Heart beat measurement: what characteristics make a device performant?

In this study, signals are analyzed for the comparison of devices measuring heart behavior. We focus on the heart rate and its variability, the blood velocity in the body and the shape of the heart pulses.

Some heart diseases and heart behavior are studied in biomedical engineering. However, it is important for that to have performant, efficient and easily usable devices to acquire the heart signals.

I analyzed signals generated by the heart beat (ECG and PPG) to compare devices measuring it: a first one that has been used by the Biomedical Engineering Department for years, the CardioHolter, and the combination of two other devices, the Empatica and Faros equipments. ECG stands for electrocardiography, the measurement of the skin electrical activity, and PPG for photoplethysmography, the measurement of blood volume changes using a light source and a detector. For the CardioHolter, the device acquires the heart signals with chest electrodes (ECG) and finger detectors (PPG). For the combination, the Faros device acquires the ECG signals with chest electrodes and the Empatica Acquires PPG signals on the wrist.

This study reveals, with the analysis of the heart rate and the pulse shape, an excellent point: the wristband (Empatica) and chest electrodes (Faros) are both performant. Unfortunately, the blood velocity analysis has as a conclusion the impossibility to synchronize clocks of those two devices contrary to the CardioHolter ECG and PPG. So they can both be used while the characteristics we want to measure and compute do not need any association of those two devices.

This study has been led because of the need to replace the CardioHolter, due to its bulkiness and outdatement, by the combination of the Empatica and the Faros devices that are way lighter and more comfortable to wear.

The department has been stuck with a device that prevents the conduct of certain studies due to its inconvenience of use. The resolution of this need is relevant for the future studies of the department and so, the future knowledge that will be acquired about the heart and blood behavior.

The application of this work will be the possibility of the use of light and easily wearable devices when a study does not require a combination of both devices. This would be very convenient and moreover would allow us to conduct a wider range of experiments, such as long term experiments needing the subjects to wear the wristband for several consecutive days, which was impossible with the device that has been used until now.