**Prediction Based Approach to Minimize Distance Traveled while Tracking Objects in Mobile Robotic Navigation**

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# Introduction

Navigation is defined as the process or activity of accurately ascertaining one's position and planning and following a route[1]. Mobile robot navigation is primarily concerned with localization, obstacle avoidance, path planning, and map building[2]. Localization is the process that determines the current position and heading of the robot. This measurement will contain some amount of error, and this error increases the difficulty of the navigation problem. The next major problem in mobile robot navigation comes from object avoidance. In stationary environments, maps can be utilized to inform the robot of all obstacles, and a static path can be determined using these maps. With no moving objects, it is safe to assume that the robot will reach it's destination by following this path. In a dynamic environment, this assumption becomes invalid since an object might move into the calculated path. Therefore, the path must be continually updated based on sensor readings of the environment. Path planning is concerned with the determination of intermediate points until the arrival at the desired location is complete. Finally, map building is the use of sensors to determine the robot's surroundings. This allows for better localization, stationary object avoidance, and path planning.

# Motivation

This project is concerned with the localization, path planning, and obstacle avoidance aspects of mobile robot navigation. Object tracking is the ability to follow an object with an unknown path. To successfully track an object the localization aspect must be able to determine the relative distance and heading of the object. The ability to track an object while maintaining a safe distance will require obstacle avoidance and path planning to manipulate the robot dynamically. The main goal of this project is to minimize the distance traveled by a robot that is tracking an object at a safe distance to avoid collisions. In real environments, the distance traveled by a mobile robot will effect the battery life of the robot. Minimizing the traveled distance can improve the ability to follow an object using minimal energy. This will allow the robot to track the object for a longer period of time before having to recharge.

# Details

The purpose of this project is to follow a moving object by traveling the minimum distance required while maintaining a cushion to avoid collisions. This will be accomplished by using a Kalman Filter to predict the next position of the object. The robot will correct its position based on this prediction while traveling the minimum distance according to a specified cushion. This project will attempt to find an optimal solution by using a Kalman Filter to handle prediction of the object's next state.

# Implementation

To implement this project, three separate programs will be created. The first program will create a known path for a robot. This path will simulate the object that will be tracked by the following approaches. The second program, a reaction based approach, will consist of a tracking robot that will will calculate the position of the object, and update its position based off this reading and the cushion provided. This will be used to set a baseline for the distance traveled in tracking an object. The final program will implement a prediction based approach by utilizing a Kalman Filter to determine the predicted position of the object to be tracked. Using this prediction the robot's position will be updated according to the cushion provided. A laser sensor will facilitate all distance measurements in each approach.

# Deliverables

The first deliverable will be a video showing the separate programs executing. This will be used to verify that both algorithms are working correctly, and following the object. Comparisons will be made between these two approaches, and discussed in the final report. The next deliverable will be a graph plotting the distance traveled by each approach in the xy-plane. This graph will be created by accessing the position of the robot, and storing each in a file. These files will later be graphed using gnuplot[3], an open-source graphing program, to get a visual of the actual paths taken by the robots. Using this plotted data, the distance traveled will be able to be calculated. Finally, the predicted position of the object, and the reported position by the object will be graphed to show the variance of the predictions. The report will discuss the accuracy of the predictions accordingly. These graphs and calculations will also be present in the final report.

# Conclusion

The goal of this project is to determine whether a prediction based approach to the object tracking problem can minimize distance traveled by the robot compared to a reaction based approach. It will utilize a Kalman Filter to handle predictions based on position readings with a laser sensor. The path of the object will be repeatable, to allow for accurate comparison of the two methods. Each program will record the results for distance calculations, and graph comparisons.

Works Cited

[1] Oxford University Press. (2014). *Oxford Dictionaries* [Online]. Available: <http://www.oxforddictionaries.com/us/definition/american_english/navigation?searchDictCode=all>. [Accessed: 2014, Nov. 24].

[2] DeSouza, G. (Unknown). *Lecture 22: Mobile Robotics* [Online]. Available: <http://vigir.ee.missouri.edu/~gdesouza/ece4330/Lecture_Notes/Lecture22.pdf>. [Accessed: 2014, Nov. 24].

[3] Gnuplot. (2014, Nov.). *Gnuplot Homepage* [Online]. Available: [http://gnuplot.info](http://gnuplot.info/). [Accessed: 2014, Nov. 24].