Smart Vacuum Cleaner Robot

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Abstract: An autonomous system for a vacuum cleaner robot car. It is equipped with an ultrasonic sensor which helps to detect and avoid large obstacles such as tables, chairs, walls etc. The system is powered by a battery and includes a fan and pipe that is connected to the mouth of the bottle. The robot car is programmed to measure the distance between the obstacle and the car and to take the direction where the distance between the obstacle and the car is greater, there by preventing any collision with the obstacles. The system is designed to help clean hazardous areas which would otherwise be difficult to reach and require human intervention. This is expected to reduce risks to mankind by enabling a safer and easier way to clean domestic and industrial environments.

Keyword: Ultrasonic sensor, Arduino UNO, DC motor, Vacuum cleaner.

INTRODUCTION:

The control system is composed of an Arduino board and an ultrasonic sensor. The Arduino board processes the data from the ultrasonic sensor. The Arduino board is responsible for controlling the movement of the car. The vacuum cleaner is composed of a vacuum fan, a battery, and a pipe attached to the top of the unit. The vacuum fan is powered by the battery and is used to suck the dust from the floor. The pipe attached to the front of the unit collects the dust. Once the pipe is full, it needs to be manually cleaned. Finally, the Robot car provides the platform for the vacuum cleaner and is responsible for the direction of the wheels, which is determined by the code uploaded to the Arduino board.

Main aim of helping to clean and maintain the environment around us. The automated vacuum cleaner can be used to clean a large area in a short period of time. It can be used in domestic as well as commercial areas, such as colleges and offices. The project can also be useful in the current era of social distancing, as it reduces the need for manual labour.

SYSTEM REQUIREMENTS

HARDWARE REQUIREMENTS

- Arduino Uno R3
- Motor Driver Shield
- DC Motor
- Ultrasonic sensor
- Servo motor
- Power supply
- Vacuum fan

SOFTWARE REQUIREMENTS

- Arduino (IDE)

HARDWARE

Arduino UNO R3

The Arduino Uno is an open source 8-bit microcontroller board based on the ATmega328P microcontroller, which is widely used in projects related to robotics, automation and control. It has a 16-MHz crystal oscillator, a USB connection, a power jack, an In-Circuit Serial Programming (ICSP) header and a reset button. The board contains 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It can be programmed with the Arduino language, and can be powered either by a USB cable or a 9V battery.

Fig.1 Arduino Uno R3

Motor Driver Shield

The Motor Driver Shield shown in the image is an electronic circuit board that can be plugged into the Arduino UNO board. The main IC (integrated circuit) used in this shield is L293D, which is a quadruple half-H bridge driver that can control the direction and speed of four DC motors. The direction and speed of the motors can be controlled by coding in the Arduino IDE software.

Fig.2 Motor Driver Shield

DC Motor

The DC motor used in the prototype is a DC brushed motor, which is an electrical motor that runs on direct current power. It is composed of a rotor, or armature, and a stator, which is the stationary part of the motor. The rotor is attached to a shaft and the stator is connected to the power source. The rotor is given a magnetic field by the stator and this causes it to rotate. As the voltage increases, the speed of the motor increases, with the maximum speed being reached at 12V. This type of motor is commonly used in robotics and other applications due to its simplicity and low cost.

Fig.3 DC motor

Ultrasonic sensor

The Ultrasonic sensor is used in the prototype to measure the distance between the car and obstacle. It uses sound waves to calculate the distance. The sensor is triggered by the trigger pin and sends out ultrasonic waves which bounce off the obstacle and is received back by the echo pin. The duration of the sound wave is used to calculate the distance. The VCC pin provides the voltage necessary to power the sensor.

Fig.4 Ultrasonic sensor

Servo motor

The servo motor has some control circuits and a potentiometer connected to the output shaft. A Servo Motor is a small device that has an output shaft. This shaft can be positioned to specific angular positions by sending the servo a coded signal. As long as the coded signal exists on the input line, the servo will maintain the angular position of the shaft. If the coded signal changes, the angular position of the shaft changes.

Fig.5 Servo motor

Power supply

In this project we have used Lithium battery(12v). A lithium battery is a type of rechargeable battery that uses lithium ions as the primary component of its electrochemical reaction. Lithium batteries are commonly used in electronic devices such as smartphones, laptops, and portable power tools because they have a high energy density and can deliver high currents.

Fig.6 Lithium Battery

Vacuum fan blades

This fan is highly efficient and has low power consumption. It is also durable and provides a long-term service. It is also designed to be used in different applications. It is also designed with a brushless motor which makes it more efficient and quieter than other fans.

Fig.7 Vacuum fan blade

SOFTWARE

Arduino (IDE)

The software used in this project, Arduino IDE. This is an application written in C and C++. Programs can be written and uploaded to Arduino boards. The version used in here is 1.8.19.

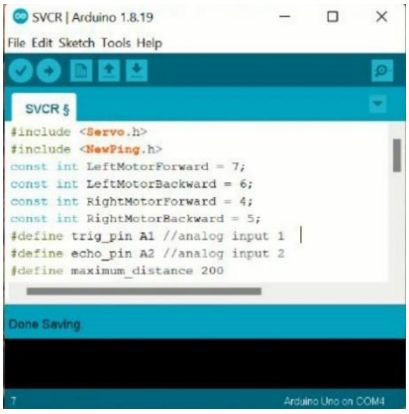

Fig.8 Arduino IDE

METHODOLOGY

1. DESIGN OF ROBOT CAR

The Robot car design shown in Fig. 9 involves the use of acrylic sheets with specific holes where the motor is attached using nuts and bolts. The motors are connected to the wheels and are soldered with positive and negative wires. The Robot car uses four

DC motors that can run at a desired speed and direction set using the Arduino IDE code. The motor shield is used to control the speed and direction of the motors. Additionally, an ultrasonic sensor is attached to the Robot car to detect the presence of obstacles in front of it.

Whenever the ultrasonic sensor detects an obstacle such as a wall, table, chair, or any other large object, the Robot car changes its direction to avoid crashing and damaging itself. This is particularly important as the Robot car is carrying a vacuum cleaner, which could be damaged in the event of a collision.

The code fed to the Arduino runs continuously, and the cycle repeats at regular intervals whenever an obstacle is detected. The batteries that power the Robot car are placed on the acrylic sheets.

Overall, the Robot car design seems to be a practical solution for cleaning hard-to-reach areas that may be inaccessible to humans. The combination of the Robot car and vacuum cleaner makes it possible to clean tight spaces and corners with ease.

Fig.9 Robot Car

2. VACUUM CLEANER

Vacuum cleaner is made up of 1L water bottle, Vacuum fan, pipe, tape, gauze bandage, batteries and switch.

To create the vacuum cleaner shown in Fig 10, the following steps were taken:

- A 1.25L water bottle was cut in half horizontally, creating a top and bottom portion.
- The top portion of the bottle had a conical and cylindrical structure. The conical structure was cut, leaving only the cylindrical part.
- A pipe with a length of 30 cm and a diameter of 1.5 cm was attached to the bottle cap area.
- The other end of the conical structure was covered with a gauze bandage to improve the vacuum.
- The cylindrical part that was separated in step 2 was taped to the conical part that has the gauze bandage.
- The other end of the cylindrical structure was attached to a fan.
- An 12V supply was provided to the fan to develop the required vacuum.
- A switch was also attached to the side of the vacuum cleaner to turn it on and off.

Fig.10 Vacuum Cleaner

Overall, this design is a simple and affordable way to create a vacuum cleaner using readily available materials. The use of a water bottle as the main body of the vacuum cleaner is a clever and eco-friendly solution that repurposes a common household item. The addition of the fan and gauze bandage help to improve the suction power of the vacuum cleaner, making it effective at picking up small particles and debris.

BLOCK DIAGRAM

The Ultrasonic Sensor is placed at the front of the car to measure the distance between the car and any obstacle in its path. The Left and Right Motors are used to control the movement of the car. These motors are connected to the motor driver shield, which controls their speed and direction. The Power Supply provides a 12V battery to the system. The Vacuum Fan is attached to the Vacuum Cleaner, which is placed at the top of the car. The vacuum cleaner serves as a weight to keep the car stable and also helps in reducing the friction between the wheels and the ground. The Battery Pack provides power to the motors and the Vacuum Fan. Overall, the proposed model is a compact and efficient design that can perform the desired tasks of an autonomous robot with ease.

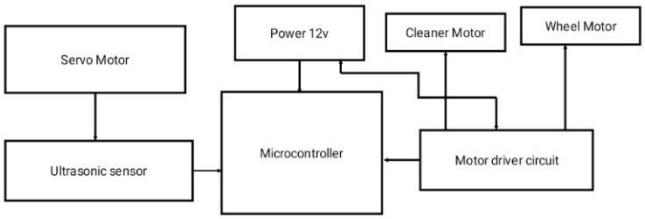

Fig. 11 Block Diagram

FLOW CHART

Once the car is started, it measures the distance using the Ultrasonic Sensor and moves forward. If the distance is less than 20cm, the car stops and reverses for a second, then turns towards the left side and measures the distance again. After getting back to its original position, the car turns right and stops for a second before returning to its original position. The car then measures both distances and moves in the direction of the greater distance to avoid a collision with any objects. If there are no obstacles in its path, the car moves in a straight direction without turning until it encounters an obstacle. This process repeats whenever there is an obstacle in the path. The program ends when the car is turned off or the battery runs out of power.

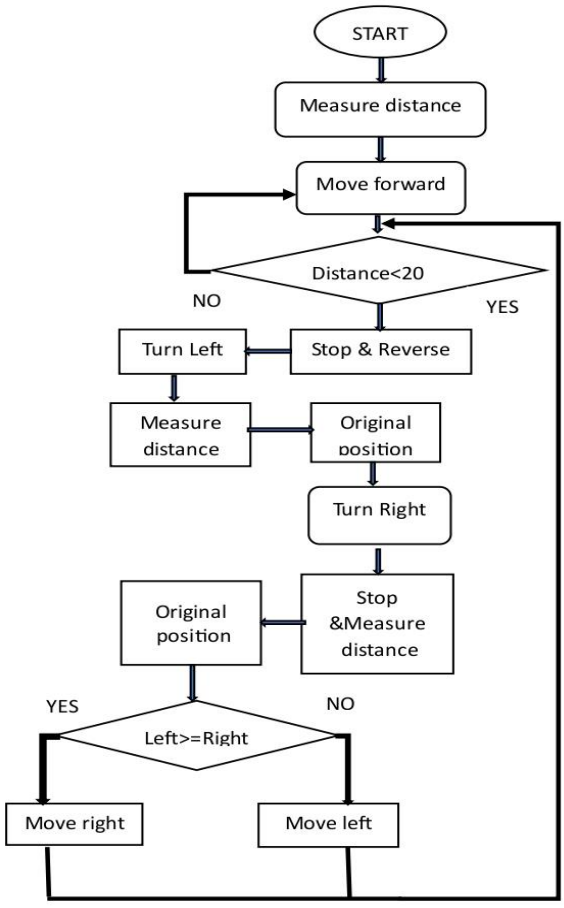

Fig.12 Flow Chart

IMPLEMENTATION

The designed prototype is an autonomous robot car that uses an ultrasonic sensor to measure the distance between the car and any obstacle in its path. It has a 12V power supply, and it runs on Arduino IDE. The algorithm is designed to make the car move in the forward direction until it encounters an obstacle. If the distance between the car and the obstacle is less than 20cm, the car stops

and reverses for a second, then turns towards the left side and measures the distance again. After getting back to its original position, the car turns right and stops for a second before returning to its original position. The car then measures both distances and moves in the direction of the greater distance to avoid a collision with any objects.

If there are no obstacles in its path, the car moves in a straight direction without turning until it encounters an obstacle. This process repeats whenever there is an obstacle in the path. The algorithm is simpler and easier to debug, making it more efficient and reliable.

RESULT

Based on the information provided, it seems that the ultrasonic sensor is used to detect obstacles in front of the robot car prototype. When an obstacle is detected, the distance to the right and left of the vehicle is calculated, and the prototype moves in the direction with the greater distance. The final setup of the prototype is shown in Fig.13

Fig.14 shows the prototype moving forward until it encounters an obstacle, at which point it stops. Fig.15 shows the prototype turning left when the distance between the vehicle and obstacle is less than 20 cm, likely to avoid collision. Fig.16 shows the prototype turning right after turning left to measure the available distance between the vehicle and obstacle.

Additionally, Fig.17 shows the amount of dust collected in the vacuum cleaner bottle. It appears that thermocol balls have been collected inside the bottle, indicating that the vacuum cleaner is effective at picking up small particles and debris.

Overall, these images suggest that the robot car prototype is capable of detecting obstacles and maneuvering around them while also collecting dust and debris using the attached vacuum cleaner.

Fig.13 Final Vacuum cleaner Robot

Fig.14 Forward Move

Fig.15 Left Turn

Fig.16 Right Turn

Fig.17 Collecting Dust

CONCLUSION

To conclude, the Smart Vacuum Cleaner project has successfully implemented a vacuum cleaner attached to an robot car prototype that can detect and maneuver around obstacles without human intervention. The vacuum cleaner is made using a fan, batteries, and a water bottle cut into two parts. The project uses pre-defined code inserted in an Arduino UNO and an ultrasonic sensor to detect obstacles and move the robot car in the direction with greater distance between the obstacle and the car. The vacuum cleaner collects dust and debris while the robot car is in motion.

The project is simple and cost-effective, and it reduces the hazards to human health by eliminating the need for human intervention in the cleaning process. However, the project can be improved by using a detachable bag for the vacuum cleaner to make removing the dust and debris simpler.

FUTURE SCOPE

In terms of future scope, this project can be further enhanced by incorporating more advanced sensors, such as cameras or LIDAR, for better obstacle detection and avoidance. Additionally, the project can be scaled up to be used in larger areas, such as offices or public spaces, by using larger robot cars and more powerful vacuum cleaners. The project can also be integrated with smart home systems to allow for remote control and scheduling of cleaning tasks

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