Comparison between probabilistic and deterministic methods to solve the Simultaneous Localization and Mapping problem in the case of bearing-only measurements

Cyril Joly[1] and Patrick Rives[1]

[1]INRIA

Estimating the motion of a mobile robot while simultaneously building a representation of its environment is a key problem for autonomous robotics. This problem is known as SLAM (Simultaneous Localization and Mapping). In this work, we address the problem of Bearing-only SLAM: the environment is made of point-based landmarks whose depth is never measured directly.

We propose to compare two algorithms based on the estimation of the whole trajectory of the robot: the SAM (Smoothing and Mapping) which is a probabilistic method based on the smoothing of the robot trajectory, and the interval SLAM which is based on a deterministic approach. The SAM is based on the linearization of the equations and the assumption that the errors follow a known Gaussian distribution. The result is a mean vector and a covariance matrix which represent the estimation and its uncertainty. The deterministic approach is based on the interval arithmetic and the assumption that the errors are bounded and that consistent bounds are known. The result of this algorithm is a set of boxes which represent the trajectory and the map with a probability of one. Moreover, an optimization of the orientation of the boxes is proposed in order to optimize interval contractions.

The comparison is made in simulation. We focus our analysis on the ability of the algorithms to provide a consistent estimation of the trajectory and the map in several cases. Consistency is validated if the belief area contains the true solution. The results show the consistency of both algorithms when the errors are centered.

In this case, if we look the size of the belief areas provided by the algorithms, the probabilistic approach delivers better results than interval SLAM. Finally, the probabilistic algorithm becomes inconsistent when input data are biased. In the latter case, interval SLAM gives good and consistent results.