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# SLAM BASED AUTONOMOUS PATH PLANNING FOR MOBILE ROBOTS

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**Abstract**

The objective of the paper is to Plan an Autonomous path for a Mobile Robots using A*(A STAR) Algorithm in Matlab. The A* search Algorithm is a simple and effective technique that can be used to compute the shortest path to a target location. Use of A star algorithm is very high due to its performance and Accuracy. The robot wirelessly receives the data from the Matlab using Xbee. Using the Data Parsing Mechanism the Commands are extracted from the data received and the required actions for the particular command is executed with the help of Mobile Unit of the Robot.

**Keywords:** A*(A STAR) Algorithm, GUI-Graphical User Interface, SLAM-Simultaneously Localization and Mapping, Wireless-Communication, Heuristics.

## INTRODUCTION

In this modern world of automation and Artificial intelligence robotics play a vital role and they have a huge scope in the future. For robots to move autonomously the must have a complete understanding of the environment and must be able to navigate within that environment by choosing the optimal path to reach the destination quicker. Usually the optimal path is the shortest path between the start and destination. In robotic mapping and navigation, Simultaneous localization and mapping (SLAM) is the computational problem of constructing or updating a map of an unknown environment while simultaneously keeping track of an agent location within it. While this initially appears to be a chicken-and-egg problem there are several algorithms known for solving it, at least approximately, in tractable time for certain environments. Popular approximate solution methods include the particle filter, extended Kalman filter, and Graph SLAM.

## PATH PLANING

Motion planning (also known as the navigation problem or the piano mover problem) is a term used in robotics for the process of breaking down a desired movement task into discrete motions that satisfy movement constraints and possibly optimize some aspect of the movement. For example, consider navigating a mobile robot inside a building to a distant waypoint. It should execute this task while avoiding walls and not falling down stairs. A motion planning algorithm would take a description of these tasks as input, and produce the speed and turning commands sent to the robot wheels. Motion planning algorithms might address robots with a larger number of joints (e.g., industrial manipulators), more complex tasks (e.g. manipulation of objects), different constraints (e.g., a car that can only drive forward), and uncertainty (e.g. imperfect models of the environment or robot).Motion planning has several robotics applications, such as autonomy, automation, and robot design in CAD software, as well As applications in other fields, such as animating digital characters, video game artificial intelligence, architectural design, robotic surgery, and the study of biological molecules.

## ALGORITHM USED

In computer science, A* is a computer algorithm that is widely used in path finding and graph traversal, the process of plotting an efficiently directed path between multiple points, called. It enjoys widespread use due to its performance and accuracy. However, in practical travel-routing systems, it is generally outperformed by algorithms which can pre-process the graph to attain better performance, although other work has found A* to be superior to other approaches. Peter Hart, Nils Nilsson and Bertram Raphael of Stanford Research Institute (now SRI International) first described the algorithm in 1968. It is an extension of Edsger Dijkstra 1959 algorithm. A* achieves better performance by using heuristics to guide its search.

The A*(A STAR) Algorithm expression is given by,

$$f(n)=g(n)+h(n)$$

f(n)->Total Path Cost
g(n)->Cost of Previous Step
h(n)->factor of distance to Target

## PROPOSED METHODOLOGY

The proposed system consists of a mobile and GUI part. The gui part is developed using Matlab GUI tool box. It is used to set the initial and final points along with randomly generation the obstacles for testing. Once the conditions are set the A star algorithm is put to use to compute the optimal path. These are send as commands to the robot from the GUI via zigbee wireless radio. The data is transmitted in a data frame format created by us that uses a '*' as the start bit and '#' as the stop bit along with the movement commands as top- 'U' , bottom – 'D', right-'R', left-'L' Once transmitted the received commands are executed by the robot and it traverses the path to reach the destination.

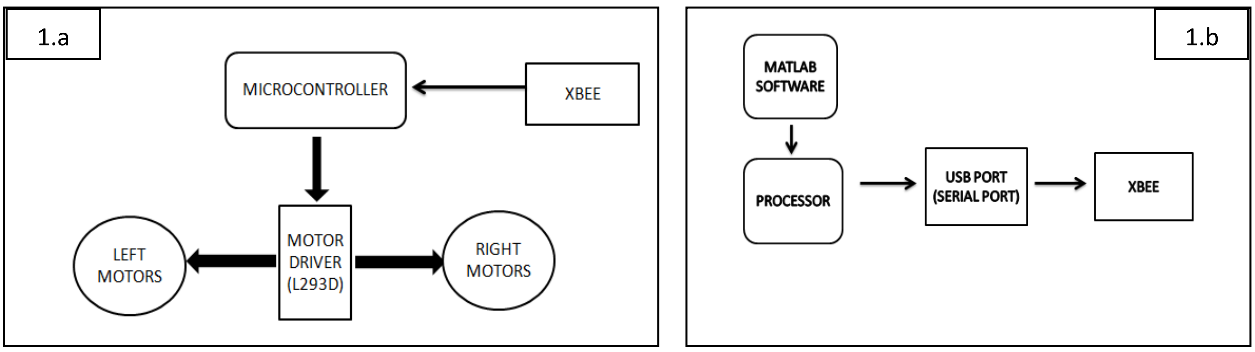


Figure : 1.a Robot block diagram and Figure : 1.b GUI Interfaces

The robot is designed to receive commands from the GUI and starts to move as per each command each command is a pre recoreded step and thus the robot moves precisely to reach the destination once reached the robot sends a message to the GUI that it has reached the target. The path taken by the robot can also be visualized on the GUI in real time.

## HARDWARE DESCRIPTION

### a. Ultrasonic Sensor

It is a sensor that uses sound waves of known frequency to locate obstacles in front of it and also identify its distance from the sensor. This is done by transmitting a sound wave and receiving the reflected signal and by calculating the time difference we can estimate the distance between the sensor and obstacle. This sensor is very accurate and can be used under bright light environment unlike IR sensors which fails under such scenarios.

**b. Accelerometer**

In this the feedback system is used for the movement of robot to monitor the traverse of the robot. To check whether the robot is moving in respective direction to reach the Destination. To get feedback from the robot IMU sensor (accelerometer) is used. The accelerometer gives the orientation of the robot. Using that values the command is send to robot via wireless Communication (Xbee) the robot is get aligned in the perfect path and to make an percise turns to reach the destination.

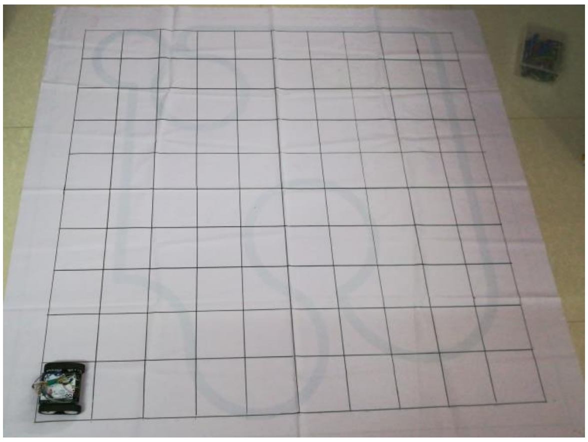

Figure 2. Artifical Arena with virtual objects

## WORKING MODEL OF PROPOSED METHOD

The Matlab software provides simple and easy tool for creating graphical user interface that can be readily used and can be easily modified. We have created a interactive graphical user interface with lots of customizable options to simulate the dynamic changes in the environment. In this graphical user interface there are options to modify the rows and columns and to define the initial and the target location.

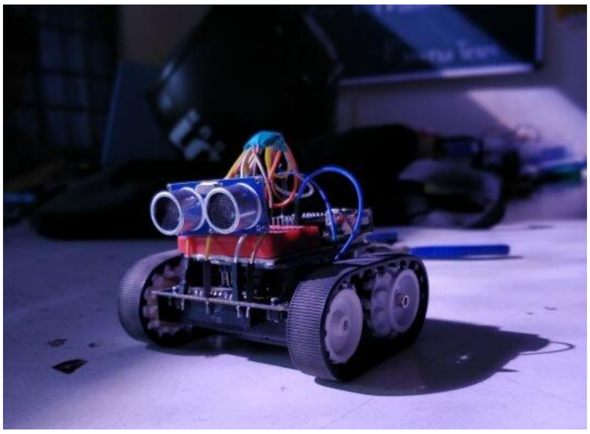

Figure 3. Working robot of the proposed work

There is also an option within the graphical user interface to set the serial port (COM Port) of the system which is used for wireless transmission through Xbee.There is a dynamic output screen to the left that displays the state of the system in real time.

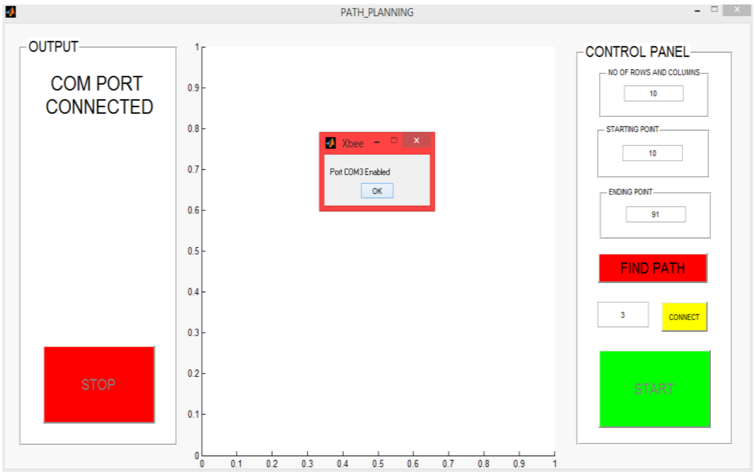


Figure 4. GUI simulation tool.

The Find path button in the graphical user interface intiates the path planning algorithm by taking the inputs as defined by the user (i.e. Number of Rows and Columns, Starting and Ending point). By creating random obstacles and then establishing the shortest path using A*(AStar) Algorithm between the initial and destination points.

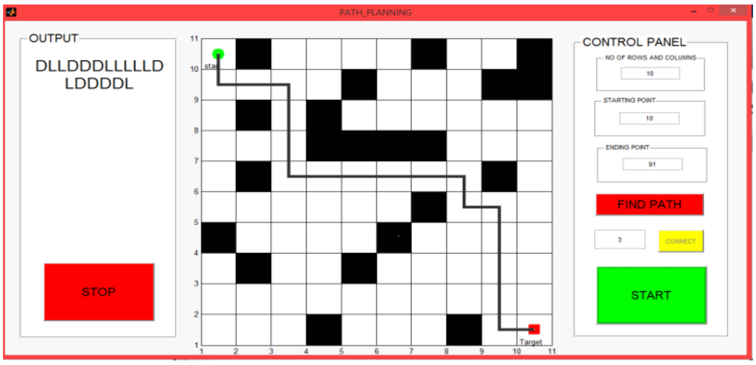


Figure 5. Astar Algorithm in Progress.

The coordinates and the commands are relayed to the robot and upon pressing the Start button the robot starts moving. While traversing the ultrasonic sensor checks for obstacles, if any it sends back the coordinates of itself and obstacle. The GUI uses these coordinates to re-map the Shortest path and sends the commands back to the robot to reach the destination.

## CONCLUSION

We have successfully developed a Graphical User Interface (GUI) in the Matlab and tested it using a mobile robot by transmitting required information using Wireless Communication (Xbee) to test the efficiency of the code and its redundancy. A*(Astar) algorithm was implemented and tested under different scenarios with random obstacles created within the Graphical User Interface. If there is any new obstacle in the Shortest Path detected by the Matlab Software while Traversing the path towards destination, the dynamically spotted obstacle and the postion of the robot is feed back to the software and new path to the destination is calculated if the object doesn't move and stationary for a calculated period.

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