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Obstacle Avoidance and Target Tracking Mobile Robot.

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ABSTRACT

Robotics, a vast emerging field, spreads across diverse applications, has been an area attracting maximum research. A robot needs a reference for locomotion. It uses both obstacle avoidance and target tracking as references in our application. Obstacle avoidance is characterized to detect and avoid the obstacle from its way. In this paper a Laser based approach is used to detect the obstacle in the known environment and a proportional control strategy is used to control the mobile robot. The technique is simulated using MATLAB and simulated results show the validity of proposed technique.

Keywords: Mobile Robot, Laser Range Finder, Obstacle avoidance, Target Tracking.

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INTRODUCTION

Robot, synonymous to automation, has replaced human efforts progressively in performing rather difficult tasks. Robot may be a fixed robot or a mobile robot. The robot that can move independently in the environment is called the mobile robot. The goal of the mobile robot is to reach the target safely by avoiding unknown obstacles in a known environment. The target tracking mobile robot uses the given initial and final states to start from initial state and to reach the desired final state. [7]The Laser Range Finder is used to detect the obstacle and avoid the obstacle from the given states.

There are many techniques available in obstacle detection system. [9]Vision based obstacle detection is one of the obstacle detection techniques. It can be done with the help of camera by using image processing techniques. The camera is fitted on the top of the mobile robot. The camera records the environment and detects the obstacle. This method needs several steps of image processing to test the environment. In image processing method, the image must be high resolution, correct size and without having any noise. Unfortunately this method is highly expensive and takes long time to detect the obstacle.

Another method for obstacle avoidance and target tracking design is range based obstacle detection. It can be done by laser range finder, ultrasonic sensor, IR sensor, sonar sensor. [8] By using an ultrasonic sensor, the obstacle can be detected. It works based on the principle of time of flight method. The time taken between the emitted and received signals is measured and the measured time is converted to distance. It gives a very accurate and fast response. This method is not practically implemented because it is too costly.

In past, the mobile robot just works in a simple environment. The reason for this study is to outline astute control methodology for a mobile robot makes it avoid obstacles and move to target area in perplexing environment. There are two fundamental parts in this study. They are obstacle avoidance and target driven obstacle avoidance model. In object avoidance, the mobile robot uses signal of the sensors to avoid an obstacles from environment. The concept of fuzzy theory and sensor data is used to design fuzzy controller.

SYSTEM DESCRIPTION

The mobile robot moving to a point simulink is used in this article.[4] The simulink model will control the mobile robot's velocity to be proportional to distance from the target.

$$v^* = K_v\sqrt{((x^* - x)^2 + (y^* - y)^2)} \quad (1)$$

And the vehicle to steer towards the target which is at relative angle of vehicle in the world frame

$$\theta^* = tan^{-1}\frac{y^*-y}{x^*-x} \quad (2)$$

The proportional controller is given by the below equation

$$\gamma = K_h(\theta^*\Theta\theta), K_h > 0 \quad (3)$$

The above equation is used to steer the wheel towards the goal. Using the simulink of moving to a point mobile robot to avoid an obstacle come its way and reach the final target safely using obstacle avoidance technique.

Simulink output for normal moving to a target point mobile robot

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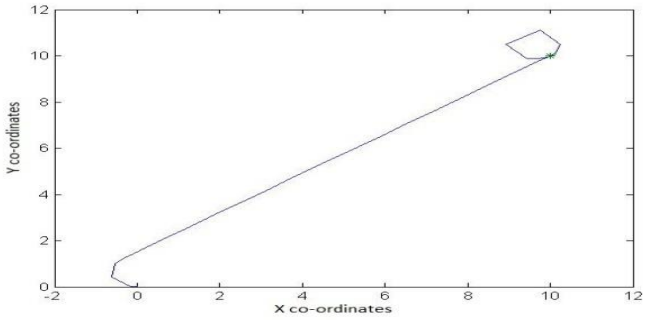

Figure 1: Target driven mobile robot simulink output.

CONTROL STRATEGIES FOR OBSTACLE AVOIDANCE AND TARGET TRACKING

The MATLAB code is used to simulate the response of the mobile robot when it meets with one or more obstacle while reaching the goal. The data of initial and final states is given. The LRF sends laser signals over a wide range in front of the mobile robot. These signals on reaching any obstacle on their course will strike and return back to the sensor of LRF. By calculating the time of flight of the laser beam the distance travelled by each beam of light is determined and the values of each are sent by the LRF to the controller that handles the movement of the mobile robot. These values are plotted and all the distance measurements will be converted into a set of points which will be plotted based on the direction in which the laser beam is sent and from the plot the approximate length of the obstacle in front of the mobile robot as well as the distance at which it is present can be found.

The distance between the obstacle and the mobile robot gives the length of the obstacle aids the direction in which the mobile robot has to move. In the program the data received from the LRF is fed as input and based on the input the mobile robot is moved with the help of a Simulink tool. The Simulink tool plots the trace followed by the mobile robot based on goal location. The program has variables that are initialized with the location of the mobile robot and the dimensions of the obstacle which will be found by the laser range finder in real time. In the program the obstacle used is in rectangular shape.

PROCEDURE FOR OBSTACLE AVOIDANCE AND TARGET TRACKING

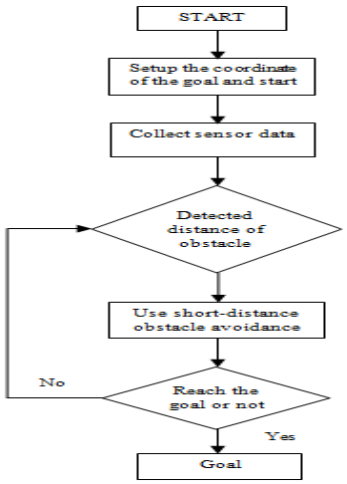

Figure 2: Obstacle avoidance model.

- At first, set the coordinates of initial and final position of the mobile robot
- The sensor data has been collected by the laser range finder which gives the distance between the mobile robot and the obstacle.
- Find the shortest path to attain the goal i.e. final position.
- The obstacle distance is calculated recursively till the mobile robot has attained the final position.

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SIMULATED RESULTS FOR OBSTACLE AVOIDANCE AND TARGET TRACKING

The obstacle avoidance and target tracking mobile robot was done using MATLAB simulation. The simulink model was used to drive the robot from initial coordinate to final target coordinate in a shortest path, called as moving to a point mobile robot. Target tracking mobile robot having an issue of intermediate obstacle which stops the robot to reach the final target coordinate. Initially, the position of the obstacle i.e. coordinates of the obstacle was given to avoid the obstacle during target tracking task and then the mobile robot has reached the final target coordinate through target tracking task.

The experiment has been carried out in the Matlab environment. The following figure shows the obstacle avoidance and target tracking using given initial and final coordinates.

Initial coordinate

X0 = [0 0 0]

Final coordinate

Xg = [10 0]

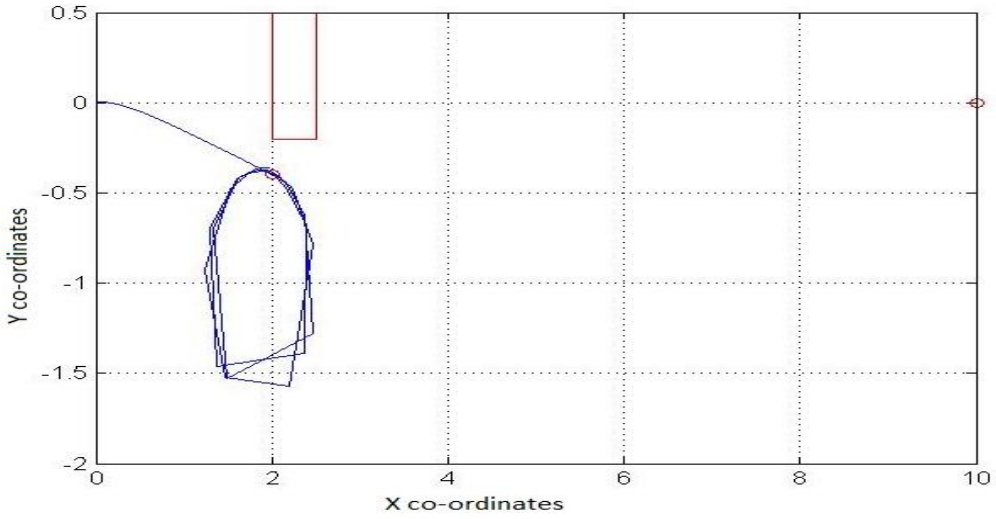

Figure 3: Stage 1 obstacle avoidance and target tracking.

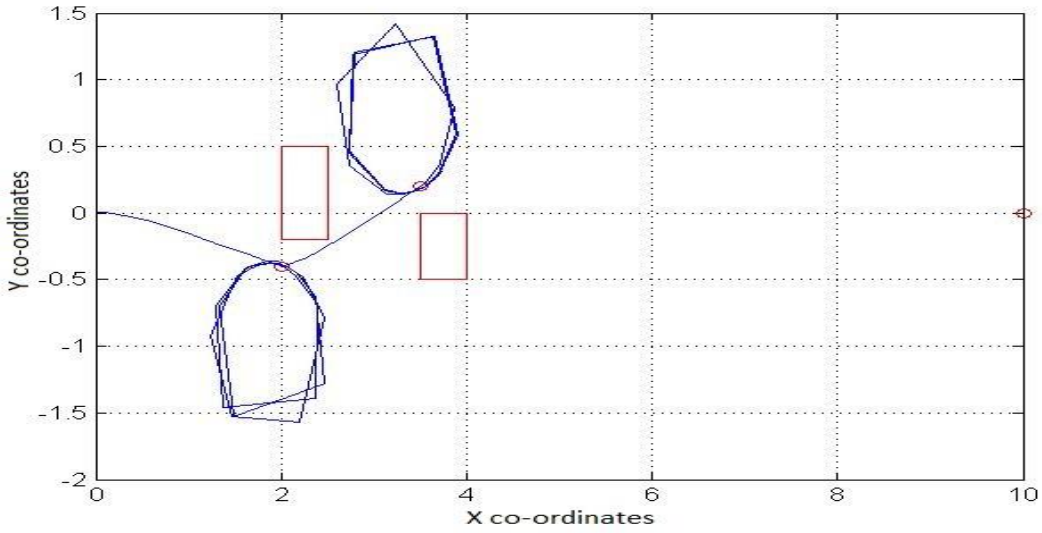

Figure 4: Stage 2 obstacle avoidance and target tracking.

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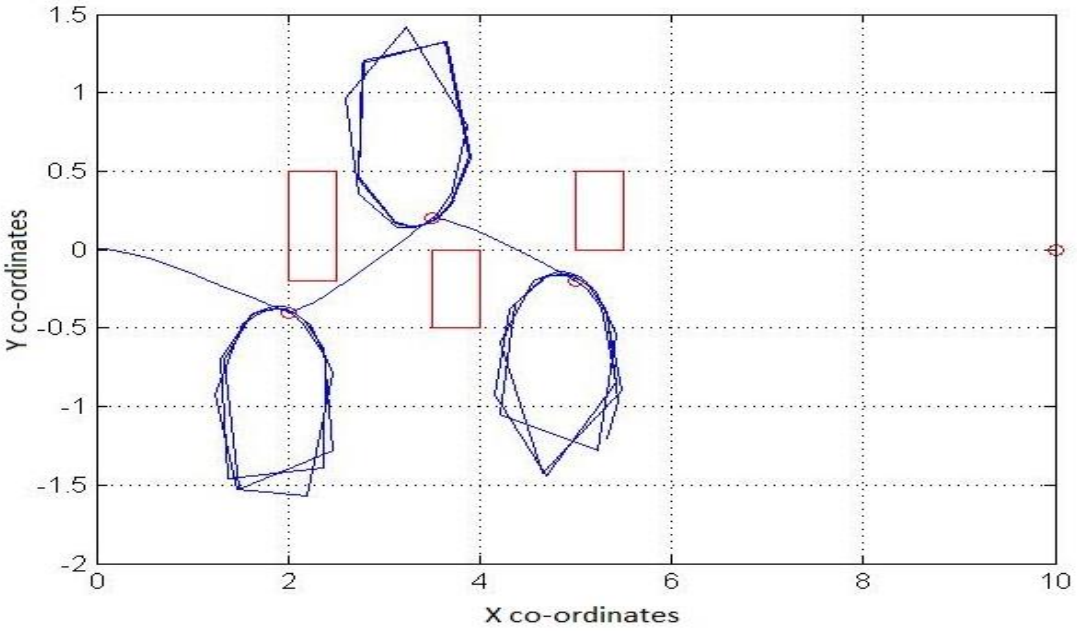

Figure 5: Stage 3 obstacle avoidance and target tracking.

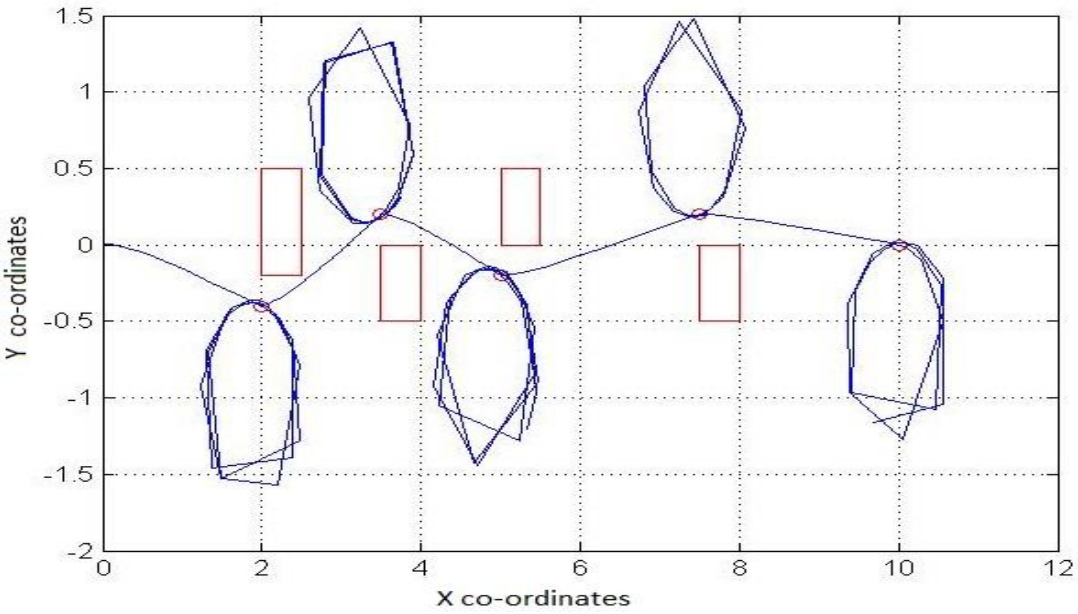

Figure 6: Final stage of obstacle avoidance and target tracking.

CONCLUSION

A laser range finder is used as a sensor for the mobile robot. Mobile robot is simulated in MATLAB for point target tracking. The simulated results show the validity of the algorithm used. An efficient simple algorithm for obstacle avoidance is used to avoid the obstacle in the path of the mobile robot. Obstacle avoidance is simulated in MATLAB. The simulated results of obstacle avoidance algorithm show the efficient obstacle avoidance of the mobile robot using a simple proportional controller action. The future work would be to solve the SLAM problem for the mobile robot and implement the path tracking and obstacle avoidance algorithm in real time environment.

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