ST5 – 61 – SMART PHOTONICS SYSTEMS FOR CONTROL AND MEASURE

Dominante : PNT (Physics and NanoTechnology), SCOC (Communicating Systems and Connected Objects)
Langue d'enseignement : English
Campus où le cours est proposé : Metz

Engineering problem

Systems using photonics - science and technology exploiting light - allow to measure, regulate and control physical quantities. These properties of photonic systems are widely used in the regulation of a laser for production systems, in the control of the deflection of a beam to visualize an object or observe the dynamics of biological cells, or in the stabilization of ultra-short pulses in telecommunications. In addition, photonic systems are intelligent systems whose measurements are used to facilitate regulation, for example with the development of telemetry and laser velocimetry - techniques widely used in industrial production and in our vehicles, and essential for the industry of the future and the autonomous vehicle.

Very recently, photonic systems have undergone a revolution in their principle and their use with the development of systems that exploit light at the nanometer and attosecond scales. These innovative systems by their new physics pose important challenges for both the measurement of their physical properties - given the very short spatial and temporal scales - and the exploitation of this measurement for the development of sensors and innovative control systems, given the limitations of our signal processing systems. By studying photonic systems, this thematic sequence will also be an opportunity to learn and master the general notions of analysis, identification and control of non-linear physical systems.

Adviced prerequisites

Basic knowledge of electromagnetism, materials, general electricity and electronics

Context and issue modules: This part is structured in conferences, round table and visit of the GDI SIMULATION site - Elancourt, in particular around the theme of "laser remote sensing".

Specific course (60 HEE) : *Photonics for the control of physical systems*

Brief description: This course will teach the essential concepts of measurement and exploitation of physical quantities of optical

electromagnetic waves, in the context of the exploitation of photonics for the observation and control of physical systems. Thus this course will assemble knowledge of:
- Optical measurement and instrumentation: general metrology and error analysis, photometry, and optical detectors, holographic metrology, velocimetry, interferometry.
- Laser source technologies: solid state physics, materials and semiconductors.
- Modeling and control of sources: analysis and non-linear dynamics of laser sources.
- Optical signal generation: techniques for spatial and temporal modulation of optical signals; engineering and design of optical beams.

The concepts covered in the course are :
- Optical metrology
- Photonic technologies including semiconductor materials and optical fibers, phase and intensity modulation
- Signal analysis using the non-linear dynamics of a physical system
- Properties and control of non-linear systems

Challenge Week : *Laser remote sensing (LIDAR) for optronic surveillance and target detection*

Associated partner: GDI SIMULATION - Elancourt

- Location: Metz campus

- Brief description : This EI is based on the use of lasers as tools to control the infinitely small and the ultra fast for, in particular, applications in the field of optronic surveillance and target detection. It is proposed to develop a photonic system whose target application is laser ranging (LIDAR). These lidars have a huge potential for defense, environment, security: identification of mobiles, gas detection, active imaging ... The detection and identification of danger or targets is a key element of defense and security devices, and are key elements for example of the devices developed by GDI SIMULATION for civil aviation or the simulation of laser fire for the training of armed forces. The students will perform the experimental realization of the LIDAR using ARDUINO plat-forms. They will have: i/ to understand the essential physical quantities related to an optical electromagnetic wave ii/ design and realize a servo-driven photonic system iii/ engineer and control innovative optical beams by exploiting spatial and temporal signal modulation techniques v/ make a choice of devices to answer an economic problem of sizing and energy consumption.

Recent advances in the realization of innovative optical beams will also allow the exploration of new beam topologies (e.g. Airy beams: non-diffracting, curvilinear trajectory, self-regenerating in case of obstacles) which open the way to improved performances (spatial resolution, speed, etc.).