Range-based Wireless Sensor Network Localization for Planetary Rovers

August K. Svensson[1], Michael Dille[2], Uland Wong[2]
[1] MSc. student, Luleå University of Technology
[2] Intelligent Robotics Group, NASA Ames

Introduction

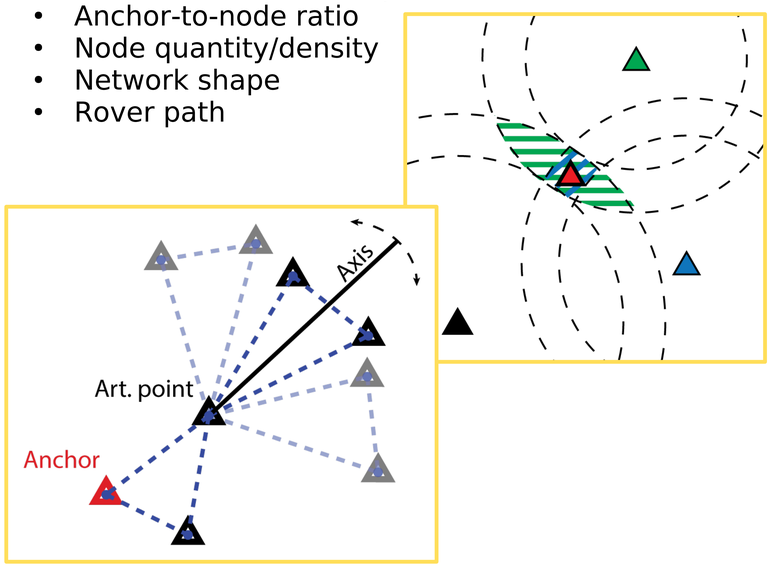
PHALANX, a prototype system featuring

- remotely deployed sensor nodes;
- wireless communication between nodes;
- ranging measurements between nodes.

Allows access to hard-to-reach areas, measurements of ephemeral phenomena, as well as RO-WSN-SLAM as a rover moves near deployed sensor nodes.

The SLAM of PHALANX:
- range-based,
- self-deployed landmarks,
- distances measured between nodes,
- ability to turn a node into an anchor via external sensing,
- limited number of nodes.

Investigate using computer simulations: what mission parameters influence SLAM performance?
- Anchor-to-node ratio
- Node quantity/density
- Network shape
- Rover path



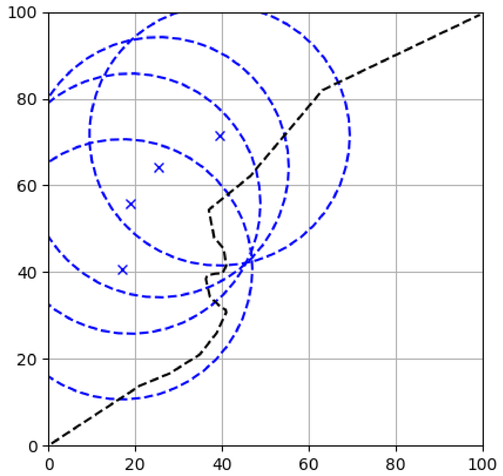
Simulation

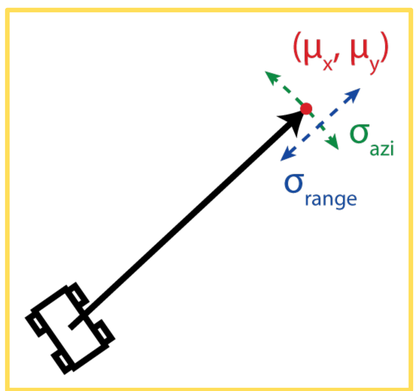
The implementation is done in 2D and uses values typical of rover missions and values measured from the PHALANX prototype nodes. The estimator is an EKF.

The simulations are run from configuration files representing the mission planning such as rover trajectory and node placement targets and mission parameters such as rover speed and noise figures.

Statistics are then collected from across simulation runs.

A simple mission scenario





Simulation node deployment

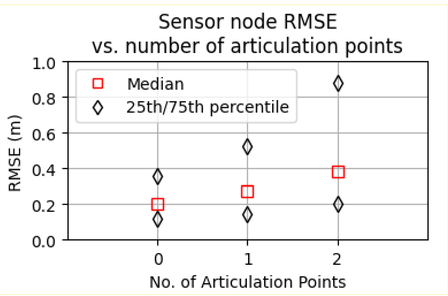
Results

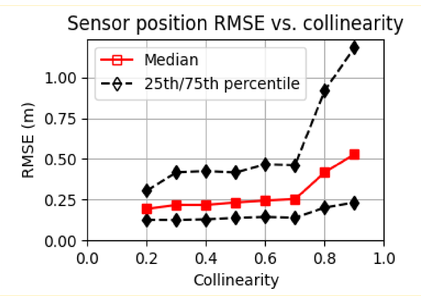
Based on results from the WSN and range-only literature, we expect that the localization error:
- grows with collinearly placed nodes
- shrinks with node density, anchor-to-node ratio

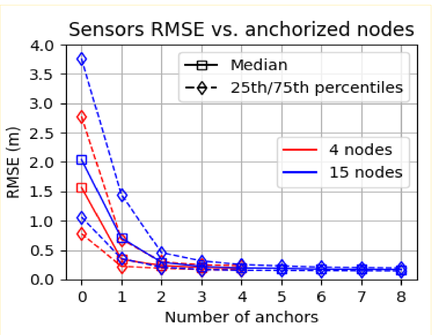
Anchors-per-node shows highest impact on error figures.

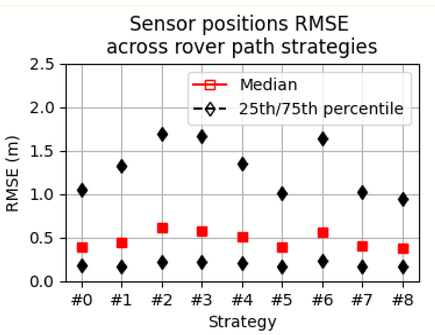
Other parameters make for lower differences, suggesting a rather stable performance with lower need of spending mission planning resources.

More careful planning can, however, lower the variance of the distribution of the resulting error.









Acknowledgments

I thank my mentors Michael Dille and Uland Wong. Thanks also to SSC and especially NASA for the internship opportunity at Ames.