

Master's Thesis Review

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Title: Robust Visual Heart Rate Estimation

Author: Radim Špetlík

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The thesis presents a camera-based estimation method of subject's heart rate. The first part of the thesis extensively reviews the related literature and identifies the key weaknesses of the prior art. The second part of the thesis proposes a novel algorithm that uses a convolutional neural network trained end-to-end, thus avoiding a complicated image and signal processing pipeline. The algorithm is thoroughly tested on three standard datasets and on a challenging ECG-fitness dataset collected by the author. Previous visual heart rate methods were demonstrated in near-ideal conditions (static co-operating subjects front-facing the camera, with no motion). The ECG-fitness dataset contains a realistic scenario, where subjects perform physical exercise on fitness machines, so challenges as a large motion, motion blur, non-uniform lighting are present. The thesis reports excellent results, outperforming the state-of-the-art algorithms especially on the ECG-fitness.

The thesis is an extensive research report presenting an original and novel method. At the time of the submission, to the best of our knowledge, we were not aware of any visual heart rate estimation method employing the convolutional networks. Radim has published two papers [1, 2] and another paper [3] is under review.

The problem is non-trivial and Radim proved he was capable of doing the research. Radim got familiar with the literature, carefully studied relevant techniques. Radim got competent in advanced signal processing and deep learning methods. Radim was very active and came up with many ideas. Radim is a skilful programmer and implemented and tested the ideas swiftly. Radim managed to collect the ECG-fitness dataset, which was a great planning and organization effort, besides the technical challenges (synchronizing ECG and cameras, storing raw videos in real-time, etc.). Importantly, Radim is a hard-worker, he invested a lot of time including weekends. His enthusiasm, creativity and indisputable competence resulted in the excellent master's thesis. For me, it was a pleasure to cooperate with Radim.

I suggest evaluating the thesis as

A – excellent.

Ing. Jan Čech, Ph.D.

Thesis Advisor

References

- [1] R. Špetlík, J. Čech, V. Franc, and J. Matas, “Visual language identification from facial landmarks,” in *Proc. SCIA*, 2017.
- [2] R. Špetlík, J. Čech, and J. Matas, “Non-contact reflectance photoplethysmography: Progress, limitations, and myths,” in *Proc. Face and Gestures, Workshop on Face and Gesture Analysis for Health Informatics*, 2018.
- [3] R. Špetlík, J. Čech, V. Franc, and J. Matas, “Visual heart rate estimation with CNNs,” in *Proc. BMVC*, 2018, in Review.