

Sheet 9

Topic: Simultaneous Localization and Mapping

Submission deadline: July 09, 2015

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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 ratings¹ (“++” 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.

¹Please 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.

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).

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 a 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?