



ERCIM "ALAIN BENSOUSSAN"
FELLOWSHIP PROGRAMME



Scientific Report

First name / Family name

Timur Lugev

Nationality

Russian

Name of the *Host Organisation*

Fraunhofer Institute for Integrated
Circuits IIS

First Name / family name
of the *Scientific Coordinator*

Dominik Seuß

Period of the fellowship

01/05/2018 to 30/04/2020

I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

My research activities were organized from 01.05.2018 to 30.04.2020 at Fraunhofer Institute for Integrated Circuits in the Intelligent Systems Group under the coordination of Dr. Jens-Uwe Garbas and Dominik Seuß.

During the fellowship, the research I conducted was related to multimodal physiological data analysis and remote heart-rate measurement using camera-based systems and deep learning.

Remotely measuring heart rate (HR) and heart rate variability (HRV) can provide substantial benefits for both the medical and the affective computing applications. There are different methodologies for the non-contact measurement of heart rate using human face video recordings. Most of the methods are based on subtle color changes of the face due to activity of the cardiovascular system. Such activity is invisible to human eyes but can be recognized using cameras. Approaches are often requiring face tracking, skin segmentation, color space transformation, signal decomposition and filtering.

However, existing solutions are still not enough computationally efficient and not very robust to motion and changing ambient lighting conditions.

Deep learning methods for estimating heart rate and heart rate variability from camera data was the main topic of the research programme. In particular, research programme covered following problems:

- 1) Research various deep learning models that can learn both appearance and motion representations of the physiological data from facial videos: CNN connected with LSTM and 3D CNNs.
- 2) Integration of the deep learning based methods for a face tracking, skin segmentation and heart rate variability estimation into the state of the art multi-stage pipeline that requires ROI selection, color space transformation, signal decomposition and filtering steps to be implemented.
- 3) Design of the end-to-end deep learning framework for recovering heart rate signals from facial videos. An end-to-end neural network for camera-based HR and HRV estimation is a model that reads motion information from video frames, distinguishes different motion sources and creates a target motion signal.
- 4) Testing and evaluation on the external and internal datasets of the video recordings with physiological data.

One of the main results of the research programme is a new framework, which uses deep spatiotemporal networks for contactless HR and HRV measurements from raw facial videos. It improves capture physiological motions under varied illumination and significant head movements. Proposed approach was evaluated on two multimodal databases that consists face videos with synchronized physiological signals. Experiments demonstrate the advantage of our deep learning based approach for HR and HRV estimation. We also achieved promising results for inclusion remote HR/HRV estimation in affective sensing applications.

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

Timur Luguev, Dominik Seuß, Jens-Uwe Garbas. Deep Learning based Affective Sensing with Remote Photoplethysmography // In 54th Annual Conference on Information Sciences and Systems (CISS), IEEE, 2020 (accepted).

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

54th Annual Conference on Information Sciences and Systems (CISS), Princeton, USA, 2020 (remotely).

IV – RESEARCH EXCHANGE PROGRAMME (REP)

Location: STARS team, INRIA, Sophia Antipolis, France.

Duration: 07-03-2019 to 14-03-2019

Contact: Dr. François Brémond

During my visit at INRIA I got acquainted with the research activities of the STARS team. The group coordinated by Dr. François Brémond has a comprehensive experience in the design of cognitive vision systems for activity recognition. In particular, STARS team has an excellent reputation in interpretation of dynamic scenes and spatio-temporal activities observed by video cameras and other sensors.

I presented them my work and my research interests related to multimodal physiological data analysis. We determined a common ground for potential research cooperation in the context of cognitive disorders diagnosis using facial expression and multimodal data analysis. I have also given a presentation of my work on remote heart rate measurements using computer vision techniques.

My visit at INRIA was very productive, and we agreed to keep in contact for scientific cooperation and applications to future project calls.