



## **MASTER IN PHOTONICS – “PHOTONICS BCN” ERASMUS+ “EUROPHOTONICS”**

### **MASTER THESIS PROPOSAL**

**Dates: April - September 2019**

**Laboratory : Optical Communications Laboratory - CommSensLab  
Institution: Department of Signal Theory and Communications – Universitat Politècnica de Catalunya  
City, Country : Barcelona, Spain**

**Title of the master thesis: Laser-speckle-based sensor for very accurate measurement of transverse and longitudinal displacements**

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**Keywords : speckle, laser, correlation, image processing, Raspberry Pi**

#### **Summary of the subject (maximum 1 page) :**

The aim of the work is to extend the capabilities of an already existing prototype sensor, developed in the framework of an academic partnership with HP Printing and Computing Solutions at Sant Cugat del Vallès, Spain, the worldwide research and development center for large-format printers of HP.

The prototype uses a low-cost laser diode emitting 5 mW at a wavelength around 650 nm, a Raspberry Pi camera and a Raspberry Pi microprocessor running an application written in Python, off-the shelf lenses and a diaphragm to measure transverse (i.e. in a plane at fixed distance from the sensor) displacements of many types of substrate with accuracies better than 150  $\mu\text{m}$  over a total displacement of 50  $\mu\text{m}$ .

The light scattered by the substrate illuminated by the laser falling within the field of view of the optical system is captured by the Raspberry Pi camera under the control of the Raspberry

Pi microprocessor. The captured images contain speckle due to the spatially coherent illumination. As the speckle field moves with the substrate, the displacement can be obtained correlating portions of the speckle fields in successively captured images.

The goals of the thesis work are:

1. To add the capability of measuring longitudinal displacements (i.e. in a direction from and to the sensor) based on an existing theoretical framework.
2. To characterize the accuracy of the measurement in this direction.
3. To study the possibility to improve the accuracy of the displacement measurement in the transverse direction by improving the speckle-correlation algorithm.

**Additional information :**

\* Required skills : Python and Matlab languages

\* Miscellaneous : engineering-minded disposition to combine knowledge in optics, electronics, signal processing and microprocessor for a practical result. Being an expert in these fields is **obviously not required**, but the candidates should be eager to learn new concepts when required.