COORDINATE TRACING AND OBSTACLE AVOIDING ROBOTIC CAR

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Abstract

This project demonstrates a robotic unit which is programmed to find an optimal path to its destination and simultaneously avoid obstacles on the way. The project is based on Arduino MEGA where the code is written in Arduino IDE Software. Optimal path finding and obstacle avoidance are the key factors for developing mobile robots. The robot uses a path finding algorithm to determine the quickest way to its goal, and an ultrasonic distance sensor mounted on a micro-servo motor for precise obstacle detection in the bot's vicinity.

Keywords: Arduino, Pathfinder, Odometry, Servo Motor, Ultrasonic Sensor, Speed Sensor, Encoders, Robotic Car, Coordinate Tracing, Obstacle Detection

1. INTRODUCTION

It can be difficult to determine the fastest route between two sites in real time. Robots that can accomplish this can be deployed in hazardous areas where human penetration could be fatal. The fundamental components of these robots can help those who are blind or deaf to sound locate nearby objects. To identify the shortest route between two sites, complex algorithms have been developed. Odometry uses motion sensor data to assess how the robot's position has changed over time in relation to a known position. It helps the robot know its present coordinates by keeping track of the coordinates that it is tracing, as stated in [1]. The bot's orientation may be determined using IMU sensors. As shown in [5], the data from these sensors can be used with the Kalman filter to reduce errors. The sliding mode method can help further reduce this orientation inaccuracy [6]. When the wheel is set in motion, an infrared speed detector is used to retrieve the encoder disc's number of ticks in order to obtain the RPM, which can then be utilised to determine the distance travelled using 2D kinematics as demonstrated in [4][7]. A fundamental component of a robotic automobile unit is obstacle avoidance, which is further broken down into static obstacle avoidance [2] and dynamic obstacle avoidance [3]. This is done with the aid of a highly sensitive ultrasonic sensor that uses SONAR technology. The information from the ultrasonic sensor is sent to a microcontroller, which determines how close the barrier is and allows the robot to avoid it [8].

In this paper, we describe a robotic unit that can trace its journey and arrive at the destination coordinates by combining coordinate tracing and obstacle avoidance technique [2][3][8]. We have employed wheel encoders and 2D kinematics in place of IMU sensors [5] to track the exact orientation of the bot. We have modelled the bot in a way that makes it capable of determining the shortest path from its present position to the final coordinates, in addition to coordinate tracing [1]. We have used interrupt pins since the entire process is taking place in real time, allowing the bot to respond quickly to any changes that the sensors pick up on and minimise any waiting time between activities. The microcontroller receives the destination coordinates through a Bluetooth module, and the user receives the processed sensor data that can be used to track the progress of the robot car.

This paper is divided as follows: The System design and the robotic unit's schematics are described in Section II. The technique, kinematics, and flowchart of the robotic unit are covered in Section III. The results are presented in Section IV. In Section V, the paper comes to a close.

2. SYSTEM DESIGN

The key components used in this robotic unit are Wheel Encoder, Ultrasonic Sensor, Motor Driver Module, Micro-servo Motor and Bluetooth Module along with circuit diagram which are shown in figure 1.

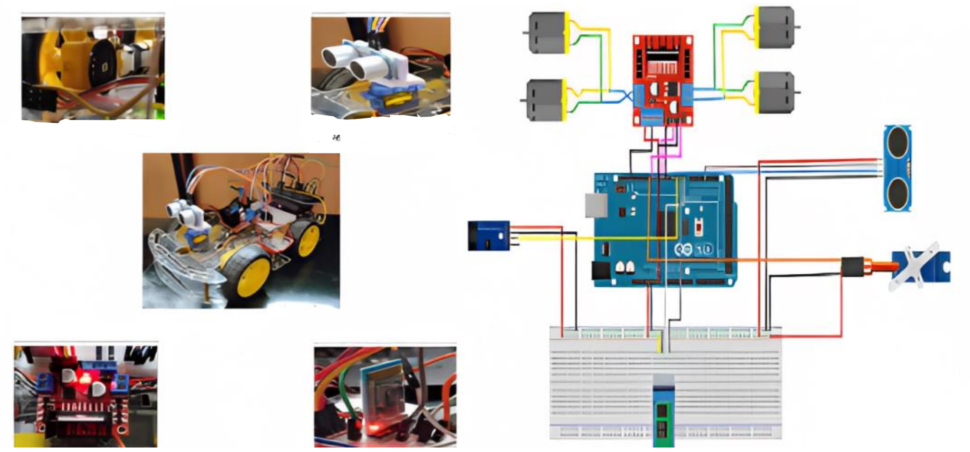

Figure 1: System Architecture

3. METHODOLOGY

Bluetooth is used to send the destination's 2D coordinates to the mobile bot. The Bluetooth module HC05 transmits data from compatible Bluetooth-enabled devices. The bot utilises these coordinates to draw a straight line to the end coordinates, which is the quickest route to the destination. This is accomplished by employing integrated 2D geometrical formulas in the code. Before beginning translation, the robot spins to position itself in a straight line leading there. Wheel encoders are used to achieve the right orientation and odometric measurements. The micro-servo motor's ultrasonic sensor, which is placed at the top, continuously scans for impediments. For real-time detection, ultrasonic and speed sensors transmit data through interrupt pins. The robot keeps moving forward until it encounters an obstruction, at which point it scans the path to its left and right by spinning an ultrasonic sensor with a micro-servo motor. The loop repeats until the goal is accomplished, choosing the obstacle-free route each time. Figure 2 provides an illustration of this technique.

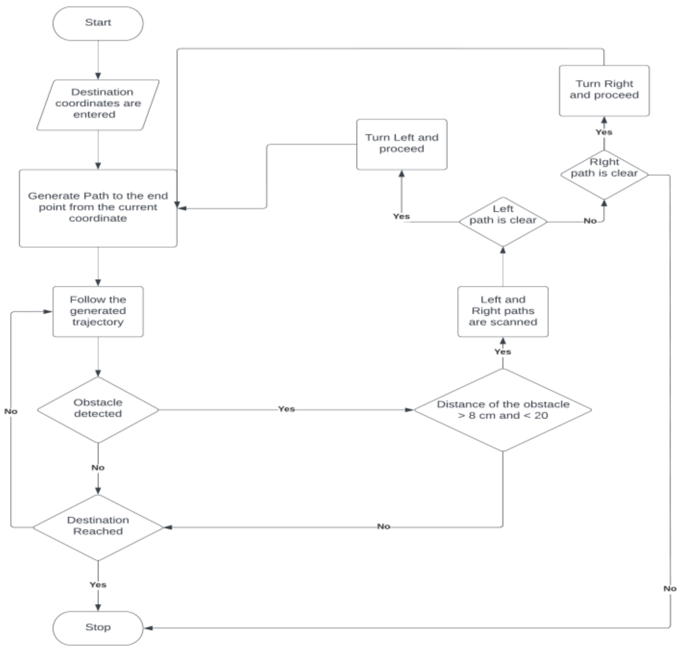

Figure 2: Flowchart of the pathfinding algorithm

3.1. Kinematic Formulae

(1) provides the formula for calculating the number of wheel rotations, and (2) provides the odometric data [9]. The tick count, or the number of voids in the encoder disc, is obtained using the wheel encoder LM393.

$$Rotations = Ticks / 20 \quad (1)$$

$$Distance\ travelled = 2 * 3.14 * radius * RPS \quad (2)$$

where *RPS* stands for rotation per second and radius is the radius of wheel.

(3) provides the formula for calculating the distance of obstruction from the chassis of the bot [10].

$$Distance\ of\ obstacle = 343 * (Time/2) \quad (3)$$

where *Time* represents the total amount of time taken by an ultrasonic pulse to leave and return back to the sensor port.

The velocity of right and left wheels is given by (4) and (5).

$$V_R = R*\omega \quad (4)$$

$$V_L = R*\omega \quad (5)$$

where ω is the angular velocity of the wheel and R is the radius of wheel. The robot moves forward when V_R and V_L are equal. It takes a left and right turn when $V_R > V_L$ and $V_R < V_L$ respectively.

Co-ordinate tracing is carried out by 2D geometrical formulae (6) and (7).

$$X' = X + r * \cos(\theta) \quad (6)$$

$$Y' = Y + r * \sin(\theta) \quad (7)$$

X, Y = old coordinates of the robot

X’, Y’ = current coordinates of the robot

r = distance between (X’, Y’) and (X, Y)

θ = the angle robot makes with respect to X_1 axis

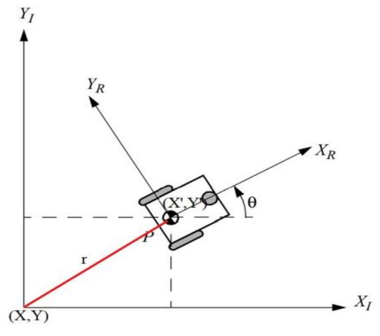

Figure 3: Global and Robot Local reference frame [11]

4. RESULTS AND DISCUSSION

The destination coordinates for the robot are (1,1). The first step is to rotate 45 degrees counter clockwise because (1,1) from (0,0) has a 1 slope (figure 4). As it advances, the robot spots an obstruction at (0.5,0.5) and turns left to get around it as illustrated in figure 5. The robot's most recent coordinates are used to construct a new, ideal course, and it stops once it arrives at its goal (figure 6).

Figure 4: Reception of Destination Co-ordinates (1,1) and Counter-clockwise turn by 45 degrees

Figure 5: Obstacle detection and avoidance

Figure 6: Optimal path generation and termination at destination

5. CONCLUSION AND FUTURE SCOPE

In this paper optimal shortest path is generated and the bot reaches its destination by avoiding obstacle(s). This is achieved by fusing coordinate tracing with obstacle detection and avoidance. We have primarily used wheel encoder to carry out this operation and the ultrasonic sensor functioning on interrupt pin provides us with real time feedback. Implementation of gyroscope to the robotic unit will enable it to move in uneven terrains. For greater precision a radar unit can be installed along with GPS communication system. Such robotic units are capable of reaching the exact final location. Implementation of the algorithm can be used to make a go to destination omni or mecanum wheel bots. Further, proportional controllers can be used to reduce the speed gradually as the bot reaches the desired coordinates and smoothen the entire process. When employed in a confined space, ArUco markers can be used on the bot to obtain feedback from the camera sensor, which can then be used to determine the exact location and orientation of the bot with relation to the camera frame.

6. REFERENCES

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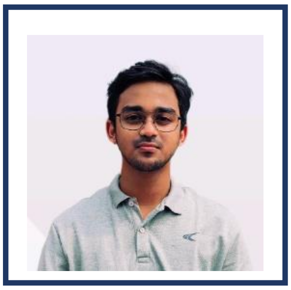
Biographies



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