T.C.

MARMARA UNIVERSITY

FACULTY of ENGINEERING

COMPUTER ENGINEERING DEPARTMENT

CSE4197 Engineering Project I Proposal

Title of the Project

rPPG Based Heart Rate Estimation From Facial Video Using Deep Learning

Group Members

Nur Deniz ÇAYLI 150116071

Esra POLAT 150116884

Minel SAYGISEVER 150116028

Supervised by

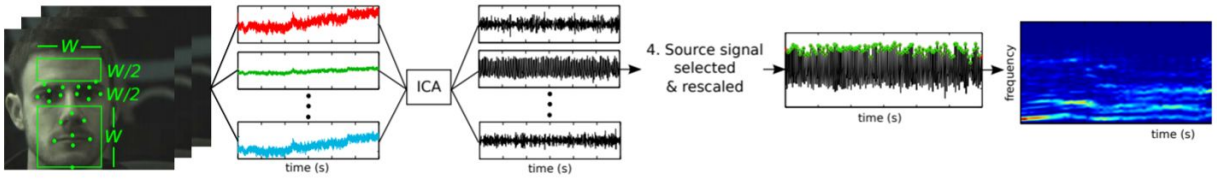
Çiğdem EROĞLU ERDEM

1. Aim of the Project

With the rapid development of technology, the innovations that have entered our lives have also shed light on clinical studies. New techniques are rapidly developing for the heart rate measurement process, which is of vital importance especially in hospitals. PPG technology, which is one of the most used methods currently, is widely used in many medical devices such as pulse oximetry using light sources of infrared and infrared wavelengths. Oximeters usually measure through finger-mounted probes. However, with pulse oximeters, if there is a problem in the patient's blood circulation, it will not be possible to measure with probes. In addition, the need for expensive disposable probes increases the cost [1]. On the other hand, patients in pediatric intensive care units, especially premature babies in incubators, are very susceptible to infections. The rPPG, contactless PPG studies, which will bring us to a solution in such sensitive situations, have been the subject of many researchers for a long time. With rPPG (remote PPG), heart rate monitoring is possible with less need for medical devices and without causing infection. Studies have been conducted for this method for a long time, but its clinical use is not yet available. Many of the studies in the literature have tried their algorithms on healthy volunteers, and these studies focused on correcting motion-related errors [2]. We focused on rPPG technology in order to examine existing studies and develop new solutions to possible problems and enable clinical use of this technology. Our aim is to find rPPG algorithms that work with the least error with deep learning methods and to contribute to the field of health. In addition, while it is possible to measure heart rate during the day with the sensors of wearable devices today, it is possible to measure our heart rate using the camera of our smartphone without having this equipment by using rPPG. Apart from the healthcare field, we aim to make it more common with systems that can be integrated into applications.

2. Methodology

Today, photoplethysmography (PPG) is one of the most used methods to measure the pulse. PPG signal is produced by the periodic beat of the heart and is used to measure parameters such as pulse, oxygen saturation, blood pressure. PPG is an optical technique based on observing light intensity changes on data [3,4]. Contact PPG sensors in wearable devices and medical equipment estimate the heart rate by taking light reflected from the skin using a light-emitting diode (LED). The components of reflected light consist of the amount of light absorbed by the skin and the pulse signals that change in time, which contributes to the absorption of light by the capillaries [5]. Since blood is red, it absorbs green light. When the heart beats, the amount of blood under the skin increases. Therefore, more green light is absorbed. The amount of light that reflects back from the skin gives us information about the pulse. In the light of this information, we can do contactless PPG studies. Non-contact measurement is possible with high sensitivity cameras by using ambient light as a source. The rPPG signal can be extracted from the light spectrum of the image acquired by a video camera. Pulse estimation is made with meaningful data remaining after the obtained signals are cleared from noise.



With proper lighting, changes in blood flow and blood volume can be observed with light reflected from the facial skin. However, recent research has shown that ambient light can be sufficient to obtain a PPG signal [6]. Although many rPPG algorithms have been presented on this subject, which has been of interest to many researchers for many years, a consistent application has not yet been accepted. This is because most developers/researchers tend to create their own test cases using a variety of cameras and have not specified the algorithms usually used for compression, making it difficult to reproduce [7]. Deep learning-based video processing plays an important role in these studies. Unlike existing images, videos

have both spatial information and temporal dynamics. Therefore, we need to take advantage of different models to solve any video related problem using machine learning. Also, when testing methods, we need to use different datasets of both genders, different ages, a wide variety of skin tones, and some with thick facial hair and / or glasses.

3. Software/Hardware Requirements

1. **Software Requirements:**
    a. Jetbrains Pycharm for Python
    b. Anaconda for the Numpy, Pytorch libraries
    c. GNU Octave for Data Processing
    d. OpenCV for Image Processing
    e. Google Colab for GPU support
    f. Google Tensorflow
2. **Hardware Requirements:**
    a. A computer running the above software and having a powerful GPU for fast data processing
    b. HD Camera
    Pulse Oximeter to verify the data

4. Draft Time Plan

In the first semester we aim to do detailed research on our project. In the second semester, we plan to apply algorithms that we decide to use, analyze and get statistics about the results of our applications to see if we are successful in our research.

5. References

[1] Ufuk B. Alkan B. Effect of Hemoglobin Level on Heart Rate Estimation with Non-contact Photoplethysmography, Cilt.17, No.2, Page.47-53, 2015

[2] Ming-Zher P, McDuff DJ, Picard RW. Advancements in Noncontact, Multiparameter Physiological Measurements Using a Webcam, IEEE Trans. on Biomedical Engineering, Cilt. 58, No. 1, 2011, s.7-11.

[3] Kamal AAR vd. Skin Photoplethysmography-A Review, Computer Methods and Programs in Biomedicine, Cilt. 28, No. 4, 1989, s.257-269.
[4] Allen J. Photoplethysmography and Its Application in Clinical Physiological Measurement, Physiol Meas., Cilt. 28, No. 3, 2007, s.R1-39
[5] Eugene L. Evan C. Chen-Yi L. Meta-rPPG: Remote Heart Rate Estimation Using a Transductive Meta-Learner, Institute of Electronics, National Chiao Tung University, 2020
[6] Verkruysse W, Svaasand LO, Nelson JS. Remote plethysmographic imaging using ambient light. Optics Express, 2008, 16(26): 21434–21445
[7] Li X, Chen J, Zhao G, Pietikäinen M. Remote heart rate measurement from face videos under realistic situations. In: Proceedings of the 2014 IEEE Computer Society Conference on Computer Vision and Pattern Recognition. 2014, 4264–4271