1   Hands-on Localization Projects

Each project proposed (see tables 1 to 3) will be performed by a group of the students and is defined by:

- **The type of Filter/Smoother used for the estimation:**

    - FEKFSLAM: Feature Based SLAM
    - PEKFSLAM: Pose Based EKF SLAM
    - GRAPHSLAM: Graph-SLAM (using GTSAM)

- **Motion model:** The primary motion model to be used will be the one using odometry as the robot displacement.

- **Measurement model:** The heading obtained from the compass will be used to complement the odometry.

- **Observation Model:** For feature based methods this defines the sensor model, this is the $h(\cdot)$ method. For Pose base methods, it defines the relative displacements between viewposes. The following types of feature will be used, depending on the project selected

    - **XY ArUco:** 2D point related to the poses provided by the detector
    - **Range Only ArUco:** ArUco to robot Distance.
    - **Bearing Only ArUco:** ArUco bearing angle.
    - **Polar Lines**: Polar lines extracted from the Laser Range Finder or the RealSense.
    - **ICP**: Registration algorithm
    - **NDT**: Normal Distribution Transform Registration Algorithm

- **Data Association:** At the first stage, when possible, the feature ID provided by the ArUco system will be used. If the feature type used does not provide any feature ID, then ICNN, will be used.

- **Optional Developments:** A set of optional parts are listed hereafter. Note that some of them only apply to some of the projects and not to others:

    - **Base Line Calibration**: Estimation of the distance between wheels.
    - **ICNN:** Individual Compatibility Nearest Neighbour.
    - **JCBB:** Joint Compatibility Branch and Bound Data Association
    - **Feature Persistence**: Force to observe the same feature n times within m observation before adding it to the state vector.

			1	2	3	4	5
FEKFSLAM	**Mandatory**	**Motion Model**	Odometry				
		Measurement Model	Compass				
		Observation Model	Point Features XY ArUco	Point Features Range Only ArUco	Point Features Bearing Only ArUco	Line Features (LRF)	Line Features (RealSense)
		Data Association	ArUco Id	ArUco Id	ArUco Id	ICNN	ICNN
	Optional		Wheel Base line Calibration				
		Alternative	ICNN	ICNN	ICNN	-	-
		Data Association	JCBB				
			Feature Persistency				

Table 1: FEKFSLAM Hands on projects

			1	2	3	4
PEKFSLAM	**Mandatory**	**Motion Model**	Odometry			
		Measurement Model	Compass			
		Observation Model	ICP (LRF)	ICP (RealSense)	NDT (LRF)	NDT (RealSense)
		Data Association	ArUco Id	ArUco Id	ArUco Id	ICNN
	Optional		Wheel Base line Calibration			
		Alternative	ICNN	ICNN	ICNN	ICNN
		Data Association	JCBB	JCBB	JCBB	JCBB

Table 2: PEKFSLAM Hands On Projects

2　Development

The project development will follow the next steps:

- STEP 1: Odometry and Compass observation Robot Implementation

- STEP 2: State Augmentation Stonefish

- **STEP 3: State Augmentation Robot (Milestone)**

- STEP 4: Stonefish Data Association and Update

- **STEP 5: Robot Data Association and Update (Milstone)**

- STEP 6: Optional development working in Stonefish

- **STEP 7: Optional development working Robot Implementation (Milestone)**

The steps labeled as milestone will be experimentally checked by the supervisor.

			1	2	3	4
Graph SLAM	**Mandatory**	**Motion Model**	Odometry			
		Measurement Model	Compass			
		Observation Model	ICP (LRF)	ICP (RealSense)	NDT (LRF)	NDT (RealSense)
		Data Association	ArUco Id	ArUco Id	ArUco Id	ICNN
	Optional		Wheel Base line Calibration			
		Alternative	ICNN	ICNN	ICNN	ICNN
		Data Association	JCBB	JCBB	JCBB	JCBB

Table 3: Graph SLAM Hands On Projects

3   Documentation

The project will be documented using a paper template already available in the moodle in word or latex format. The moodle also includes an example about how to report the equations of your work.

4   How to choose

A google forms is available for you to choose the projects you are more interested in by preferences. You must choose 3 projects by priority (high, medium low). Only one member of the team show submit the selection. Once all answers are collected, each group will get a project assigned based on the preferences of the whole class.

    https://forms.gle/f2adXGaygGgRQwVF7