2SC6190 – Laser remote sensing (LIDAR) for optronic surveillance and target detection

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Department: DOMINANTE - PHYSIQUE ET NANOTECHNOLOGIES
Language of instruction: ANGLAIS
Campus: CAMPUS DE METZ
Workload (HEE): 40
On-site hours (HPE): 27,00

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 an innovative control-command solution for the generation of ultrashort laser pulses and the implementation of a photonic system whose intended application is laser telemetry (LIDAR: laser radar). These "lidars" have enormous potential for defense, the environment, security: mobile identification, gas detection, active imaging, ... The detection and identification of danger or targets is a key element of the defense and security systems , and are key elements for example devices developed by GDI Simulation for civil aviation or simulation of laser shooting for the training of the armed forces.

Quarter number
ST5

Prerequisites (in terms of CS courses)
None

Syllabus
The students will be divided into different groups each performing 4 practical works.
Practical Work Proposal:

1 / a session on the emitting laser: realization and characterization of a laser transmitter regulated in temperature so as to maintain its constant power
2 / a session on the generation of a laser pulse: study of the generation of a laser pulse via the use of an optical feedback loop
3 / a session on the shaping of the laser beam: shaping of the laser beam via the appropriate optics and / or via the use of a spatial light modulator (SLM) allowing ultimately the use of beams not Conventional (ex bundles of Airy)
4 / a session on the receiver: development of the device for receiving and analyzing the optical signal

These 4 sessions will be followed by a session on the synthesis of the different experiments for the realization of a telemetry device and possibly the development of the servo system necessary for the laser signal to reach the target.

Class components (lecture, labs, etc.)
Experimental and digital realization in team in the form of a challenge

Grading
Oral presentation in front of CS professors and industrial partner GDI Simulation

Resources
optical set-ups
Pedagogical Team : Delphine Wolfersberger - Nicolas Marsal

Learning outcomes covered on the course

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

iv/ 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.).

Description of the skills acquired at the end of the course

C4 Have a sense of value creation for his company and his customers
C6 Be operational, responsible, and innovative in the digital world
C7 Know how to convince

ST5 – 62 – ENERGY INTELLIGENCE AND SMART BUILDING

Dominante : GSI (Large Interacting Systems) and SCOC (Communicating Systems and Connected Objects)
Langue d'enseignement : French with specific modalities to allow the adaptation of students with a low level in French: all the materials are in English, the tutorials, the practical work as well as the integration teaching are provided in English. Support sessions in English are also scheduled.
Campus où le cours est proposé : Rennes

Engineering problem

Buildings must no longer be considered as simple consumers, but as true energy players, fully integrated into their ecosystems, and must be fully integrated into a renewed vision of society, where comfort and health are in harmony with energy management. To do this, we need to rethink the systems that make up the building, through new control functions and stronger interactions with the occupants. The "building" ecosystem is complex, because it is made up of a heterogeneous set of systems: local production, storage, supply, sale, and the various equipment, which must be coordinated for optimized management.

The engineer's challenges are first to analyze the needs and to specify the intelligent control systems. This design is based on the integration of control algorithms deployed on communicating systems to achieve an optimal compromise between technology - cost - efficiency, such as closed-loop performance, communication frequency and protocol, sensor autonomy and actuator lifetime.

Adviced prerequisites

None

Context and issue modules : This part is organized around several conferences that should give students the keys to understanding the major issues associated with this thematic sequence. Starting with the industrial issues: what are the needs of today and tomorrow, in terms of services and technologies: challenges and scientific obstacles. Then presentation of the difficulties encountered for the capture of heterogeneous data from which we can perform analyses and exploit these data.

Knowledge contributions will be given to understand the needs and the heterogeneity to be taken into account for the management of comforts (air

quality, thermal comfort, ...). Finally, a last intervention will present the "Research" point of view around intelligent buildings.

Specific course (60 HEE) : Students will be required to choose from one of the following two specific courses:

Option 1: *Energy-efficient communications*

Brief description: With a global electricity consumption of 6 to 10% corresponding to 4% of greenhouse gas emissions, ICST (Information and Communication Sciences and Technologies) must rethink the way they transmit, process and store data. The arrival of 5G (5th Generation mobile) and the explosion of connected objects (Internet of Things) suggest that the sector will continue to grow strongly in the coming years, making it all the more urgent to offer more environmentally friendly communications. The need for spectral efficiency (transmitting a given data rate in a given bandwidth) must then be combined with a strong energy efficiency constraint (transmitting while consuming as little as possible). This course provides training in digital communication concepts and tools for which energy efficiency is explicitly taken into account.

Option 2: *System architecture and modeling*

Brief description: Today's systems are increasingly complex. This complexity comes from the complexity of their structure and the interactions between the different components, the increase and the complexity of the exchanged data, the heterogeneity of concepts, substances, trades, standards, but also the human complexity (organization, ergonomics, psychology, sociology...). In order to better control this complexity, it is often necessary to rely on a modeling of the different artifacts of the system. This modeling allows, at different phases of the system's life, to better understand the needs it must meet, to structure its architecture, to make analyses in order to predict its behavior and thus to make a justified choice between several solutions. The different models constitute a common reference for the different parties involved in the design of the system. The objective of this course is to train students to model and structure a system architecture. Technological systems will be privileged with domains such as avionics, railways, industry, health, energy etc. Emphasis will also be placed on the ability to identify the characteristic performance attributes essential in the design, implementation, operation and management of complex systems.

Challenge Week 1: *Hierarchical management of thermal comfort*

Associated partner: Delta Dore (to be confirmed)

- Location: Rennes campus

- Brief description : The objective is to define a modular system, allowing the implementation of hierarchical control strategies between a local regulation of comfort per zone and a supervisor managing the intermittence of the occupation, the limitation of available power in order to minimize the consumption related to thermal comfort. The challenges induced by this project are the consideration of societal issues (human, comfort and energy efficiency), technical constraints (power limitation, ease of implementation and robustness of the solution) and the technologies allowing the implementation. The different groups will have to collaborate to address the different aspects of the project and to achieve a proof of concept.

Challenge Week 2: *Remote control of thermal comfort*

Associated partner: Delta Dore (to be confirmed)

- Location: Rennes campus

- Brief description : In the context of thermal renovation, remote control solutions are often much more straightforward to deploy than solutions that require running new cables through the walls. The objective of this integration course is to realize the whole remote control system for the heating of several rooms. This realization requires the actual implementation of the communication system between the controller and the heating devices. Groups will compete to find the most relevant technological solution while integrating economic and ecological dimensions.