

# COMPUTER AND CONTROL ENGINEERING

## MUR DM 117/STMicroelectronics - Measurements in optical spectrometry for the evaluation of vital parameters

<b>Funded By</b>	MINISTERO DELL'UNIVERSITA' E DELLA RICERCA [P.iva/CF:97429780584] STMICROELECTRONICS S.R.L. [P.iva/CF:00951900968] Politecnico di TORINO [P.iva/CF:00518460019]
<b>Supervisor</b>	OLMO GABRIELLA - gabriella.olmo@polito.it
<b>Contact</b>	Alessandro Gumiero, STMicroelectronics, Agrate Brianza Luigi Della Torre, STMicroelectronics, Agrate Brianza Stephane Piccolo, STMicroelectronics, Agrate Brianza
<b>Context of the research activity</b>	<p>The proposal is in the context of eHealth: use of innovative technologies for non-invasive vital sign monitoring of subjects affected by chronic diseases and/or elderly, frail people during their activities of daily living. The potential of wearable sensors operating in optical spectrometry will be analyzed as for the estimation of several parameters: heart rate /rate fluctuations; breathing rate; diastolic and systolic blood pressure; serum concentration of several substances (e.g., lactate, alcohol). The movement artifact removal will be addressed in order to afford dynamic measurements.</p> <p>Progetto finanziato nell'ambito del PNRR - DM 117/2023 - CUP E14D23002020004</p>
	<p>This research proposal regards the use of optical spectrometry to provide innovative estimation of vital signs and parameters, in view of the design of a health monitoring system able to operate in home environment.</p> <p>The first objective of this research is to study the application of optical multispectral sensors to achieve a reliable estimation of:</p> <ul style="list-style-type: none"><li>- heart rate and heart rate variability;</li><li>- breathing rate;</li><li>- diastolic and systolic blood pressure.</li></ul> <p>To this end, experimental instrumentation available at STMicroelectronics, Agrate Brianza, will be made available. The Ph.D. candidate will be involved in the experimental set-up and the data collection on healthy subjects. Artificial Intelligence (AI) algorithms will be identified, trained, validated and tested and on these data (along with proper libraries already present in STMicroelectronics), using usual ECG and sphygmomanometer data as</p>

## Objectives

ground truth.

The second objective of this research is to set up a reliable procedure to measure different substances and/or markers in the patient blood using a multispectral optical approach. Again, experimental instrumentation available at STMicroelectronics, Agrate Brianza, will be made available. The Ph.D. candidate will be involved in the experimental set-up and the data collection on healthy subjects. The optical absorption characteristics of the substances whose estimation is clinically relevant (lactate, glucose and alcohol, but possibly also others) will be matched to the spectral characteristics of the available instrumentation.

The measured data will be analyzed using advanced Artificial Intelligence algorithms in order to achieve a reliable estimation of their serum concentrations.

The last objective of this study is related to the use of proper wearable sensors developed in STMicroelectronics using MEMS technology, for the long-lasting extraction and computation of ECG/EEG bio-potentials. This could complete the setup of a eHealth platform monitoring vital signs and parameters.

The expected results are:

- design and evaluation of AI algorithm(s) for vital sign estimation in healthy subjects;
- identification of substances of clinical interest that can be reliably measured using multispectral cameras, and preliminary AI algorithms;
- Validation and testing of MEMS sensors for ECG/EEG measurements.

The main innovation relies in the use of multispectral optical cameras for the estimation of vital signs, and the integration with other wearable sensors to achieve a complete eHealth platform.

In this context, the candidate activity will address:

ACTIVITIES: YEAR 1.

Task 0: state of the art of hearth/breathing rate and blood pressure estimation using optical multispectral cameras. Attention will be paid to motion artifact removal in order to enable dynamic measurements.

Task 1: Preliminary design of AI algorithms for hearth/breathing rate and blood pressure estimation using optical multispectral cameras.

Task 2: Measurement campaign in healthy subjects (organized in STMicroelectronics Labs, Agrate Brianza).

Task 3: AI algorithms validation and testing.

Task 4: Preliminary analysis of the possible concentration estimation of some substances of interest (alcohol, lactate, glucose, others?).

YEAR 2.

Task 5: Measurement campaign (continued).

Task 6: AI algorithm implementation for the evaluation of substance concentration.

Task 7: Design of algorithms for bio-potential estimation using wearable MEMS sensors.

YEAR 3.

Task 8: Final refinement of the algorithm. Validation and testing.

Task 9: Possible experimentation on patients, to be defined and submitted to

the competent Ethics Committee,  
Task 10: Critical analysis of the results, proposal of integration of the different algorithms in a prototype eHealth platform.

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 early 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 Journal of Translational Engineering in Health and Medicine

MDPI Sensors

Frontiers in Neurology

Cooperations:

The Ph.D. position is co-funded by STMicroelectronics, Agrate Brianza, in the context of DM 117/2023. The Ph.D. candidate will spend a period of at least six months in the STM Labs, Agrate Brianza. Moreover, an agreement is being established for a period to be spent at Uppsala University to carry on joint research on these topics.

**Skills and  
competencies  
for the  
development of  
the activity**

Preferred skills:

- Expertise in the fields of Signal Processing, Image and Video Analysis, Statistics and Machine Learning.
- Basics in spectroscopy analysis.
- Basics in digital electronics.
- Good knowledge in data acquisition and managing.
- Good knowledge of C, Python, Matlab, Simulink programming languages.
- Good problem solving attitude relational and team work attitude.