# ELECTRICAL, ELECTRONICS AND COMMUNICATIONS ENGINEERING

## DET - Design of Mid-Infrared Silicon Photonics biosensor using AI-based single pixel imaging

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| **Funded By** | Dipartimento DET |
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| **Context of the research activity** | The PhD student will work in the framework of the Italian National project MIRABILIS (MId infRAred laBel free Interferometric detectorLess Imaging in photonic circuitS) which aims to design, simulate, and experimentally demonstrate a Mid-Infrared (MIR) single-pixel sensor enabling tissue imaging in reflection mode. |
| **Objectives** | The sensor to develop will implement an optical-feedback-based imaging system where a Quantum Cascade Laser (QCL) works both as radiation source and detector. It will use scanless single-pixel compressed sensing by illuminating the target tissue via a sequence of randomly distributed QCL light patterns, generated by an Optical Phase Array (OPA). The feature of the target to be imaged is recovered by analyzing the light intensity collected by a bucket detector represented by the QCL via optimized compressed sensing algorithms.<br><br>The main PhD activity will focus on applications of Artificial Intelligence for the control of the OPA and the image reconstruction.<br>Due to the complexity of the OPA layout, it is generally difficult to deterministically predict the electrical control signal that need to be applied to the thermal controls of the various OPA branches to project on the target the desired far field profiles. A careful modeling of the real OPA will be required to accurately reproduce the behavior of the real device. This propaedeutic modelling activity will be carried out using well established numerical simulation techniques using commercial software. Then, a Deep Learning approach will be conceived and implemented to allow for a precise tuning the radiation pattern generated by the OPA, to generate the random distribution of light required for single pixel imaging.<br><br>For the reconstruction of the image from single pixel acquisitions of the target, the PhD candidate will start analyzing and implementing the most promising analytical methods proposed in the last years and based on CS deterministic |

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| | algorithms. Moreover, a machine learning based approach will be investigated and compared against the traditional solutions. We expect the artificial intelligence-based methodology to provide significant improvements in terms of versatility, accuracy, and speed.<br>The project will be carried on under the scientific supervision of Prof. Paolo Bardella and Prof. Lorenzo Columbo at the Department of Electronics and Telecommunications (DET) of the Politecnico di Torino. |

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| **Skills and competencies for the development of the activity** | • Basic knowledge of modern optics and optoelectronics.<br>• Knowledge of machine learning techniques.<br>• Experience in numerical calculus using Matlab.<br>• Good level of English, spoken and written.<br>• Good attitude towards team-work. |