PROJECTS 2017/18

Instituto Superior Técnico

Departamento de Engenharia Electrotécnica e de Computadores

September 2017

LIST OF AVAILABLE ROBOTS AND DEVICES

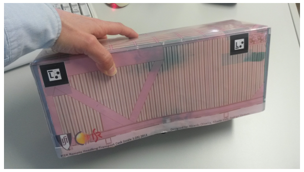
- **7 Pioneers 3DX (with Hokuyo laser range finder)**

Pioneer 3DX

- **2 Pioneers 3AT (with SICK laser range finder)**

Pioneer 3AT

- **1 ITER scale vehicle**



ITER scale vehicle

- **1 DJI Phantom 2 drone**

DJI Phantom 2

- **Several Kinects, Laser Range Finders (LRF), and other sensors**

Microsoft Kinect

Hokuyo URG-04LX-UG01

SICK LMS 200

PROJECT

24 PROJECTS:

- Groups of 3-4 students
- Focused on 1-2 of the course topics
- Use of ROS strongly suggested
- Demonstrated in real robots

PROJECT TOPICS

Project topics and code scheme:

[L*n*] – Localization

[S*n*] – Simultaneous Localization And Mapping (SLAM)

[M*n*] – Mapping

[RL] – Reinforcement Learning

[I*n*] – International Thermonuclear Experimental Reactor (ITER)

[H*n*] – SocRob@Home

PROJECTS: Localization

Goal: estimate in real-time the pose (position+orientation) of a mobile robot; evaluate estimation performance, as well as absolute localization, and robustness to “kidnapping”.

Available methods:

Extended Kalman Filter (EKF)

Monte Carlo Localization (MCL)

Available sensors:

Laser Range Finder (LRF)

Microsoft Kinect

Magnetometer

Wi-Fi RSSI

Project codes:

[L1] MCL + LRF Localization

[L2] EKF + LRF Localization

[L3] MCL + Kinect Localization

[L4] EKF + Kinect Localization

[L5] MCL + Magnetometer Localization

[L6] EKF + Magnetometer Localization

[L7] MCL + Wi-Fi Localization

[L8] EKF + Wi-Fi Localization

PROJECTS: SLAM

Goal: estimate simultaneously the trajectory (position+orientation) of a mobile robot and the landmark positions (map); evaluate estimation performance and robustness to "kidnapping".

Project codes:

[S1] – EKF-SLAM + Marker

[S2] – FastSLAM + Marker

[S3] – GraphSLAM + Marker

[S4] – EKF-SLAM + UWB

[S5] – FastSLAM + UWB

[S6] – GraphSLAM + UWB

Available methods:

EKF-SLAM

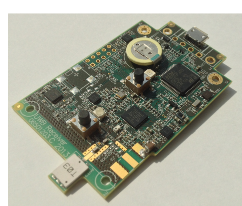
FastSLAM

GraphSLAM

Available measurements:

Visual marker

Ultrawide band (UWB)



PROJECTS: Mapping

Goal: estimate the map of a floor using Occupancy Grid Mapping; evaluate quality of the map with respect to ground truth.

Available sensors:

- Laser Range Finder (LRF)
- Microsoft Kinect
- Sonar

Project codes:

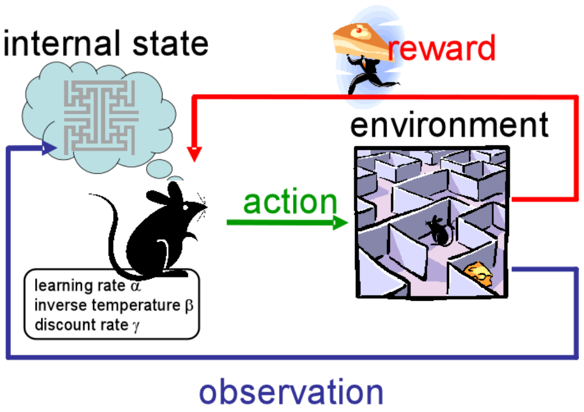
- [M1] – LRF Mapping
- [M2] – Kinect Mapping
- [M3] – Sonar Mapping

PROJECTS: Reinforcement Learning

Goal: a real robot will learn a task (to be defined by the group, e.g., a maze) in a real structured environment; evaluate learning rate, performance, and robustness to noise.

Method: reinforcement learning techniques will be used, i.e., the robot will learn its task based on rewards received from its human teacher. The rewards will be provided by the human using gestures recognized by a Kinect. Off-the-shelf localization and mapping packages can be used to estimate the robot location in the designed (preferably structured) environment.

Project code: [RL] – Reinforcement Learning



PROJECTS: ITER

Goal: estimate in real-time the pose (position+orientation) of a mobile robot; evaluate estimation performance comparing with ground truth (e.g., using a motion capture system).

Available methods:

Extended Kalman Filter (EKF)

Monte Carlo Localization (MCL)

Available measurements:

Onboard LRF

Offboard LRF

Visual markers

Available robots:

Cask Transport System scale model

Drone (DJI Phantom)

Project codes:

[I1] – Onboard LRF + EKF Localization

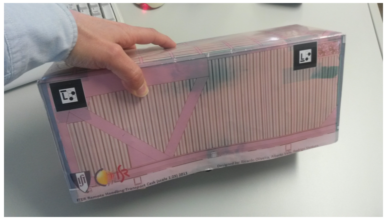
[I2] – Onboard LRF + MCL Localization

[I3] – Offboard LRF + EKF Localization

[I4] – Offboard LRF + MCL Localization

[I5] – Drone + Markers + EKF Localization

[I6] – Drone + Markers + MCL Localization



PROJECTS: SocRob@Home

Context: the SocRob@Home team is focused on the participation on scientific robot competitions on the problem of service mobile robots targeting domestic environments.

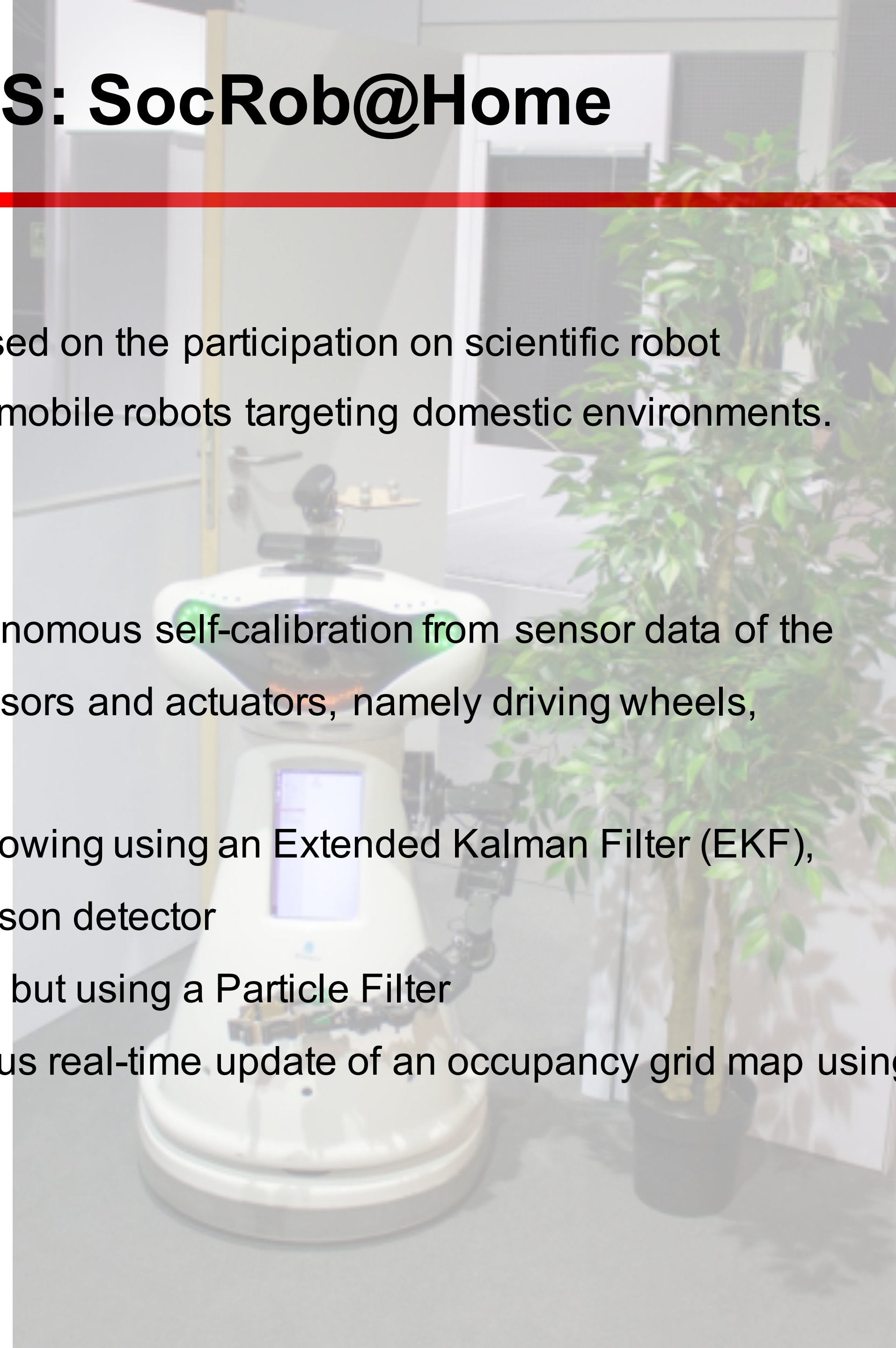
Available projects:

[H1] – Geometrical self-calibration: autonomous self-calibration from sensor data of the geometrical transformations among sensors and actuators, namely driving wheels, cameras, and a robot arm.

[H2] – EKF people following: people following using an Extended Kalman Filter (EKF), fusing odometry and a vision-based person detector

[H3] – PF people following: same as S2 but using a Particle Filter

[H4] – Map real-time update: autonomous real-time update of an occupancy grid map using Laser Range Finder (LRF) data



PROJECT ASSESSMENT AND SCHEDULE (1)

- <u>Continuous assessment</u>*: each group does an oral progress presentation (1 group member per presentation) every other week in its designated shift (4 groups per shift per Lab day) – total of 5 intermediate presentations in LSDC4 + 1 final presentation per group in a public poster session at the Torre Norte's entrance hall*
- <u>Project progress presentations during laboratory sessions</u> *start on 9 Oct 2017 (fourth week of classes)*
- *Projects presented to students Thursday (21 Sep) in the theoretical class*
- *There will be a 3-session* <u>short course on ROS</u> *in the first three weeks:*
  - *[introduction] 21 Sep 18:30-20:00, room EA4*
  - *[practical] 25, 26, and 28 Sep 18:30-20:00, room LSDC1*
  - *[hands-on] 2 and 3 Oct 18:30-20:00, room LSDC1*

<u>Project Report Hand-in</u>: 10 (shift 1) and 17 (shift 2) Dec 2017
<u>Final public poster session</u>: 5 Jan 2018

PROJECT ASSESSMENT AND SCHEDULE (2)

VERY IMPORTANT

Schedule for lab classes -- Autonomous Systems

	#	Shift 1	Shift 2
Monday	1	9-Oct	16-Oct
	2	23-Oct	30-Oct
	3	6-Nov	13-Nov
	4	20-Nov	27-Nov
	5	4-Dec	11-Dec
Tuesday	1	10-Oct	17-Oct
	2	24-Oct	31-Oct
	3	7-Nov	14-Nov
	4	21-Nov	28-Nov
	5	5-Dec	12-Dec
Thursday	1	12-Oct	19-Oct
	2	26-Oct	2-Nov
	3	9-Nov	16-Nov
	4	23-Nov	30-Nov
	5	7-Dec	14-Dec

PROJECT ASSESSMENT AND SCHEDULE (3)

***Project Grading*:**

- ***FAIL**: nothing works, not much relevant work done in design + implementation, no reasonable explanation (e.g., problems with hardware) for failure to show results*
- ***10-14**: at least some experimental results can be shown, significant design + implementation work made of at least fair quality*
- ***15-17**: good experimental results, significant design + implementation work made of at least good quality and supported by theory*
- ***18-19:** very good experimental results and design + implementation work made and supported by theory*
- ***20**: excellent and flawless experimental results and design + implementation work made and supported by theory; in exceptional cases could correspond to the factors listed for 18-19, extended with some original unsolicited extra work*

WHAT'S NEXT

1. [UNTIL 26 SEP] Send an e-mail to both course professors with the composition of your group, plus 3 projects and 3 lab classes, both listed by decreasing preference order. Use the following template:

- *Student1_number* *Student1_name*
- *Student2_number* *Student2_name*
- *Student3_number* *Student3_name*
- *Student4_number* *Student4_name*

1. *Project code and title that we prefer the most*
2. *Project code and title that we prefer (2nd)*
3. *Project code and title that we prefer (3rd)*

1. *Lab class (Mon, Tue, or Thu) and shift (1 or 2) that we prefer the most*
2. *Lab class (Mon, Tue, or Thu) and shift (1 or 2) that we prefer (2nd)*
3. *Lab class (Mon, Tue, or Thu) and shift (1 or 2) we refer (3rd)*

2. FACULTY ASSIGN PROJECTS TO GROUPS NO LATER THAN 1 OCTOBER

3. GROUPS REGISTER IN FENIX NO LATER THAN 6 OCTOBER