Bordeaux INP
ENSEIRB
MATMECA

MICA Project

Project made by : Lucas Stefanutto lsteffanutto@enseirb-matmeca.fr
Luca Zelmans lzelmans@enseirb-matmeca.fr

Introduction

The Matlab implementation of a cardiologist assistant has been implemented to assist all the medical profession by detecting automatically diseases thanks to algorithm. Thanks to signal processing and general algorithm Mica is able to detect heart diseases.

Detection of Q, R and S waves

When we talk about the heart, we talked about beats. A beat, can be translated as an electrocardiogram, which is a measurement of the electrical activity of the heart. We examine the electrical potential between two point of the body, with electrodes, in function of the observed parameters.

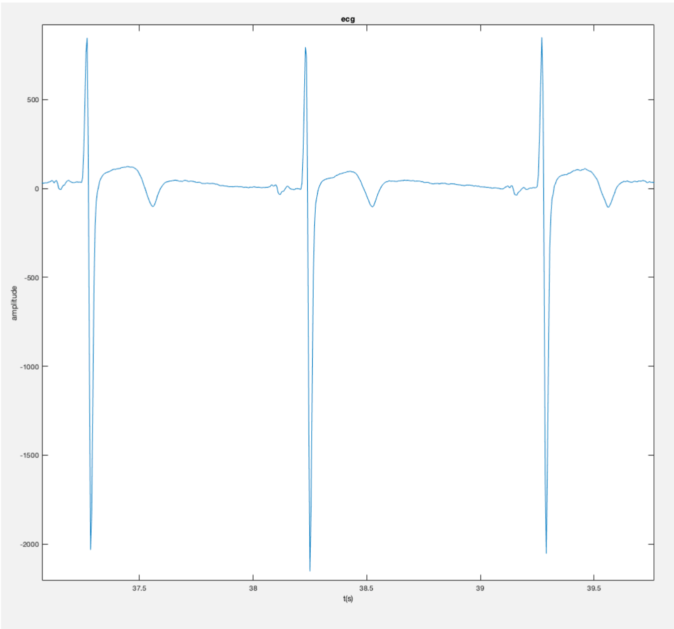

Figure 1 : 3 heart beats

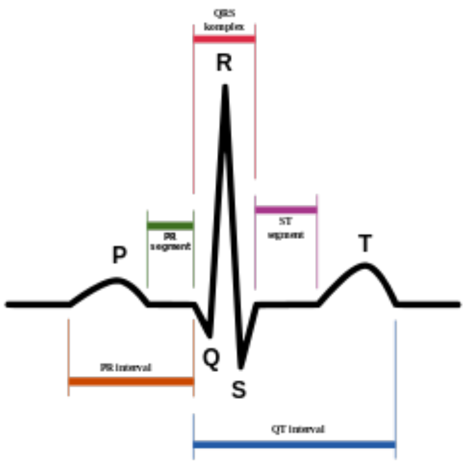

Figure 2 : 3 Schema of a PQRST complex

The next step is to implement the Pan and Tompkins algorithm described as below

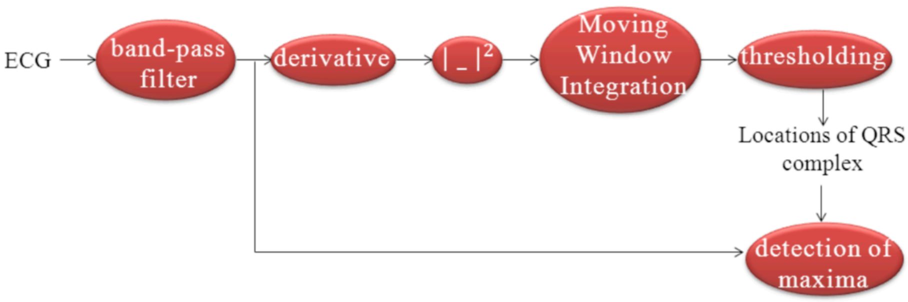

Figure 3 : Pan and Tompkins algorithm

As it is shown below, the signal is filtered by a band-pass filter (the combination of a low-pass filter (1) and a high pass filter(1)). It implies a group delay of 21.

The transfer function of the low-pass :

$$H = \frac{(1 - z^{-6})^2}{(1 - z^{-1})^2} \qquad (1)$$

And the transfer function of the high-pass filter :

$$H = \frac{(-1 + 32z^{-16} - 32z^{-17} + z^{-32})}{(1 - z^{-1})} \qquad (2)$$

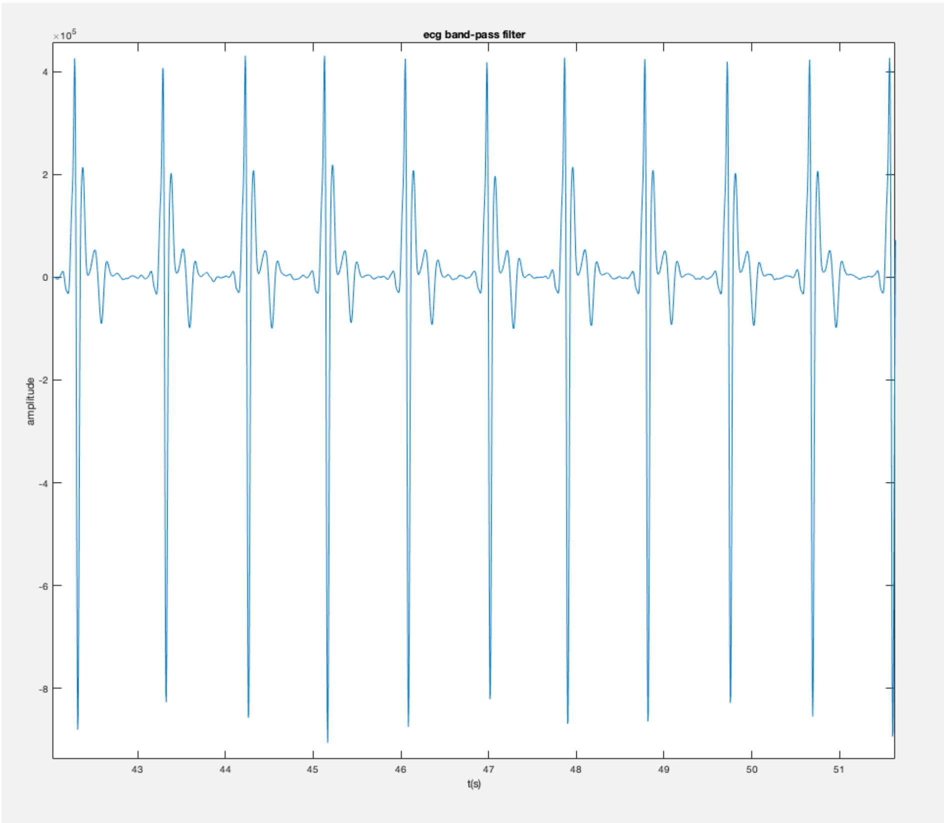

Figure 4 : ECG after the band-pass filter

Then, the signal if differentiated by a filter which add a group delay of 2. The five-point differentiation filter transfer function is :

$$H = \frac{1}{T_s}(-z^{-2} - 2z^{-1} + 2z^{1} + z^{2}) \qquad (3)$$

We have the output where we can notice two peaks :

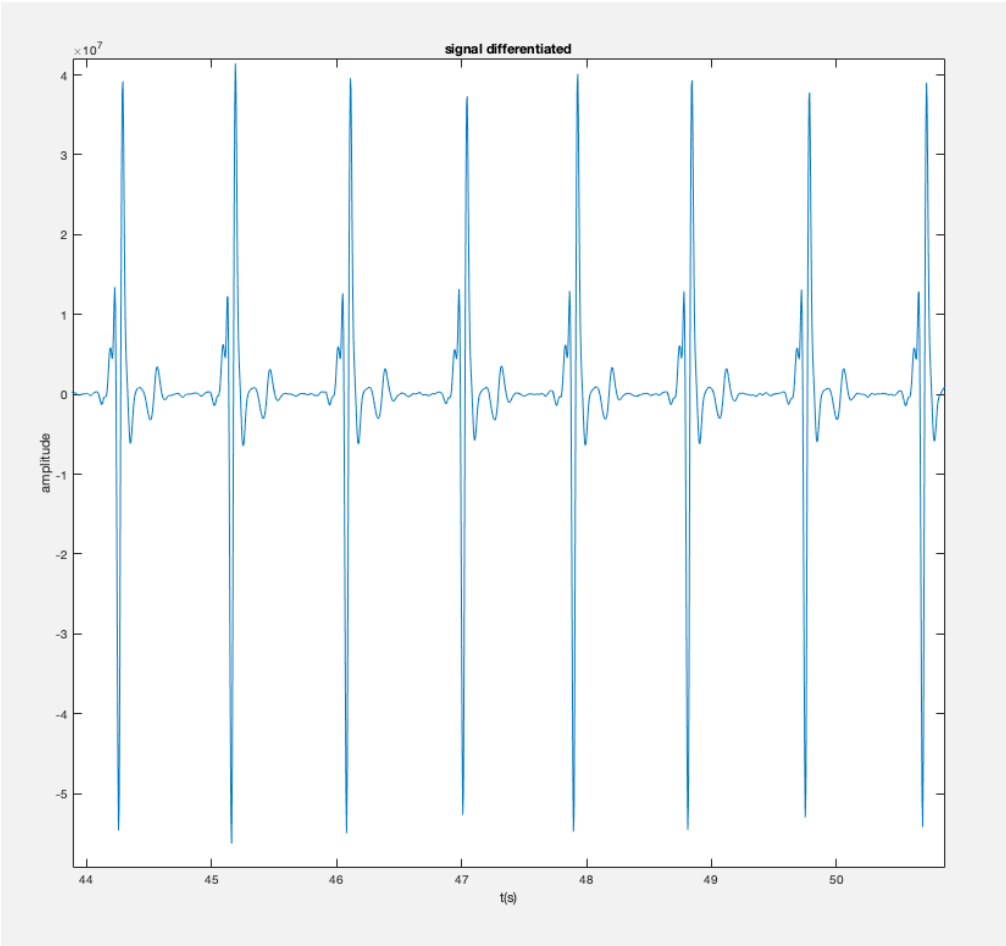

Figure 5 : ECG after the derivative filter

In order to intensify the local extrema, we square the signal.

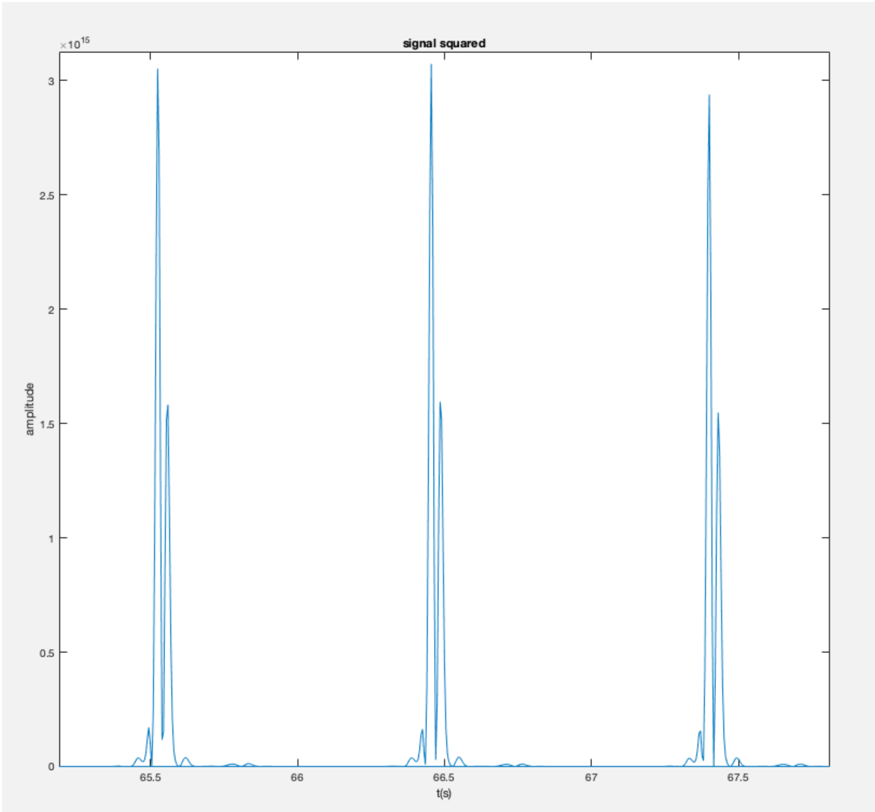

Figure 6 : ECG filtered squared

Finally, the next processing consists in a moving-window integration step (4), s_{sq} represents the signal after being squared. With N, the width of the window :

$$s_{MWI}(n) = \frac{1}{N}\sum_{i=1}^{N-1} s_{sq}(n-i) \qquad (4)$$

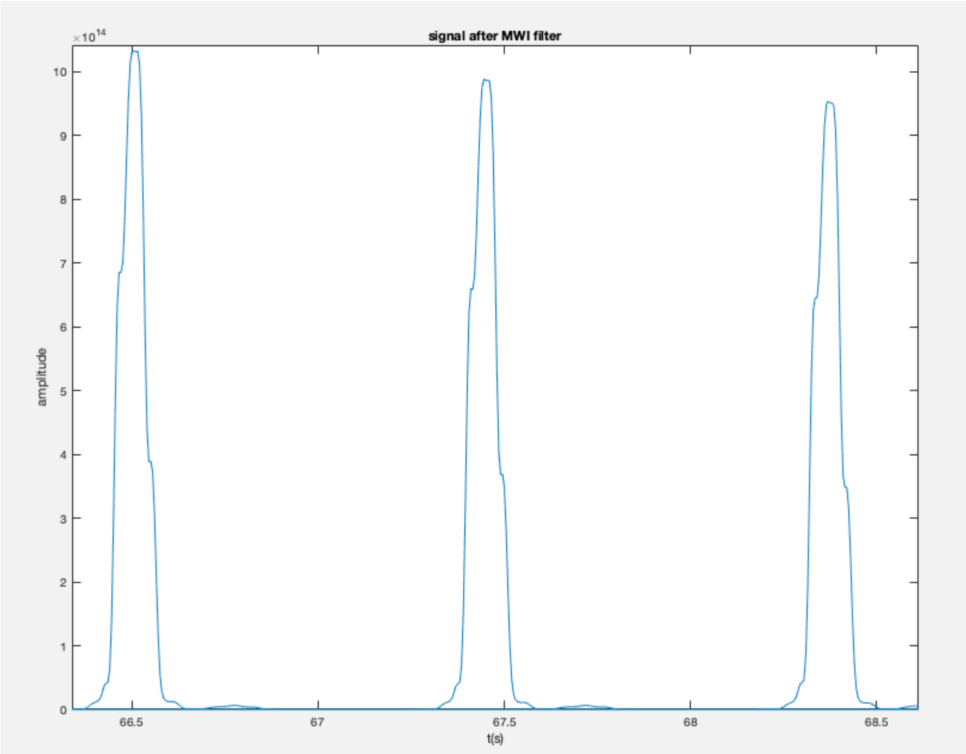

Figure 7 : ECG filtered with MWI

Now that with have implemented the Pan and Tompkins algorithm, our goal is to identify the Q, R and S complexes. In order to detect the R complex, we establish a threshold equal to the maximum of the signal after the moving window multiplied by a factor equal to 0.28 (the best one we found). Then the R peak are the peaks greater than this threshold.

To finish, the Q and S peaks are, respectively, the minimum on the left side and the minimum on the right part of the QRS complex centered on R peaks.

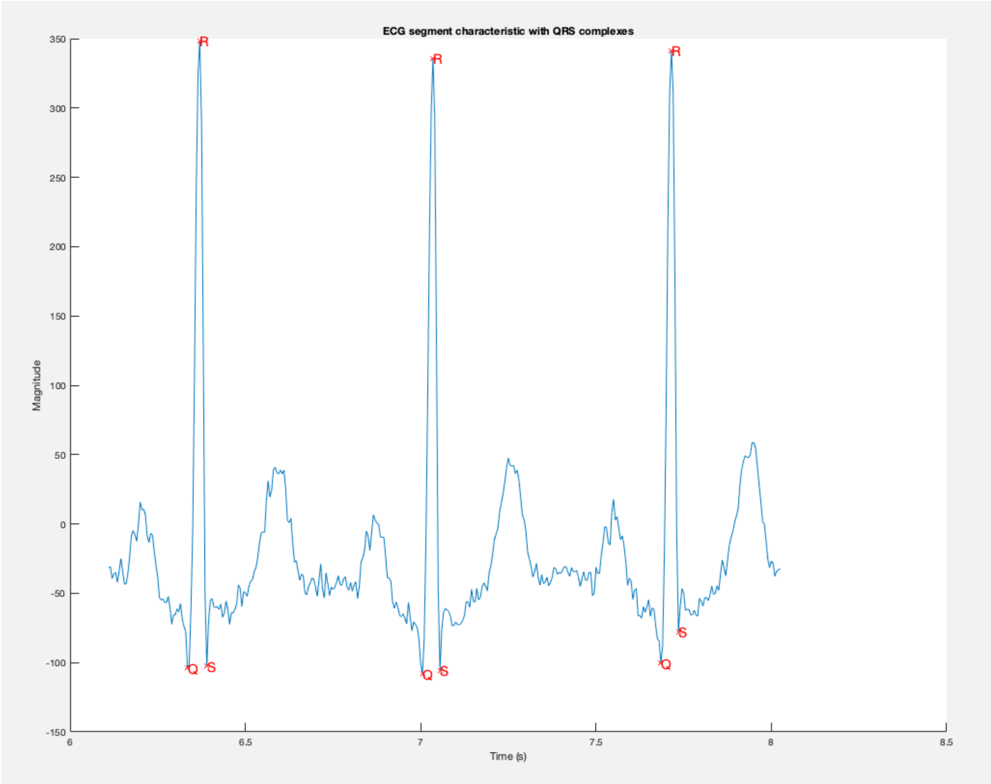

Figure 8 : 3 QRS complexes

Note: Code for diseases finished but we have to finish the user interface to finish our report.