Principles of Biosignals and Biomedical Imaging

Master on Biomedical Engineering

P_3, 2nd Semester 2022/2023

Vectors

Lab Session 1

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In this lab some basic concepts on vector spaces of signals are addressed

1) **Synthetic data**
   a) Implement a function to generate a column vector containing a sine wave, $sin(2\pi f(t)t)$, with a growing frequency, $f(t)$ from $f(0) = f_1$ to $f(T) = f_2$. The inputs of the function are the duration, T in seconds, the frequencies, f_1 and f_2, in Hz and the sampling rate, f_s, in samples per second

$$x = chirpTone(T, f_1, f_2, f_s) \tag{1}$$

   .
   b) Listen the sound produced in the previous item with $f_1 = 100$, $f_2 = 2000$ and $f_s = 4000$ Hz using the MatLab function *soundsc*.

   c) Save the sound vector in an audio file to be read in normal audio players (use the MatLab function *audiowrite*).

2) **Real Data**
   a) Audio (1D)
      i) Read the audio file "Let It Be.mp3" from the Data section of the webpage of the discipline, using the MatLab function *audioread*. Read carefully the help documentaion of this function.
      ii) Compute the length of the file in seconds. Explain the approach you used.
      iii) Reproduce the music backwards.

   b) Electrocardiogram (1D)
      i) Read the *.mat file "116m(2).mat" containing a real ECG trace.
      ii) Visualize the ECG trace and comment.
      iii) Estimate the sampling frequency that leads to a realistic ECG trace.
      iv) Detect the R peaks and estimate the heart rate (HR) from the inter-peak intervals.

   c) Images (2D)
      i) Load the image House8000.png and creatively find hidden information in it ("...As the philosopher Jagger once said: You Can't Always Get What You Want ....".
      ii) Suggest and implement a method to improve the quality of that information.
      iii) Suggest and implement a method to recover the original image. Compute the Signal-to-noise ratio of the recovered image comparing it with the original one.