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Differential Drive 2 Wheel Odometry

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ABSTRACT

Things that we used:

- We used a 2 wheel differential drive robot for indoor mapping of an environment.
- Used MATLAB PRM path planner to find an obstacle free path in the environment
- Used image processing to find obstacles in the environment.
- In cases where image processing failed to give the exact location of the obstacle, we used an ultrasonic sensor as an interrupt to avoid collision

What did we get:

- As we increased no. Of nodes the probability of getting an obstacle free path increased but at the same time no. Of combination between the nodes increased ${}^{n}c_2$ times this caused a lot of lag in the MATLAB software as data to be processed increased at a rapid rate.
- Connection distance and look ahead distance: distance between two nodes cannot be less than the dimension of the bot so we need to set the connection distance between two nodes to be atleast 1.25 times of the dimension of the bot.

Keywords: Robot, Differential Drive, MATLAB

I. INTRODUCTION

Industrial robots generally have their base fixed [1-4] .The have several limitations including localization and Path planning. In this paper, we present the specifications, Equations, Procedure for simulations and their results.

Robot Specification:

- 2 wheel differential drive robot
- wheel encoders intact with it to give the runtime RPM of the bot
- Magnetometer intact with it to give change in orientation of the bot.

Procedure followed:

Differential drive odometry can be used even in multiple wheels. The RPM of one set of wheels can be varied with respect to the other to follow any trajectory on the plane.

Using image processing a binary grid like structure of the environment is developed. In the grid 1 is for obstacle and 0 is for free space.

Using MATLAB probabilistic road map planner we get an obstacle free path by tuning the number of nodes and connection distance between two nodes.
The more the number of nodes we define more accurate obstacle free path we get but at the same time the processing speed is a constraint since we have ${}^{n}C_2$ combinations for the nodes.

Again, we need to tune the connection distance more 1.25 times the bot dimensions. In rare cases our bot might collide with the obstacle due to errors. The best way to ensure that this doesn't happen is using an ultrasonic sensor whenever the bot is about to collide, the reading becomes less than a particular value which we can define as threshold. We called a function to move right or left for a small duration as an interrupt to avoid collision.

Equations used could be widely seen in all open literature including the one in our references [1-4].

$$\begin{cases} \dot{x} = v\cos\phi \\ \dot{y} = v\sin\phi \\ \dot{\phi} = \omega \end{cases} \qquad v = \frac{R}{2}(v_r + v_\ell) \Rightarrow \frac{2v}{R} = v_r + v_\ell$$

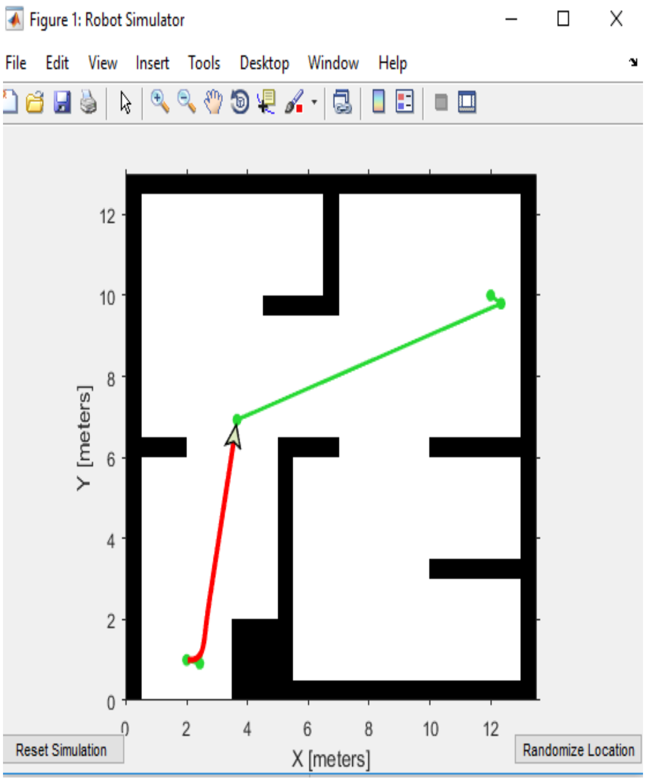
$$\omega = \frac{R}{L}(v_r - v_\ell) \Rightarrow \frac{\omega L}{R} = v_r - v_\ell$$

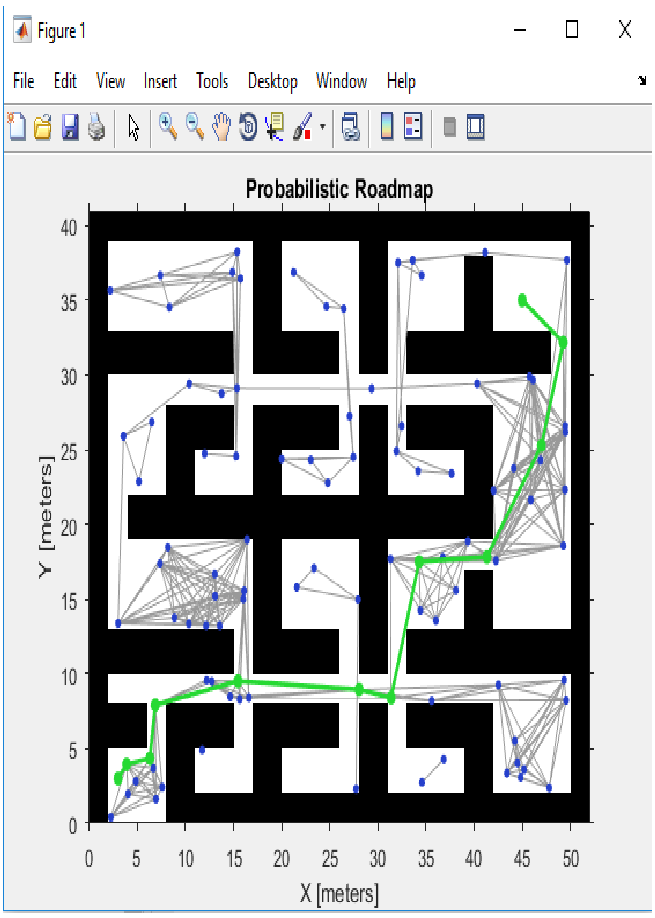
Design for this model!

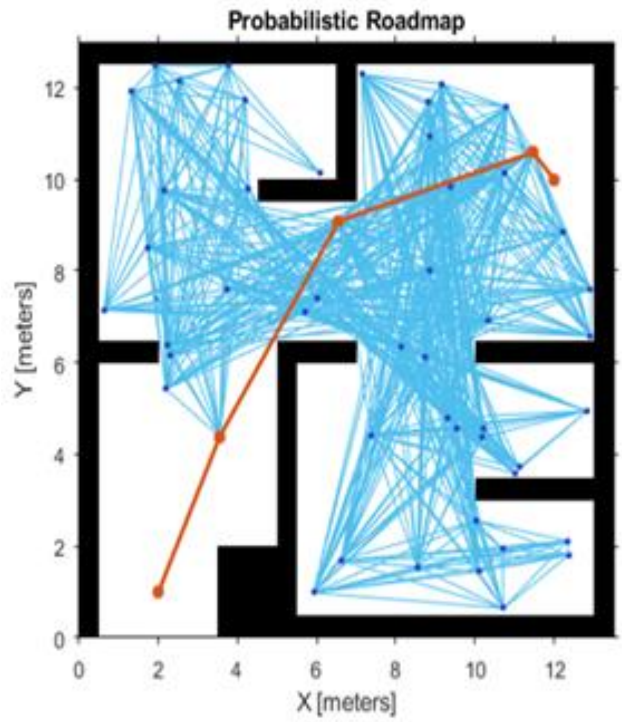
$$\begin{cases} \dot{x} = \frac{R}{2}(v_r + v_\ell)\cos\phi \\ \dot{y} = \frac{R}{2}(v_r + v_\ell)\sin\phi \\ \dot{\phi} = \frac{R}{L}(v_r - v_\ell) \end{cases} \qquad v_r = \frac{2v + \omega L}{2R} \quad v_\ell = \frac{2v - \omega L}{2R}$$

II. SIMULATIONS OBTAINED

We present the following results Simulation with the obstacle present, Probalistic road map.



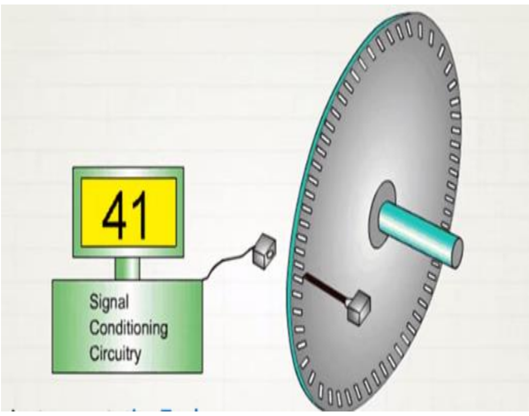




III. APPLICATIONS

A. Encoders

Encoders are used to generate rotary or linear motion into digital signal. This is used for controlling motion parameters such as speed, rate, distance, direction.



The Encoders typically consists of rotating and stationary electronic circuit. The rotor disc in absolute optical encoder uses opaque and transparent segments arranged in a Gray Code pattern. The stator has corresponding pairs of LEDs and phototransistors arranged so that the LED light receives through the transparent sections of the rotor disc and detected by phototransistors on the other side. After the electronic signals are amplified and converted, they are then available for the evaluation of the position of speed of the disc.

B. Ultrasonic Sensors

An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object.

IV. CONCLUSION

This can be used in unmanned mapping of terrain of unknown alien planet. Since planets are generally spherical in shape, a sphere has no starting and ending points. The coordinate from which our rover started is considered to be 0,0 and all the other coordinates are calculated with respect to it using image processing we can define the starting and ending points of the rover for the terrain to be mapped and the obstacles will be detected. We have used encoders here to get the rpm and distance traversed. Here, in our work we set a threshold if it crosses the, then interrupts are used to move it away from the obstacle and continue in its desired path.

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