# Innovation Projects 5A EIS 2018-2019

## Contents

# Digital Art Subjects

# BYTEBEATCOIN

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**Keywords**: **Retrocomputing – Low-tech – Low-fi – Disnovation – Cryptocurrency – Music – Sound – Waveform – Generative – Portable device – Low-def screen**
**Skills: creative coding, hardware making, hacking in general**

## Context

Innovation as a rhetorical tool, innovation as social acceptance.
Thinking about the history of innovation as a term and as a politic principle that tends to be a permanent demand, we aim to work on a retro computing physical object (hardware) as an innovative project. With this object we focus on the inherent ambiguity of the innovation principle, in particular its relationship with obsolescence and reactivation, re-actualization and capitalism.
The idea behind this object is simple, since music doesn't generate enough money, why not make money to generate music?
A proposal between irony and popularization of self-sustaining universal income access.

## Project Description and deliverables

The goal is to build a portable device that generate *bytebeat* music through cryptominning. Initiated by Ville-Matias Heikkilä in 2011, *bytebeat* can be defined as "short computer programs, sometimes consisting of as few as three arithmetic operations in an infinite loop that can generate data that sounds like music when output as raw PCM audio". These short programs follow the form:

```
main()
{
    int t=0;
    for(;;t++) putchar(EXPRESSION);
}
```

Using the total amount of resolved hashes during cryptomining as the iterative variable of a bytebeat formula will generate sound based on computing power.

## Resources

- L'innovation qu'est ce que c'est ?, http://www.cite-sciences.fr/archives/francais/ala_cite/expositions/observatoire-innovations/definition-innovation/definition-innovation-1.html
- Anthony Masure, Le design des programmes (Inauthenticités de l'innovation), 2014, http://www.softphd.com/these/walter-benjamin-authenticites/inauthenticites-innovation
- Benoit Godin, The Politics of Innovation : Machiavelli and Political Innovation, or, How to Stabilize a Changing World, http://www.csiic.ca/PDF/WorkingPaper17.pdf
- Machiavel, Le Prince, 1513
- Nicolas Maigret & Bertrand Grimault , Statement, disnovation.org/curation.php
- Kragen, Bytebeat, http://canonical.org/~kragen/bytebeat/, 2011
- Ville-Matias Heikkilä, Some deep analysis of one-line music programs, http://viznut.fi/texts- en/bytebeat_deep_analysis.html, 2011
- Ville-Matias Heikkilä, Discovering novel computer music techniques by exploring the space of short computer programs, http://viznut.fi/texts-en/bytebeat_exploring_space.pdf, 2011

# FAUNE: Zoomorphic and biomorphic communicating companions

**Supervisor: Igor Deschamps**

**Contacts: julie@metalab.fr, igor@metalab.fr, jonathan@metalab.fr**

**Key words: microcontrollers, A.I., wireless systems, sensors and actuators**

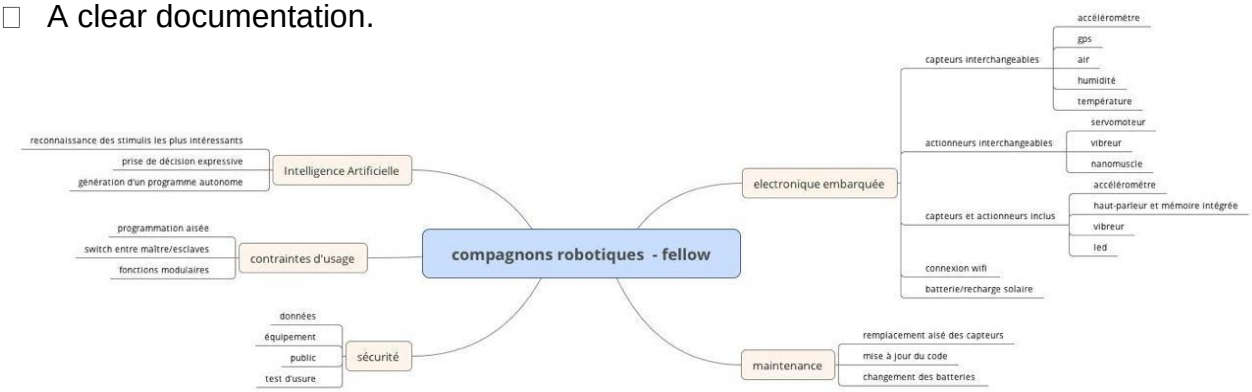
**Skills: C, team working, A.I., PCB, usages and outreach, security**

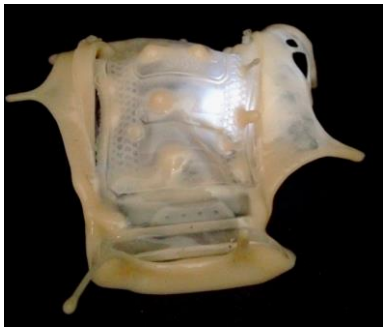
## Context

FAUNE aims at giving a sensitive and interactive depth to everyday technologies, richer, stimulating and surprising. The companions can be seen ad small autonomous beings, able to communicate through sonic, visual and kinetic languages. They are smart enough to speak to each other and to act according to their environment and relatively to the people around them. Their behavior is based upon a generic kinetic and haptic typology of actions. The companions are autonomous and complementary. FAUNE interactions' quality will create an artificial social eco-system, fundamentally new by its relational design. Artistically, FAUNE is a profound exploration of artificial intelligence, sound, light and movement as joint vectors of meaning and felling.

## Deliverables:

- Eco-system of 3 autonomous communicating agents with an embedded and un-centralized AI.
- Software environment for programming these agents.
- A clear documentation.



*« compagnon_#1 »* recherche design

# *MP: Mechanic Panorama – Landscape Trap*

**Supervisor and email : Arnaud Chevalier, chevalier-arnaud@orange.fr**

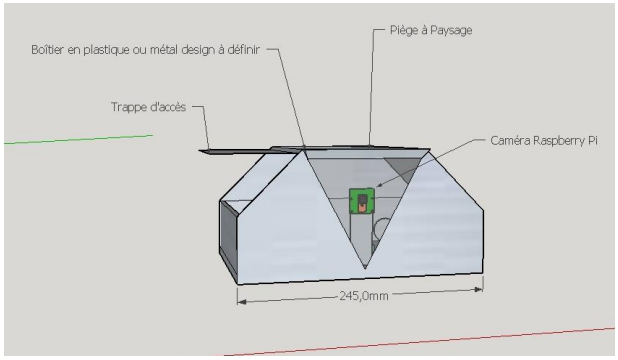
**Keywords: Raspberry Pi, Raspberry Pi camera, Intervalometer, Design et conception**

**Skills: DSP, embedded software, hardware design**

## Project Context and Goals:

*Mechanic Panorama* is an interactive video installation. It reproduces 24h landscapes videos captured from windows of various cities inhabitants. Placed in a machine equipped with a video-projector, these images can be manipulated through time by the use of a large wooden wheel. Hence, one can navigate back and forth in a full day and night from several points of view. This piece is a sensitive map of people intimate perspective on their cities. Created in 2016 at 8fablab in Crest during les “Journées du Patrimoine”, this installation has since been presented in Rennes, Grenoble, Villeurbanne and is set to travel in several places from Isere to Savoie.

## Project description and deliverables:




*Mechanic Panorama* now evolves more and more to address specifically each territory in which it travels. This supposes to create a large amount of new content for each location. The current technic, using a DLSR is quite demanding and time-consuming. We now need to improve the filming methodology by creating a new tool, way more flexible. Here starts the ***Landscape Trap*** Project.

It aims at creating an autonomous digital photo module able to capture 24h time-lapse once set on someone window or balcony. This project contains both hardware specification and prototyping and its software counterpart. Follow some elementary features of the object:

**The Box** – kind of small, it must be hermetic to water and dust. There will be an opening protected by synthetic glass and an access for a couple of. A maintenance opening could be useful.

**Mounting** – An adjustable hook will allow mounting the system on any fence or balcony. It should be compatible with standard photo/camera tripod.

**Electronics** – Inside the box will be placed a DSP or micro-computer (a Raspberry Pi for instance – the choice must be driven by the ability of the tool to handle images, lot of them) and a digital camera, both properly secured.

**Software** – It will handle a large variety of settings, including an intervalometer (allowing adjusting the timing between to shots and the total duration of the capturing process) and parameters such as ISO, shutter speed, focal ratio, etc.

# *VOID MOVE()*

**Supervisor: Yves Brozat**
**Email**: yves.brozat@gmail.com
**Keywords**: **accelerometers, embedded systems, multi-agent, IoT, interaction design**
**Skills**: **project management, hardware design and software development for embedded system, wireless sensors networks, Arduino**

## Context:

This project will be conducted in close interaction with the supervisor having a double competence in artistic creation and in engineering. The team of students will be involved in every aspect of the a digital art creative process. This kind of process, based on an original artistic idea, relies on a very close dialogue and co-evolution of both artistic and technical aspect, and is very open to the concept of emergence.

Observing and measuring movement to recreate movement, interact with physical or virtual universe by moving physical objects through space and time, here are the aims of void move().

## Project description:

void move() is a technological artifact, interested in the art of movement, and supposed to be used in the context of artistic performances (on stage with living performers). The device includes a static depth camera (such as the Kinect V2 offering a 3D tracking in position) and is connected to several accelerometers attached to objects and performers, measuring precise motion dynamic data. Several mapping strategies will connect these data to a variety of interactive media contents and process, bridging sound and image, and using the OSC (open sound control) protocol.

Juggling (diabolo) will be the first context of use for void move(). A qualitative movement analysis of performers will allow to anchor the creative perspective of the device in that specific case. It will drive the choice of the appropriate media and displays regarding both technical and esthetical aspects. A preliminary objective is to project the rendered visual on a 360° semi-transparent screen positioned around the juggler.

# *1000 SIGNATURES*

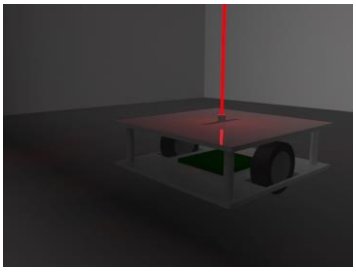
**Contact emails:** **contact@collectif-coin.com**

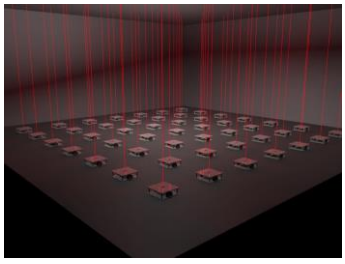
**Keywords:** **swarm robotics**

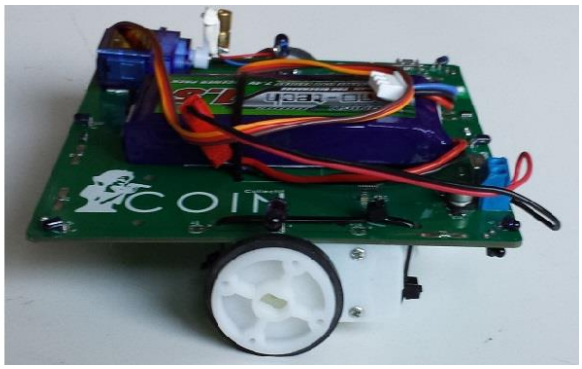
**Skills:** **robotics, computer engineering, sensors**

## Project Context and Goals:

*1000 signatures* is a digital art installation. It features 50 individual computer-controlled robots. Their metal structures slowly roams the floor. Their integrated red laser beams are diffracted by the ambient smokescreen. A synchronized ambient sound composition accompanies the installation.







## Project description and deliverables:

For now we have a 3 robots prototype and a first onboard software focused on swarm behavior. Movements of the swarm are not yet satisfactory.

Based on a previous six month work achieved by a 5A engineer student, the aims of this project are to :

- Clarify the specifications
- Modify the electronic if necessary
- Achieve a fonctional onboard and control software
- And why not, produce the swarm

Subtargets:

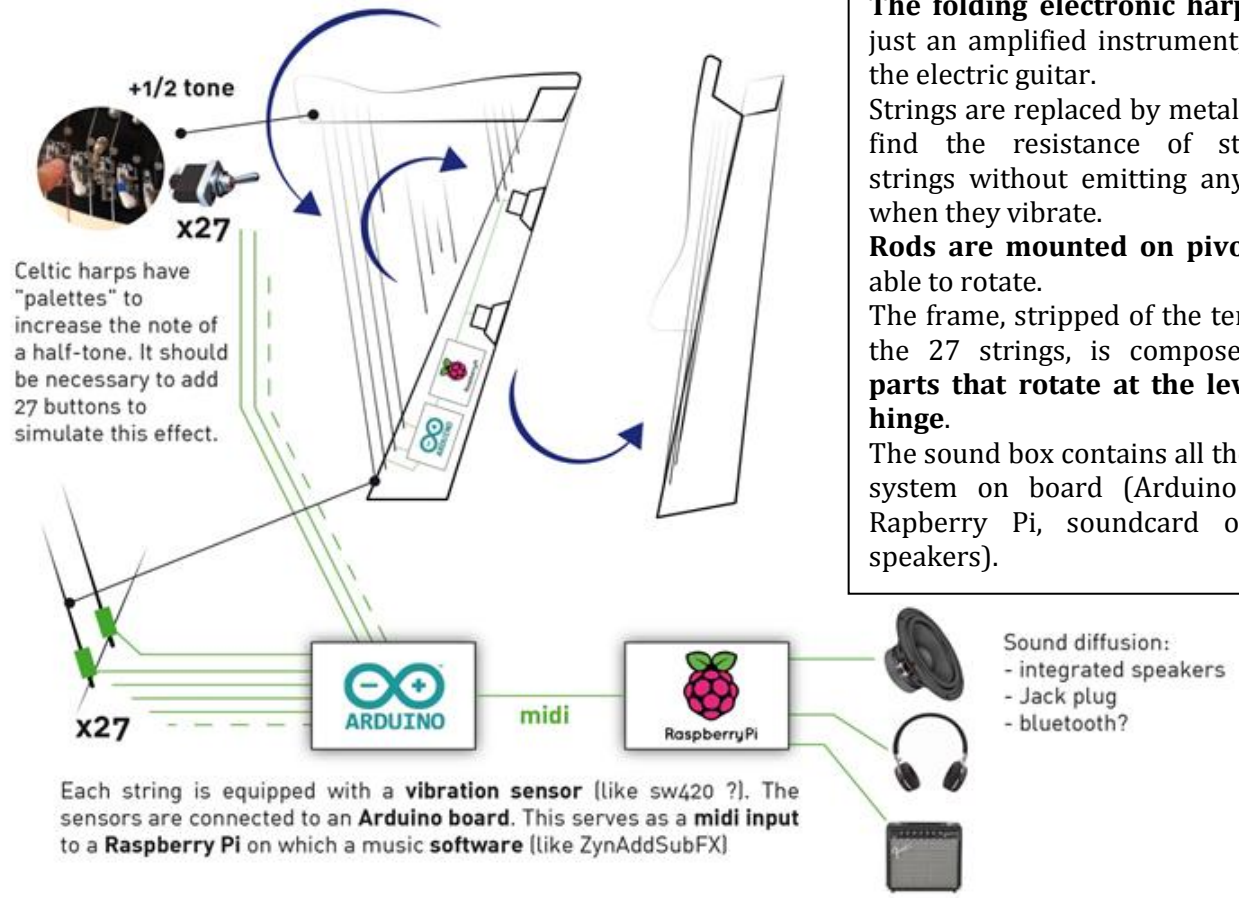
- Achieve a very slow and organic movement of the swarm, using only IR emitters and sensors
- Control each laser in ignition and position
- Find a way to “program” the behavior of the swarm during representations.

# *HARP: Transportable folding electronic harp*

**Designer:** **Pol Dubuis**, contact@poldubuis.com - **06 98 04 18 77**
**Keywords:** **music, electronic, Arduino, Raspberry, practice, folding, training**
**Skills:** **electronics, programming, creativity, collaboration, prototype**

The harp is a bulky instrument and it is **difficult for musicians to move** with their instrument. On the one hand, the music requires a **regular practice** and holidays are often a moment of forced break for students (cool or not ?!...) and, on the other hand, it could be interesting to have an electronic instrument **to jam** easily with friends ...
Even if we want here to realize a **training instrument**, an electronic harp would also allow this classical instrument to come to search for new repertoires of the MAO.

**DESCRIPTION:**
**The folding electronic harp** is not just an amplified instrument, as can the electric guitar.
Strings are replaced by metal rods to find the resistance of stretched strings without emitting any sound when they vibrate.
**Rods are mounted on pivot** to be able to rotate.
The frame, stripped of the tension of the 27 strings, is composed of **2 parts that rotate at the level of a hinge**.
The sound box contains all the sound system on board (Arduino board, Rapberry Pi, soundcard or amp, speakers).




**The project could be supervised by a designer (15 years experience) to give coherence to the project, and by a harp teacher and her students from the Conservatoire de Romans to create a really useful and functional prototype.** The industrial property of this idea belongs to Pol Dubuis and has been protected by the INPI

# Subjects proposed by external companies

# *AIOT: A IO T Device*

**Contact emails:** **Gerard.pospischek@gmail.com, Nicolas.fourty@lcis.grenoble-inp.fr**

**Keywords:** **IoT, RF, LPWAN, BLE Long Range, Cloud, Security, Mesh**

**Skills:** **Wireless Communication, Programmation Java, Python, C,C#, Php, Embedded electronics, antennas, communication systems, EMC**

## Project Context and Goals:

Supply Chain needs are important in areas such as: Fleet Management, Automatic Inventory, indoor-outdoor location, security, asset monitoring, Loads optimization, deliveries, ...
Generaly, wherever human intervention is needed today, we must seek automation to eliminate human error, and reduce physical risks (handling, TMS, ..), facilitate the feedback of information to increasingly complex systems via APIs, or Webservices.
Wireless and low-power communication technologies (Smart BLE, Wifi, Zigbee, NBIot, Lora, Sigfox, ...) development, as well as radio identification technologies (RFID Uhf, Nfc, Wisp, ...) can be combinated with sensors , and different connected objects in heterogeneous networks.
Thus appear on the market: pallets location devices, warehouse indoor location, transport monitoring and optimization platforms,…

## Project description and deliverables:

The target of this project is to demonstrate that it is possible to develop embedded "All in One" devices to monitor different parameters (presence, temperature, movements, shocks, pressure, brightness, position, ...) thanks to sensors integrated into the devices.
We choose to limit the investigations field of this project so as not to be "lost":
- Bluetooth
- 5-6 nodes (Devices) (scaling study)
- Nodes must, individually, be able to be multisensors
- A cartography (2 / 3D) will have to display and refresh the information and the changes of states at a defined frequency (between 2 and 10 seconds)

These devices will communicate together and to the gateway in Bluetooth, in order to reassemble in real time their presence, their position, and their different data from the sensors, in a restricted field to the space of the container (example truck trailer, container)
The environmental constraints are varied and numerous: Temperature variation (-30 to + 60 ° C), shocks, pressure change (closed doors Vs open doors), metal walls or liquid presence, etc.
The energy constraints are also strong, the components of the system infrastructure (including container equipment) must have the longest possible life (> 24 months) without recharging.
Each device will communicate with the other neighbors in a mesh-based low-power network in order to transmit, calculate and store their relative position.
The purpose of this network is to cyclically detect, record and transmit to a BLE 5.0 LR gateway connected to a cloud server, information about each of the devices detected in the gateway field.
This type of approach aims to drastically reduce human controls, ensure the maintenance of information permanence and guarantee maximum content integrity by historically recording events in all phases of the supply chain.
The data need to be secure end-to-end of course.

# *CATAPULT: High Level Synthesis for Hardware Security*

**Supervisors:** **Athanasios Papadimitriou, David Hély, Vincent Beroulle**
**Collaboration with Mentor Graphics**
**Contact emails:** **firstname.name@lcis.grenoble-inp.fr**
**Keywords:** **Catapult, High Level Synthesis, HLS, Hardware Security**
**Skills:** **Catapult, C/C++, VHDL or Verilog, FPGA, IC, Hardware Security**

### Project Context and Goals:

Many aspects of our current life rely on the exchange of data through electronic media. Powerful encryption algorithms guarantee the security, privacy and authentication of these exchanges. Nevertheless, those algorithms are implemented in electronic devices that may be the target of attacks despite their proven robustness. Several means of attacking integrated circuits are reported in the literature. Among them, fault injection and side channel attacks have been reported to be important and effective means to perform attacks.

Mentor Graphics Catapult HLS is a High Level Synthesis platform which provides to designers the capability to describe hardware by using ANSI C++, instead of VHDL or Verilog, with the goal to increase productivity and performance. The tool is able to generate RTL code which can be used either with FPGA or IC design flows.

### Project description and deliverables:

The main purpose of this project is to use High Level Synthesis design flows so as to increase the resilience of either MCUs or crypto-cores against hardware attacks.

The students will choose an existing open-source target hardware description (e.g. RISC-V MCU or AES crypto-core) written in C++ for HLS. Then they will perform multiple synthesis runs with Catapult to produce RTL descriptions and proceed with FPGA implementation.

After the implementation the students will have the opportunity to attack the various design versions by means of an existing Correlation Power Analysis (CPA) platform in order to study their security level. Fault attacks may also be performed by means of clock or voltage glitches.

Finally, countermeasures should be proposed, implemented and tested with the described flow, in order to compare with the unprotected MCU or crypto-core. Once again multiple optimization scenarios should be considered and tested.

### Deliverables:

- FPGA implementation of existing open-source MCU or crypto-core, synthesized with Catapult
- Countermeasures against Correlation Power Analysis attacks, synthesizable with Catapult
- Results of hardware security evaluations of the protected and unprotected designs

**This work depending on the results may lead to the proposal of an internship in collaboration with Mentor Graphics.**

# Subjects proposed by Esisar Students

# *JARVIS*

**Contact emails:** guillaume.rattin@etu.esisar.grenoble-inp.fr & **Wikto Wasowicz**

**Keywords:** **AI – Voice Recognition – STM32 – Microphone – Iron Man – Butler – Communication**

**Skills:** **C/C++ programming – Embedded programming – ARM architecture – Artificial Intelligence – Network**

## Project Context and Goals:

Nowadays the fast development of artificial intelligence fascinates the people. One of the best uses of IA is to assist and support humans in their daily tasks. In this project we will work on a low-consumption solution to extend a voice recognition system in a whole house.

## Project description and deliverables:

This project aims to develop a voice recognition algorithm in an embedded system. A Jarvis system already exists on RaspBerry Pi, but it's a heavy hardware (4 CPU cores, lots of RAM, high core clock, etc.) which consumes a lot of electrical power (2,5A x 5V = 12,5W). In the Jarvis project we will create a small voice command from scratch, implemented on a STM32 target. The goal of this project is to make a light embedded system that could be deployed in an entire house to enable voice commands without involving an over-consumption of electrical power. Some Discovery boards already have a microphone, so it could be a good starting point for the project. Anyway the computing power of these boards might not be sufficient, so the hardware is not yet definitely chosen, and a FPGA could make the processing more efficiently.

The prime objective is to process an audio signal to give rise to the voice recognition. Then we could work on a network to establish communications between some boards. The signal processing could be done on one board that receives the audio signals from other boards or it could be implemented on all the boards indepently. In the second case the network is optional.

In response to the commands, some actions can be programmed but it's not the first goal. A simple dialog based on prerecorded audio samples may be sufficient. Ex: "Jarvis?" "Yes Sir?" is cool enough and can be considered as a proof that everything can be controlled from the voice recognition system.

# *BHCS: The Bionic Hand that can be Controlled by a SMARTPHONE*

**Contact emails:** **alexandre.autran@etu.esisar.grenoble-inp.fr**

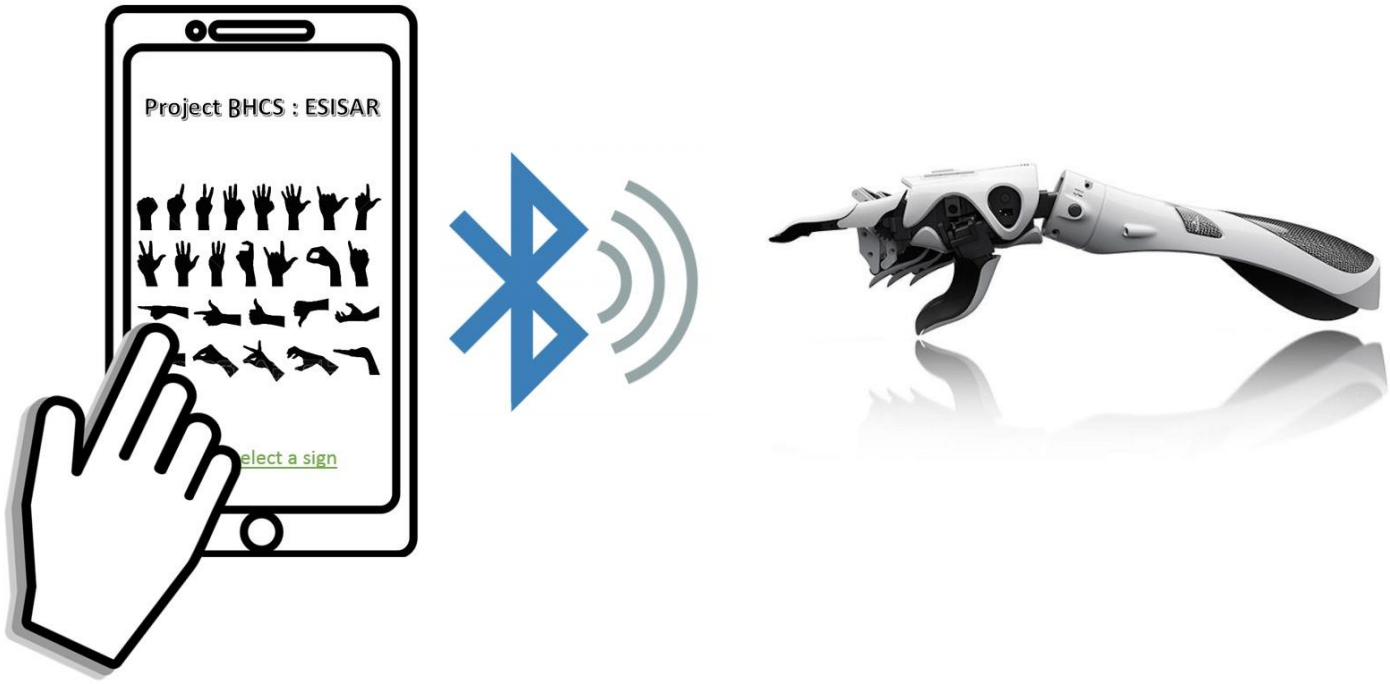
**Keywords:** **3D Printed bionic Hand, Android Studio, Arduino, Bluetooth communication,**

**Skills:** **Informatics (Arduino (C/C++), Java, Xml), 3D Print and**

**Project Context and Goals:** This project comes after seeing the technological progress of other countries. It aims to show that the French engineer can also intervene in the development of the bionic prosthesis.
So, the goal of this project can be decomposed in 3 parts with a bonus:

- Print and assembly 1 right hand and forearm + purchased equipment
- Make an Application for Smartphone
- Make a communication between the entities
- BONUS: Make a glove to replace the Smartphone

## Project description:




It will be necessary to start with the different parts to print with the 3D printer (we will use 3D parts .stl already existing and open source to save time), and order the equipment.
Then, in parallel it will be necessary to start the Smartphone application and the Arduino code (both will have to communicate by Bluetooth).
At last, and if time permits, we will can make a glove to replace the smartphone and who will control the bionic hand more precisely and always by Bluetooth.

**Deliverables:** **APK and project of the application, Arduino code and the Bionic Hand**

# *ECGA: Electrocardiogram Authentication*

**Contact emails:** **Louis.Morge-Rollet@etu.esisar.grenoble-inp.fr** et **Antoine.Linares@etu.esisar.grenoble-inp.fr**

**Keywords:** **Electrocardiogram (ECG) – authentication algorithm - Research domain**

**Skills:** **Sensor – Instrumentation – Electronic – Filtering (Hard & Soft) – Advanced signal processing (MATLAB and C/C++) – Machine Learning (Python and C/C++) – Embedded programming (C/C++)**

## Project Context and Goals: (10 lines)

The authentication algorithms are more and more important nowadays. They are integrated everywhere for normal uses (Personal Computer, Tablet, Smartphone) but also use to protect very critical data and others confidential uses. The principal methods for normal use are numerical or graphical passwords, the principal problem with these methods is that they are really vulnerable to social engineering or spying. To answer at this problem the best solution is to use biometrics solutions (based on the eyes shapes, the fingerprint …). The goal of the project is to develop a biometric authentication algorithm based on the electrocardiogram. The project is about the hardware required to record the ECG but also all the algorithms to process signal and authenticate a person with it. The design of the complete system need to care about the classic embedded constrains such as price, energy consumption, process time…

## Project description and deliverables: (1 page max)

As it is explain below the project is composed of different parts:

- Choose the best electrode and positioning to maximize the signal quality respecting the non-invading and the place constrains
- Choose the write instrumentation circuit to obtain the best signal quality considering the constrain of the system (place, energy consumption, ...)
- Determinate the necessary filtering to reduce noise/baseline drift and make a choice about their software/hardware implementations (Op-amp filtering, RT algorithm, …)
- Choose the potential necessary signal processing algorithm to increase the signal quality
- Choose the best microcontroller and regulator to implement the algorithms
- Find and process different databases to study different ECGs from different persons and find the characteristic of an ECG considering the heartbeat
- Choose the right transformation required for the data recorded (scaling, dimension reduction, …)
- Create an algorithm to authenticate a person with his ECG

The deliverables of the project will be a PCB card with all the electronic required for the project and the algorithms to process the ECG signal and authenticate a person.

The aim of this project will be to prove that a person can be identify from his ECG signature and the algorithm can be implementing on an embedded architecture considering classics constrains of embedded systems: price, energy consumption, place, process time, ...

# CSAW Competition

# *CSAW ESC: Embedded Security Challenge*

**(2 teams possible)**

**Contact emails:** **Cyril.Bresh@lcis.grenoble-inp.fr**
**Keywords:** **Hardware Security, PLC, Fault attack, process control, PLC**
**Skills:** **embedded programming, communicating system**

### Project Context and Goals:

The objective of this project is to participate to the Embedded Security Challenge of CSAW.

### Project description and deliverables:

The theme of this year's ESC competition is **covert data exfiltration from Internet-of-Things (IoT) devices**. IoT devices are physical devices that have embedded electronics and software, and can interconnect and exchange data allowing enhanced dynamic automation and control actions. These devices are becoming ubiquitous, with several billion devices already deployed and several more billions projected to be deployed in the near future. A significant concern regarding IoT devices is their usually poor security posture, stemming from quick time-to-market requirements and lack of appropriate regulations. As IoT devices are being increasingly deployed in diverse environments, they introduce additional security threats to these environments.

The ESC 2018 competition considers the expansion of the threat landscape caused by IoT devices, and invites contestants to **develop covert attacks that (mis)use IoT devices - smart bulbs in particular - to exfiltrate data through side-channels from air-gapped networks**.

The following (fictional) motivational scenario sets the stage for the ESC 2018 competition:

*Lean Enterprise Advanced Knowledge Solutions (LEAKS) is a private technology company that gets awarded most of the defense and military contracts of the country of IoTilandia. Given the sensitive nature of its contracts, LEAKS employs a complete air-gap separation for all its internal networks, ensuring no data is leaked through public connections.*

*A recent presidential order requires that all IoTilandia companies, including LEAKS, "IoTize" [sic] their infrastructure by making everything smarter; coffee makers, fridges, chairs, and light bulbs. To abide to this presidential order, LEAKS has installed sophisticated* ***smart light bulbs*** *in their offices and connected them to their internal network.*

In the CSAW Embedded Systems Challenge 2018 (ESC18), you are tasked to exploit these newly installed smart light bulbs to exfiltrate IoTlandia secrets, bridging the air-gapped networks of LEAKS.

# Subjects proposed by LCIS Lab

# *SECURELOC: Attacks against an UWB Localization System*

**Supervisor:** **Baptiste Pestourie**
**Contact emails:** baptiste.pestourie@lcis.grenoble-inp.fr, nicolas.fourty@lcis.grenoble-inp.fr; vincent.beroulle@lcis.grenoble-inp.fr;
**Keywords:** **UWB, localization, IoT, Time-of-Flight ranging**
**Skills:** **embedded programming, hardware security, wireless network communication**

## Project Context and Goals:

An 802.15.4 UWB indoor localization system has been developed within the Sacco platform that can be used for **security- and safety-critical applications**. These applications can be, for example, location based access control, robots supervision in industrial environments, or supply chain optimization. With the **current expansion of the IoT**, such applications are getting very popular and widely spread and have huge **security requirements**. Thus, the purpose of our localization system is to provide a **prototyping platform** for both **indoor localization** and **security**.

The main objective of this project is to develop an **attack** against the developed system, based on reported flaws of 802.15.4 standard, and to propose **novel countermeasures** against the demonstrated exploits.

## Project description and deliverables:

Our platform consists of a set fixed anchors estimating in real time their distance to several tags within a room, using a Time-of-Flight ranging method. The positions of each tag are obtained by multilateration, the position of the anchors being known. The platform is based on UWB 802.15.4 chips.

Several flaws have been reported on the security of 802.15.4 (Sastry et al. *"Security considerations for IEEE 802.15.4 networks*", 2004). These flaws let an opportunity for an attacker to modify the distance measured between a tag and an anchor, and as a consequence, to alter the position of a tag. We would like to demonstrate these vulnerabilities by mounting an attack against an UWB tag.

The project will focus on two of the main vulnerabilities identified: (1) some nonce that are reset to known values and (2) a weak protection against replay attacks. For (1), the objective is to propose a protocol to decrypt a message based on that flaw. For (2), the team will have to mount an eavesdropping attack and to implement a concrete jamming & replay attack scenario. Then, the team should propose a countermeasure for the demonstrated vulnerabilities.

The team should provide a **feasibility report** on the proposed attacks, and ideally a **demonstration of a reproducible attack scenario** that modifies the position of a static tag. Also, the team should propose **countermeasures** to secure the chips against attack exploiting the identified vulnerabilities.

# *WPT: Wireless Power Transfer*

**Supervisors: Nicolas Barbot, Etienne Perret**
**Emails:** nicolas.barbot@esisar.grenoble-inp.fr
**Keywords: Wireless power transfer, antenna, rectifier, EM simulations.**
**Skills: Embedded systems, PCB realization, EM simulation**

**Project Context:**

Nowadays, Internet of Things, need several enhancements to be deployed in new applications. One of the most important is related to the battery of the device which has to be present to power the device and enable communications. This same battery also increases the cost of the product and, in the same time, and reduces the lifetime of the device.

**Project description and deliverables**

The objective of this project is to design a prototype which can harvest the electromagnetic energy of a distant emitter (915 MHz RFID reader or 2.4 GHz Wi-Fi access point…) to feed a simple LED or a low-power microcontroller. The architecture of this prototype is composed of an antenna, a matching circuit, a rectifier and the load (LED or microcontroller) and is presented in figure 1.

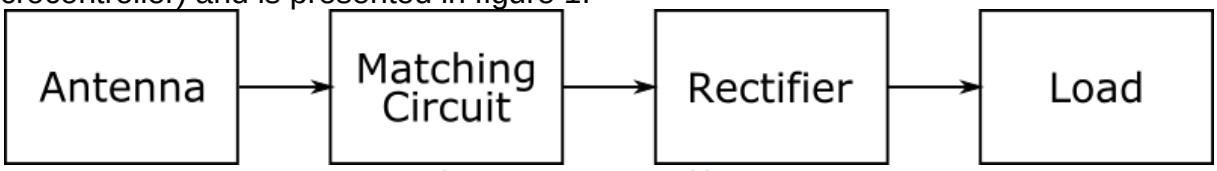



Figure 1: Prototype architecture

In the first step of the project and after the realization of a simple prototype using a LED, experiments could be conducted to estimate the performance of the prototype such as the polarization of the incident wave, the attenuation as a function of the distance (Friis equation) the directivity of the antenna… Figure 2 presents some examples. The objective is to realize a compact and movable prototype that can be shown in some RF courses in order to help students to better understand wave propagation and antenna.

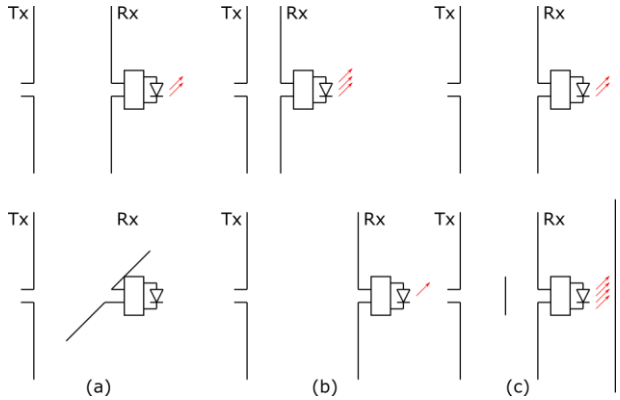



Figure 2: Use cases of the prototype (a) impact of the polarization, (b) Impact of the distance, (c) Impact of the antenna

Figure 3: WISP Prototype

In the second step, simple LED will be replaced by a low-power microcontroller. Different prototypes have already been developed in research laboratories; one of the most important projects is probably the WISP (Wireless Identification and Sensing Platform) project. This project is based on the MSP430 microcontroller and can work up to 10 ft from the RFID reader (see figure 3). Moreover, this platform can backscatter information to the reader using classical RFID tag modulation.

# *FAULT-EMB: Fault model analysis in embedded systems*

**Contact emails:** **Oum-El-Kheir.Aktouf@grenoble-inp.fr**

**Keywords:** **dependability, safety, fault analysis, fault model**

**Skills:** **reading and understanding English, Java or C programming skills**, **UML**

## Project Context and Goals:

A research project is being conducted at the LCIS lab. with collaborators from Europe (Germany, Sweden, Czech Republic) and USA. The objective of this research project is to analyze faults, errors and failures in modern embedded systems taking into account both hardware and software components and determine corresponding fault models. This research project is in its very beginning and the proposed innovation project **Fault-Emb** will be part of its building blocks.
The objective of the Fault-Emb project is to perform a state-of-the-art analysis of faulty behavior within hydraulic actuators and to build corresponding structural and behavioral models.

## Project description and deliverables:

The first step consists of performing a Systematic Literature Review to find relevant papers for selection of Faults, Errors and Failures for Hydraulic Actuators. Then, findings will be mapped in the provided taxonomy (already available) and an abstract prototype behavioral model will be built in terms of state machines in Java or C programming language.
The very abstract behavioral model can be simple: Input, Processing and Output. The internal processing should do the mapping between the input and output. For example, a fault, received as an input by the component can lead to a failure or to multiple failures. Or a failure can be caused by one or multiple faults. Data for the input and output is collected from the taxonomy.

Deliverable 1: A catalogue of Faults, Errors and Failures according to the taxonomy for the hydraulic actuators. The taxonomy will be given.

Deliverable 2: structural and behavioral implementation of classes in Java or C. The instantiated objects need to process the input stimuli and provide the corresponding output. When internal components are interacting, failures will propagate between components.
A component needs to expose correct behavior and faulty behavior ( as deviation from the correct behavior ) depending on the injected fault.
The faulty behavior is given to the component as input parameter and will resemble a simple fault injection technique.

Deliverable 3: Class diagrams, state machine diagrams and deployment diagrams for the provided source code.

# *RCEMP: Remote Code Execution on Medical Pump*

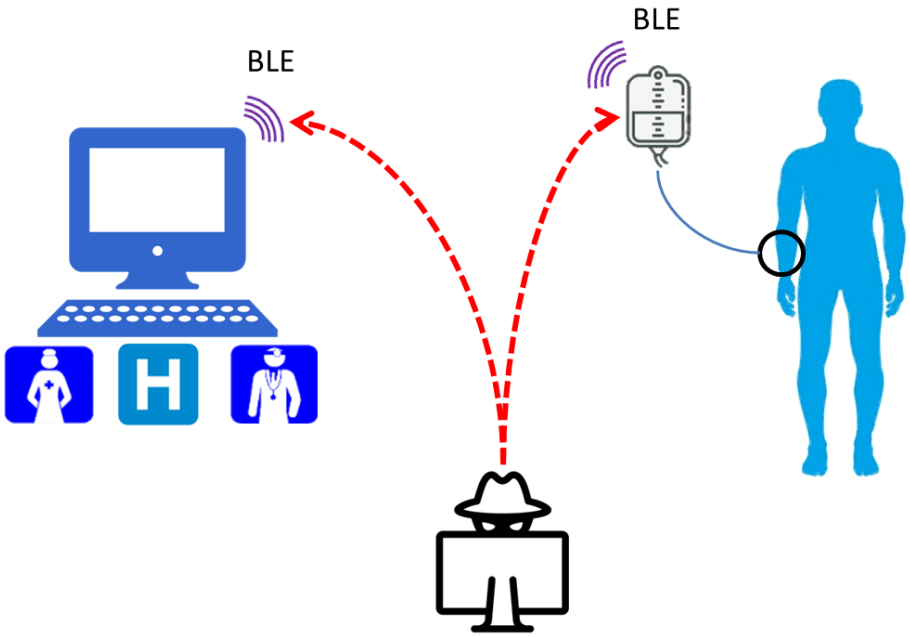
**Supervisors:** **Cyril Bresch, Nicolas Barbot, David Hély**
**Emails**: **cyril.bresch@lcis.grenoble-inp.fr, nicolas.barbot@esisar.grenoble-inp.fr, david.hely@esisar.grenoble-inp.fr**
**Keywords:** **Pentesting, Software Exploitation, Internet of Things, BLE, STM32.**
**Skills**: **Python, C programming, ARM Assembly**.

## Project Context:

This project falls within the framework of the European Project SERENE-IoT (Secured & EneRgy EfficieNt hEalth-care solutions for IoT market). SERENE_IoT project aims at contributing to develop high quality connected care services based on IoT devices. In this project, the LCIS performs security evaluations of processing units that will be integrated within IoT system. The purpose of LCIS is twofold, first analyzing such systems and points out the weaknesses, secondly, developing hardware based security mechanisms that will be integrated in IoT systems.

## Project Description and Deliverables:

Currently a medical connected pump model was developed by the LCIS on a STM32 board. This model contains software vulnerabilities that can be remotely exploited by a hacker.
The goal of the project is to demonstrate that it is possible to exploit such vulnerabilities through a BLE communication protocol.




The implementation of this demonstrator needs to be done in two stages. First, the team will improve the demonstrator by implementing a BLE connection between the pump model and a remote computer. To make the demonstrator close to reality the remote computer will handle a simple GUI that displays the state of the pump. Secondly, the team will develop an exploit and execute remote code via BLE connection.

# *VISION: Vision-based control of a quadcopter platform*

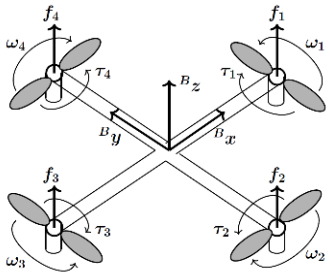
**Contact emails:** ngoc-thinh.nguyen@lcis.grenoble-inp.fr, ionela.prodan@lcis.grenoble-inp.fr

**Skills: Informatics (C, Matlab/Simulink), Modeling and System Identification (Newton-Euler formalism), Control Theory (PID, Nonlinear Control, Vision-based Control), Electronics**

## Context

The project will focus on localization and hovering/landing control implementation of a Parrot Rolling Spider micro drone using the built-in sensors including a down-facing camera.

The platform is composed from an aerial unit (the Parrot drone) and a host which sends/receives data by using Matlab/Simulink (Simulink Support Package for Parrot Minidrones). The Parrot Rolling Spider drone weighs 54 grams and is equipped with ultrasonic, 6-DOF IMU, air pressure and camera sensors. This quadcopter is controlled either by the smartphone via wireless connection or by the PC thourgh the Matlab/Simulink interface.




The project will concentrate on the following issues (any other ideas and innovative directions are strongly encouraged):

- understand the platform and the Simulink Support Package for Parrot MiniDrones (https://fr.mathworks.com/hardware-support/parrot-minidrones.html);
- solve and implement the hovering/landing problem for the Parrot drone using vision-based control on Matlab/Simulink;

At the start of their project activities the students have to:

- familiarize with existing nonlinear quadcopter dynamics,
- familiarize with Matlab/Simulink.

## Expected results

At the end of the project the students are expected to:

- be proficient with C and Matlab/Simulink environment;
- have tested the theoretical notions over experimental platforms provided by LCIS laboratory and to have obtained results validating them.

**References**

[Ref. 1] R.W. Beard, T.W. McLain (2012) : Small unmanned aircraft: Theory and practice. Princeton University Press.

[Ref. 2] I. Prodan, S. Olaru, R. Bencatel, J.B. Sousa, C. Stoica, S.-I. Niculescu (2013): Receding horizon flight control for trajectory tracking of autonomous aerial vehicles. *Control Engineering Practice*, vol. 21, no. 10, pp. 1334 -1349.

[Ref.3] N.T. Nguyen, I. Prodan and L. Lefevre (2017): Quadcopter trajectory tracking using a two-layer optimization-based control strategy, *Proceedings of the 25th IEEE Mediterranean Conference on Control and Automation (MED'17)*, pp. 115--120.

# *GAZEBO: Control of a quadcopter platform by using ROS and Gazebo*

**Contact emails:** clement.raievsky@lcis.grenoble-inp.fr ngoc-thinh.nguyen@lcis.grenoble-inp.fr, ionela.prodan@lcis.grenoble-inp.fr

**Skills:** **Informatics (ROS, Gazebo, Python, Matlab/Simulink), Modeling and System Identification (Newton-Euler formalism), Control Theory (PID, Nonlinear Control), Electronics**

## Context

The project will focus on localization and control implementation of a Crazyflie micro drone using an external positioning system interfaced with ROS (Robotic Operating System).

The platform is composed from an aerial unit (the Crazyflie) and a host which sends/receives data through a dedicated USB radio dongle (the Crazyradio PA). The host platform can be either a Linux or Windows PC or an embedded system like Raspberry Pi or smartphone (in which case the communication is done via Bluetooth LE protocol). The Crazyflie quadcopter weighs 27 grams and the size is 92x92x29 mm. This quadcopter is equipped with an STM32 microcontroller, a 9-axis IMU sensor and a pressure sensor with a small Li-Po battery. This quadcopter is controlled either by the joystick/PC client or by the smartphone via wireless connection with 2.4 GHz Crazyradio PA and Bluetooth Low Energy module.

The Crazyflie receives references from the ground and follows them in low-lovel control loops which are implemented on the embedded CPU installed on it. These references can be provided either manually (via joystick controllers) or as the result of computations on the host platform.

ROS

GAZEBO

The project will concentrate on the following issues (any other ideas and innovative directions are strongly encouraged):

- understand the platform and its capabilities (Crazyflie http://www.bitcraze.se/crazyflie/);
- use the Loco Positioning system (a miniature GPS system) to find the absolute 3D position of object in space;
- solve and implement the control problem for the Crazyflie using an open-source platform for writing robotic software called ROS (Robotic Operating System) http://wiki.ros.org/;
- compare the experimental results of the Crazyflie with the simulation results on the Gazebo simulation software;

## Expected results

At the end of the project the students are expected to:

be proficient with Python, Matlab/ Simulink environment, ROS and Gazebo;

have tested the theoretical notions over experimental platforms provided by LCIS laboratory and to have obtained results validating them.

# *QUADLOC: Localization and trajectory tracking of a quadcopter platform*

**Contact emails:** ngoc-thinh.nguyen@lcis.grenoble-inp.fr, ionela.prodan@lcis.grenoble-inp.fr

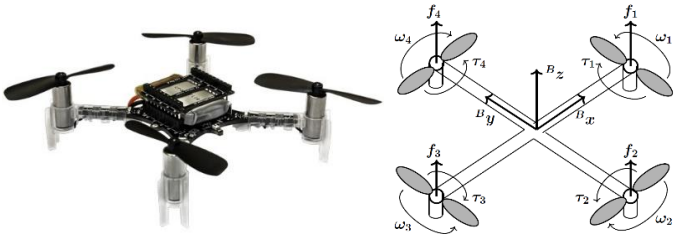
**Skills:** **Informatics (Python, C, Matlab/Simulink), Modeling and System Identification (Newton-Euler formalism), Control Theory (PID, Nonlinear Control, Optimal Control), Electronics**

## Context

The project will focus on localization and trajectory tracking control implementation of a Crazyflie micro drone using the external positioning system – Loco Positioning.

The platform is composed from an aerial unit (the Crazyflie) and a host which sends/receives data through a dedicated USB radio dongle (the Crazyradio PA). The host platform can be either a Linux or Windows PC or an embedded system like Raspberry Pi or smartphone (in which case the communication is done via Bluetooth LE protocol). The Crazyflie quadcopter weighs 27 grams and the size is 92x92x29 mm. This quadcopter is equipped with an STM32 microcontroller, a 9-axis IMU sensor and a pressure sensor with a small Li-Po battery. This quadcopter is controlled either by the joystick/PC client or by the smartphone via wireless connection with 2.4 GHz Crazyradio PA and Bluetooth Low Energy module.

The Crazyflie receives references from the ground and follows them in low-lovel control loops which are implemented on the embedded CPU installed on it. These references can be provided either manually (via joystick controllers) or as the result of computations on the host platform.




The project will concentrate on the following issues (any other ideas and innovative directions are strongly encouraged):

- understand the platform and its capabilities (Crazyflie http://www.bitcraze.se/crazyflie/);
- use the Loco Positioning system (a miniature GPS system) to find the absolute 3D position of object in space;
- solve the trajectory tracking problem and implement the tracking controller for the Crazyflie using Python;

## Expected results

At the end of the project the students are expected to:

- be proficient with Python, C and Matlab/ Simulink environment;
- have tested the theoretical notions over experimental platforms provided by LCIS laboratory and to have obtained results validating them.

**References**

[Ref. 1] R.W. Beard, T.W. McLain (2012) : Small unmanned aircraft: Theory and practice. Princeton University Press.

[Ref. 2] I. Prodan, S. Olaru, R. Bencatel, J.B. Sousa, C. Stoica, S.-I. Niculescu (2013): Receding horizon flight control for trajectory tracking of autonomous aerial vehicles. *Control Engineering Practice*, vol. 21, no. 10, pp. 1334 -1349.

[Ref.3] N.T. Nguyen, I. Prodan and L. Lefevre (2017): Quadcopter trajectory tracking using a two-layer optimization-based control strategy, *Proceedings of the 25th IEEE Mediterranean Conference on Control and Automation (MED'17)*, pp. 115--120.