Camera-based Vital Sign Measuring

DTU Compute

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Introduction

Heart rate and blood pressure are generally good indicators of a persons health.
Current methods of measuring these all require contact with the subject, but recent work has shown ways of doing this without direct contact. In this poster we present a method of measuring heart rate using a low cost camera in ambient light. Furthermore we present a concept of expanding this method to estimate blood pressure. These methods are possible to implement in real-time applications e.g. for continuous monitoring via a webcam.

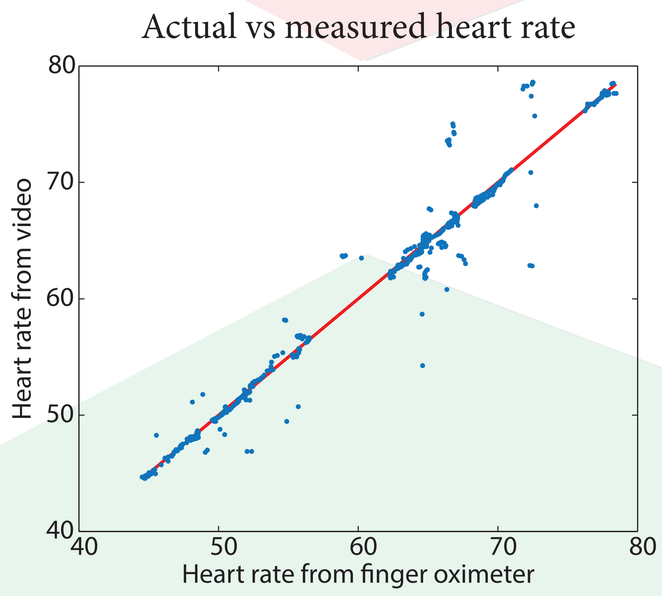
Heart Rate

The oxygen saturation of blood is higher when flowing from the heart than when flowing to the heart. This causes a difference in how the skin reflects light, and results in a very small color change. The aim of this method is to measure this change of color.
We first detect the face in a video stream using the Viola-Jones algorithm. In each frame we calculate the averages of the red, green and blue color channels thus obtaining three values for each frame. With the entire video this results in three signals, a red, a green and a blue. Some proportion of the heart rate signal is contained in each of these. In order to extract it and to filter out noise and motion artifacts we perform Independent Component Analysis on the signals. This yields three new signals one of which is the heart rate signal. This signal was found to be the one having the highest peak in its Fourier transform, and the heart rate is extracted as the frequency of this peak.
The method is visualized below.

Flow diagram of heart rate estimation

Results

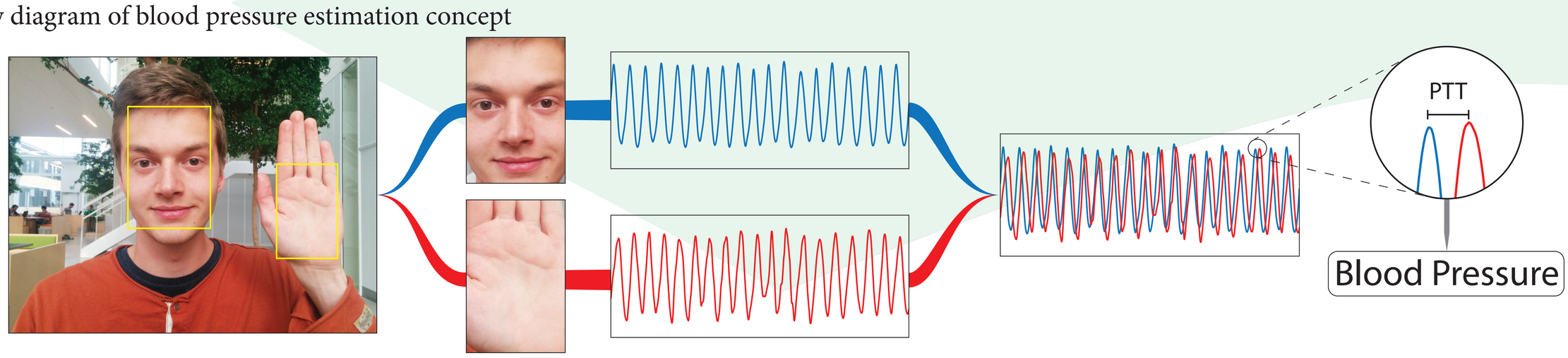
We have evaluated our method on 16 test subjects (11 men and 5 women) capturing a 60 second video of each. We then extracted 30 second long moving windows from these videos spaced one second apart. This gives us a total of 496 observations.
We compared our results with the heart rate obtained from a commercial finger oximeter. The correlation plot is in the figure to the right. The correlation coefficient is 0.98 and the standard deviation of the difference is 1.9 BPM (beats per minute).



Blood Pressure

We present a novel concept for estimating blood pressure without physical contact. Prior work has shown that there is high correlation between the time it takes a pulse wave to reach a point on the body, called the pulse transit time (PTT), and the blood pressure.
Using the former method we find the heart rate signals of the hand and face respectively. The phase delay between these signals is found and is used to estimate the PTT which subsequently is used to estimate blood pressure.
The method is visualized below.

Flow diagram of blood pressure estimation concept



Conclusion

We have presented a method for non-contact measuring of a persons heart rate using only an inexpensive camera and ambient lighting, and we found that the performance of the method was similar to that of a commercially available pulse oximeter.
We have also presented a concept where we utilize this method to give an estimate of the blood pressure. This is the focus of our ongoing work.
Both of these methods will be able to run in real-time on mainstream hardware such as a smartphone.

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