SU 2017-2018, MES, DISAL-SU27 Project Summary

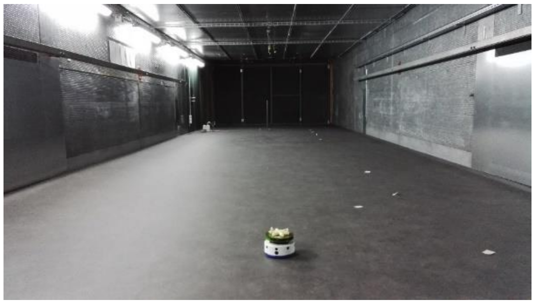
Path Planning Algorithms for Odor Distribution Mapping:

Real World Experiments on Khepera IV Robot

Danjiao Ma

Professor : Alcherio Martinoli
Assistant(s) : Faezeh Rahbar, Ali Marjovi

During a previous project in DISAL, four path planning algorithms for odor distribution mapping were developed in simulation: one of which is "fix-grid" algorithm, evenly distributing the sampling positions in the fixed trajectory; three others, "Entropy", "Mutual Information" and "Balanced Mutual Information", are based on information theory, aimed at maximizing an information-theoretic quantity at each step. The goal of this new project is to deploy these information-theoretic path planning algorithms on Khepera IV robots and adapt them for real world experiments in the DISAL's wind tunnel. Except for these four path planning strategies, an additional "random-walk" algorithm will be developed as a baseline method.

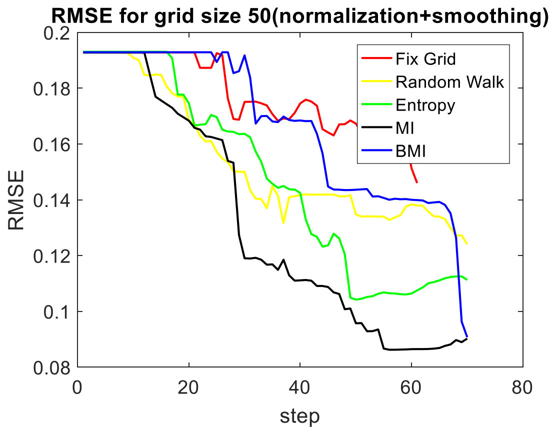


General View of Wind Tunnel Set-up

With a full environment set-up, 90 experiments have been conducted in the wind tunnel to evaluate the performance of the different path planning strategies in various conditions. And relevant algorithmic parameters are optimized, including correlation length and kernel function.

The experiments are conducted for two different grid size, 50 cm and 25 cm. Based on the experiment result, the ideal correlation length is 5 block numbers for larger grid size and 10 for smaller grid size. As for kernel function, square-exponential is validated to be best choice in webots simulation. During wind tunnel experiment, we proposed shifted-square-exponential kernel function to consider the wind influence to odor spatial model. However, the application of this shifted kernel function needs further validation.

Under the tuned algorithmic parameters, the experiment result is kind of comparable with simulation. Generally, the performance of Entropy, MI and BMI algorithms are advantageous in terms of their efficiency to reduce RMSE and covariance than Fix-Grid and Random Walk algorithm. MI algorithm woks fast to reduce both RMSE and covariance at the early stage, due to is broad samplings. Entropy could also reduce the estimation error quickly, but it is less efficient in the first few steps than MI algorithm. As for BMI algorithm, its performance is less satisfactory than expected, which should be caused by inefficient controller (simulation) and noisy measurement (experiment). As a baseline method, the overall performance of random work is less favorable than the information-theoretic algorithms, even though it can reduce RMSE efficiently in the first few samplings due to its broad step size.



Experiment Result for Grid Size 50 cm

As for the future work, it is worthwhile to spend more time on kernel function analysis, both theoretically and experimentally. And it is also much important to repeat the experiments for each case with the hardware problems avoided.