

Active Informative Path Planning for Gas Source Localization Task

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Gas leaks can potentially have a serious impact on both human health and infrastructure integrity. As a result, developing efficient techniques for the localization of gas leaks is crucial.

The goal of this project is to develop new path planning methods to make the Gas Source Localization (GSL) task more efficient, as well as to utilize the information gathered by the robot along its path.

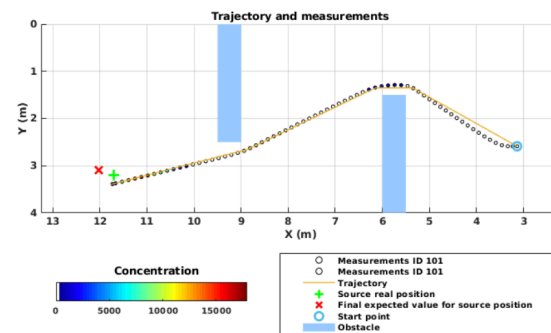
The first step was to determine the information feature the robot would use to plan its path. Three features were considered: belief, mean, and variance. After conducting multiple simulations of a pre-existing belief clustering algorithm with these three different methods (simulations conducted on Webots), it was found that belief appeared to be the most optimal information feature. This conclusion was based on the results obtained by comparing various metrics, such as final errors and experiment time.

After selecting an information feature, we shifted our focus to the core of the project: developing new strategies for path planning. We initially worked on improving the pre-existing clustering strategy by optimizing certain aspects. However, a new approach was required to better account for individual cells in the map.

In this new approach, we focus on the information the robot can continuously gather as it navigates through the environment. The objective is to maximize the information collected along the robot's path toward the target position while minimizing the time required to locate the gas source. This strategy, based on the A* algorithm, was coupled with various scoring functions (balancing information gain and travel distance) to select the most interesting cell to visit on the information map.

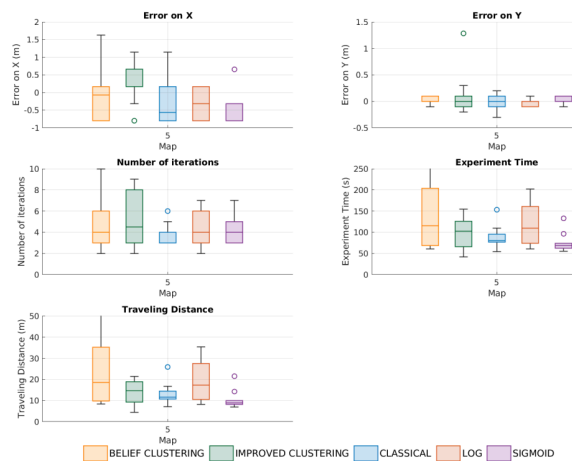
Once these new strategies were developed, extensive simulations were conducted, varying the complexity of the test maps, the starting positions of the gas source and the robot, the

sampling mode, and the values of certain hyperparameters for each path planning function. The results were compared against those of the pre-existing clustering strategy.



GSL Task simulation

It was observed that the new A*-based functions were generally more effective than clustering algorithms, as determined by metrics such as final errors and experiment time. Additionally, the choice of scoring function proved to depend on parameters such as the complexity of the map or the sampling mode used.



Performance Analysis of Algorithms