Remote Heart Rate Monitor

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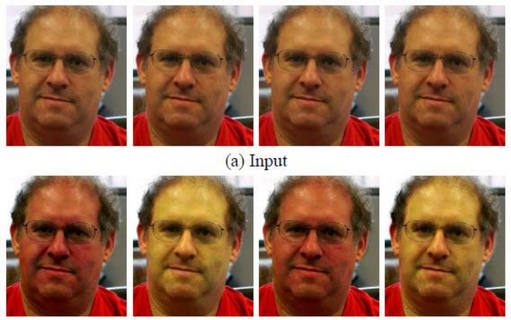
Background

Contactless heart rate monitoring has seen a rise in popularity when compared to alternate heart rate monitoring methods.Through various papers Remote Photoplethysmography (rPPG) has shown great promise, but has been constantly met with difficulties when dealing with heavy movement[1].



(a) Input

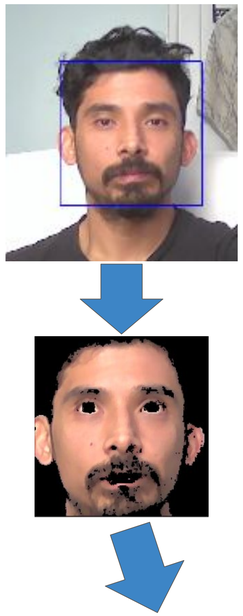
(b) Magnified

As shown in the figure above, variances in color from skin reflection are subtle and usually invisible, but they can be magnified to show their effects. The subtle variance in color depends on the volume of blood traveling through the face at the moment within the frame capture.[2] This variance can be used to calculate heart rate.

Goals

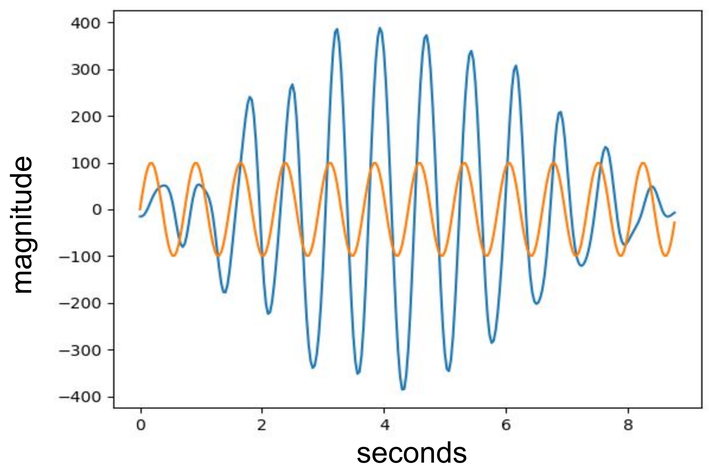
Create an application which takes a video input and uses image processing and signal processing techniques to calculate the subject's heart rate.

Implementation



1. Multiprocessing and Threading
   a. Maintains timing constraints for real time processing.
2. Locate Face
   a. Crop image and zero non-skin pixels
3. Processing
   a. Multi-dimensional Averaging of relevant pixels from received frames
   b. Color Distortion Filter (CDF) to eliminate noise caused by movement. [3]
   c. Standard deviation normalization (Z-norm)
   d. Combine red, green and blue channels to improve the signal.
   e. Applying a moving average filter.
   f. Fast Fourier transform and Band-Pass filter

clean signal (blue) and sine wave constructed from the acquired frequency (yellow)



Accomplishments

- Incorporated face detection and a skin classifier to eliminate unwanted space in the image for processing.
- Acquire RGB pixels from the images and provides the average over the desired pixels.
- Utilize multiprocessing and threading to meet timing constraints.
- Multiple classes defined to improve modularity.

Future Improvements

- Enhance the face detection and skin segmentation process to reduce false positives
- Consider machine learning to make the algorithm more resilient to noise, especially from movement.
- More user friendly interface

References

[1]G. de Haan and V. Jeanne, "Robust Pulse Rate From Chrominance-Based rPPG," in IEEE Transactions on Biomedical Engineering, vol. 60, no. 10, pp. 2878-2886, Oct. 2013, doi: 10.1109/TBME.2013.2266196.

[2]Wu, Hao-Yu et al. "Eulerian Video Magnification for Revealing Subtle Changes in the World." ACM Transactions on Graphics (TOG) 31.4 (2012): 1–8. Web.

[3] W. Wang, A. C. Den Brinker, S. Stuijk, and G. De Haan, "Color-Distortion Filtering for Remote Photoplethysmography," 2017, pp. 71–78, doi: 10.1109/FG.2017.18.

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