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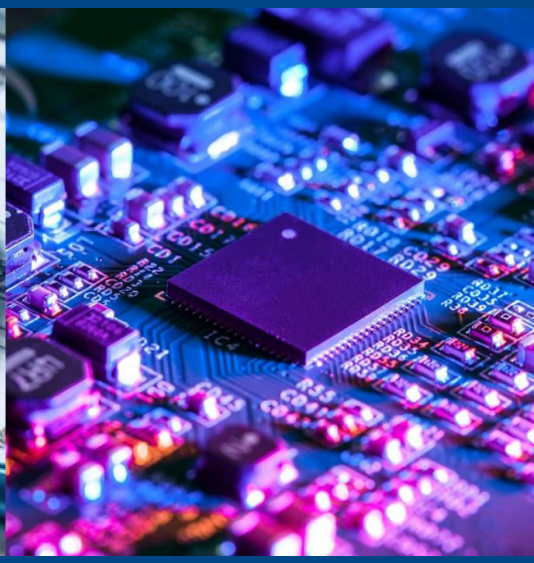

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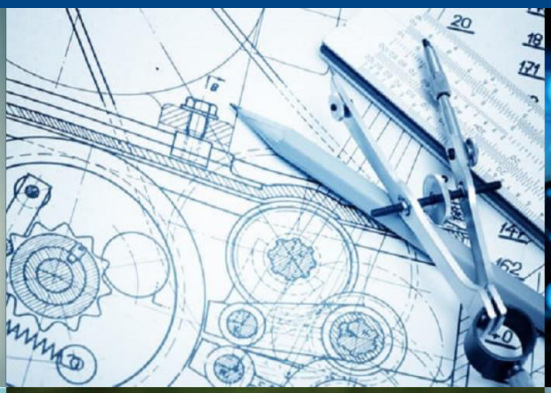

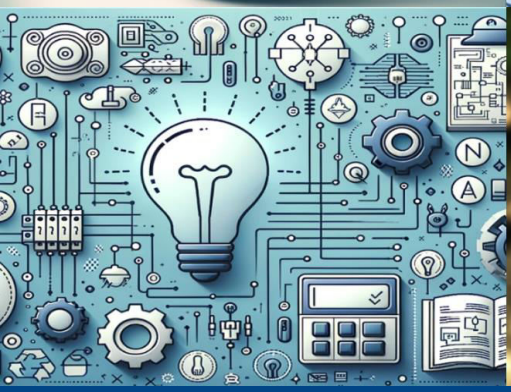

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Smart Vacuum Cleaner Robot for Automatic Floor Cleaning

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ABSTRACT: A new service robot designed for cleaning tasks in home environments is introduced. System has three subsystems: electrical, software and mechanical of which microcontroller, sensors (opponent and light) and motor are the electrical and mechanical subsystems respectively and the software subsystem is the brain of the robot. The cleaning robot uses a microcontroller to detect obstacles and manipulates its direction as per the inputs. It is programmed to accept inputs to sense obstacles around it and control the robot to avoid any collisions. In case of an obstacle, or a potential collision, the microcontroller controls the wheels of the robot by a motor driver to avoid collision. The vacuum cleaner at the bottom of the robot performs the cleaning process.

KEYWORDS: Vacuum Cleaner Robot (VCR), Arduino UNO, Arduino Motor Shield (AMS), Lithium ion Battery, Servo Motor, Ultrasonic sensor.

I. INTRODUCTION

An Arduino-based vacuum cleaner is a cleaning device that is powered and controlled by an Arduino microcontroller. The Arduino board is programmed to control the motors, sensors, and other components that make up the vacuum cleaner. This allows for a high degree of customization and control over the cleaning process, making it possible to program the vacuum cleaner to clean specific areas, adjust the suction power, and even navigate around obstacles. Additionally, an Arduino-based vacuum cleaner can be connected to other devices and systems, such as a smartphone or a home automation system, to provide remote control and monitoring capabilities. This makes the vacuum cleaner not only a practical cleaning tool, but also a fun and educational project for makers and hobbyists interested in robotics and home automation. A. Vacuum Cleaner A vacuum cleaner, commonly referred to as a vacuum or a hoover, is a machine that creates suction to take dirt off of surfaces like floors, couches, draperies, and other objects. Typically, electricity is used to power it. Either a dust bag or a cyclone collects the dirt for subsequent disposal. Small battery-powered hand-held vacuum cleaners, wheeled canister models for home use, domestic central vacuum cleaners, enormous stationary industrial machines that can hold hundreds of liters of dirt before being emptied, and self-propelled vacuum trucks for cleanup of significant spills or removal of contaminated soil are all different sizes and models of vacuum cleaners that are used in both homes and industry. Both solid objects and liquids can be sucked up using specialized shop vacuums. The performance of a vacuum cleaner can be measured by several parameters: 1. Airflow, in liters per second or cubic feet per minute (CFM or ft^3/min) 2. Air speed, in metres per second [m/s] or miles per hour [mph] 3. Suction, vacuum, or water lift, in pascals [Pa] or inches of water. B. Obstacle Avoiding Robot An obstacle avoidance robot is an autonomous robot that can move through its environment and avoid obstacles in its route without any human involvement. It is outfitted with sensors that identify obstacles in its path and algorithms that allow it to decide how to avoid them. The robot can be built to work in a range of conditions, from straightforward inside settings to challenging outdoor terrains. As they can travel through unfamiliar environments and avoid potential dangers, these robots are frequently utilised in applications including surveillance, exploration, and transportation.

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II. LITERATURE REVIEW

D. C. Patel et.al. In this paper the Indigenous vacuum tunnel made with 18,000 rpm DC motor is sufficient to vacuum small objects for commercial cleaning purpose. The indigenous wiper system made with Teflon bevel gears is strong enough to wipe the floor. The indigenous Arduino logic programme for working of limit switch, infrared sensor and drive motors is sufficient to turn smart vacuum cleaner in commercial floor by developing arbitrary path and cover all the floor area. The developed AI vacuum cleaner is highly cost effective compared to commercially available smart vacuum cleaners.

R. Radha et.al.They have created a cleaning programme that uses a hand gesture controlled robot and obstacle avoidance to carry out all cleaning tasks in both manual and autonomous modes. The user controls the robot using hand motions, and it works wonderfully. We are introducing features like dust bag full and battery status indication for autonomous mode. It detects the wall's edges, corners, and adequate cleaning. This robotic application is employed in settings like homes, workplaces, and businesses. Time is saved, and the human condition is improved.

T. B. Asafa et.al. The journal describes about A robot vacuum cleaner has been designed, fabricated, and put through testing. It is shaped like a disc and collects dirt using a retractable trash can with a cooling fan installed on top. The suction fan contributes to the vacuum created, which draws dirt to the trash can. A front caster wheel, two rear wheels, and ultrasonic sensors are used by the robot to navigate. When the inbuilt battery is fully charged, it can run continuously for two hours on a 28.8 V DC battery

M. Vijayalakshmi et.al. The vacuum cleaner robot designed in this journal is run more effectively to remove dry dust particles that are present on the floor. Since the robot is wireless, therefore they can navigate a vast region. Additionally, less human interaction means less human work. The robot can be upgraded with additional features to improve cleaning, including self-charging, self-dust disposal, the ability to sense and identify dust, as well as the ability to travel in the direction of dust.

E.S. Rahayu et.al.In this journal the Vacuum cleaner is designed which can run automatically and manually. In automatic mode the robot will move randomly in a room by avoiding the obstacles and cleans the room. Whereas in manual mode the robot moves on the command of the person with the help of a controller and cleans the room. The only problem is that the robot can't clean the narrow places due to its design.

Charnia Iradat Rapa et.al. In this research about Design of Micro controller Arduino Mega 2560, we need four Ultrasonic sensors to detect the obstacles in 25 cm distance. The driver will move in accordance with the state of the obstacles and activate the vacuum cleaner to sweep and clear the dust after a dust censor that can detect dust with a size less than about 0.30 mg/mm3 causes the LCD to display logic "1.By considering all the above-mentioned journals, as per our knowledge we observed that In comparison to conventional vacuum cleaners, the arduino-built vacuum cleaners are more cost-effective and efficient. The vacuum cleaners built on an Arduino platform can be operated both manually and automatically thanks to their design. However, the main drawback is that it takes longer than normal cleaners.

III. METHODOLOGY

The methodology for creating an Arduino-based smart Vacuum cleaner entails defining the cleaning requirements, selecting the necessary hardware components, such as motors, sensors, and batteries, writing the software code using the Arduino IDE, assembling the components in accordance with the design, testing and debugging the system to ensure it satisfies the requirements, improving the design to add features, and documenting the design and code for later use. To produce a practical and effective tool that can carry out particular cleaning activities automatically or manually, this requires amix of hardware and software design and testing.

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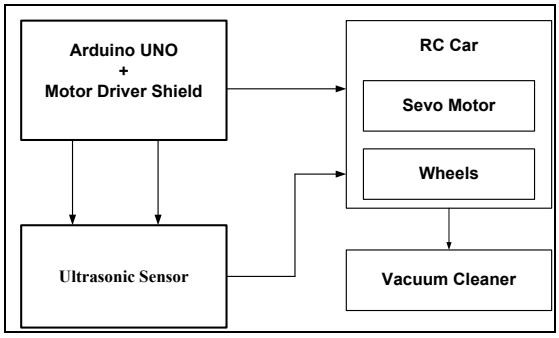

Fig.1 Block Diagram

3.1 WORKING PRINCIPLE

As soon as the robot is turned on, an ultrasonic sensor measures the space in front of it. If the distance is less than 20 cm, the robot stops moving, and it moves backwards while the servo motor rotates at an angle to measure the space on the robot's right and left sides. The robot goes in that direction if the distance is larger than 20 cm, and the process is repeated if the robot encounters any impediments. The vacuum cleaner is turned on at the same time as the robot. The vacuum cleaner cleans the area by sucking up all the dust particles, bits of paper, and other undesired things.

Once the system is turned on, the Arduino is powered by a power source, and thevehicle moves using a motor driver and caster wheel until an obstacle is detected, If an obstacle is detected, the robot changes its direction using the motor driver and program that has been loaded into the Arduino. The robot continuously changes its direction as it moves through the area it overs the entire space of the room. During the movement of the robot the vacuum cleaner is also turned on. The vacuum cleaner picks up the dust particles and cleans the area it moves.

IV. BLOCK DIAGRAM DESCRIPTION

As Shows the block diagram of the proposed model. Here, Motor Driver Shield is placed on top of Arduino Uno. In the front of the prototype, Ultrasonic sensor is attached which measures the distance. Towards the back of the car, vacuum cleaner is placed. The vacuum cleaner holds the CPU Fan. The wheels, DC Motor and batteries placement is as shown in figure.

4.1 Arduino UNO

The Arduino UNO is a standard board of Arduino. Here UNO means 'one' in Italian. It was named as UNO to label the first release of Arduino Software. It was also the first USB board released by Arduino, The Arduino UNO includes 6 analog pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header. It is programmed based on IDE, which stands for Integrated Development Environment. It can run on both online and offline platforms.

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller (MCU) and developed by Arduino.cc and initially released in 2010.The microcontroller board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by a USB cable or a barrel connector that accepts voltages between 7 and 20 volts, such as a rectangular 9-volt battery. It has the same microcontroller as the Arduino Nano board, and the same headers as the Leonardo board.

4.2 Arduino Motor Shild

The Arduino Motor Shield is based on the L298, which is a dual full-bridge driver designed to drive inductive loads such as relays, solenoids, DC and stepping motors. It lets you drive two DC motors with your Arduino board, controlling the speed and direction of each one independently. You can also measure the motor current absorption of

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each motor, among other features. The shield is Tinker Kit compatible, which means you can quickly create projects by plugging Tinker Kit modules to the board.

The Arduino Motor Shield allows you to easily control motor direction and speed using an Arduino. By allowing you to simply address Arduino pins, it makes it very simple to incorporate a motor into your project. It also allows you to be able to power a motor with a separate power supply of up to 12v. Best of all, the shield is very easy to find. For all of these reasons, the Arduino Motor Shield if a cool little to have in your arsenal for rapid prototyping, and general experimenting.

4.3 Ultrasonic Sensor

Ultrasonic sensors are based on the principle of sound waves, which are emitted by a transducer and then reflected when they encounter an obstacle. These reflected waves are then detected by the sensor and used to determine the distance and direction of the obstacle. The frequency range of ultrasonic sensors typically falls between 20 kHz and 200 kHz. Ultrasonic sensors are lighter in weight and cheap [69,84], making them highly suitable for use in UAVs. Ultrasonic sensors are unidirectional and used in multi-sensor configuration [87,88] for complete 360° coverage. A previous study in [88] shows an array of 4 ultrasonic sensors utilized in fusion with an IMU for indoor UAV localization in a GPS-denied environment. Similarly, an array of 12 ultrasonic sensors is fused with IMU in [85] for collision-free UAV autonomous indoor navigation.

Ultrasonic sensors have a limited detection range, typically up to a few meters, making them unsuitable for detecting obstacles from far distances. Additionally, they can be affected by external interferences, including ambient noise and weather conditions, which can impair their performance, as concluded in [89]. Furthermore, their ability to accurately measure the size and shape of obstacles is limited, which may restrict their efficacy in specific scenarios.

To comprehensively understand the various categories of perception sensors, this paper presents a comparative analysis in Table 5. The comparison matrix emphasizes 12 key evaluation metrics that are deemed critical for low-altitude obstacle detection and collision avoidance. This analysis aims to facilitate the reader's comprehension and evaluation of the different sensor categories about their performance capabilities.

4.4 Servo Motor

A servo motor is an electromechanical device that produces torque and velocity based on the supplied current and voltage. A servo motor works as part of a closed loop system providing torque and velocity as commanded from a servo controller utilizing a feedback device to close the loop. The feedback device supplies information such as current, velocity, or position to the servo controller, which adjusts the motor action depending on the commanded parameters. Servo motors are available in an extensive variety of types, shapes and sizes. The term servo was first used in 1859 by Joseph Facort, who implemented a feedback mechanism to assist in steering a ship with steam to control the rudders.

TABLE-I. COMPONENT LIST

Sr.No.	Parameter
1	Arduino UNO
2	Arduino Motor Shild
3	Ultrasonic sensor
4	Servo Motor
5	6V Motor
6	Jumper wire
7	Gear Motor
8	Lithium ion battery
9	USB Cable
10	Adapter
11	Slider switch
12	DC Socket

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V. RESULT

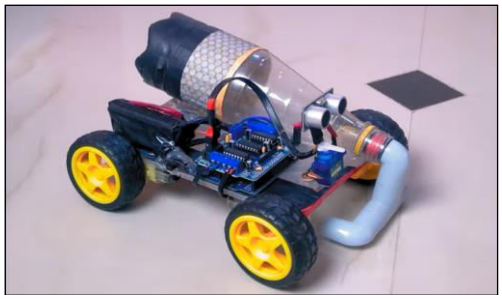
Here we propose an automated vaccum cleaner robotic system that allows for automatic cleaning of a particular area or room by covering the area using border analysis. The robotic system follows a zigzag path to cover entire room. The system uses ultrasonic sensors for boundary sensing and operates accordingly in order to cover entire room. The system also has a vacuum suction cleaner attached to its back for dust suction. It also displays the time utilized for complete cleaning session and displays it on LCD display post the cleaning process.

The system uses microcontroller based circuit system in order to monitor ultrasonic sensors as well as operate LCD display and control robot movement at the same time. The system detects one corner of room and starts from there, it then activates vacuum cleaner motor in order to start the suction system. The robot now operates in a zig zag manner by turning once a corner is reached. It cover the complete area automatically. There should be no obstacle in the entire room for this system to work properly. This can be resolved in future improvements in the system.

VI. CONCLUSION

In this project Smart Vacuum Cleaner has been implemented. It was works on a pre-defined code inserted in Arduino UNO. Whenever RC car encounters any obstacle, it turns to the side where the distance between obstacle and car is more. This project helps collect the dust using a vacuum cleaner made using CPU fan and batteries without human intervention thereby reducing the hazards to human health. This is a simple and cost-effective cleaner. However, using a detachable bag may be better as removing the dust becomes simpler.

The use of a smart vacuum cleaner has been implemented in this project. It operated using pre-written code that was placed into an Arduino UNO. When an impediment is encountered, a Vehicle will turn to the side. When there is more space between the car and the obstruction. This invention uses a battery-powered vacuum cleaner and a axial fan connected to the 6v motor to collect dust without the need for human interaction, lowering the risks to human health. This cleaner is easy to use and reasonably priced. However, since cleaning the dust becomes easier, utilising a detachable bag can be preferable. A lithium battery with an input power of 3.6 watts powers the vacuum cleaner that was created for this project. An anemometer measures the air velocity passing through the vacuum cleaner, while a pressure gauge measures the pressure inside the vacuum cleaner. The vacuum cleaner\'s effectiveness is 29.79%.



Hardware Model

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