ROS and experimental robotics

MU4RBR04 – Parcours ISI, SAR, SMR

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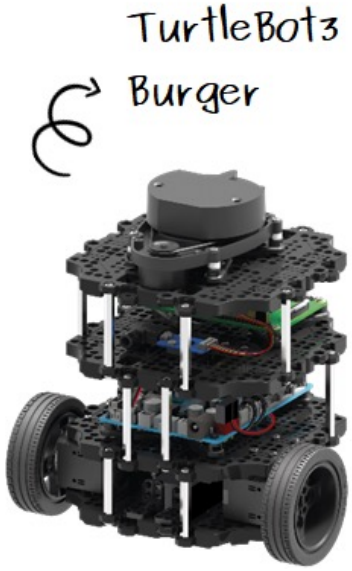
Presentation of the teaching unit (UE)

An UE dedicated to ROS (a software framework for Robotics) and experimental robotics.

You will exploit all your competencies in:

- Python,
- signal/image processing,
- automatic control,
- etc. on a physical robot.

ROS



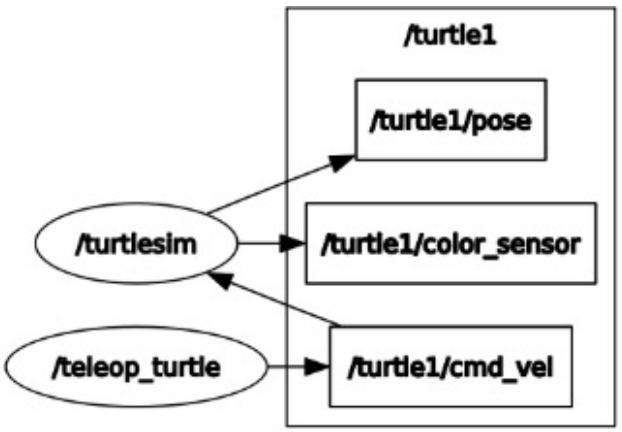
This course is based on **new pedagogical methods** that aim to maximize your time in class to do experiments

Personal and autonomous work through tutorials is mandatory !

Skills (1/2)

At the end of this teaching unit, you will be able to:

- **Master all the root concepts of the ROS software**
  - nodes, messages, topics, services, etc.
- Write a standard subscriber and publisher node in Python
- Understand and exploit a simulated robot description in a **physical simulator**



Skills (2/2)

At the end of this teaching unit, you will also be able to:

- Extract from the simulation some motor and sensory data (LIDAR and a camera) to achieve navigation in a simulated environment:
  - Emergency stop behavior,
  - Line following, etc.

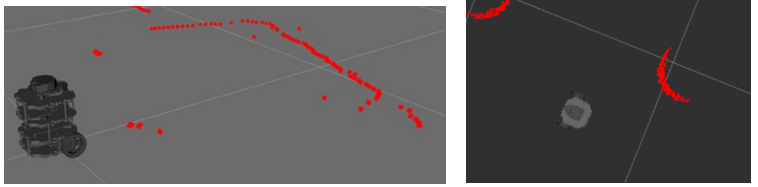
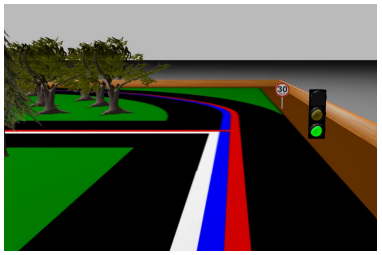


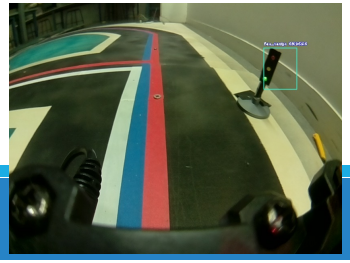
Illustration of simulated LIDAR detection



Simulated camera and line following algorithm

- Interface with a real robot, and to adapt all the written code to real data in order to make the robot autonomously navigate on a small dedicated arena.

Real camera and line following algorithm



Your work

You have to work **on your own** :

- Install a virtual machine on your own computer to run ROS

VMware workstation player

- Prepare the first weeks of practicals by **following the tutorials** seriously and conscientiously
  - **Your success in this teaching unit depends directly on this work**
  - We will be available to answer all your questions as soon as possible on Moodle forum.
  - Never hesitate to ask a question during this phase, don’t get stuck

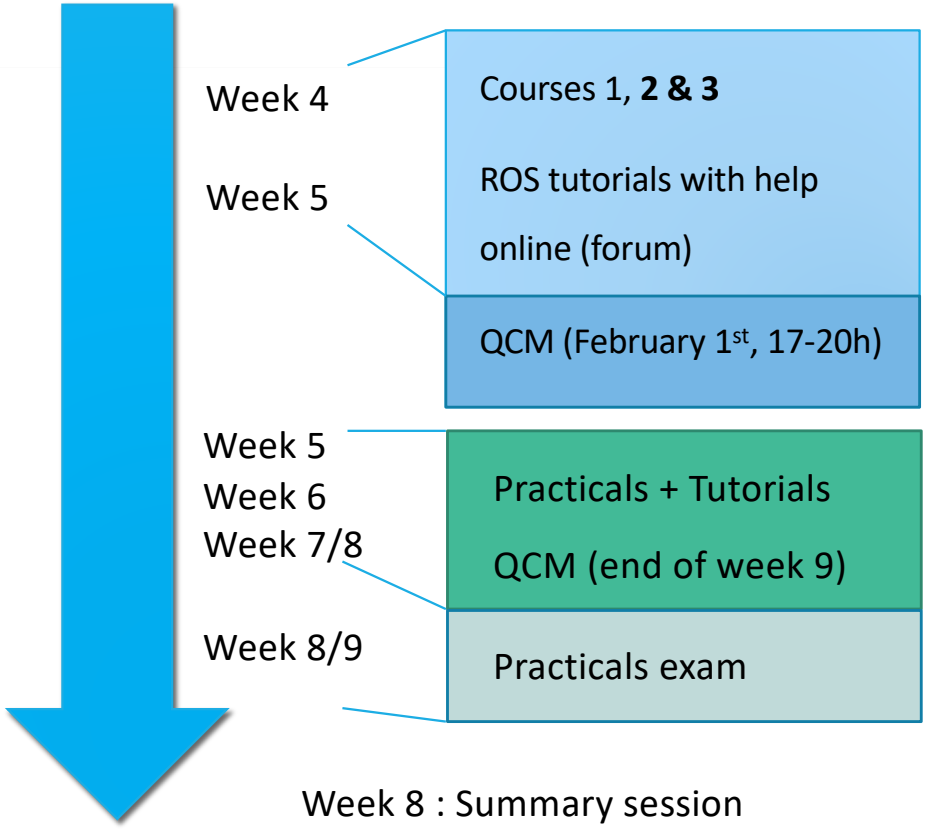
Organization (1/3)

1st phase

Definition of the root concepts of ROS, and complementary elements on event-based programming and client-server communications

Programming of a simple **ROS teleoperation node**, on the basis on **ROS tutorials**

Application to the control of very simple simulated robot (turtlesim) *and of a realistic simulated robot (Turtlebot 3 burger)*



Organization (2/3)

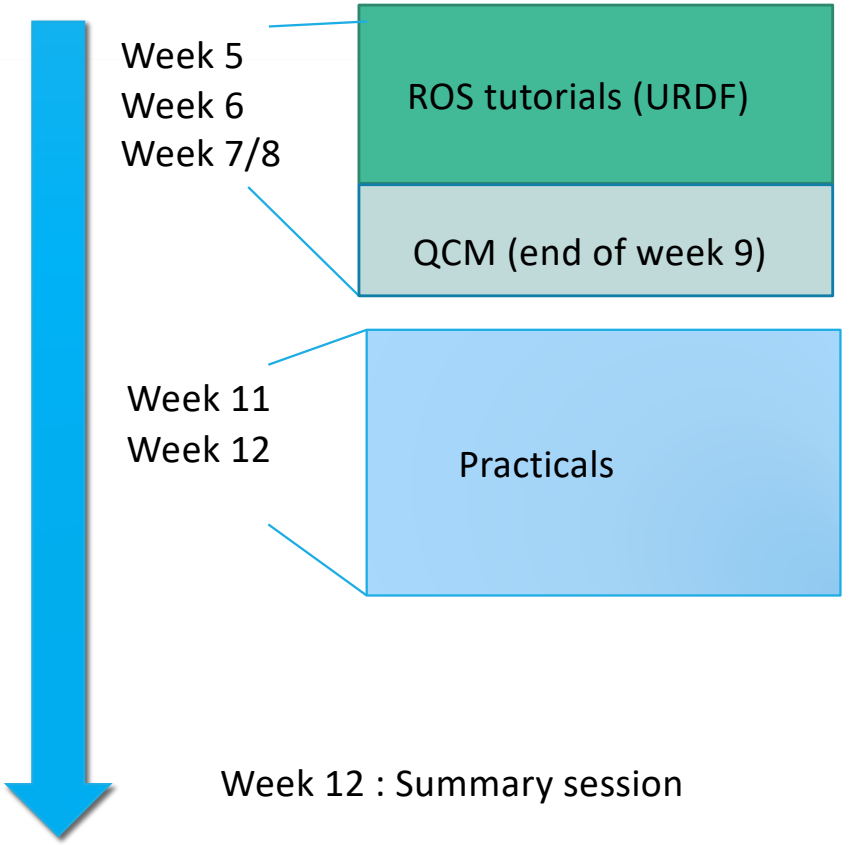
2nde phase

Short introduction to the geometrical definition of a simple robot (URDF)

Exploitation of the description with gazebo to gather sensorimotor data from a camera and a laser distance sensor

- Exploitation of the laser data to trigger an “emergency stop” behavior in a ROS node
- Elements of image processing with openCV to program a line following algorithm

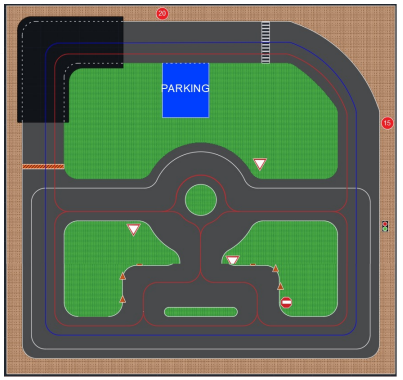
Tests of the approach with the simulated robot



Organization (3/3)

3rd phase

Project aiming at merging all the previous developments in order to make a Turtlebot 3 burger:



- autonomously navigate in an environment mades:
  - of lines to follow
  - of obstacles to avoid.

- Weeks 13-15: 6 x 4 hours sessions
- Week 16: Project evaluation

Evaluation

MCQ1 (ROS): **12,5 pts (ER) 10 questions / 7 mn** **Date: 1/02 (17h-20h)**

Practical exam (phase 1): **25 pts (ER !!), 1h30, individual**

- Date : ISI = 24/02, IPS/SAR : 27/02

MCQ2 (URDF): **12,5 pts (ER) 10 qu. / 7 mn** **Proposition: 4/03 to 5/03 (08h-20h)**

Phase 3 (Project): **50 pts**

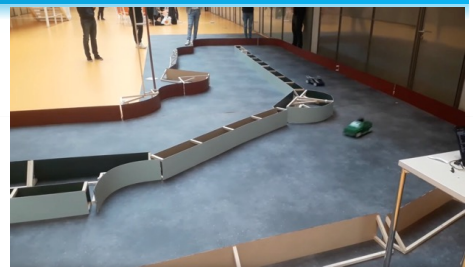
- >> evaluation criterions on Moodle

TOTAL = 25% MCQ + 25% Exam + 50% Project

To conclude !

All the information and teaching aids are available on Moodle

One more thing ...



Autonomous car competition: ENS, Centrale, ENSTA, IUT de Cachan, etc.

- SU team for the competition, made of all interested student, potentially coming from all Master !
- sat. 15th april, ENS Saclay
- current ongoing work with M2 students (ISI & SAR) : buildong of the car, electronical architecture, ROS software, sensor interfaces, etc.

=> the team is looking for new students, which could work on the competition during the ROS teaching unit!