

Principles of Biosignals and Biomedical Imaging

Bachelor in Biomedical Engineering (LEBiom)

P_3 , 2nd Semester 2024/2025

Project

Bioengineering Department (DBE)
 Instituto Superior Técnico / Universidade de Lisboa

Consider the video examples provided at the course page containing records of people's faces. Fig.1 shows a frame video. Implement in Python/ MATLAB the following methodology to compute heart rate, taking as input a video.

- 1) Select/ Draw the most appropriate Region of Interest (ROI) in your frame. You might want to select multiple ROIs in a frame. Justify your choice.
- 2) Extract the RGB signal from your ROI.
- 3) Suggest a method to extract pulse signal (recommended: Plane-Orthogonal-to-Skin method) and describe it. For pulse signal extraction following POS method [WANG, Wenjin, et al. *Algorithmic principles of remote PPG. IEEE Transactions on Biomedical Engineering*, 2016, 64.7: 1479-1491.].
 - a RGB pixel average : $c(n) = [r(n), g(n), b(n)]^T$
 - b Temporal normalisation : $\tilde{c}(n) = \text{diag}^{-1}(\mu(n)) \cdot c(n)$, where $\mu(n) \approx \frac{l_f-1}{l_f} \mu(n-1) + \frac{1}{l_f} c(n)$
 - c Projection to plane orthogonal to skin (to produce signals s_1 and s_2) : $\begin{bmatrix} s_1 \\ s_2 \end{bmatrix} = P \cdot \tilde{c}(n)$, with $P = \begin{bmatrix} 0 & 1 & -1 \\ -2 & 1 & 1 \end{bmatrix}$ the projection matrix that projects $\tilde{C}(n)$ onto the plane orthogonal to $[1 \ 1 \ 1]^T$
 - d Alpha tuning (to produce the pulse signal) : $h(n) = s_1(n) + \alpha \cdot s_2(n)$, with $\alpha = \frac{\sigma(s_1)}{\sigma(s_2)}$
 - e $H(n)$ normalisation : $H(n) = \frac{h(n) - \mu(n)}{\sigma(n)}$
- 4) Filter $H(n)$ with an adequate filter and cut-off frequencies.
- 5) Perform systolic peaks detection of the filtered pulse signal $H(n)$.
- 6) Compute the heart rate.

Some important packages required for this project are: *dlib* (<https://github.com/davisking/dlib> - for Python or <https://github.com/paleckar/matlab-dlib-facetrack> - for MATLAB).

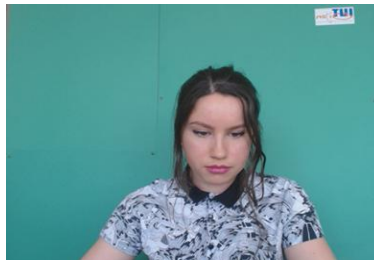


Fig. 1: Raw frame in a subject's video.