SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Part 1 (3A)

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LOCALIZATION NETWORK FOR PLANETARY EXPLORATION WITH A MULTIROBOT SYSTEM

Abstract

Localization is of utmost importance for mobile robots. A method having the benefits of external reference nodes without the need of a priori localization of the nodes has been researched. Our approach uses a group of simple and robust robots that can autonomously build a localization network. For localization, each robot only needs wheel encoders and one sensor that can identify a landmark and measure a bearing angle to the landmark. With these sensors, the robots are able to localize themselves within bounded error. Additionally, a mechanism for deploying the landmarks is needed.

The localization system does not have any specific requirements for the environment and can work in an unstructured environment such as on the surface of an uninhabited planet. The landmarks can be deployed sparsely because only one landmark needs to be visible for our algorithm to work. If no landmark is visible, the robot relies on the odometry sensors. Depending on the relative accuracy of these sensors, the landmarks can be placed dozens of meters apart. For data association, exact identification of each landmark is required. This can be done with artificial landmarks having unique identification numbers. In our experiments, radio-frequency identification (RFID) technology is used. For outdoor applications a system with longer range can be chosen.

As the landmark positions are unknown at the beginning, the robots have to work together in order to correctly localize the landmarks. The localization problem is closely related to the SLAM problem. When localizing the landmarks, the main source of error is the accumulated odometry error of the robots, which in a group is assumed to have a mean close to zero. Thus, when the location estimates of several independent robots for a common object are combined, the location estimate of the object converges towards the correct position. The fusing of information in cooperative localization can be performed using an Extended Kalman filter.

Both simulations and laboratory experiments with real robots have been conducted. The simulations clearly indicate how different error sources affect the localization accuracy. In addition, a multirobot approach has been compared to a single robot scenario. Laboratory experiments have shown that with passive RFID technology, the robots can localize landmarks with unknown initial position and estimate their own pose simultaneously. So far, two robots have been used and two more robots will be equipped with RFID technology in the near future.