

## ANR Project

### Photonic Integrated Circuit with System on Chip for Sub-Picometric Displacement Sensor.

Acronym : PICSONDE

### Post-Doctoral position in embedded Signal Processing (Man-Woman)

The PICSONDE project, carried out by the partnership within the Laboratory for Analysis and Architecture of Systems (LAAS), Toulouse and ESEO proposes an innovative cost-efficient real-time embedded optical system-on-chip (SoC) vibrometers based on optical feedback interferometry (OFI), for in-situ measurements.

In this framework, we seek to appoint a post-doctoral researcher with experience in Real-Time signal processing for embedded systems to integrate the Group Signal, Image, Instrumentation ([www.gsii.fr](http://www.gsii.fr)) at ESEO school of engineering in Angers – France.

#### Context

The major challenge of predictive maintenance is to provide correct estimations of the material/structure degradation state of an equipment. Many studies conducted in this context aim to offer low-cost non-invasive techniques to prevent or reduce critical failures by proposing a schedule for parts replacements, thereby achieving cost savings. These techniques mostly involve optical observations, as well as vibrations, sound and electrical analysis. PICSONDE particularly focuses on vibration testing, also known as Experimental Modal Analysis, which is widely used to monitor and investigate the response of the equipment structure during operation, and represents roughly 70 to 80% of the current market of predictive maintenance equipment. Sensors typically used to capture vibration information include piezoelectric and MEMS-based accelerometers that can achieve a few tens  $\mu\text{g}/\text{VHz}$  noise levels at low cost. However, though accelerometers are inherently capable of relatively large bandwidth (up to a few kHz), they are not strictly non-intrusive especially for small machines where their own mass may impact the vibration behaviour. Contactless techniques, like interferometry, present drastic competitive advantages to monitor small machines and probe critical measurement points in harsh environment, such as high temperatures, or in hard-to-reach locations. Furthermore, measuring displacements, instead of accelerations, leads to much higher precision in the very low frequency domain that is of particular interest for low-speed machines like wind turbines.

#### Description of the position

This post-doctoral position will mainly be focused on implementing algorithm to process Optical Feedback Interferometry (OFI) signals in order to retrieve the target displacement with high resolution, high precision and wide bandwidth. The targeted noise power spectrum density is 0.1  $\text{pm}/\text{VHz}$  for a bandwidth greater than 20 kHz.

The main tasks of this post-doctoral position (not limited to):

- Robust detection of OFI fringes in the presence of speckle
- Optical feedback factor C tracking and estimation in the presence of speckle
- OFI phase unwrapping based on non-uniform sampling (NUS) techniques and/or machine learning techniques
- Efficient interpolation method (for NUS)
- Embedded signal processing on an FPGA for real-time processing

#### Candidate profile

PhD in engineering or relevant fields.

Relevant experience in Real Time signal processing

Good knowledge of MATLAB/Simulink, VHDL and C/C++ for embedded systems.

Additional desired experience but not strictly required:

- Working with Xilinx Vitis (Vivado/Model Composer and System Generator) platform.
- Working with real-time or post-processing of OFI data (especially at time domain) related to vibrometry (exploiting target's displacement and/or speed).
- Implementation or portability of algorithms into a SoC programmable device (Xilinx Zynq-7000 MPSoC)

Fluent in English (oral and written), knowledge of French is appreciated.

Excellent interpersonal skills, ability to work independently, good organization skills.

### About the Signal Image and Instrumentation research group (GSII)

Within the ESEO, the Signal, Image and Instrumentation team (GSII) is a research group active at international level in the fields of electronics, signal and image processing, instrumentation, and embedded systems with main focus on Biomedical, Geophysics and Non Destructive Testing (NDT) applications. Other fields on interests involve Data Mining and Machine Learning, with recent extensions to Artificial Intelligence.

### Keywords

Embedded digital signal processing, FPGA, System-on-a-Chip, (SoC), optical sensing.

### Location

ESEO school of engineering, Angers with possible short missions at LAAS, Toulouse.

### Duration

24 months, starting within the year 2021

### Salary

Gross annual salary is approximatively : 35000 €

### To apply for this position

Please send your CV, motivation letter and at least two recommendation letters at [service.rh@eseo.fr](mailto:service.rh@eseo.fr)

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