Innovation projects 5A EIS – PX505 – 2025-2026

Responsible: Ionela PRODAN

September 2025

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Part I
Organizational details of PX505

0.1 Attributes of the Innovation Project

PX505 is a multidisciplinary project[1] addressed to the 5th year students of ESISAR of the EIS (Electronique, Informatique et Systèmes) specialization, the apprentice students and the Master IMESS attendees.

The main goal is to create a real or virtual prototype ("demonstrator") combining several disciplines taught at ESISAR (minimum two).

What is innovation?

> Innovation is using novel ideas and approaches to solve existing problems, it also means being creative.

The students are asked for innovation, not invention:

- An invention is something entirely new that has never been done or seen before.
- Innovation is a change or modification to improve something that already exists.

For example, Thomas Edison is credited for the invention of the light bulb in 1879, however, generations of light bulb innovations have created the millions of different and improved light bulbs in use today.

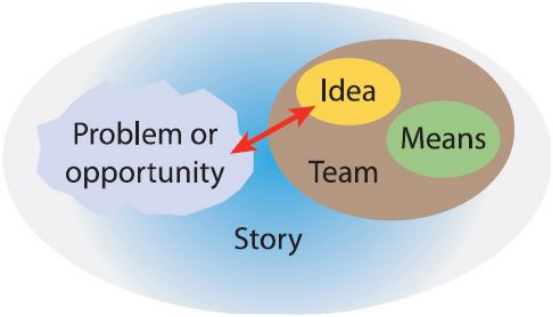
Hence, the students are not asked for something entirely new, but improvement or expansion of something that is already in use. That is:

- use of a new technology (e.g., Artificial Neural Network, ROS - Robotic Operation System) for an existing usage (motion recognition, motion planning, etc.);
- creation of a new usage (e.g., automatic plants watering, smart building monitoring, etc.) using existing technologies (automate the process).

What are the attributes of the innovation project?

We underline that *"good projects start with an idea that is rooted in a problem or opportunity"*.

- The first step for the students is to find a good problem which is to be addressed by a clear idea (i.e., choose a proposed subject or provide their own).
- The team develops the idea to act on the problem.
- The team has access to the means necessary to implement the idea for solving the problem: i) team skills and motivation; ii) tools and instrumentation; iii) funding provided by ESISAR to each team (i.e, 300 euros for all projects and 600 euros only for the digital arts projects).
- The story is a way for the team to develop and talk about their ideas among the members and to be able to explain them to other people who understand or not technology.



How the innovation project is organized?

Team composition: Depending on the year and the total number of students, the responsible of PX505 will create teams of 4 students, mixing apprentice, IMESS and EIS students of ESISAR, with different background.

Project selection: Each student chooses and orders at least 6 subjects (see the list of subjects hereinafter). The link for selecting the projects will be provided at the end of august 2020.

If several students/teams select the same subjects then a random draw will be performed. The students are encouraged to respect the final composition of the team. No modifications will be done once the project will start.

Project evaluation: The teams have to provide 3 deliverables: a mid-report (20%), a final report (40%) and a public oral defense (40%). Even if the project outcome will be evaluated for the entire team, individual marks for each student are also possible.

[1]This work benefits from the French government IRT Nanoelec program, ANR-10-AIRT-05.

Digital Arts Specific Support: These types of projects benefit from workshops with artists and brainstorming, exhibition and/or show visits. The students involved in such projects will have specific technical support and funding. The responsible for this type of project is Yann.Kieffer@esisar.grenoble-inp.fr.

0.2 Responsible Innovation

Responsible innovation considers the role that new products, processes or business models have in society. This means a responsible approach towards innovation involves creating change that has positive impacts on society and the environment.

It is worth noting that innovation processes, systems and investments should preferably be focused on addressing societal challenges and our urgent global problems, in climate, health, planning, energy, water and quality of life [2].

Hence, it is of the essence that the students acquire an adequate and shared conception of responsibility for their innovations and new technologies:

- Are their innovations saving lives?
- Are they producing jobs equitably?
- Are they helping to save the planet from heating up?
- Are they safe and secure?
- Do they also respect our privacy?
- Do they respect the freedom and autonomy of people?
- If not, how can we make them so?

Note that, addressing the societal challenges of each project will represent an evaluation criteria for the reports and projects defenses.

0.3 Students' role

To achieve the goals of the project, the team must understand and implement the idea. The students are encouraged to be autonomous, motivated and very well organized all along the duration of the project. These are the key elements for obtaining very good results.

The students need to take advantage of the 2 free half-days per week in the timetable to meet and work on their project.

For the final defense, when explaining how the project is innovative, it is important to also consider why the innovative solution is better than the more traditional method(s). Possible reasons include:

- saves time;
- is more cost-effective or efficient;
- increases reach and potential beneficiaries;
- reaches new beneficiaries that would not have been reached otherwise;
- targets a completely new area (very rare).

Finally, any trouble appearing throughout the project must be brought to the attention of the supervisor(s) and/or the PX505 responsible.

0.4 Supervisor(s)' role

As mentioned above, the students are encouraged to work autonomously and put their ides into practice. Of course, discussing the ideas with the team's supervisor(s) will speed up the progress of the project and offer a global view of the expected results. Hence, the supervisor(s) is(are) expected to:

- monitor(s) the progress of the project;

[2] Jakobsen, Stig-Erik and Fløysand, Arnt and Overton, John: *"Expanding the field of Responsible Research and Innovation (RRI)–from responsible research to responsible innovation"*, Taylor & Francis, 2019.

- proofread(s) and evaluate(s) the reports;
- participation in, and evaluation of the defense;
- validate(s) the instrumentation purchases;
- check(s) on the coordination of the group and the active participation of each of the members (a weekly discussion with the students is encouraged);
- co-evaluate(s) of the final oral presentation.

0.5 Reports and presentation templates

All the reports and presentations must be written and defended in English.

The intermediate report (representing 20% of the final grade) must contain (8 pages maximum):

- the project idea (≈ 1 page)
- a detailed project development plan (≈ 2 pages);
- a project schedule or Gantt diagram (1 page);
- a distribution of individual tasks (1 page);
- milestones and risk analysis ("plan B") (≈ 2 pages);
- insights on the societal challenges of their innovation;
- a complete purchase list (validated by the supervisor(s)).

The final report (representing 40% of the final grade) must contain (15 pages maximum without Annex):

- Abstract (10 lines maximum)
- Introduction (≈ 1 page)
- Related work (≈ 2 pages)
- Demonstrator architecture (≈ 3 pages)
- Validation environment and results (≈ 7 pages)
- Societal challenges of their innovation (≈ 1 page)
- Conclusions (≈ 1 page)
- Annex: project organization, specific schematics, photos, code or proofs (no page limitation)

The defense presentation timetable contains (20 minutes maximum):

- 15 minutes for presenting the topic, the approach, the results and the societal challenges of the product/system;
- 5 minutes for demonstration;
- 10 minutes for questions and answers.

The final presentation must clearly show the contribution of each participant in the project: each project member must present some of the slides with a uniform distribution (as the industrial project defense in the 4th year). The final grade is individual.

0.6 Deadlines

Hereinafter, are delineated the innovation project deadlines. The links for selecting the projects and uploading the mid and final reports on Chamilo will be provided along the Semester.

- **Project selection: 15 Sept - 19 Sept 2025**

  The students must connect to the following link and select all the projects in order of their preferences:

  https://docs.google.com/forms/d/1hkfw3oAw9OVxY79p-VG_vdJ0H52iZdbbN2ESnN6HLvo/edit

- **Project assignment and the selected teams: 23 September 2025**
- **Starting of the project: 23 September 2025**
- **Mid-report submission: 4 November 2025**

  The students must upload the report on Chamilo:

  ESISAR PX504 Innovation Project 5A EIS/Travaux d'étudiants/MidReport PX505 (2025/2026)

- **Final report and presentation submission: 16 January 2026**

  The students must upload the report and final presentation on Chamilo:

  ESISAR PX504 Innovation Project 5A EIS/Travaux d'étudiants/FinalReport&Slides PX505 (2025/2026)

- **Project defense: 23 January 2026**
- **Video preparation of the selected projects: until end of January 2025**

Note that each team will have at their disposal a room in building C of Esisar to properly develop their work. Some important details on the rooms are the following:

- the rooms are provided in very good conditions so we required that they are maintain as they are during the whole duration of the project;
- they keys of the rooms will be given by Stéphanie Ruard in Oct. They should be returned on 6 January 2026 to Stéphanie Ruard <stephanie.ruard@esisar.grenoble-inp.fr> (office C).

Part II
External proposals

1 AI-Loc: AI for UHF RFID Localization

Contact details	**christophe.loussert@acceliot.com**
Project keywords	**Artificial Intelligence, Machine Learning, RF communication**
Skills	**Data science, Embedded programming and Experimentation**

1.1 Project context and goals

RFID Technology is a mature technology that is use in many applications like logistic or stores. In this project, we want to address a well known problem that is still unsolved: the localization of UHF RFID tags detected by the reader.

Figure 1: Use case of the project : localization of different articles in a store.

Classical state of the Art using existing overhead RFID systems have a high detection rate ($> 99\%$), in a 7 m diameter zone but a poor position accuracy:

- ± 1 m for 80% of the tags
- ± 2 m for 15% of the tags
- ± 3 m for 5% of the tags

Based on this knowledge, the goals of the project is to:

1. Improve position accuracy down to ± 0.5m
2. Reduce the outliers down to 1%

1.2 Project deliverables

1. Measure the different radiation patterns of the RFID system (ideally in an anechoic chamber)
2. RFID test campaign in a large size room to collect data
3. DSAI (DataScience and Artificial Intelligence) to:
   - structure the raw data (time series)
   - try several classifiers from statistical to Neural Network delivering for each EPC its position (x,y,z) or its zoning

References

[1] *2023-2024 PX505 on RFID dock door.*

2 Phase-Loc: Phase for UHF RFID Localization

Contact details	**christophe.loussert@acceliot.com**
Project keywords	**Artificial Intelligence, Machine Learning, RF communication**
Skills	**Data science, Embedded programming and Experimentation**

2.1 Project context and goals

RFID Technology is a mature technology that is use in many applications like logistic or stores. In this project, we want to address a well known problem that is still unsolved: the localization of UHF RFID tags detected by the reader.

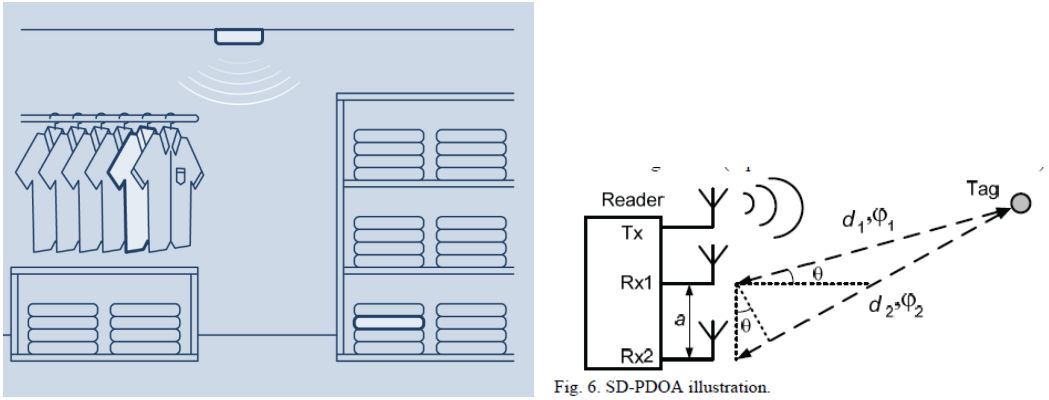


Figure 2: Use case of the project : localization of different articles in a store.

Phase in RFID has been documented by the academic world. However it has never been experimented because it needs a specific reader (dual simultaneous receivers). RFID reader from Acceliot has this capability.

The objective of this project is to exploit the Acceliot reader to extract phase variation between the signal receive by the 2 receivers. Using dedicated post-processing algorithms, direction of the interrogated UHF RFID tag can be estimated.

2.2 Project deliverables

1. Python/pandas script to calculate the RFID phase
2. RFID test campaign in an anechoic chamber and in open space
3. DSAI (DataScience and Artificial Intelligence) to:
   - structure the raw data (time series)
   - try several classifiers from statistical to Neural Network delivering for each EPC its position (x,y,z) or its zoning

If good performance can be obtained using this technique, scientific paper can be written and submitted to IEEE conference.

References

[1] *2023-2024 PX505 on RFID dock door.*

[2] P. V. Nikitin, R. Martinez, S. Ramamurthy, H. Leland, G. Spiess, and K. V. S. Rao. "Phase based spatial identification of UHF RFID tags". *2010 IEEE International Conference on RFID (IEEE RFID 2010)*. 2010, pp. 102–109.

3 LandG: Stratospheric Gondola Stabilisation System

Contact details	**sebastien.jean@univ-grenoble-alpes.fr, didier.donsez@imag.fr**
Project keywords	**Flight control, embedded system programming, mechanical design**
Skills	**C/C++ or Python embedded programming, mechanics, control command**

3.1 Project context and goals

Some CSUG (http://www.csug.fr) experiments are performed in near space during stratospheric balloons flights. Such experiments are placed inside a gondola (30x30x30cm / 3kg) lifted up by an Helium-inflated balloon (up to 30km high) and slowed down by a parachute.

Because the gondola is linked to the parachute using a single string, it rotates during the flight. Some experiments however require that the gondola points to a given direction.

The scientific objective of the project is to design a gondola stabilisation system, able to control the orientation of the gondola (with a fixed target or varying during the flight). This implies both mechanical and control command considerations `https://leblob.fr/videos/thingsat-un-acces-espace-democratise`.

Figure 3: Stratospheric ballon (before burst).

3.2 Project deliverables

The tasks and deliverables of the project are:

- Report stating/analysing relevant approaches wrt stabilisation system mechanical and control command considerations.
- Prototype of the solution (mechanics, embedded system design and source code, ...) that will be tested during a stratospheric flight in summer 2026.

All along the project, supervision will be also realized by Didier DONSEZ, Full Professor Polytech Grenoble / LIG, CSUG.

References

[1] J. Ashenberg. "Conceptual Study of Gondola Stabilization in a Balloon System". *Journal of aircraft* 45.2 (2008), pp. 486–492.

4 LandGM: Shared Gondola Manager

Contact details	**sebastien.jean@univ-grenoble-alpes.fr, didier.donsez@imag.fr**
Project keywords	**Flight control, embedded system programming, mechanical design**
Skills	**C/C++ or Python embedded programming, mechanics, control command**

4.1 Project context and goals

Some CSUG (http://www.csug.fr) experiments are performed in near space during stratospheric balloons flights. Such experiments are placed inside a gondola (30x30x30cm / 3kg) lifted up by an Helium-inflated balloon (up to 30km high) and slowed down by a parachute. These flights are operated by CNES from Aire-Sur-l'Adour station for various universities space centers (CSU). In the last few years, each CSU was building its own gondola (fulfilling a set of CNES safety rules) and was planning its flight. CNES is now thinking about operating a joint flight with mutualized gondolas.

The scientific objective of the project is to define a shared gondola system, allowing to handle several payloads (experiments). Such system must be able to:

- deliver power supply (various common voltage) and position
- multiplex air-to-ground communications and monitoring/configuring payload

Figure 4: Stratospheric ballon (before burst).

4.2 Project deliverables

The tasks and deliverables of the project are:

- Report stating/analysing relevant approaches for both gondola and ground segment.
- Prototype of the solution (mechanics, embedded system design and programming, ground software suite, …) that will be tested during a stratospheric flight in summer 2026

All along the project, supervision will be also realized by Didier DONSEZ, Full Professor Polytech Grenoble / LIG, CSUG.

References

[1] J. Ashenberg. "Conceptual Study of Gondola Stabilization in a Balloon System". *Journal of aircraft* 45.2 (2008), pp. 486–492.

5 Hand: Open hardware and electronics hand muscles characterization and rehabilitation tool for therapists

Contact details	**auredarth@ik.me, julia.cremillieux@gmail.com**
Project keywords	**hand physical therapy, open source hardware/software**
Skills	**data acquisition, signal processing, user interface design**

5.1 Project context and goals

Julia Crémillieux is a hand rehabilitation specialist practicing in Valence. In her experience, patients recovering from trauma or surgery often lack precise measurement tools to assess the strength of their long fingers and the intrinsic muscles of the hand in vivo [2]. Two years ago, a prototype device was developed that attempted to collect force data via pressure sensors and provide feedback to patients, but its sensors lacked sufficient sensitivity and the data did not meet expected accuracy [1]. Building on recent advances and improved clinical understanding, the aim of the present project is to design a small, battery-powered, autonomous measurement system capable of capturing isolated forces (including lateral pressure, phalangeal stacking, rotational motion, finger locking) and providing real-time feedback. The device will be low-cost, easily assembled, and documented so that practitioners and enthusiasts can reproduce or adapt it, enabling better modeling and monitoring of hand rehabilitation.

Figure 5: Soft Robotic Glove for Neuromuscular Rehabilitation (credits: Wyss Institute at Harvard University)

5.2 Project deliverables

- Complete specifications of device, with detailed references for parts, and instructions for assembly.
- For each application or use case:
  - One sheet presenting the application, expected benefit, and approximate cost;
  - Application software (preferably hosted online in a permanent manner);
  - Software installation guide;
- A user guide for the application, aimed at hand physical therapists

References

[1] *2023 "Hand it" project final report.*

[2] C.-Y. Chu and R. M. Patterson. "Soft robotic devices for hand rehabilitation and assistance: a narrative review". *Journal of neuroengineering and rehabilitation* 15.1 (2018), p. 9.

Part III
Students proposals

Part IV
Digital Arts proposals

Part V
LCIS/ESISAR proposals

6 PlaceR: A robust place recognition system for bio-inspired navigation model

Contact details	**simon.gay@lcis.grenoble-inp.fr**
Project keywords	**Computer vision, navigation.**
Skills	**Java or Python**

6.1 Project context and goals

Exploring and navigating in large unknown environment is still a great challenge for artificial systems such as robots and UAVs. Most of models use SLAM algorithms (Simultaneous Localization And Mapping), but face problems related to motion drift and can require important computational resources. Several approaches drew inspirations from animals, especially rats, to cope with these issues. A bio-inspired model [1] was developed in LCIS laboratory to allow robust visual navigation on embedded platforms. This model however requires an accurate system to visually recognize already visited place. A previous student group studied and evaluated different types of algorithms for scene recognition, leveraging their reliability, advantages and inconvenient (the report will be provided as a resource for the project). The aim of this project consists in developing, implementing and testing a mechanism enabling the visual recognition of a visited place, that relies on algorithm that can run on embedded platform (e.g. Raspberry Pi).

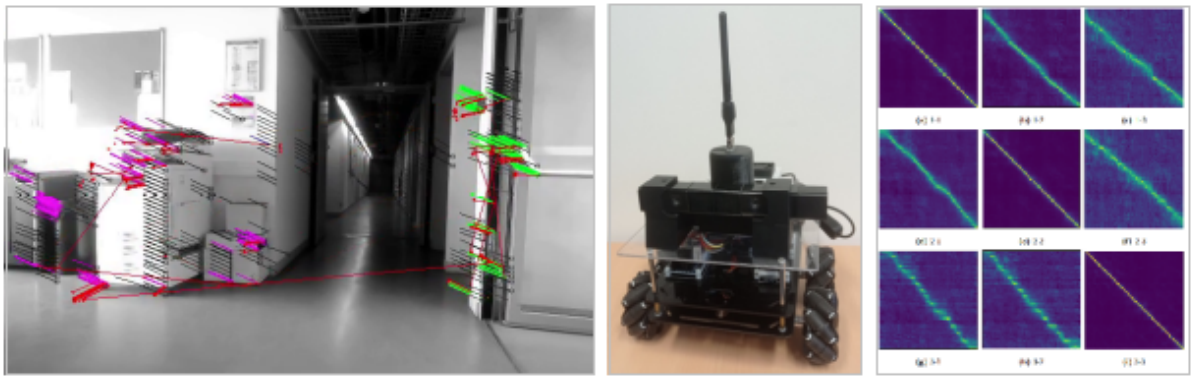


Figure 6: left: the visual navigation system detects points of interest (Vertical lines and ORB features) and define their distances through stereo-vision. Middle: robot with embedded nano-computer and stereo camera. Right: confusion matrices obtained by applying a place recognition algorithm on image sequences from recorded videos.

6.2 Project deliverables

- Understanding feature detection and visual recognition algorithm
- Development of algorithms for robust place recognition
- Evaluation of models on image datasets and on embedded (robotic) platforms
- Technical report of proposed approaches and experimental evaluations

References

[1] S. L. Gay, N.-T. Truong, E. Pissaloux, and J.-P. Jamont. “Towards predictive and decentralized bio-inspired navigation models for distributed systems”. *2021 IEEE Symposium Series on Computational Intelligence (SSCI)*. IEEE. 2021, pp. 1–8.

7 Nav: Decentralized Multi-Agent Navigation with Centralized Monitoring

Contact details	**simon.gay@lcis.grenoble-inp.fr, ionela.prodan@lcis.grenoble-inp.fr**
Project keywords	**Network, Embedded computer, Multi-agents systems**
Skills	**Java or Python, JavaScript, networks**

7.1 Project context and goals

Exploring and navigating in large unknown environment is still a great challenge for artificial systems such as robots and UAVs. A bio-inspired navigation model developed in the LCIS laboratory proposes to distribute the environment map and localization algorithms over a swarm of robots to reduce the individual cpu and memory consumption of each robot. The current test system uses a set of four robots with embedded nano-computers and relies on a centralized network (router) for robot-to-robot communication. Such indirect communication generates communication latencies and issues, especially when the swarm is far from the router. The aim of this project is to:

- develop an decentralized robot-to-robot network (either ad-hoc or access point),
- develop monitoring tools to analyze and measure the communication volume between robots.

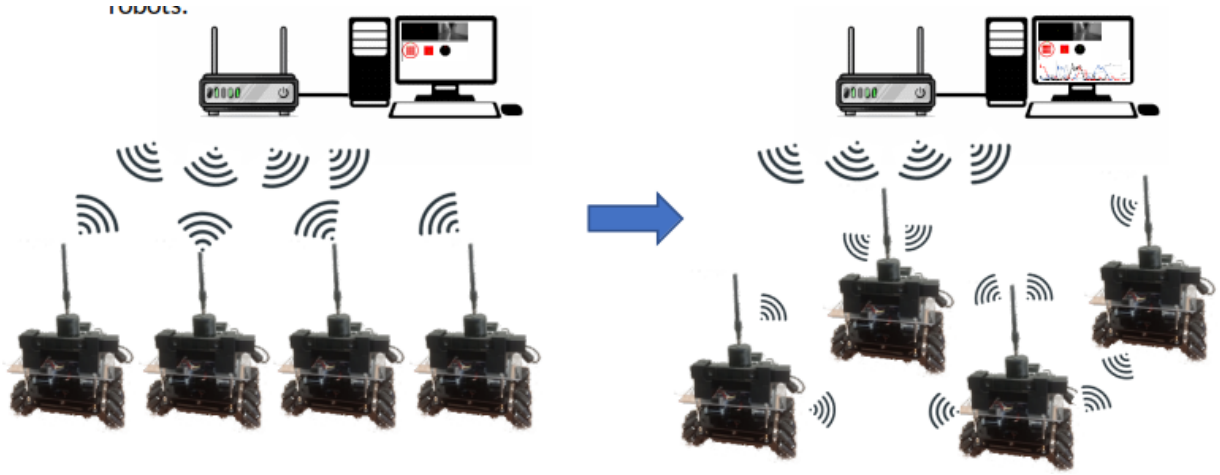


Figure 7: left: the current network relies on a central router that is used both for robot-to-robot communication and to control and monitor the swarm. Right: the targeted network with ad-hoc network for the robot-to-robot communication, the router being only used to control and monitor the swarm. The project also requires the development of network monitoring tools in order to evaluate the efficiency of the distributed navigation system.

7.2 Project deliverables

- review of ad-hoc network methods and protocols
- Development, implementation and testing an ad-hoc network on the swarm of robots
- Development of monitoring tools to measure data volume exchanged by the robots
- Technical report of proposed approaches

References

[1] J. Chung, J. Fayyad, Y. A. Younes, and H. Najjaran. "Learning team-based navigation: a review of deep reinforcement learning techniques for multi-agent pathfinding". *Artificial Intelligence Review* 57.2 (2024), p. 41.

8 BHFR3: Bionic Head and Facial Recognition

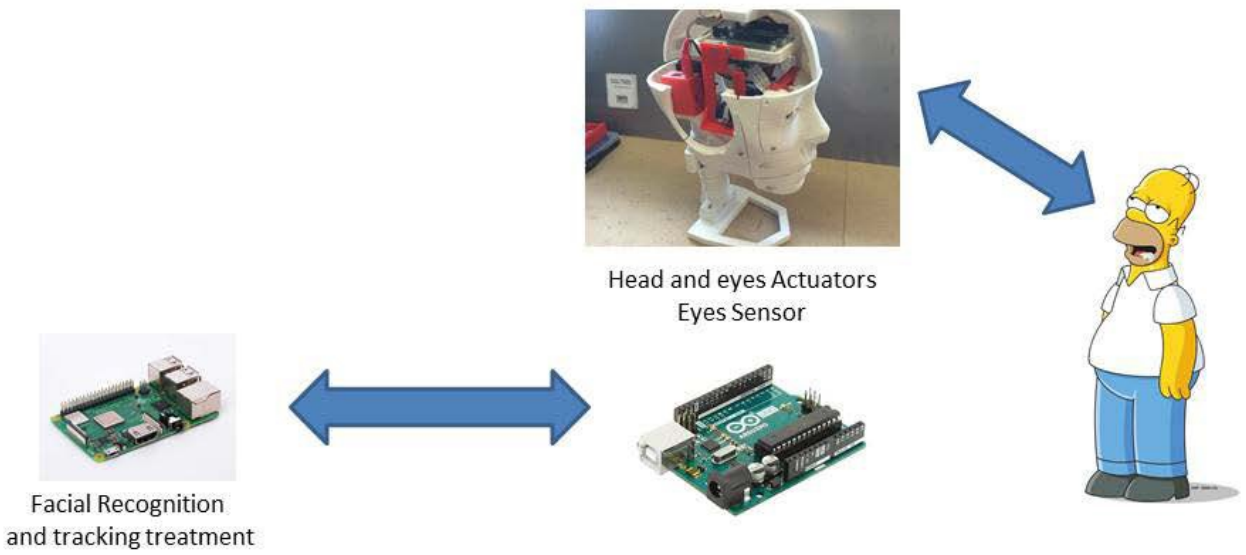
Contact details	**laurent.guilloton@esisar.grenoble-inp.fr**
Project keywords	**Camera, Facial Recognition, Jetson Nano/RPI/STM32/Arduino.**
Skills	**embedded programming, Electronics, 3D printing.**

8.1 Project context and goals

BHFR3 is the continuation of a previous project. It aim to create interaction between a robot and a human. By using developments on facial recognition like OpenCV [2] it would be interesting to develop a demonstrator recognizing shapes and faces to launch an action, a message, ...

So this project can be decomposed in different parts :

- finish printing and assembling the head and neck of the robot
- Control head and neck movement
- Study the different method for facial recognition and how implement them on an embedded computer.
- Choose and implement one of these methods on a Raspberry Pi [1] or Jetson Nano [**jn**].



This work will eventually develop new features such as opening a door depending on the person detected or otherwise.

8.2 Project deliverables

- Head and eyes functional
- Comparative facial recognition algorithms
- Implementation and test in the final prototype

References

[1] *Raspberry Pi*. https://www.raspberrypi.org/.

[2] G. Bradski. "The OpenCV Library". *Dr. Dobb's Journal of Software Tools* (2000).

9 RISC-V contest: FFT on CV32A6

Contact details louis.morge-rollet@esisar.grenoble-inp.fr
Project keywords RISC-V, FFT, CV32A6
Skills Computer architecture, embedded systems, signal processing

9.1 Project context and goals

Each year, Thales, GDR SOC^2, and CNFM propose to the students, in Master 2 and registered in a French engineering school/university, to participate to a contest [1] around RISC-V Instructions Set Architecture (ISA). Thales will award €5000 to the winning team and €3000 to the second best team.

RISC-V is a recent open ISA that is gaining every day more attraction, especially for embedded systems. From this ISA, OpenHW Group propose two implementations, CV32A6 (32-bit version) and CV64A6 (64-bit version), sharing the same source code and referred together as CVA6 [2].

This year's contest will focus on architectural modifications of the CV32A6 RISC-V soft-core to accelerate a Fast Fourier Transform (FFT) algorithm processing $N = 2^r$ samples (with N: an integer). An FFT [3] is an algorithm that computes the Discrete Fourier Transform (DFT) of a signal, faster ($O(Nlog(N))$ than the classic implementations of the DFT ($O(N^2)$). Its applications are numerous, such as in engineering for anomaly detection or in music for style classification. The goal of the contest is to modify the CV32A6 architecture and/or add a coprocessor to accelerate the FFT algorithm provided as an application written in C.

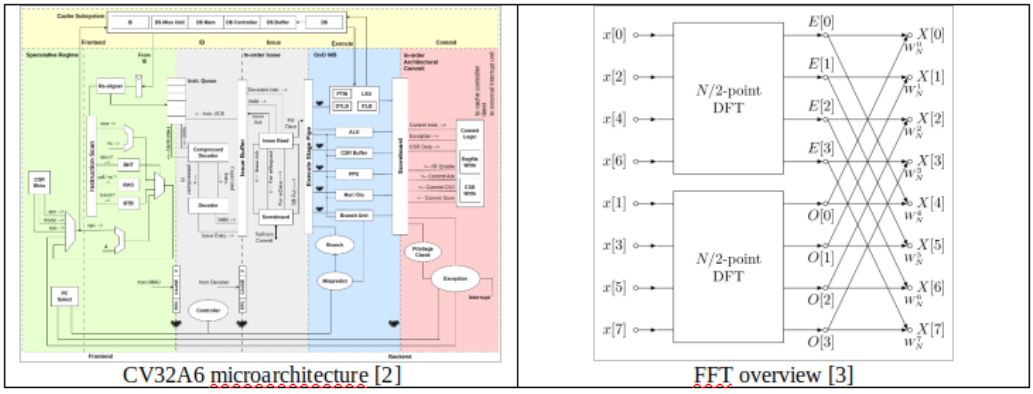


Figure 8: Microarchitecture of the CV32A6 and FFT algorithm.

9.2 Project deliverables

- A 6-page report presented as a scientific paper, in French or English, with illustrations
- A 10-minute recorded video, that will be presented during the defense session, in French or English
- A link to your new source code and results uploaded on GitHub
- The reports from the tools that justify the results presented in the report.

References

[1] *6th national RISC-V student contest 2025-2026 – Accelerating an FFT on CVA6 RISC-V processor.* link.

[2] *CVA6: An application class RISC-V CPU core – OpenHW Group.* link.

[3] *Fast Fourier Transform – Wikipedia.org.* link.

10 VIEWS: Visualizing Electromagnetic Wave Sources

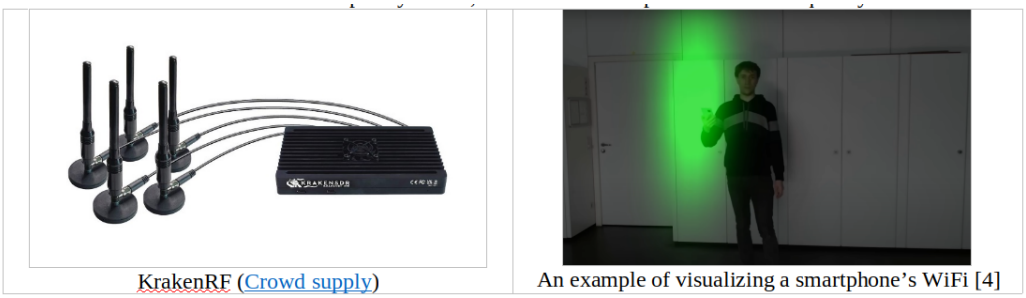
Contact details	**louis.morge-rollet@esisar.grenoble-inp.fr, pierre.lemaitre-auger@esisar.grenoble-inp.fr**
Project keywords	**sensor fusion, direction-of-arrival estimation, computer vision, Raspberry Pi**
Skills	**GNU Radio, OpenCV, embedded programming with Python, antenna array design**

10.1 Project context and goals

Most of the electromagnetic spectrum are invisible to our eyes, excepted for visible radiations. It could be interesting to visualize other electromagnetic sources, such as microwave radiators, which are widely used for radiocommunications. Indeed, it could help spectrum regulation authority to detect interference sources or unauthorized transmissions.

In this project, we propose to develop sensor fusion techniques to make microwaves visible. On one hand, a video of the scene will be recorded with a Raspberry Pi Camera. On the other hand, the Kraken RF (see left figure, [2]) will be used to estimate the Direction-Of-Arrival (DOA) of the microwave source(s) with GNU Radio. Finally, sensor fusion techniques will merge these two measurements, to superimpose DOA estimation on top of the video (see right figure), as a heat map, with OpenCV or others computer vision framework. Depending of project advancement, the students could also design a specific antenna array, to improve the DOA estimation.

At this time, some projects have proposed this kind of approaches [1, 3, 4], but they were limited to WiFi communications and/or required a large amount of time for the estimation. Our proposition could allow a real-time sensor fusion embedded on a Raspberry Pi 4 B, and it will be independent of the frequency band.



KrakenRF (Crowd supply)

An example of visualizing a smartphone's WiFi [4]

Figure 9: Kraken RF device which can be used as a direction of arrival sytem. Expected result of the project.

10.2 Project deliverables

- Bibliographic study on the visualization of microwave sources
- Documented Python codes of the project
- An image of the Raspberry Pi 4 B SD card
- Report containing the details of project

References

[1] *Build a Camera Than Can See Wifi | Part 3 SUCCESS ! – The Throught Emporium.* link.

[2] *KrakenRF, a coherent radio receiver for Radio Direction Finding.* link.

[3] *This camera can see WiFi – The Thought Emporium.* link.

[4] *This ESP32 Antenna Array Can See WiFi - Jeija.* link.

11 R-DATA: Robust Detector Design Against Temperature Attacks an Aging

Contact details	**vincent.beroulle@esisar.grenoble-inp.fr**
Project keywords	**Hardware attacks, Ring oscillator, Power-off, attacks**
Skills	**FPGA design, embedded programming**

11.1 Project context and goals

The rapid evolution of hardware-based attacks has exposed critical vulnerabilities in embedded systems. One emerging class of attacks, known as Power-Off Temperature Attacks (POTAs), exploits thermal stress to accelerate aging in sensitive components like Ring Oscillators (ROs). These attacks can cause irreversible damage and performance degradation without being detected by conventional security mechanisms. To counter this growing threat, as shown in Fig 1, we introduce OMM (Online Monitoring Mechanism), a resilient hardware-based detection framework. OMM is combined with a complementary Glitch Detector to form RTM (Robust Test Mechanism). These modules operate independently while continuously cross-validating each other's behavior, ensuring robustness even against sophisticated attack attempts.

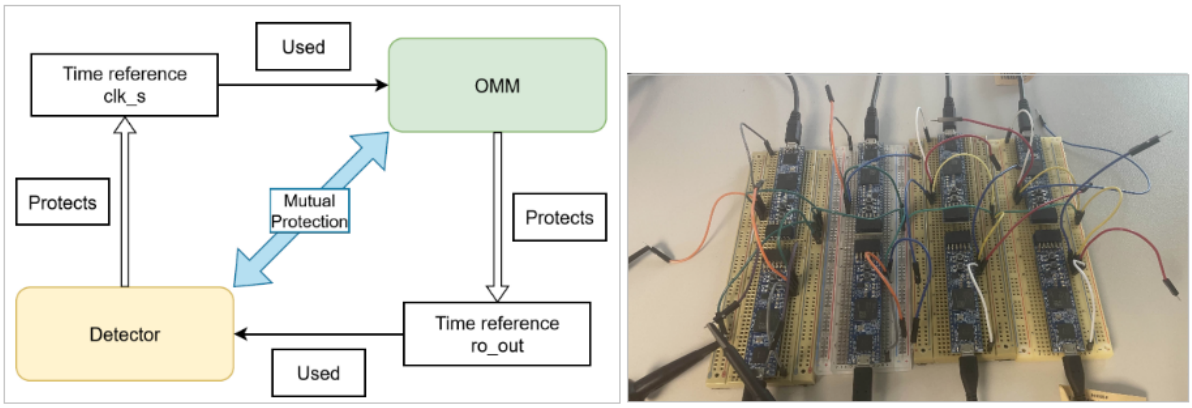


Figure 10: left: Detector protection principle. Right: experimental setup to characterize aging.

The objectives of this project, R-DATA, are

- Experimental campaign to test the robustness of the OMM module against thermal attacks (with experimental set up similar to the one on Fig. 2).
- Redundancies will be implemented to ensure the reliability of the experiment (several FPGAs, with several RO and detectors and various internal temperature).
- Validation of the temperature attack detection, and the aging protection.

11.2 Project deliverables

- FPGA VHDL codes, simulation and implementation validations
- Experimental Campaign Results: measurements of the variations of the performances of the Detectors and of the OMMs
- Eventually, improvement on the experimental setup: automation of the measures, augmentation of the number of robust detectors with various frequencies

References

[1] M. Esmaeilian, V. Beroulle, and D. Hély. "On Power-Off Temperature Attacks Potential Against Security Sensors". *Sensors* 25.6 (2025). ISSN: 1424-8220. URL: https://www.mdpi.com/1424-8220/25/6/1912.

[2] A. Douadi, G. Di Natale, P. Maistri, E.-I. Vatajelu, and V. Beroulle. "A Study of High Temperature Effects on Ring Oscillator Based Physical Unclonable Functions". *2023 IEEE 29th International Symposium on On-Line Testing and Robust System Design (IOLTS)*. 2023, pp. 1–7. DOI: 10.1109/IOLTS59296.2023.10224886.

12 A-FPGA: Integrated near field antenna in an FPGA

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Project keywords FPGA, Wireless, Radiofrequency, Antenna.

Skills embedded programming, VHDL, RF communications, Python.

12.1 Project context and goals

The use of Field-Programmable Gate Array (FPGA)-accelerated computing is an increasing trend. However, when multiple parties are involved in the development and deployment of an FPGA accelerated system, a number of security concerns arise including a higher risk of hardware Trojans. A hidden transmitter embedded into a chip to extract secret information is a well-known type of hardware Trojan. Various ways of implementing covert channels have been proposed in the past [1]. FPGA interconnects are typically utilized as digital resources to connect the logical building blocks of an FPGA. Because of the flexibility in the FPGA interconnect, all of the wires in the interconnect will never be simultaneously utilized. These unutilized wires can combine into a single net on the FPGA while retaining a specific physical shape [2]. When this shape is excited, energy is emitted from this shape, much like a radio transmitter. This is then captured by a wide-band antenna this is controlled by an automated testing apparatus. Some progress was made last year: loop, monopole, and patch antennas were implemented on FPGA, and a semi-automated setup using scripts and signal generator was used for testing. Patch 22000 showed the highest emission near 100 MHz.

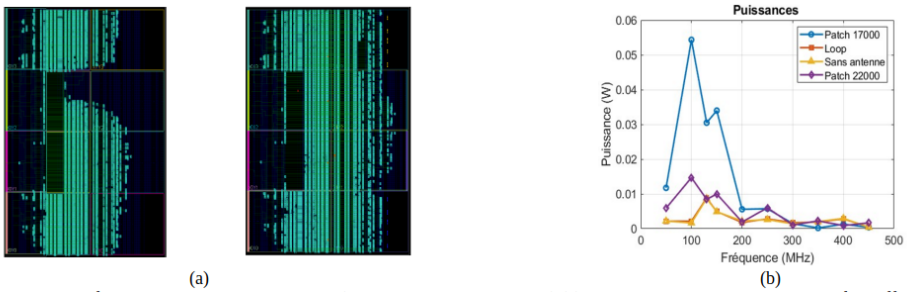

Figure 11: (a) Schematic of the integrated antenna in Vivado (b) Measured EM Power

This project aims to extend prior work on FPGA-integrated antennas by improving measurement tools and analyzing antenna performance more deeply. Both hardware integration and software automation are involved. Key Goals:

- Set up an automated near-field measurement bench and Perform detailed EM measurements
- Integrate and test various antenna types on Spartan-3 FPGA
- Compare antenna performance across designs and boards

12.2 Project deliverables

- Design, implement and validation of Near Field antennas on the provide FPGA board.
- Report on the measurement of the performances of the antennas

References

[1] M. Esmaeilian, V. Beroulle, and D. Hély. "On Power-Off Temperature Attacks Potential Against Security Sensors". *Sensors* 25.6 (2025). ISSN: 1424-8220. URL: https://www.mdpi.com/1424-8220/25/6/1912.

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13 P-FPGA: PUF-based Hardware Authentication Platform on FPGA

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Project keywords Authentication, Wireless Security, FPGA, IoT, PUF.
Skills Embedded Programming, VHDL, Python, Signal Processing.

13.1 Project context and goals

In wireless embedded systems, especially in the Internet of Things (IoT), securing device identity is critical. Conventional cryptographic authentication schemes may be too heavy for low-power devices and susceptible to key extraction attacks. To address this, this project builds on a novel physical-layer authentication [1] platform based on PUF-enhanced Ring Oscillator (RO) systems developed for FPGA-based IoT modules [2]. This method uses process variations in FPGA hardware to create unique device-specific frequency signatures. By integrating a Physical Unclonable Function (PUF) and frequency-modulated communication (2-FSK), each device transmits data using a unique and unpredictable frequency pattern. A master module on the receiver side then verifies the device in real-time by comparing the received frequency with pre-enrolled patterns stored in a secure database.

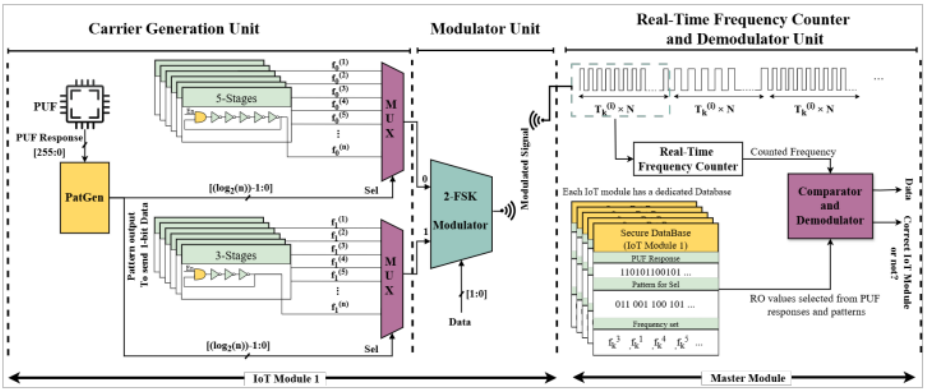

Figure 12: Illustration of a PUF-based hardware authentication mechanism. The transmitting IoT module uses ring oscillators (ROs) selected via PUF response to generate 2-FSK-modulated signals. At the receiver side, a real-time frequency counter and comparator validate the transmitted signal against a pre-registered frequency pattern database.

The project aims to validate the authentication system across different FPGAs and assess its robustness in various conditions.

- Deploy the system on multiple FPGA boards to check if each can be uniquely identified via RO-based signatures.
- Integrate and test various antenna types on Spartan-3 FPGA
- Evaluate stability under thermal stress (using external heating or internal techniques like RO-based self-heating).

13.2 Project deliverables

- Implementation of the authentication system on multiple FPGA platforms.
- Experimental report on identification accuracy and thermal robustness.

References

[1] M. Esmaeilian, V. Beroulle, and D. Hély. "On Power-Off Temperature Attacks Potential Against Security Sensors". *Sensors* 25.6 (2025). ISSN: 1424-8220. URL: https://www.mdpi.com/1424-8220/25/6/1912.

[2] M. Esmaeilian, L. Morge-Rollet, D. Hely, E.-I. Vatajelu, and R. Siragusa. "A PUF-Enhanced Ring Oscillator-Based Authentication System for IoT Devices". *Int. Symp. On VLSI*. 2025, pp. 1–4.

14 FlyBOLT: Embed the BOLT flight controller within a medium-size drone

Contact details	**{ionela.prodan, nicolas.barbot}@lcis.grenoble-inp.fr**
Project keywords	**UAV, quadcopter, flight controller.**
Skills	**Programming, C, Python, Qualisys Track Manager (QTM)**

14.1 Project context and goals

Unmanned Aerial Vehicles (UAVs) are nowadays used in many areas: health, military, precision agriculture and the like. To properly control a UAV such as a quadcopter, a flight controller (an autopilot), is embedded within the system. This device is composed of a microcontroller and different sensors (accelerometer, gyroscope and magnetometer). The main objective of the microcontroller is to generate the correct signals to the actuators (the 4 motors of the quadcopter).

The Esisarium platform includes, among others, several nano drones and the Crazyflie Bolt [1] which is a Crazyflie 2.X compatible flight controller for brushless builds. Also, a medium-size quadcopter platform, X500 produced by Holybro [3], has started to be used by several students. This quadcopter does not include a flight controller. The BOLT flight controller has the same architecture that the one used to control the Crazyflie drones [2]. This controller is fully opensource and can be modified to answer specific needs. The architecture is based on a STM32 microcontroller and the project is written in C.

The objective of the proposed innovation project is to modify the firmware of the BOLT flight controller to enable it to control the X500 Holybro platform. To the best of our knowledge, this has not yet been implemented in practice. Last year, a a groups of students successfully integrated the BOLT flight controller. This year, we aim to extend that project further.

In order to validate the proper functioning of the quadcopter, tests and validation will be done in the Esisarium platform. This platform is able to localize any object (equipped with markers) more than 30 times per second with an accuracy lower than 1 mm. Trajectory generation and tracking algortihms already developped by several PhD students will be tested over the X500 Holybro platform and the BOLT autopilot.

Figure 13: (a) X500 Holybro platform. (b) BOLT flight controller.

14.2 Project deliverables

- Understand and build the firmware associated to the BOLT controller.
- Modify the firmware to be able to control the brushless motors of the X500 Holybro frame.
- Optimize the firmware to be able to control the quadcopter.
- Test the already existing algorithms for trajectory tracking to realize complex missions.

References

[1] *Bitcraze Bolt 1.1.* https://store.bitcraze.io/collections/kits/products/crazyflie-bolt-1-1.

[2] *Bitcraze Crazyflie 2.1.* https://store.bitcraze.io/collections/kits/products/crazyflie-2-1.

[3] *Holybro X500 V2 Kits.* https://holybro.com/collections/x500-kits/products/x500-v2-kits.

15 DACTCR: Developing a Control Algorithm for Dual-arm Concentric Tube Continuum Robots

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Project keywords Concentric Tube Robot (CTR), Multi Tasks Control, Redundancy Resolution Techniques, Model Predictive Control

Skills C++, Python, ROS2

15.1 Project context and goals

Robot-assisted Single Port (SP) surgical systems (Figure 1) have become popular in laparoscopy, consisting of multiple flexible instruments and an endoscope emerging through a single cannula. This innovative approach presents several challenges related to a smaller workspace and visual field of view compared to multi-port laparoscopy. Recent advances in CTCR modeling have opened the door to model-based control strategies capable of achieving millimeter accuracy in trajectory tracking while avoiding actuation collisions [1]. Previous works on DACTCR has focused on enhancing SP systems by increasing autonomy in a specific surgical subtask, thus simplifying procedures and reducing the surgeon's workload [1].

Figure 1: Da vinci SP consisting of multiple flexible instruments and an endoscope emerging through a single cannula. Image source: Intuitive Surgical, Inc.

15.2 Project deliverables

The tasks and deliverables of the project are:

- Review of the state-of-the-art in CTCR control.
- Development of a model-based control algorithm for single-arm or/and dual-arm CTCR.
- Explore the feasibility of a Model Predictive Control implementation.
- Validation of the developed controller in our existing C++ and ROS 2 simulation environment.
- Reporting the results in a report.

References

[1] T. Alsaka, P. Cinquin, and M. T. Chikhaoui. "Hierarchy Control of Dual-arm Concentric Tube Continuum Robots with Different Redundancy Resolution Techniques". *International Symposium on Advances in Robot Kinematics*. Springer. 2024, pp. 140–148.

16 RFwaves: Permittivity Characterization using RF waves

Contact details	**etienne.perret@lcis.grenoble-inp.fr, mohsen.shafeghati@lcis.grenoble-inp.fr**
Project keywords	**RF permittivity characterization, Radar, RF, Pole and residue extraction from measured data**
Skills	**Electronic / RF design, RF measurements, signal processing**

16.1 Project context and goals

RF characterization of dielectric materials is becoming an increasingly important scientific and commercial activity. Despite significant efforts by the RF community to develop reliable characterization solutions, these techniques still depend on RF test fixtures that are heavy to implement, expensive, and have a limited range of applications (such as specific materials, frequencies, and resolution). As a result, they are not well-suited to meet the growing needs of companies, most of which lack the advanced skills and equipment needed for these methods. The project aims to demonstrate the technical viability of a new solution for RF characterization of dielectrics. This approach differs from current techniques because it will allow the characterization of a broader variety of materials (plates, solids, liquids, powders, etc.) at a lower cost.

This project aims to assess the performance of a new wireless RF method for characterizing dielectric powders, such as sugar, salt, and flour, as well as liquids like water. The students will be responsible for conducting experiments and the post-processing step to determine the complex permittivity of this kind of dielectrics.

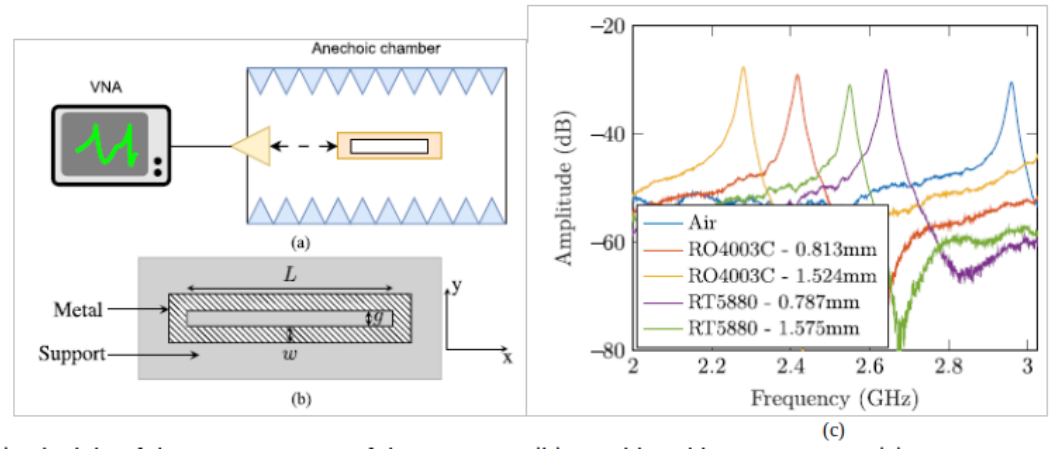


Figure 14: (a) Principle of the measurement of the scatterer. (b) Considered loop resonator. (c) Measurement of the S11 parameters for a loop resonator in air (blue) and on the different substrates.

16.2 Project deliverables

- Dedicated elements for adapting the measurement bench to characterize powders and liquids.
- MATLAB calculation code responsible for extracting the desired quantities.
- Report on measurements of the various structures characterized.

References

[1] E. Perret and F. Costa. "Resonant Scatterer Quality Factor Increasing based on Sustained Excitation by Multiple Reflections for Wireless Sensor Applications". *2024 54th European Microwave Conference (EuMC)*. 2024, pp. 680–683.

[2] F. Requena, N. Barbot, D. Kaddour, and E. Perret. "Wireless Complex Permittivity Measurement Using Resonant Scatterers and a Radar Approach". *IEEE Transactions on Microwave Theory and Techniques* 71.10 (2023), pp. 4427–4436.

17 Print3DAbs

Contact details	**etienne.perret@lcis.grenoble-inp.fr, mohsen.shafeghati@lcis.grenoble-inp.fr**
Project keywords	**RF permittivity characterization, Radar, RF, Pole and residue extraction from measured data**
Skills	**Electronic / RF design, RF measurements**

17.1 Project context and goals

Idyllic Technology (https://www.idyllic.technology) markets identification solutions based on radar technology. It is developing a reading system capable of emitting RF pulses lasting a few tens of picoseconds, as well as printed tags to perform the identification function. To improve the performance of its solutions, absorbent surfaces with very specific characteristics are awaited. These characteristics relate to the RF performance to be achieved (reflection and transmission coefficient as a function of frequency), as well as the thickness and total cost of the solution. Currently, there is no commercial solution that meets all the desired specifications.

Over the past several years, 3D printing has experienced exponential growth, enabling the custom printing of RF absorbers [1, 2]. An initial state-of-the-art review identified several approaches capable of meeting various current constraints. The most promising are shown in Fig. 1 [3, 4]. These structures are based on the use of a specific plastic filament (with losses) and innovative geometries (see Fig. 1).

The goal of this project is to design, manufacture, and characterize absorbing surfaces using 3D printing. Another manufacturing method may be explored in parallel, depending on the progress of the main task. Students will be required to replicate the structures described in the selected reference articles and work on printing them using the 3D printers available at the Esisar and Idyllic sites. The manufactured structures will be characterized using an RF measurement bench, on which students will be trained. Several iterations of manufacturing and characterization will be necessary to develop a solution that can be used by Idyllic.

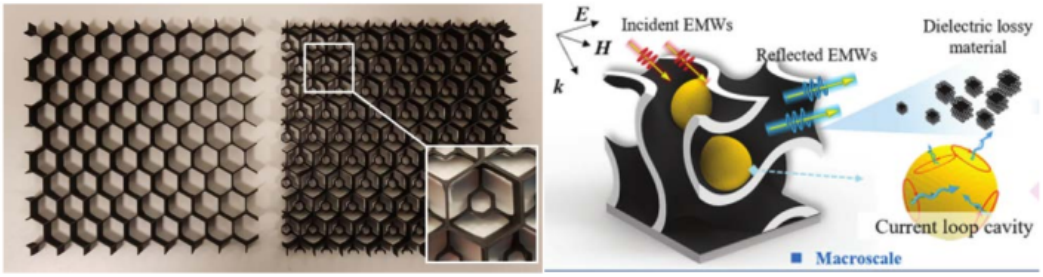


Figure 15: (a) Honeycomb Microwave Absorbers [4], (b) Gyroid concept [3].

17.2 Project deliverables

- Design, production, and characterisation of RF absorbers.
- Report on measurements of the various structures characterised
- Files and printing guide.

References

[1] X. Chen, W. Wang, R. Su, Y. Huang, Y. Li, and R. He. "3D-printed electromagnetic microwave absorption structures: a comprehensive review". *Journal of Materials Chemistry A* 13.28 (2025), pp. 22240–22270.

[2] Q. An, D. Li, W. Liao, T. Liu, D. Joralmon, X. Li, and J. Zhao. "A novel ultra-wideband electromagnetic-wave-absorbing metastructure inspired by bionic gyroid structures". *Advanced Materials* 35.26 (2023), p. 2300659.

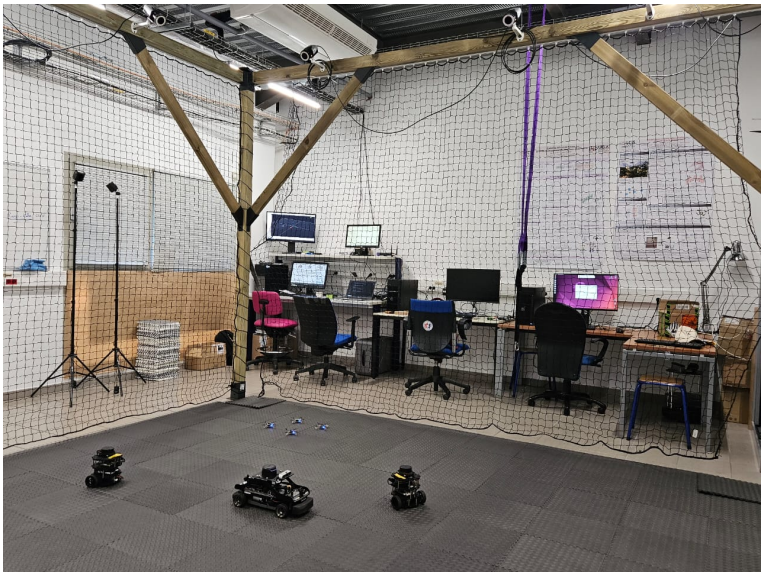
18 TRC: TrustRobotics Challenge at CSAW'25 Europe

Contact details	**{ionela.prodan, khanh,trang,hung}@lcis.grenoble-inp.fr**
Project keywords	**Drones, Quadruped Robot, Qcar, Turtlebots**
Skills	**Programming, C, Python, Qualisys Track Manager (QTM)**

18.1 Project context and goals

Launched in 2025, the TrustRobotics Challenge at CSAW'25 Europe is a competition dedicated to highlight the most innovative and impactful research in the field of safe and secure robotics https://esisar.grenoble-inp.fr/fr/recherche/trustrobotics-challenge.

The Esisarium platform at the LCIS lab and Esisar-Grenoble INP features state-of-the-art motion capture systems and a variety of terrestrial, aerial, and quadruped robots. It provides a unique opportunity for students to develop innovative and creative projects, such as making heterogeneous robots dance in sync to music or coordinating them to perform complex collaborative tasks.



18.2 Project deliverables

- gain hands-on experience with the Qualisys motion capture system.
- install and understand ROS and Gazebo for robotic simulation and control.
- test, refine and enhance existing control algorithms to execute complex robotic missions.
- integrate multiple robot types (terrestrial, aerial, quadruped) into coordinated tasks.
- develop synchronized behaviors, such as multi-robot dance or collaborative missions.
- implement real-time monitoring and visualization of multi-robot operations.

References

[1] C. K. Dinh, M. Vincent, J. Barreiro-Gomez, I. Prodan, C. Ocampo-Martinez, and N. Quijano. "B-Splines-Based Mechanism Design in Population Games for Distributed Evolutionary Dynamics Formation Control". *Control Engineering Practice* 152 (2025), p. 106066.

19 Noise: Power Line Noise Minimization

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Project keywords Noice cancellation, microcontroller, acoustic
Skills Embedded programming (C/C++), signal processing

19.1 Project context and goals

Nowadays, high voltage overhead power lines [1] are widely spread in electrical grid. These lines are used to transport electricity across long distances, from the electrical power plants to towns and urban centers, carrying up to 400 000 V. However, these high voltages are able to ionize air that create partial electronic discharges, known as corona effect [2]. This phenomenon is really problematic because it reduces the transmission efficiency, produces electromagnetic interferences, but also create audible unwanted noise, similar to sizzling.

The goal of this project is to create an acoustic system able to suppress this unwanted noise, using adaptive noise cancelling [3]. These technics consist to reduce unwanted noise by using two microphones: (1) a reference microphone that record the noise, and (2) an error microphone to control the noise cancelling quality. Furthermore, a cancelling speaker is also used, to generate an anti-noise, controlled by an adaptive filter.

This power line noise-cancelling system could be built around a microcontroller, such as a STM32. Indeed, this kind of microcontrollers can leverage on several analog-to-digital and digital-to-analog converters, and contains peripherals/coprocessors (DMA, FPU, HMAC, etc.) to efficiently implement adaptive filter.

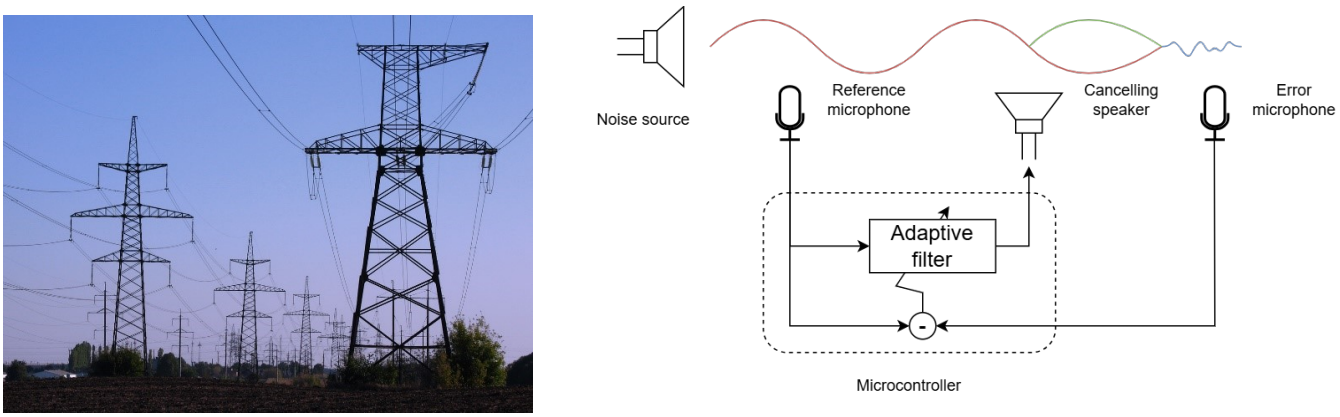

Figure 16: (a)330 kV overhead power line [1]. (b) Adaptative noise cancellation [3]

19.2 Project deliverables

- Bibliographic study on noise cancellation technics
- Documented codes of the project
- Report containing the details of project