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Review Article

Elements needed to implement the Obstacle-Avoidance Robots

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Abstract
The intelligent machine known as the Obstacle Avoiding Robot has the ability to autonomously detect obstructions in its path and avoid them by changing course. The ability to avoid collisions is a crucial requirement for any autonomous mobile robot, and this design makes that achievable. The obstacle-avoiding robot is currently used by the majority of military organizations for a variety of duties that would be too risky for soldiers to undertake. This paper discusses the problem of obstacle avoidance in mobile robot navigation systems. The navigation system is thought to be of the utmost importance because the robot needs to be controlled from its starting point to its goal without colliding with anything. The robot must be able to avoid obstacles and reach its destination. In this study, the implementation of the robot's navigational behaviors to avoid obstacles is examined.

Keywords: Arduino Uno, Ultra Sonic Sensor; LM298N Motor Driver Module; Navigation; Obstacle Avoidance; Wheels.

INTRODUCTION

Research on robotic navigation is starting to take off on its own. Experts in robotics began to develop a variety of free routes finding algorithms. Because the robot must be able to be securely controlled from the starting point to the objective (destination), the navigation system is seen to be of utmost importance. The robot must be able to avoid obstacles or, to put it another way, not run into them. This is the first of two aspects that function as a guide. Second, the robot must constantly ensure that it reaches its objective (target). The difficult part is deciding one of the various travel options to choose. In reality, a driver is frequently still plagued by uncertainty when making decisions, like in the example above. If this is implemented in a mobile robot (autonomous robot), it will be quite intriguing. If these issues are applied to autonomous mobile robots with obstacles that the robot must avoid, new issues can be created from simple ones like these. A mobile robot's need to be able to recognize obstacles and decide how to avoid them would lead to complicated issues, not to mention the fact that the main target (goal) can vanish from the camera's field of vision. All of that necessitates an extremely challenging computing procedure. Since the sensor that will be used is a camera sensor, the light intensity is a factor that must also be taken into consideration. The aforementioned elements will make it challenging for the robot to reach its destination. Many studies have been conducted on obstacle avoidance, beginning with the presentation of fuzzy algorithms for reactive navigation for mobile robots in complex situations [1-61]. According to this study, fuzzy logic is fairly effective and responds quickly to challenges. Only static impediments in the robot's workspace are addressed in this study; moving obstacles brought on by moving objects are not taken into account. This study only focused on static obstacles that unexpectedly appeared, but model-based predictive controller (MBPC) using neural networks and ultrasonic sensors is also used to navigate mobile robots around static obstacles that unexpectedly appear in their workspace [62]–[77]. Motion planning and mobile robot pathways using the Dynamic Artificial Neural Network (DANN) method [78] – [80]. A mobile robot can be guided by this research around both static and moving obstacles on a level surface. Generalized Dynamic Fuzzy Neural Networks (GDFNN), a combination of the neural network and fuzzy methods, were used to design real-time control autonomous mobile robots in order to further improve the robot's ability to overcome obstacle avoidance [81]. The experimental results demonstrate that GDFNN performs better than traditional fuzzy logic control. Additionally, some people use Reinforcement Learning with Neural Networks (RLNN) to solve the obstacle avoidance issue for mobile autonomous robots [82]. The outcomes of the simulation demonstrate that the robot may enhance its capacity for learning and can carry out the tasks set forth in a complicated environment [89–92]. Researchers are beginning to innovate by fusing camera sensors with lasers to detect impediments in real-time. This kind of sensor can accurately identify two- and three-dimensional objects [83]. Stereo-vision systems were created based on a combination of omnidirectional cameras and perspective cameras, even in more recent research [84]. This method uses a long field of view from a perspective camera and a 360°C field of view from an omnidirectional camera to estimate the positions of obstacles in three dimensions. In earlier investigations, a number of vision system implementations based on color sensors [85], camera sensor Pixy 2 CMUcam5 [86], and thermal cameras [87] were examined. The experiments mentioned above produce excellent results, specifically real-time obstacle detection. However, no movable barriers were employed in the earlier studies. The objective of this study is to create a moving obstacle avoidance technique. This project will create an autonomous mobile robot based on previous research that can navigate on its own to avoid moving impediments brought on by environmental changes in the robot's working environment. Two webcams are utilized as stereo vision sensors to identify the environment. Pedestrians are employed as obstacles because their upper bodies can be detected. This object was chosen since the actual environment is where the robot is working. In order to send the robot to the target (destination), the intelligence technique as a control system must be able to deal with the issue of moving impediments in the work area. Neuro-Fuzzy is the control system that is utilized to avoid obstacles. with this investigation, a three-wheeled omnidirectional robot was used with the anticipation that it would be able to navigate obstacles with ease and flexibility. In order for the mobile robot to arrive at a predetermined target (goal), it is necessary to design a robot behavior that has the ability to identify the target object, the ability to detect moving obstacles and make decisions to avoid them flexibly. The robot will use these actions to navigate. The robot is guided from its starting position to its destination using stereo vision and the Neuro-Fuzzy algorithm. Omnidirectional robotics and the Neuro-Fuzzy algorithm are used to help the robot recognize impediments and make decisions that the robot will avoid in order to improve its capacity to deal with changing surroundings. This research focuses on robot navigation systems, which include locating the target (destination), which is considered to always be in the robot's line of sight, identifying obstacles and dodging them, and generating flexible and fluid movements. Pedestrians, who are detected using upper body detection, are the obstacle items used. The robot uses a corridor and an indoor chamber that are each 4 meters long and 4 meters wide as its workspace. Since the robot does not follow a path when walking, this study is not concerned with covering the smallest distance. The goal of this project is to create a stereo vision-based navigation system to assist omnidirectional mobile robots in avoiding obstacles. The suggested approach makes use of the Neuro-Fuzzy algorithm to generate a barrier-free path in real-time and direct the robot's movement so that it is adaptable and fluid. Designing a robot behavior that can recognize the target object, detect moving impediments, and make flexible judgments to avoid them is important in order to direct the mobile robot to reach a predefined location. Examining the robot's navigational behaviors is the aim of this study. As demonstrated, this study increases the state-of-the-art in obstacle avoidance based on the visual sensor for robot navigation systems by using a stereo camera to detect a target and obstacles as input to ANFIS. There are two main parts to the research methodology for this paper. The first stage is to develop a method for controlling the linear and angular velocity of autonomous mobile robots [88].

How to Create a Robot That Avoids Obstacles Using Ultrasonic Sensors

Before building the robot, it is essential to understand how the ultrasonic sensor works because it will be essential in spotting obstructions. Keeping track of how long it takes to broadcast ultrasonic beams and how long it takes to receive them after they have impacted a surface is the basic principle underlying how an ultrasonic sensor works. The formula is then used to calculate the distance. The trig pin of the HC-SR04 is therefore set high for at least 10 us. To transmit a sound beam, eight pulses at a frequency of 40 kHz are used. The signal hits the surface and bounces back, landing on the HC-SR04's receiver echo pin, where it is subsequently picked up. The Echo pin was already very high when the message was sent [94–95].

THE SEVERAL USES FOR OBSTACLE-AVOIDANCE ROBOTS

1. Almost all mobile robot navigation systems can make use of obstacle-avoiding robots.
2. They can be employed for domestic chores like automatic vacuuming.
3. Additionally, they can be employed in hazardous conditions where human penetration might be lethal.

COMPONENTS THAT ARE REQUIRED IN THE IMPLEMENTATION OF THE OBSTACLE AVOIDANCE ROBOTS

1. Arduino NANO or Uno

Is a board for an ATmega328P microprocessor. It has a 16 MHz ceramic resonator (CSTCE16M0V53-R0), 6 analog inputs, 14 digital input/output pins (of which 6 can be used as PWM outputs), a USB port, a power jack, an ICSP header, and a reset button. It comes with everything required to support the microcontroller; to use it, just plug in a USB cable, an AC-to-DC adapter, or a battery to power it.

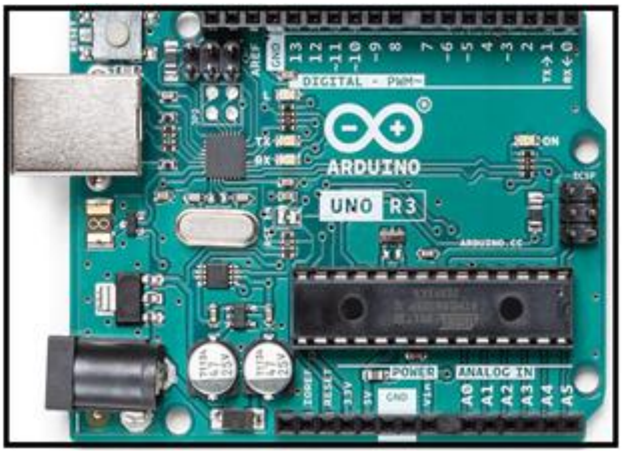

Fig.1. Arduino Uno

2. HC-SR04 Ultrasonic Sensor

The 2cm to 400cm (about an inch to 13 feet) range of the HC-SR04 distance measuring sensor makes it an economical and simple device to use. There are two ultrasonic transducers in the sensor. The first is an ultrasonic sound pulse transmitter, while the second is an ultrasonic sound pulse receiver that searches for reflected waves. In essence, it is a sonar, which submarines use to find items beneath the surface. When an object or obstacle gets in the way of the ultrasonic it emits at 40 000 Hz, which travels through the air, it will bounce back to the module. You can determine the distance by taking into account the sound's speed and travel time. We need to activate the Trig pin on high for 10 seconds in order to produce the ultrasound. This will emit an ultrasonic burst that lasts for eight cycles and moves at the speed of sound. After that 8-cycle ultrasonic burst is sent, the echo pin immediately goes high and begins listening for that wave to be reflected off a surface. The echo pin will time out after 38 ms and return to a low state if there is neither an object nor a reflected pulse. The echo pin will disappear earlier than those 38 milliseconds if we receive a reflected pulse. The distance the sound wave traveled, and consequently the distance from the sensor to the item, can be calculated based on how long the echo pin was on high. Actually, we are aware of both the values for time and speed. The speed is the sound speed, which is 340 m/s, and the period is the duration that the echo pin was high. We still have one more step to complete, which is to divide the result by 2 and this is so that we can determine how long it takes for the sound wave to reach the object and then bounce back.

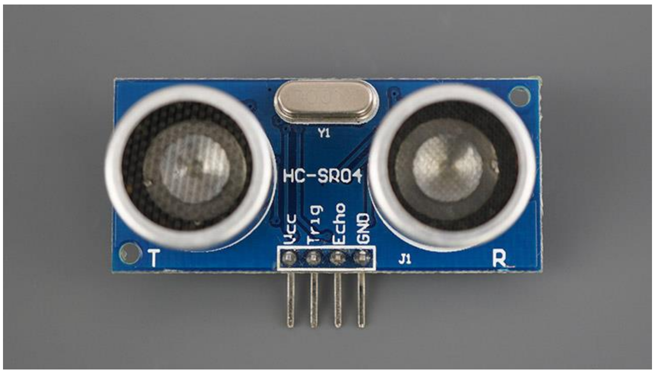

Fig. 2. HC-SR04 Ultrasonic Sensor

3. LM298N Motor Driver Module

For driving DC and stepper motors, the L298N Motor Driver Module is a high-power motor driver module. An L298 motor driver IC and a 78M05 5V regulator make up this module. Up to 4 DC motors or 2 DC motors with speed and direction control can be managed by the L298N Module. The L298N Motor Driver module is made up of an integrated circuit that contains an L298 Motor Driver IC, a 78M05 voltage regulator, resistors, capacitors, a power LED, and a 5V jumper. Only when the jumper is in place will the 78M05 voltage regulator be activated. The internal circuitry will be powered by the voltage regulator when the power source is less than or equal to 12 volts, and the 5-volt pin can be utilized as an output pin to power the microcontroller. When the power source is more than 12 volts, the jumper should not be installed, and a separate 5 volts should be provided through the 5-volt terminal to power the internal circuitry. Motor A and Motor B's IN1, IN2, IN3, and IN4 pins regulate direction, while ENA and ENB pins control speed for each motor.

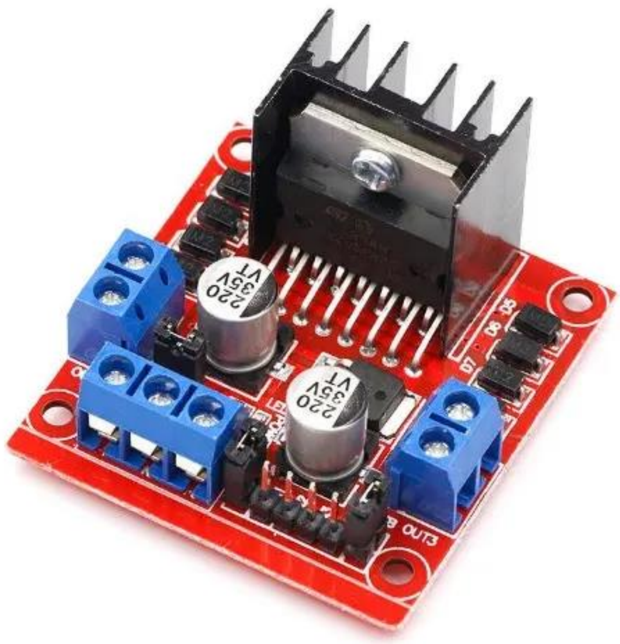

Fig. 3. LM298N Motor Driver Module

4. 5V DC Motors

Any of a group of rotating electric motors that use direct current (DC) electricity to create mechanical energy is referred to as a DC motor. The majority of types rely on the magnetic field's forces. For a portion of the motor's current to occasionally shift direction, almost all types of DC motors contain an internal mechanism that is either electromechanical or electronic. Because they could be supplied by existing direct-current lighting power distribution networks, DC motors were the first type of motor that was widely employed. A DC motor's speed can be varied across a large range by varying the supply voltage or the amount of current flowing through its field windings [96].

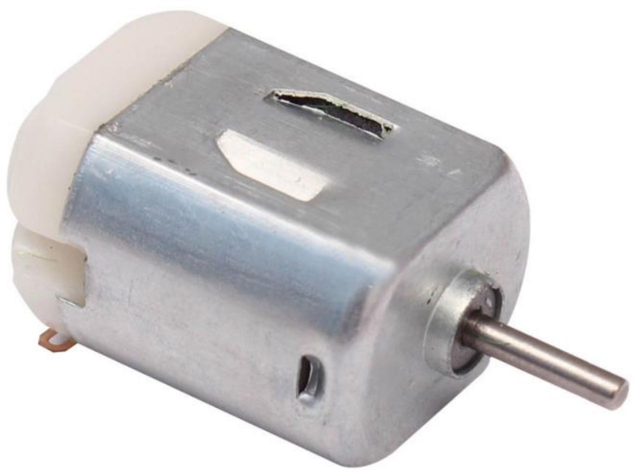

Fig. 4. DC Motor

5. Battery

Batteries are made up of one or more cells, each of which produces a flow of electrons in a circuit as a result of chemical reactions. An anode (the "-" side of a battery), a cathode (the "+" side), and some type of electrolyte (a material that chemically reacts with the anode and cathode) make up all batteries.

Fig. 5. Batteries

6. Wheels

A wheel is a rotatable circular component that rests on an axle bearing. One of the essential parts of the wheel and axle, one of the six fundamental machines, is the wheel. Wheels and axles work together to make it simple to move heavy items, whether they are used to support a load or do work in machines. Wheels can be used for a variety of other things, including steering wheels, flywheels, pottery wheels, and robotic wheels.

Fig. 6. Wheels of robots

CONCLUSION

The distance measurement method, according to the study, is achieved by dividing the baseline and focal length by the separation between the midpoints of the two frames. To support the ability to avoid obstacles, it is essential to raise the accuracy of distance measurements to obstacles and targets. At a distance of 250 cm, the highest measurement error for an obstacle is 3.40 percent, but the maximum measurement error for a target is 1.39 percent at a distance of 180 cm. The measurement error for the goal distance is 0.00% for distances of 80 cm or 240 cm, while the measurement error for the obstacle distance is 0.00% for distances of 190 cm. When the robot recognizes a target item based on the target angle and angle delta data, where these values are processed by ANFIS to generate angular velocity, the robot's trajectory will change. Throughout multiple testing, the robot's heading toward the target's least value was 0.03 degrees. The speed of Vy, which is calculated by analyzing the object's distance and angle, is what determines whether the robot will move to the right or left when it detects an obstacle. The benefits of obstacle-avoiding robots are emphasized, and the elements necessary for their implementation are examined.

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