real-time execution on an embedded system

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Project Description

Wearable bio-signal monitoring systems are miniaturized devices, providing the acquisition, onboard processing and wireless transmission of different bio-signals for prolonged periods of time. These systems allow non-intrusive and long-term monitoring of vital parameters of patients, such as electrocardiogram (ECG), respiration or skin conductance. They represent novel solutions for healthcare and wellness wearable applications. In particular, the frequency spectral analysis of biomarkers like RR intervals (heart period) are used for assessing cardiovascular diseases, stress and sport performance. However, any heart beat based biomarker like RR intervals are non-equally sampled data. Therefore, the goal of this project is to implement a power spectral density (PSD) estimation of non-equally sampled data algorithm for its real-time execution on an embedded platform developed at the Embedded Systems Laboratory. Moreover, this algorithm will need to be optimized to minimize their computational complexity and memory usage, and therefore maximizing the lifetime of the system, which is critical for this kind of applications.

The students’ tasks include:

1. Study the state-of-the-art PSD algorithms for non-equally sampled data and port one of them to C for its execution on a low-power embedded microcontroller.
2. Optimize the embedded implementation to minimize computational complexity and memory usage.
3. Evaluate this optimized implementation in terms of accuracy, CPU and memory usage and energy consumption.

The project will be carried out at the Embedded Systems Laboratory of EPFL under the supervision of Prof. David Atienza, Dr. Adriana Arza and PhD student Giulio Masinelli.

Requirements:

1. Advanced programming experience in C for embedded devices.
2. Good knowledge of Matlab for scripting and signal processing.
4. Interest in biomedical applications and practical work on wireless sensor devices.