Hacettepe University Department of Electrical/Electronics Engineering
ELE401-402 Graduation Project
Robotics Algorithms in Action with Gazebo and a Simulated TurtleBot

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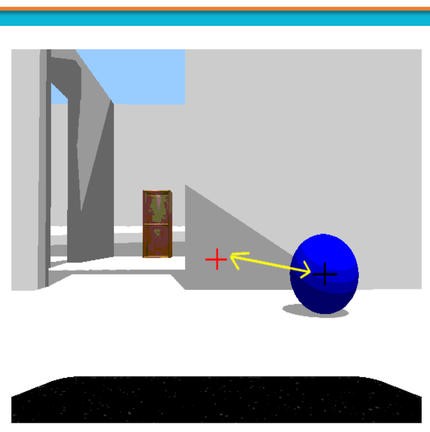
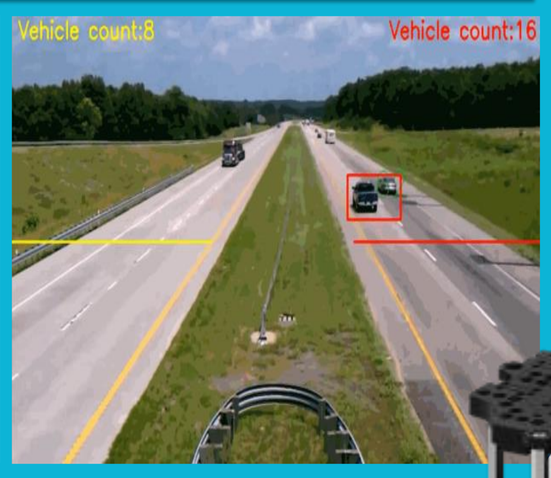
Introduction

- The Robot Operating System (ROS) is a flexible framework for writing robot software. It is a collection of tools, libraries, and conventions that aim to simplify the task of creating complex and robust robot behavior across a wide variety of robotic platforms.
- In this project, teleoperation, path planning, track and follow an object, maze solving algorithms have been tested in complete virtual environment with realistic scenarios. ROS toolbox provides an interface connecting MATLAB and Simulink with the Robotic operating system enabling you to create a network of ROS nodes.

TRACK AND FOLLOW AN OBJECT

Blob analysis is a fundamental technique of computer vision based on the analysis of consistent image regions. As such it is a tool of choice for applications in which the objects being inspected are clearly distinguishable from the background. A great deal of Blob analysis methods allows us to create tailored solutions for a wide range of visual inspection problems. Furthermore, MATLAB uses vision.BlobAnalysis function with the minimum and maximum area size to compute the area size and centroid of the area. These terms will be useful when it comes to tracking and following an object. Subsequently, it inserts a shape around the detected object including object area and centroid.





TURTLEBOT3

GAZEBO

LINUX

ROBOTICS

MAZE – SOLVING ALGORITHM

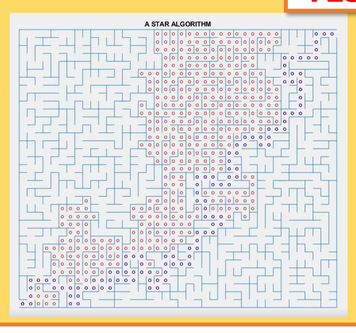
A Star Algorithm

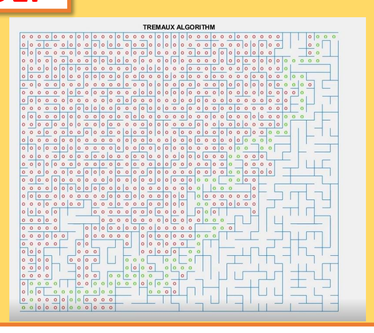
- has a feed-back system
- can't scan empty map
- complex coding
- It needs the location information of the target.

Tremaux Algorithm

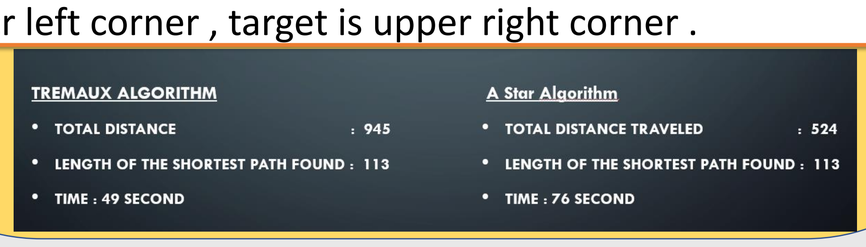
- has a feed-back system
- can scan the empty map
- simpler coding
- Does not need location information

TEST AND RESULT





Scanned paths are shown in red. , the shortest paths found are shown in green. figure on the left a star starting point is lower left corner , target is upper right corner .

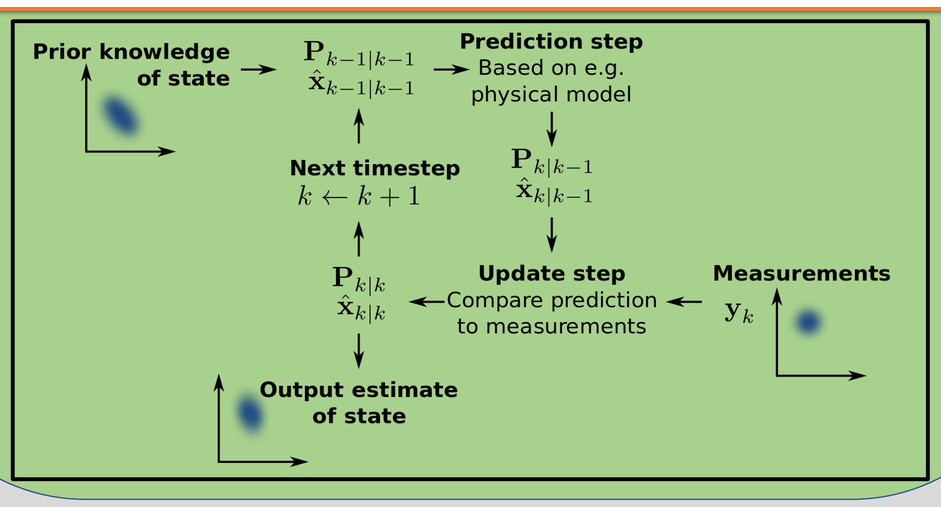


STATE ESTIMATION WITH KALMAN FILTER

❖ Kalman filters are used to estimate states based on linear dynamical systems in state space format. The process model defines the evolution of the state from time k−1 to time k as:

$$x_k = Fx_{k-1} + Bu_{k-1} + w_{k-1} \qquad (1)$$

where F is the state transition matrix applied to the previous state vector x_{k-1} , B is the control input matrix applied to the control vector
u_{k-1} and w_{k-1} is the process noise vector that is assumed to be zero-mean Gaussian with the covariance Q.



GMAPPING AND SLAM

❖ SLAM refers to Simultaneous Localization and Mapping. It is the process of building a map using range sensors (e.g. laser sensors, 3D sensors, ultrasonic sensors) while the robot is moving around and exploring an unknown area. The range sensor is used to detect the distance to obstacle whose estimated locations will be stored into a data structure (e.g./ 2D array) and when the robot is moving, it keeps updating this data structure my setting cell either occupied or empty based on the estimation of its location and the estimation of the distance to the obstacle. Usually, this process uses filtering techniques like Kalman filters to remove noises.