Lab 1 : ECG enhance

Q1 :

Graph time signal and FFT : 50Hz has no effect on QRS peak but on P and T yes because of their frequencies that are too fast (approx. 0.02). The no effect is certainly due to ratio of noise/signal. For the FFT graph, we can put a low-pass filter at 40 Hz as all the high frequences will be removed. But there is no clear frequency and there is no lower threshold. The disadvantage is that this is not helpful to visualize a clearly different signal

IIR filter:

Q2: delay of 0.05. There is less noise and a phase shift (due to the filter). However, the flatness supposed to be observed before the T wave is noisy instead. The auricular contraction is also bumpy which is not normal (roundness instead). The smoothness of the curve is due that this filter applies the previous results on the calculi. The filter is not at linear phase. There is also an important difference of amplitude in some parts of the graph.

Help to know more about the physiology of the patient

Q3: The low-band and stop-band frequencies are here to avoid the 50Hz peak which is due to powerline and to allow the normal ECG frequency to be visualized (max frequency ≃20Hz for QRS complex).

IIR filter (zero phase)

Q: With the zero-phase approach, we have no delay between the curves. However, we have some distortion, especially on the QRS complex. One of them is that the peak with the filter is lower. This one leads to a better approximation.

Linear phase FIR filter

Q: The “plateaux” are better after the P-wave and the QRS-complex (less noise). However, the delay is bigger than the previous graphs. The curves are almost the same. The periodization of the filter is showing us a previous T-wave.

Lab 2: breathing estimation

Hilbert transform

Q1: envelop only went with positive values and positive maxima are followed by the envelop.

Q2: With the Hilbert envelop, we have the positive values that are added with the absolute value of the negative values of the signal. Therefore, it does not follow the negative maxima.

Q3: the narrow band is better, so the envelop oscillates less and the signal is smoother as the applied passband has the good interval.

Q4: However, some peaks are overestimated by the envelop.

Q5: The unwrap phase is relatively linear.

Q6: The unwrap function will reconstruct the phase function by joining its uncontinous points to each other.

Q7: The instant frequency varies a lot which is a bit surprising because we had an instantaneous phase that was relatively linear.

Q8: The space between the maxima on the original wave form is reflected on the breathing frequency graph by drops when the distance between two peaks is bigger and higher values when the distance is smaller. There is an effect of boundary (asymptote) at the beginning because there is no previous values. It doesn’t occur at the end because the previous values are present.

Lab 3: Hand washing detection

Q1: The amplitude is very large. Therefore, we cannot see much and analyze from this figure.

Q2: The range of amplitude is much better. We see between 22 and 28 Hz, we have a series of small amplitude movements at high frequencies, which is what we expected from a washing sequence. There is still some high frequencies that could be noises.

Q3: We select the frequencies that correspond to the sequence of interest. It gives us a sinusoidal signal, which is smooth.

Q4: So we don’t have any offset because we want to know exactly when the person is washing their hand.

Q5: It helps to assess when the washing occurs. The movement of washing generates a lot of accelerations.

Q6: It is detected with the biggest peak from the acceleration graph.