Autonomous Vehicle: Obstacle Detection and Decision-Based Navigation

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Abstract- This paper presents the navigation of an autonomous vehicle in real-world environments. Due to uncertainty in the environment, a complex decision based mechanism is required for path tracking based on sensing the environment and controlling the robot under different conditions. The autonomous vehicle consists of 3 ultrasonic range finders (sensors) mounted on the chassis which is used to determine the distance in three different direction: left, right and front. Several test cases are considered to take into account different situations like different types of obstacle and the position of obstacles. The robot makes its decision using if-else conditions and the speed is varied for smooth navigation.

Index Terms- Arduino Uno, Autonomous vehicle , chassis ,dc motor, decision-based mechanism, navigation, servo motor, ultrasonic range finders,.

I. INTRODUCTION

Autonomous vehicle is a device that has various applications in day to day life. It has to deal with several uncertainties and has to pass through all the obstacles that come in its way. It has to analyse every situation differently and has to come up with a proper decision in order to avoid wrong turns leading to accidents.

The autonomous vehicle analyses part of the environment through each of its sensor and gives the reading for further analysis. We have considered possible situations by the distance observed by the sensors and have devised mechanism using the servo motor so that the autonomous vehicle can move around to accomplish its task.

The speed of the vehicle varies and is based on how far or near the obstacle is from the vehicle.

As the 3 sensors are fixed in 3 directions which are perpendicular to each other, diagonal distance cannot be calculated and such obstacles which come in the way cannot be avoided.

II. SYSTEM DESIGN

The system design is made using different hardware components and the software is used to write the program for the autonomous vehicle to perform different actions in different conditions. Figure 1 shows the *Autonomous vehicle design*.

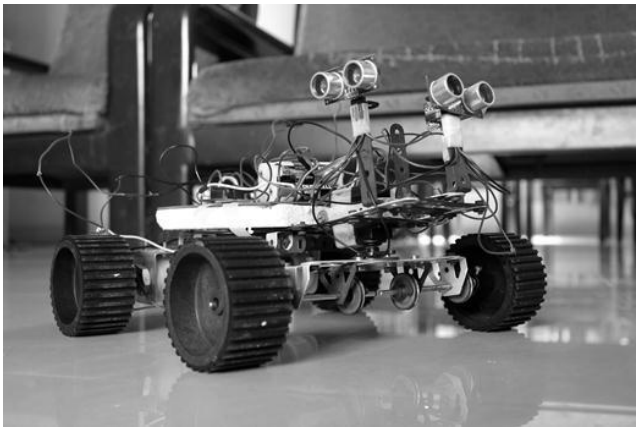

Figure 1: Autonomous vehicle design

A. Hardware Components

The autonomous vehicle consists of a chassis made using *Mechano*. It has two dc motors each of 300 rpm connected on its back wheels responsible for back and forth movement of the vehicle. A 12V rechargeable battery is used to drive the dc motors.

The servo motor having 6 kg torque controls the turning direction of the autonomous vehicle.

Three ultrasonic range finders are mounted on the chassis. They emit sound when they sense an obstacle and the reflected sound gives the distance the robot is from the sensor. 6V AA batteries are used to run the *Arduino* Uno.

B. Software Components

The *Arduino* Uno is a microcontroller board based on the ATmega328 .The decision-based mechanism is made using *Arduino* which is an open-source physical computing platform**.**

III. IMPLEMENTATION

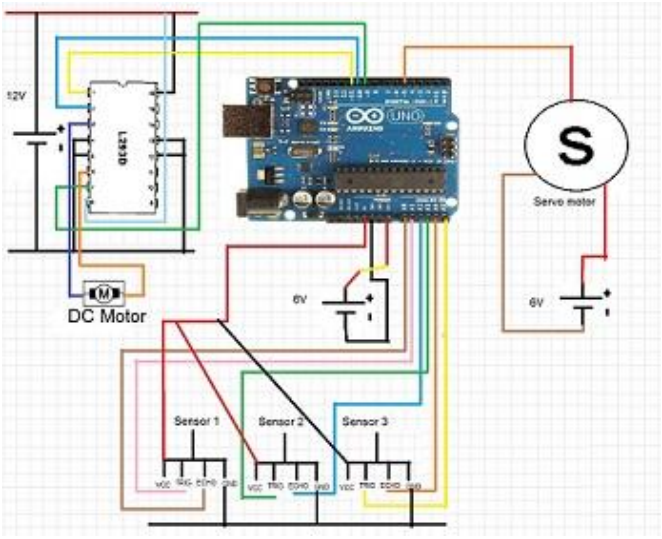

Figure 2 Schematic Diagram

Figure 2 shows the schematic diagram of the Autonomous vehicle. The different hardware components are connected together for its operation.

A. Sensing the environment

The echo and trigger pins of the three sensors are connected to the *Arduino* Uno to calculated the sensor readings. The front sensor on the chassis is used to indicate the distance at regular interval .The front sensor is responsible to detect whether an obstacle is coming in the way of the robot in its line of sight.

Based on that, the left and right sensor readings are taken into consideration and appropriate control system is designed.

B. Decision-based mechanism

The dc motor has a dynamic speed function which is determined by the distances calculated by the ultrasonic range finders. If the autonomous vehicle is in a free environment it will run at maximum set speed. The speed reduces as the obstacle approaches the vehicle or vice versa. Due to hardware limitations and specifications the speed cannot be varied to a great extent as it hampers the movement of the autonomous vehicle.

After acquiring the front sensor readings which indicate that there is an obstacle, the servo motor is used to turn the vehicle in the desired direction on sensing the obstacle. The servo motor is fixed at an angle of 93 degrees which is its center and it turns upto 133 degrees either the left or right direction.

If the distance calculated by the right sensor is less than that acquired by the left sensor the autonomous vehicle takes a left turn slowly and begins its journey in that direction until it comes across a new obstacle. Similar it turns right if the left sensor reading is less than right sensor. There is an additional possibility that both the sensor have very less reading. In this case the vehicle takes reverse and after sometime again begins the sensing and takes decision accordingly.

C. Varying the speed

The autonomous vehicle drives with a speed of 250 rpm if no obstacle is found in the long run. As soon as it comes closer to an obstacle it reduces its speed to 200 rpm to have smooth turning. While turning the vehicle reduces its speed to 0 and then again regains its speed to 250 rpm in case of no obstacle on the new path.

IV. RESULTS

The autonomous vehicle was tested in an environment having several obstacles in different positions. It showed accurate movement for every condition that it encountered and the navigation was done successfully. The speed variation was also observed during navigation.

V. CONCLUSIONS

The ultrasonic range finders give an accurate reading to some extent for the robot to judge its movement. But using GPRS, camera, sonar as well as image processing the navigation can become better and can lead to useful findings in the field of research and industries.

The behaviours that were considered were respect to human driving the vehicle. The decision system can be improvised and can be further developed considering the geographical conditions for better results.

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REFERENCES

[1] Sanjiv Singh, Paul Keller, Obstacle Detection for High Speed Autonomous Navigation, Field Robotics Center, Carnegie Mellon University, Pitsburgh PA 15213

[2] Pradalier, C. INRIA, Inst. Nat. Polytech. de Grenoble, Saint Ismier, France Hermosillo, J.; Koike, C.; Braillon, C.; Bessiere, P.; Laugier, C.,An autonomous car-like robot navigating safely among pedestrians, Roboticsand Automation, 2004. Proceedings.ICRA '04. 2004 IEEE International Conference

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