

Embedded systems – System modeling

Course goal : experience and learn how to design, create, and implement a small embedded robotic solution (with Lego EV3 or any other robotic solution), while working as an international team.

Teachers

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GitHub : <https://github.com/myrobotswillconquertheworld> (code examples and ressources)

We (your teachers) will be your clients, as we will submit to your teams **problems that needs to be solved**. For the length of the course, we expect you to behave as professional engineers, regarding the quality, exactitude, etc. of all your production.

We are here to teach you as much as we can: there is no stupid question, if you don't ask, you will never know. We are available 24/7 by mail.

This document is a guide, but if you have alternative solutions / plans, tell us. We are open to any ideas or initiatives. Good ideas and innovation will be rewarded with bonus points.

Schedule

Lessons are on Monday afternoon, on the following days :

- November 20th
- November 27th
- December 4th
- December 11th
- December 18th
- January 8th
- January 15th
- January 16th (To be confirmed)

However, we expect you to work more than just the few hours that we will spend together. To succeed, you need to **work steadily and avoid last minute rush**.

Some lesson will start with a short presentation by your teachers on a given topic to help you (the V cycle, Robot mobility, How to do test-driven development, ...)

For the rest of the lesson, we will review each group progress, grade your achievements (if needed) and help you / answer your questions

Team organization

You will be in teams of 3 to 5 students, from various origins and background. Each team will name:

- A Project manager, in charge of :
 - > Leading and coordinating the team
 - > Reporting team progress or problems to us
 - > Delegating tasks and taking decisions
- A software chief engineer, in charge of :
 - > Leading the software design & structure
 - > Publication of source code on Github
- A hardware chief engineer, in charge of :
 - > Leading the hardware design
 - > Creating a model of the robot with Lego Digital Designer (or similar)
- A test chief engineer, in charge of :
 - > Leading the tests design and validation
 - > Keeping track of test success/failure
- A documentation manager (optional), in charge of:
 - > Leading the writing of robot's documentation, both in the code and in any other form

The aim of these attributions is to help you structure your team and avoid the common error of "one student do all the work but everyone gets all his points". You can challenge this organization and propose something different if you wish. However, everyone in the group must understand and be able to explain all the robot functionalities / other team members part.

Subjects

Here the two problems to be solved :

- Each group has to choose one.
- Look up the specification for each of those before choosing !
- Each Project has 3 steps from bronze to gold.
- Each step has a test specification that will give the minimum requirements for each level.

Search and rescue

- **Problem to solve : create a robot that can search, find and rescue a defined object**
- **Test sheet : 2023_Test_search&rescue**
- **Bronze :**
 - The robot is able to autonomously explore a square 1.5m x 1.5m area and detect the target
 - The robot is able to home in on the target
- **Silver :**
 - The robot is able to pick up the target and get back to his starting point
 - He is able to choose between multiple search path (at least 3) depending on the situation
- **Gold :**
 - The robot is able to report to a remote system, with a graphical user interface.

Anti drone system

- **Problem to solve : create a robot that can detect and fire at flying drones**
- **Test sheet : 2023_Test_antidrone.pdf**
- **Bronze :**
 - The robot is able to scan the sky and detect the target
 - The robot is able to evaluate the distance to target
- **Silver :**
 - The robot is able to shoot the target taking into account its altitude/elevation and distance
- **Gold :**
 - The robot is able to report to a remote system, with a graphical user interface

Grading

General concept

You will need to deliver documents and/or achievements at nearly each sessions, and the final product / robot will be graded as well, as follow:

- 50% of the points on four different achievements (10pts)
- 50% of the points on the final project (10pts)
- 2 bonus points on innovation and risk taking

The aim of this grading is to force the groups to work on a regular basis, and also to “save” groups that would have worked well along the way but may end with a failed/unusable robot in the end.

Achievements to deliver

> Achievement 0 (0pts), due date NLT Nov 20th 2023

- Form a group, and a name for the group
- choose a subject, read the specifications
- discuss the subject/problem with your client/teachers
- Learn the basics of Lego Mindstorm
- appoint group members to all positions
- report all this to your teachers by mail

> Achievement « basic » (2.5pts), due date NLT Nov 27th 2023

- Choose between EV3dev OS or another robotic system for your project
- Choose a development environment (Eclipse, PyCharm, ...) and adequate plugins
- Install this OS on one EV3 brick / Setup the bases of your robotic system
- Test a simple sensor-motor loop, and demonstrate that loop to your teachers
- Open a Github project for your project and post your test code
- Present a first design solution to your teachers with a ppt (and any additional media needed), and present to your clients (teachers) your solution for the 3 intermediary construction steps Bronze, Silver, Gold, with according tests (you have an example PPT in the files).
- Provide a draft of a clear diagram of your robot
- (Optional) If needed, ask for additional pieces / sensors / bricks to be ordered.
- Report to your teachers by mail

> Achievement « Bronze » (2.5pts), due date December 4th 2023

- Project step Bronze : test and validation Bronze is achieve
- Course correction : problem encountered and planning towards Silver
- Present a progress report to your teachers

> Achievement « Silver » (2.5pts) due date December 18th 2021

- Project step Silver : test and validation Silver is achieved
- Course correction : problem encountered and planning towards Gold
- Present a progress report to your teachers

> Achievement « Team work and personal skills » (2.5pts), no due date

- Personal skills and investment in the group (Quality of your work, attitude, professionalism, etc.)
- General team impression, including but not limited to:
 - team work,
 - timing,
 - professionalism
 - writing skills,
 - etc.
- Good usage of any needed tools (Github, EV3, Python, Clarity of source code)
- Quality of the documentation
- Beauty and style of your robot

> Final presentation « Gold » (10 pts) due date January 15th and 16th

On the last day, you will deliver and present your solution (step Gold):

- Present your work to your clients/teachers (30 min max, any media), including:
 - Code structure (classes, functions, why...)
 - Hardware description (choices and why)
 - Specifications and tests review (which one you pass, which one you fail)
 - Problem encountered
 - Any other information that may be of interest (unitary test, matlab simulation, Simulink, ...)
 - Do a live demonstration (15 min),
 - Answer questions (15min).
- Each student must be able to change some parameters in the system and explain it
- We expect you to dress up for this presentation.

In a practical way

- each group will have a Lego box, with an EV3 brick, some motors, sensors, and lego pieces. Please write the group name and number on the box, and store it safely in the lab's cupboard. You are responsible of your brick, pieces, and project. You can take your project home for a while if needed, but all robots and pieces have to come back at the end.
- If you never played with Lego, do not underestimate the building time : finding a simple yet sturdy structure for your robot is difficult and time consuming.
- If you need additional pieces, sensors, motors, just ask (ASAP), we can order them (**Remember to do it as quickly!**).
- If you want to use another robotic platform, it's possible, but ask quickly : the buying process of ISEP is quite long.
- Remember that you will be judged by real-world engineers and as young engineers : we expect a high level of professionalism and a good attitude.