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Heart Rate Estimation Based on RGB Camera for Emotion Analysis of Children with Autism Spectrum Disorder

P V Pedro Henrique[1], C L Lucas[1], B F Teodiano[1]

[1]Federal University of Espírito Santo, Vitória, Brazil

phvettoraci@hotmail.com

Background, Motivation and Objective

It is known that children with autism spectrum disorder (ASD) have difficulty in interacting with humans as well as demonstrating emotions. However, they are more likely to interact with machines and this can lead to a better cognition as well as improve the child's interaction with humans. Nevertheless, heart rate is not a voluntary behaviour associated with emotions. Thus, it is proposed here a method to estimate the heart rate through an RGB camera. The camera is installed on a robot used to interact with children with ASD.

Methods

This work has Ethical Committee Approval from Center of Sciences of the Health of the Federal University of Espirito Santo (UFES/Brazil), under number 1,121,638, since June 26th 2015. It is known that the blood oxygenated haemoglobin absorbs the green light. Thus, we can focus attention on the variation of the green light of a child's face to estimate his/her heart rate. Python is the programming language used for our software development. The first step is to detect the region of interest (ROI), which is done using the Haar Cascade tracking algorithm. The files containing the face features were acquired from the OpenCV web page on Github (https://github.com/opencv/opencv/tree/master/data/haarcascades). We use ROIs from cheek and nose. After this, we calculate the average of the green component (equalized to increase contrast) from the pixels inside these ROIs previously detected. However, due to face movements, to find the green variation caused by the heart rate, the original average green signal is interpolated to equalize the time gap between the frames. Then, the result is multiplied by a hamming window to minimize the amplitude caused by the discontinuities in the boundaries of the signal. Using FFT (Fast Fourier Transform), we can obtain the peak frequency related to the heart rate. After this, we just have to multiply that frequency [Hz] by 60 to obtain the heart rate in bpm.

Results

Our method can capture the aforementioned ROIs (Figure 1), generate the green light variation curve (Figure 2) and, after subtracting the values due to face movements, plot the curve in frequency (Figure 3).

Discussion and Conclusions

According to the literature, errors found for this method are around 3 bpm, which represent a satisfactory result. The next steps of this research are: first, to compare the results obtained here with conventional methods. After that, to improve the code to detect variations in movements, since, to the current date, there is a need for low mobility.

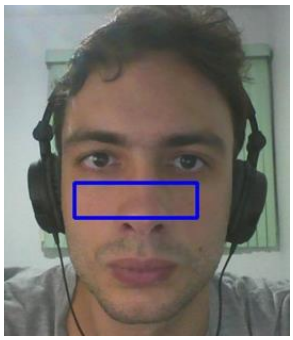

Figure 1 - Face detection and ROI generation.

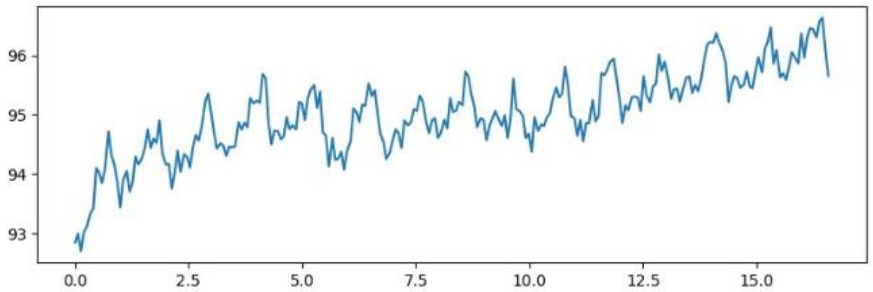

Figure 2 - Green light variation due to heart rate.

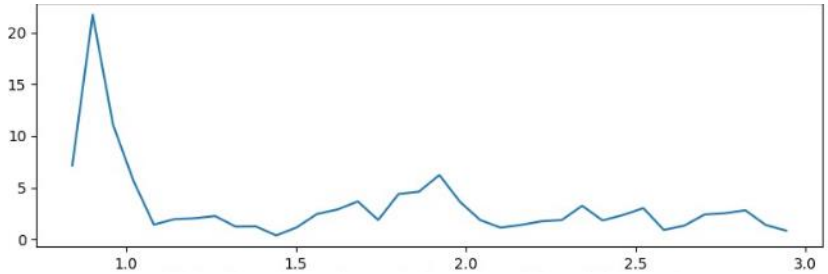

Figure 3 - FFT from heart rate signal.

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Keywords Heart rate; RGB camera; Emotions; Children with autism spectrum disorder.