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Collective Robot Localization – Exploring Information Merging Strategies

Rafael Mosberger

Professor : *Alcherio Martinoli*
Assistant : *Amanda Prorok*

Single robot localization is a major research field in autonomous mobile robotics, and has been studied extensively in the last decade. Yet, various publications point to the fact that multi-robot systems can solve tasks more efficiently than a single robot. Thus, this project focuses on strategies for information sharing among multiple robots towards better localization performance.

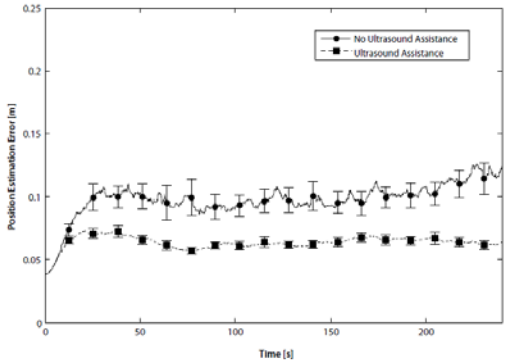
The work involves extending an existing multi-robot localization algorithm running on a model of the Khepera III robot within the robotic simulation software Webots. Each robot is endowed with a particle-based localization algorithm using on-board sensor information. The robots exploit a standard communication channel and a range-and-bearing board to share their current position estimate aiming to improve a single robot's belief of its own position. The range-and-bearing board uses high-frequency modulated infrared emissions and provides the robot with non-anonymous information about the distance and relative angle to other robots. Infrared sensors are used as inputs for a Braitenberg controller performing obstacle avoidance and a dead-reckoning self-localization module provides the robot with odometry measurements.

The main goal of the project is to explore strategies for integrating the so far unexploited ultrasonic sensors available on the Khepera III robot into the localization algorithm. Ultrasonic sensors rely on different physics than infrared sensors and therefore show complementary characteristics. Sensor fusion methods are examined to combine the data from the different sensors to attain information of higher accuracy.

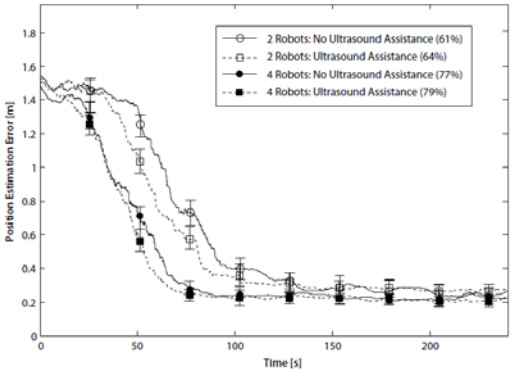
In its basic version, Webots does not provide an adequate way of simulating an ultrasonic sensor as the propagation of sound waves is modeled only simplistically. Thus, a simplified model of the Khepera's ultrasonic sensors using the sound plugin *SWIS2D* is developed. The result is a simulated sensor device that can be added to the existing model of the Khepera III robot in Webots in order to simulate its ultrasonic sensors.

The ultrasound sensor is then integrated into the existing multi-robot localization algorithm. The measurement data acquired by the ultrasonic sensors provides an additional source of information that is included during a sensor data fusion process.

Experimental results show that the integration of the ultrasonic sensors increases the accuracy of both position tracking and global localization.



Simulation results of a system of 4 robots performing position tracking. The graph represents the evolution of the average estimation error of all 4 robots over time. The errorbars show 95% confidence interval.



Simulation results of a system of 2 and a system of 4 robots performing global localization. The graph represents the evolution of the average estimation error of all robots over time. Errorbars: 95% CI.