Albert-Ludwigs-Universität Freiburg
Lecture: Introduction to Mobile Robotics
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Sheet 10

Topic: Simultaneous Localization and Mapping

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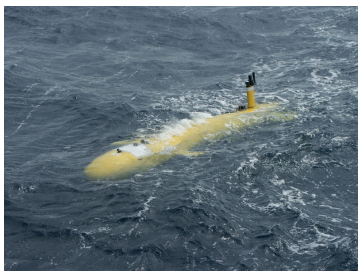
Exercise 1: Features for Landmark-based SLAM

Robots operate in many different environments. In each environment different types of landmarks may be useful. For each of the following three environments: office, outdoor and underwater think of five different types of landmarks that might be well suited.

How useful are your landmarks in combination with the following sensors: sonar, laser, monocular vision, and stereo vision? Please submit your ratings [1] ("++" very useful, "+" useful, "−" not useful, "−−" not possible) in tabular form with short explanations for not-obvious ratings.





Exercise 2: Bearing-only SLAM

Bearing-only SLAM refers to the SLAM problem when the sensors can only measure the bearing of a landmark but not its range. One problem in bearing only SLAM with EKFs concerns the initialization of landmark location estimates, even if the correspondences are known. Discuss why, and devise a technique for initializing the landmark location estimates (means and covariances) that can be applied in bearing only SLAM.

Exercise 3: Data Association

Features extracted from an observation can be interpreted as matches with features in the map, new previously unobserved features, or false alarms (noise).

[1] Please note, that different ratings can be possible under different assumptions (e.g. lighting-conditions). The optimal choice of landmarks is still an open research question.

Consider two features z_t^1 and z_t^2 extracted from an observation z_t, and a map $m_t = \{l_1, l_2\}$ with two features. An assignment ψ associates each observed feature z_i to a map feature l_j, or marks it as a false alarm or as a new feature.

(a) Write down all possible assignments for the two observed features z_t^1 and z_t^2, and the two map features l_1 and l_2. Note that in an assignment an observed feature can be associated to one map feature at the most.

(b) Suppose now that for a given assignment, every observed feature marked as a new feature is added to the map, and every map feature without an matching observed feature is removed from the map. How many new assignments are generated from the set of assignments computed in the previous exercise if at time $t + 1$ a single feature z_{t+1}^1 is extracted?