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Supervisor Expression of Interest
MSCA - Marie Sklodowska Curie Action - (PF) Postdoctoral Fellowship 2024

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Department Name: Dipartimento di Elettronica, Informazione e Bioingegneria
Research topic:
Electronic and optoelectronic Measurements

MSCA-PF Research Area Panels:

- ☐ ECO_Economic Sciences
- ☒ ENG_Information Science and Engineering
- ☐ ENV_Environmental and Geosciences
- ☐ LIF_Life Sciences
- ☐ MAT_Mathematics
- ☐ PHY_Physics
- ☐ SOC_Social Sciences and Humanities
- ☐ CHE_Chemistry

Brief description of the Department and Research Group (including URL if applicable):

The Dipartimento di Elettronica, Informazione e Bioingegneria (DEIB) is one of the largest European ICT departments. With nearly 1000 members, the Department is a vital institution capable of promoting education, fundamental and applied research, and technology transfer to companies. Research is the main focus of DEIB, pursued according to the highest international quality standards. The six department sections bring together consolidated competences in systems and control, computer science and engineering, electronics, telecommunications, bioengineering and electrical engineering. The DEIB participated in **131 H2020 projects**, for a total value of about € 43M, 20 of which as Coordinator, and participates in **about 18 Horizon Europe projects**, for a total value of almost € **11M**, 4 of which as Coordinator.

The Research Group involved in this project is **Optical measurements and laser instrumentation,** located in the Measurements of OpticaL and Electronic Systems laboratory (MOLES). Researchers in the lab develop new methods and tools dealing with electromagnetic fields, from electrical to optical frequencies. The main research activities are about optical interferometry, prototypes of optical and electronic sensors for industrial applications, optical measurements and electro-optical sensors..

https://www.deib.polimi.it/eng/deib-labs/details/5
https://www.deib.polimi.it/eng/research-lines/details/102

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TITLE of the project: Novel laser vibrometer for vital parameter detection, aimed to implement a Hidden Optical Lie Detector (HOLD)

Brief project description:

The HOLD project is about the development of practical laser interferometer and vibrometer sensors for the detection of vital signals from human beings, that are measured by directly aiming the laser beam onto the skin of the subject.

The main application is aimed at a real-time truth/lie detector, that is capable of detecting deception and hostile intent of a subject, for application to homeland security, flight passenger screening and police interviews. There is a growing worldwide interest in developing automatic technologies for this scope, to relieve and neutralize the individual and subjective assessment of human operators. The working principle is based on the fact that the heart rate and the shape of the pressure wave in the carotid artery are strongly correlated with the status of the subject (relaxation and tranquility, or stress and deception).

The proposed technical method for the measurement of the skin vibration is a self-mixing laser interferometer, that is a smart interferometric configuration simply based on a semiconductor laser and a focusing optics, where the reference arm typically present in standard interferometric configuration is missing.

This technique has been pioneered by the involved Professors, and it has been demonstrated to be very versatile and to have potential for realization of practical instruments and sensors having a low cost.

During the project, suitable solutions for the optical configuration and electronic signal processing will be developed, with the goal of obtaining a high rate of successful detection of vital parameters, derived from the vibration measurement performed on the skin of subjects/patients.

The main goal of the project is to accomplish a solid step forward in the self-mixing technology, and in particular in adapting it to automatic detection of the heart beat vibrations, while operating from a remote distance (2m) and with suitable algorithms that allow to continuously retrieve the signal in practical real-life conditions.

Technical fallouts of the HOLD project include a comprehensive category of vital sign parameters that can be measured directly on the human skin, including:

i) the carotid pulse shape;

ii) the arterial pulse wave velocity;

iii) mechanical and dynamic properties of the respiratory system;

iv) the long-desired remote blood pressure estimation.

All the above parameters are highly important in remote and contactless health monitoring, and could open new applications with large positive impact on the communities.