

COMPUTER AND CONTROL ENGINEERING

DM630/STMicroelectronics - AI Based non-invasive vital signs monitoring

Funded By	MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] STMICROELECTRONICS S.R.L. [P.iva/CF:00951900968]
Supervisor	OLMO GABRIELLA - gabriella.olmo@polito.it
Contact	
Context of the research activity	Vital signs monitoring is crucial to improve citizens' quality of life of, reduce cost of public healthcare, mitigate risks, better address treatment. In this context, little invasive signal detectors, or the possibility of remote monitoring, would enable usage in daily life environments. As a case study, remote monitoring of drivers' vital signs represents a situation where the reduction of invasiveness is crucial, and vital sign detection could decrease significantly risks associated to accidents. Progetto finanziato dal PNRR a valere sul DM 630/2024 - CUP E14D24002440004
	The activity will be performed in cooperation with STMicroelectronics S.r.l., Via Olivetti, 2 - 20864 Agrate Brianza (MB) The scope of the research is to study and develop a robust methodology to monitor a driver in vehicle by detecting continuously vital parameters such Heart Rate and SpO2. The invasiveness of the device must be reduced to the maximum possible extent, so as to not to affect the status of the driver him/herself. In principle, non-contact monitoring would be the preferred solution. To this end, devices like global shutter cameras will be explored with different illumination system in the IR domain in order not to blind the driver. Moreover, a robust methodology for signal processing, face detection, recognition of the points of acquisition and reduction of the noise introduced by vibration or human motion will be devised and experimented. Deep or machine learning methodologies will be evaluated to reduce motion artifacts, focusing both on performance and real time response with very short latency. In parallel of the main activity, a collection of ECGs will be performed to improve the automatic identification of cardiac anomalies. WORKPLAN: YEAR 1. Task 0. Revision of the state of the art related to in-vehicle vital signs remote

Objectives

monitoring.

Task 1. Collection of ECG data in hospital and RSA to set up algorithms for anomaly detection (contact ECG sensors).

Task 2: Implementation and testing of algorithms for heart rate (HR) anomaly detection and classification (contact ECG sensors).

Task 3. Development of a prototypal system for contactless PPG detection in vehicle.

ACTIVITIES: YEAR 2.

Task 4. ML and DL models to clean up the signal from electrical and background noise. Implementation and testing of algorithms for HR anomaly detection and classification (contactless).

Task 5. Collection of databases in vehicle to train the models.

Task 6. First results of the prototypal system in vehicle. ACTIVITIES: YEAR 3.

Task 7. Finalization of the data collection campaign in hospital, and related data analysis. Task 8. ML and DL models to reduce the noise due to the motion and vibration.

Task 9. Finalization of the algorithms and the preparation of demo in vehicle during normal usage

Task 9. Critical analysis of the results, proposal of integration of the algorithms with a robust trial on the field.

Task 10. Critical analysis of the results, proposal of integration of the algorithms with heterogeneous data present in the patient's clinical records.

N.B: Due to the complexity and novelty of this topic, the Task description is forcedly preliminary and may be subject to modifications depending on the obtained results.

We plan to have at least two journal papers published per year.

Target journals:

IEEE Transactions on Biomedical Engineering

IEEE Journal on Biomedical and Health Informatics

IEEE Access

IEEE Journal of Translational Engineering in Health and Medicine

MDPI Sensors

COOPERATIONS:

-CNR-IEIT

-Mauriziano Hospital, Cardiology Department

A cooperation is on going with Cooperativa Valdocco to perform measurements of cardiac activity of elderly persons, using wearable devices.

ON GOING PROJECTS ON RELATED TOPICS:

· PNRR Ecosistema NODES Nord-Ovest Digitale e Sostenibile

· PNRR Salute Complementare "Health Digital Driven Diagnostics, prognostics and therapeutics for sustainable Health care"

· PRIN-PNRR 2022 "Objective monitoring of axial symptoms in Parkinson's disease: quantitative assessment in daily life based on the use of wearables, video sensing and artificial intelligence (OMNIA-PARK)"

Skills and

Expertise in the fields of Signal Processing, Data Analysis, Statistics and Machine Learning (e.g. feature selection and ranking, supervised and unsupervised learning).- Basic knowledge of bio-signal data processing

**competencies
for the
development of
the activity**

(EEG, ECG, EMG, EOG). Basic knowledge in hardware and mechanical developing. - Good knowledge of C, Python, MATLAB, Simulink programming languages. Basic knowledge of orcad and Solidwork (or similar) - Good relational abilities and knowledge of the Italian language, to effectively manage interactions with patients during the evaluation trials.