ABSTRACT

Localization, the process of obtaining and processing the information of the robot pose in the movement space, is a fundamental issue in autonomous mobile robots as this information is required to determine the desired robot movements. For this task, all the available sensor sources must be used in order to reduce the error in the pose estimation, as the measurements are subject to noise and nonlinearities.

The formulation of a new sensor fusion framework that improves the localization of mobile robots with limited computational resources, navigating individually in the environment or in assembled heterogeneous groups, is the central and fundamental issue of this thesis.

The proposed algorithms use the dynamic model of an Ackermann and a differential steering mobile robots, along with the Kalman Filter fusion scheme to perform the local pose estimation using the inertial sensors measurements, which is updated with the global sensor information on an event based schedule. This type of correction produces a new kind of Kalman Filters that reduce the resources (execution time and bandwidth) needed to perform the sensor fusion to localize the robot, but with similar performance when compared to the more complex fusion methods and with bounded error evolution, being this the main contribution of this thesis.

The proposed event based algorithms for individual robots are extended to include the multirobot cooperative localization case for heterogeneous groups of mobile robots. This is done by modifying the event based update to include the relative pose information of the various nearby neighbors in a distributed Kalman Filter. The relative measurements of the range and bearing between robots is used along with the transmitted pose estimation of each robot (using agent managed communications) to update the local pose estimation. Once again this approach allows an efficient robot localization, with improved accuracy and bounded error while reducing the use of the platform bandwidth and computational resources. This method also performs a smart sensor fusion, as it only takes into account the most reliable relative sensor information, discarding inaccurate measurements or the ones delivered from distant robots.

The proposed algorithms have been extensively tested through simulations and by implementation in several mobile platforms, which shows the correct performance of the methods. Also, the several long walk tests performed reflect the stability and robustness of the algorithms when working in long distances. In addition, the tradeoff between the error covariance and the bandwidth usage is analyzed for the proposed cooperative localization method.

Finally, the several extension and continuation possibilities of the present work are exposed in areas such as the simultaneous localization and mapping (SLAM), the extension to omnidirectional platforms, the implementation in different heterogeneous robot groups, the alternative definitions for the event required by the proposed methods and their effect in the localization performance.

Keywords: Sensor fusion, Kalman filtering, distributed Kalman filtering, odometry, robot localization, pose estimation, mobile robots, event based systems, event based estimation, event based communication, cooperative localization, robot sensing systems, multirobot sensor fusion, *LEGO NXT*.

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