

Probabilistic Robotics

PRR06, Fall 2017

Lab Assignment : Localisation and SLAM with Extended Kalman Filters

Assigned: Tuesday September 26

Due: Thursday October 5; 13:00 in the afternoon

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Introduction

An Extended Kalman Filter (EKF) is a classical method used for robot localization. It is also historically the basis for a Simultaneous Localization and Mapping algorithm [2]. The method has been applied with considerable success in a number of robotic applications. It is easy to implement, and the computational complexity is low for a limited number of landmarks. Here EKF-SLAM is applied to a RoboCup soccer field, with six colored landmarks around the field (see figure 1). The locations of these landmarks are known apriori (the locations are explicitly mentioned in the RoboCup rules), but for these assignment you shouldn't take this information for granted and make your own estimate of their positions.

For this configuration measurements collected by Steffen Gutmann is used [1]. Steffen directed an Aibo over the field with a joy-stick, and recorded the odometry updates and the observations of the landmarks of the Aibo. The observations are vision based. There is a camera in the head of the Aibo and image processing routine was active to detect objects of the right color in the field of view. The Aibo has a limited field of view, so only 1-2 landmarks are visible at the same time.

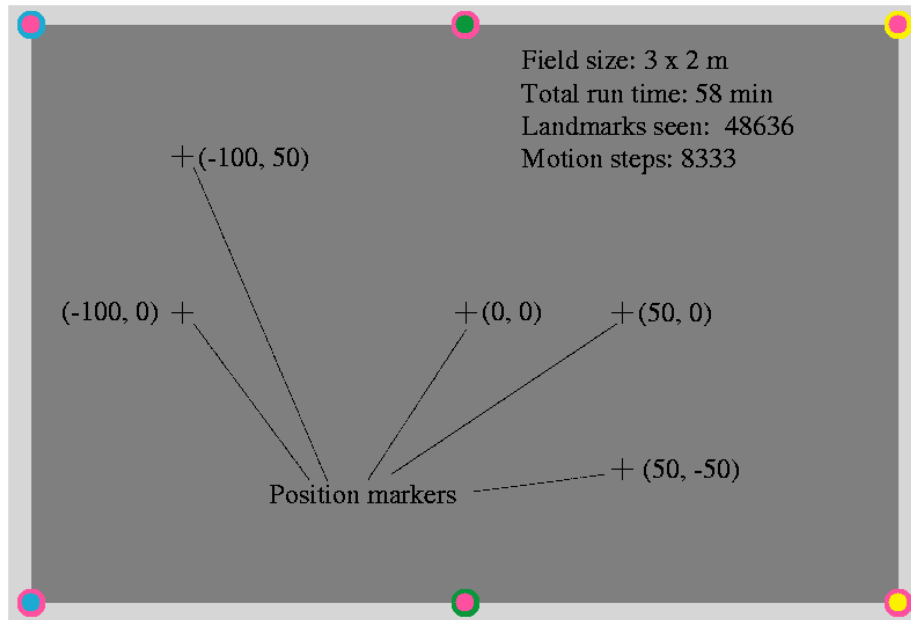


Figure 1: The field of the RoboCup 4-Legged League as used in the experiment. The 4-Legged robot walked several times an 8-shaped path over this field.

1 Task 1 - Localisation

Download the EKF localization code `EKF.m`¹ and the data files `dlog_firstmark.dat`², `dlog_secondmark.dat`³ and `dlog_thirdmark.dat`⁴ from the UvA Probabilistic Robotics public site. The marks are actually a tick on the robot-head, which were performed on respectively position $(500 - 500)$, $(500, 0)$, $(0, 0)$ for the first three marks, followed by mark four and five $(-1000, 0)$, $(-1000, -500)$ in the complete logfile⁵. The Aibo robot then heads back to the first marked position.

Visualize the uncertainty in the localizations from this code (which is an implementation of Table 7.2 from the book. Assume a noise of 15% on range measurements and 10° on the bearing measurement.

¹<https://staff.fnwi.uva.nl/a.visser/education/ProbabilisticRobotics/EKF.m>

²https://staff.fnwi.uva.nl/a.visser/education/ProbabilisticRobotics/dlog_firstmark.dat

³https://staff.fnwi.uva.nl/a.visser/education/ProbabilisticRobotics/dlog_secondmark.dat

⁴https://staff.fnwi.uva.nl/a.visser/education/ProbabilisticRobotics/dlog_thirdmark.dat

⁵<https://staff.fnwi.uva.nl/a.visser/education/ProbabilisticRobotics/dlog.dat>

2 Task 2 - SLAM

Modify the code to implement the algorithm in Table 10.1 of the book. Analyze the performance and suggest possible improvements.

3 Hand-In

You can work on this assignment in pairs. When you have completed the assignment, upload both your solution to Blackboard. This should be a PDF, with your Matlab scripts as pseudo-code (for example with the matlab-prettyfier package).

References

- [1] J.-S. Gutmann and D. Fox, “An Experimental Comparison of Localization Methods Continued”, in “Proc. of the IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS’02)”, pp. pp. 454–459, October 2002.
- [2] R. C. Smith and P. Cheeseman, “On the Representation and Estimation of Spatial Uncertainty”, *The International Journal of Robotics Research*, volume 5(4):pp. 56–68, 1986, doi:10.1177/027836498600500404.