Real Time Implementation of Square Path Tracing by Autonomous Mobile Robot

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Abstract. Since last 30 years, autonomous mobile robot is one of the booming fields as well as in near future this field will be top research areas among various scientists and researchers since lot of recent technology have been changing frequently. In this paper, a small work has been executed by mobile robot for path tracing by using online robot simulator Robotsetup 1.0.13071. The simulation results have been displayed by tracing perfect square path by autonomous mobile robot which is advantageous to dense and cluttered environment by using this online simulator.

1. Introduction

In recent years, mobile robotics have been considered be one of the fastest emerging field with respect to various researchers around the world. In many fields, mobile robots have an ability to substitute humans due to its fast response and accuracy of work. There have many applications such as surveillance, rescue operations, petrochemical applications, automation, construction activities, mobile applications, hospital ambulances, airport guides, transportation, software operations, autonomous driving and many more industrial applications related to mobile robots which are readily available in the market.

For industrial type of applications, mobile robot can move autonomous with or without taking help from human. Autonomous robot is defined as ability for determining the defined actions in order to perform various tasks associated with it by means of perception system. Control systems take care of all subsystems which comprises whole of the system.

There are four basic components used by mobile robot which are locomotion, perception cognition and navigation. The problems related to locomotion is related to kinematics and dynamics of control theory. The areas of perception related to computer vision and technologies related to sensor. For analysing the data received from various sensors, cognition plays an important role for actions to be performed. Navigation algorithms involves planning, information theory as well as artificial intelligence

2. Related Works

Path Planning is said to be one of the vital task for mobile robot. For navigating from initial state to goal state, a collision-free environment has been established [1]. Mobile robots are being deployed for both static and dynamic environments. There are various possible paths are available from initial state to final state but best optimal path have been selected while selecting some optimal parameters such as
shortest distance, path smoothness and consumption of minimum energy. Optimal path has been selected in partially known or unknown environments for local path planning[2].

Cell decomposition algorithm have been used for path planning so as to identify geometry areas or different cells that is being occupied by various objects [3]. If cell decomposition is lossless, then this method is termed as exact cell decomposition [4] since the borders of the environment has been considered as the function. If cell decomposition approximates the actual map, then this method is termed as approximate cell decomposition [5][6] as well as probabilistic cell decomposition[7][8]. For robot planning motions, cell decomposition is very useful method mentioned in[9].

3. Methodology

The various steps have been executed while running mobile robot navigation system which are mentioned below. In this section, we consider some assumptions.

- Both of the wheels should have same radius, same circumference
- The moment of inertia should be constant.
- Surface of the floor should be acting on minimum friction.
- All the four wheels should be equidistant from each other
- Motors used in the robot should be same power and configuration

3.1. Forward motion

In this step, the mobile robot has been considered to be two wheels acting on the speed of mobile robot. The speed of the mobile robot taken to be 20 cm/s acting on the both of the wheels that is right wheel and left wheel. Here , we take the original point to be (0,0). If both the wheels should be taken in positive notion as the mobile robot moves in the forward direction.

3.2. Right Direction motion

Here, mobile robot makes right turn by changing the velocities of both left wheel velocity and right wheel velocity. Here there are two types of turns are being executed which are follows.

3.2.1 Soft Right Turn

In soft turn, it defines that the mobile robot has very smooth turn which makes the mobile robot navigates in smooth environment. Here, the right wheel velocity is +20 cm/sec whereas the left wheel velocity is -20 cm/sec i.e. wheel will be rotating in anti- clockwise direction and then turns with a delay with 2000ms which makes a perfect right turn of angle 90 degrees

3.2.2 Hard Right Turn

In hard turn, the accuracy of turning of mobile robot has not been able to maintain a 100% turn but this turn is much helpful when there is sudden obstruction or obstacles are Infront of mobile robot. Here, accuracy is not much so important but avoiding the obstacles is more prime importance for this turn. While executing the hard turn, the velocities of motor have large differences comparing to soft turn. The right wheel velocity should be maintained at 20 cm/sec while the left wheel velocity is drastically reduced to 0 cm/sec so that it requires few milliseconds for taking right turn.

3.3. Left Direction motion

Mobile robot makes a left turn by making necessary changes in the velocities of both left wheel as well as right wheel. Therefore, left turn has been divided into two categories.
3.3.1 Soft Left Turn

Here, the mobile robot moves in the left turn that makes very smooth where it navigates in smooth environment. In this turn, velocity of left wheel is +20 cm/sec i.e. wheel is rotating at clockwise direction whereas right wheel velocity moves at -20 cm/sec rotating in anticlockwise direction and then makes a delay of 2000 ms which makes it a perfect left turn of angle 90 degrees.

3.3.2 Hard Left Turn

In this turn, accuracy of making left turn is inappropriate since maintaining will be an important issue. Hard Left turn means the turn will be less than 90 degrees as per direction of rotation of mobile robot. This turn will be very much helpful when obstacles are sudden in front of mobile robot. Here, calculated left wheel velocity is 20 cm/sec while right wheel velocity has been reduced to 0 cm/sec resulting to a few milliseconds to execute the operation. Hard left turn or Hard right turn is being executed when there is sudden appearance of the obstacles in front of mobile robot and there is increase of friction between wheels and floor which increases the heating of the wheels. This results in worn out of the wheels applied only in emergency situations.

3.4. Left Direction motion

In this direction, mobile robots moves in the backward direction when there is space limitation since there is less space is available for making right turn or left turn. In this turn, the velocities of left wheel and velocities of right wheel are both negative which means that each wheel rotates in anti-clockwise direction. The normal speed of left wheel velocity is -20 cm/sec and normal speed of velocity of -20 cm/sec suggesting that the friction among the wheels and surface of floor to be minimum so that skidding of mobile robot should not take place.

4. Application of DC motor in mobile robot

Two DC motor is being used for mobile robot. For wheels to be rotate in clockwise direction or in anticlockwise direction, DC motors play important role while running mobile robot. Hence, these motors are bidirectional since the motors operate in either direction. The explanation of rotation is explained in detail in following subsections using H- Bridge Configuration

4.1. Motor OFF

![H-Bridge Configuration](image)

Figure 1. DC Motor is OFF condition
For the above figure, SW1, SW2, SW3, SW4 are switches are being used. M is Bidirectional DC motor and supply used there is +5V. As from figure, motor is on OFF since all switches (SW1-SW4) are in OPEN condition. Hence, no current flows from the supply to motor.

4.2. Motor is in CLOOCWISE direction

![Figure 2. DC Motor rotates CLOCKWISE direction](image)

Here, motor runs in clockwise direction since switches SW1 and Switches SW2 are being closed. The direction of current suggests that current is supplied from VCC which goes from switch SW1 and goes to SW4 and goes to GND. The arrow indicates that motor rotates in CLOOCWISE direction.

4.3. Motor is in ANTICLOCWISE direction

![Figure 3. DC Motor rotates ANTICLOCKWISE direction](image)

In this figure, motor runs in the anticlockwise direction where the switches SW2 and SW3 are being closed. The direction of current suggests that the current is being taken from the supply VCC which goes to switch SW2 and then to SW4 which ultimately gets grounded. The arrow shows that motor rotates in ANTICLOCWISE direction.
5. Simulation Results

Using Robotsetup 1.0.13071 Simulation software, the results are being verified by using previous sections which are being shown in below figures.

![Figure 4. Mobile robot is in starting position](image)

In this figure, mobile robot is stationed in the starting point (0,0). Here, the left wheel velocity and right wheel velocity considered to be at 0 cm/sec.

![Figure 5. Mobile robot is in forward position](image)

In this figure, mobile robot moves in forward direction for 200 ms where velocity of left wheel and right wheel calculated to be 20 cm/sec.
Here, mobile robot turns a right soft turn where right wheel velocity and left wheel velocity is 20 cm/sec and -20 cm/sec and moves in 200 ms.

Here, the mobile robot moves in forward direction for 200 ms where right wheel velocity is 20 cm/sec and left wheel velocity is -20 cm/sec. At this point, mobile robot moves in right direction which is shown in below figure.
Figure 8. Mobile robot moves in again right side

For turning right in mobile robot, the left wheel velocity and right wheel velocity taken to be 0 cm/sec and -20 cm/sec. The duration of soft turn right takes place is 2050 ms.

Figure 9. Mobile robot moves in forward direction

In this figure, mobile robot goes for forward direction mode for 5000 ms where speed of left wheel is 20 cm/sec and right wheel velocity at -20 cm/sec. At this particular point, the mobile robot turns soft turn which is described in below figure.
From the above figure, mobile robot makes a prefect soft turn of duration 2000 ms which already covered ¾ th of the path traversed. Here, left wheel velocity is reduced to 0 cm/sec whereas velocity of right wheel maintained at 20 cm/sec.

Figure 11. Mobile robot moves in forward direction
From the above figure, mobile robot completes the square path travelled by mobile robot which in turn results in accuracy while maintaining proper duration of each right turn making a perfect square. This software stimulates the whole execution process and result have been shown above.

6. Conclusion and future works

The simulating results of mobile robot have been simulated using online from internet named “Robotsetup 1.0.13071” where results have been executed with an path planning of accuracy of 100%. Here, speed of the vehicle has been kept constant throughout the simulation and the timing of executing a complete path is approximately taken to be 1.5 minutes. In this proposed work, optimised path we have taken as there has been limitation of space constraints in the software.

Here, this software provides the solution for the proposed path planning algorithm. In order to execute robot planning algorithm in larger context such as running in huge and larger space environments, this software proposes a good solution for finding initial solutions in smaller scale environment. Hence, in future works, this algorithm will be helpful for finding path tracing in complex as well as dense environments in a shorter version which provides successful results on developing on it a larger scale.

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