Temasek Defence Systems Institute

Temasek Defence Systems Institute

Multiple Robots Localization via Data Sharing

Ng Cheng Leong
Oleg Yakimenko (Thesis Advisor)
Roberto Christi (Co-Advisor)

Objective

- Develop a technique for multiple robots to work together in improving the robot localization accuracy.
- Develop a simulation model to analyze performance of technique under various configurations

Research Idea

In this thesis, the robots are assumed to be operating in an environment without external sensors. In this concept, each robot has an erroneous perceived pose of itself. Each robot than makes a measurement of the relative position of all robots within line of sight and share this data out.

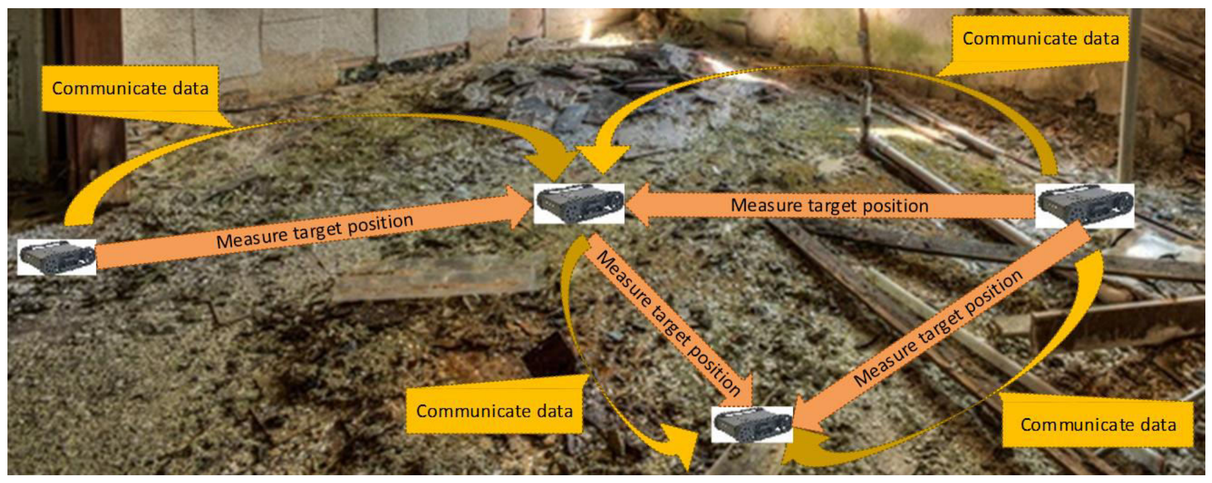
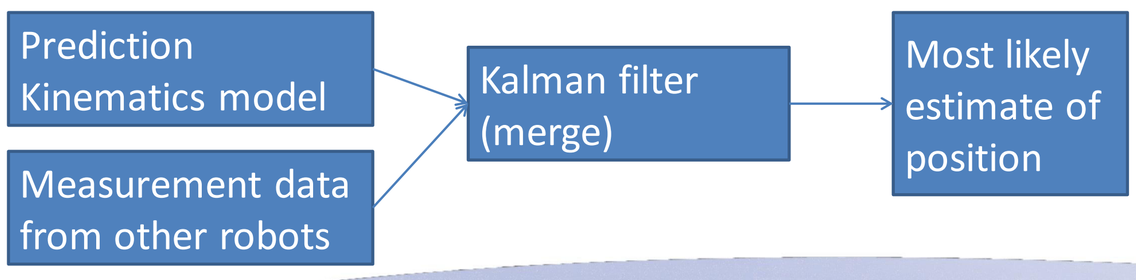


Figure 1: Concept of operations

Each robot then computes the most likely position using Kalman filtering based on a kinematic model and measurement data from other robots.



Research Results

Various configurations like number of robots, rate of error of odometry were simulated. Below shows some of the results.

	Error reduction of data-sharing robot localization over individual robot odometry					
	Low odometry error		Medium odometry error		High odometry error	
	6 robots	12 robots	6 robots	12 robots	6 robots	12 robots
Robot 1, v = 0.6m/s	4.000	1.723	0.619	0.378	0.485	0.341
Robot 2, v = 0.6m/s	4.041	1.692	0.613	0.379	0.484	0.339
Robot 3, v = 0.6m/s	3.999	1.738	0.617	0.379	0.477	0.332
Robot 4, v = 0.6m/s	4.041	1.743	0.623	0.379	0.487	0.345
Robot 5, v = 1.2m/s	2.867	1.217	0.435	0.270	0.345	0.247
Robot 6, v = 1.2m/s	2.727	1.200	0.439	0.274	0.349	0.241

Table 1: Ratio of RMS Error of localization data comparing data-sharing technique to individual robot odometry

Potential Applications

- Mobile robotics applications in GPS-denied zones
- Mobile robotics applications in indoor environments
- Navy fleet operations under GPS-denied zones

Future Work

- Develop technique for robot to identify and measure another robot
- Develop technique which includes a stationary beacon to provide “ground truth” to the robot team

Reference:
[1] Thrun, Sebastian, Wolfram Burgard, and Dieter Fox. 2005. *Probabilistic Robotics*. Cambridge: MIT Press.
[2] Negenborn, Rudy. 2003. "Robot Localization and Kalman Filters." PhD diss., Utrecht University.
[3] Parker, Lynne E. 2008. "Distributed Intelligence: Overview of the Field and its Application in Multi-Robot Systems." *Journal of Physical Agents* 2(1): 5–14.
[4] Grewal, Mohinder S., and Angus P. Andrews. 2014. *Kalman Filtering: Theory and Practice with MATLAB*. 4th ed. Hoboken: John Wiley & Sons.

NUS National University of Singapore