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SEMI AUTOMATIC ROBOTIC FLOOR CLEANER WITH OBSTACLE AVOIDANCE FOR INDOOR APPLICATIONS

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Abstract - *Households of today are becoming smarter and more automated. Home automation delivers convenience and creates more time for people. Domestic robots are entering the homes and people's daily lives, but it is yet a relatively new and immature market. However, a growth is predicted and the adoption of domestic robots is evolving. Several robotic floor cleaners are available on the market but only few ones implement wet cleaning of floors. The purpose of this project is to design and develop Robotic Floor Cleaner. Vacuum Cleaner Robot is designed to make cleaning process become easier rather than by using manual vacuum. The project is to design and implement of semi-automatic robotic floor cleaner with obstacle avoidance and wet cleaning attachment.*

Key Words: **Automatic Floor Cleaner, Robotic Floor Cleaner, Dry & Wet Cleaner, Semi automatic robotic floor cleaner, Robotic Vacuum Cleaner**

1. INTRODUCTION

With life getting busier, many of the urban families find it difficult to keep the house clean. Especially when families are becoming nuclear nowadays and both husband and wife go to work; Waiting for the maid to come early in the morning and getting satisfied unwillingly even if nothing has been properly cleaned is what we see many times in the modern families. However, the robotics industry seems to have given such families a boon, the automated robot floor cleaner. They clean the house floor automatically and also get charged automatically while you are at work. Automatic floor cleaner is a system that enables cleaning of the floor by the help of highly stabilized and rapidly functionalized electronic and mechanical control system. Floor cleaning is achieved by different technique which might be of different kinds.

Different types of floor need different type of treatment. The floor should be totally dry after the cleaning process. Otherwise it may result in hazard. On some floors sawdust is used to absorb all kinds of liquids. This ensures that there wills no need of preventing them from spill of. Different types of floor cleaning machines are available today such as floor buffers, automatic floor scrubbers and extractors that can clean almost all types of hard floors or carpeted flooring surfaces in very less time than it would have taken using traditional cleaning methods. Again the cleaning would be different for different floorings.

Cleaning is the essential activity in our day to day routine to maintain hygiene. Basically in household floors the floor has to be cleaned regularly. Different techniques are used to clean the different types of surfaces. Mostly we clean floors manually or we depend on maids. We as a Indians always consider wet cleaning as a final step in cleaning process. Households of today are becoming smarter and more automated. Home automation delivers convenience and creates more time for people. Domestic robots are entering the homes and people's daily lives, but it is yet a relatively new and immature market. several robotic vacuum cleaners are available in the market but only few ones implement wet cleaning of floors.

2. LITERATURE REVIEW

Mobile robots are a major focus of current research and almost every major university has one or more labs that focus on mobile robot research. Mobile robots are also found in industrial, military and security settings. Domestic robots are consumer products, including entertainment robots and those that perform certain household tasks such as vacuuming or gardening. From then on more sophisticated robot is designed for household equipment for automating the tasks including washing machine, micro woven. After that only the revolution of mobile robotics came to household usages**.** In the following section contributions of market available products in the area is presented.

Scooba

- Manufacturer: iRobot (American)
- Type of Use: Wet Washing of Floor
- Technology: IR with virtual wall accessories
- Price: Rs. 31,392

Braava

- Manufacturer: iRobot, KITECH, Sony
- Type of Use: Floor moping for hard surfaces/Dry clean
- Technology: IR with virtual wall accessories for industrial cleaning
- Price: Rs. 44,705

Aguabot 5.0

•Manufacturer: Milagrow

•Type of Use: Wet Mopping and Dry Cleaning

•Technology: Various sensors (Obstacle, Optical, Accelerometer, Gyro), Extra thick -

Anti Slippage - Doorsill Crossing Wheels

• Price: Rs. 32,990

Exilient ReadyMaid Robotic Vacuum Cleaner

•Manufacturer: Exilient
•Type of Use: Wet Mopping and Dry Cleaning

•Technology: 6th sense, robotic scheduling, charging, UV cleaning, robotic obstacle detection, Robotic fall detection, All cleaning modes

• Price: Rs. 22,000

Difference between 'traditional' floor cleaners and floor cleaning robots

A floor cleaning robot works a lot like a traditional, manual vacuum cleaner. The main difference is that a robotic floor cleaner is equipped with brushes, which move the dust to the nozzle. Some robotic floor cleaners have extra brushes which collect the dust on both sides of the robot and brush this dust right into the nozzle. This feature allows the robots to sweep along walls and thus cleaning is more effective. The effectiveness of a robotic floor cleaner is also determined by the quality of the suction mechanism and the brushes. In comparison with manual vacuum cleaners, the cleaning process of robotic vacuum cleaners takes a longer time. It is slower and through its limited battery life it sometimes has to recharge within its cleaning round. Therefore, completing the vacuuming of an entire room takes longer. This is something the consumer is well aware of and since the robot cleans mostly when the consumer is not at home, this should not be a problem.

3. METHODOLOGY

Usually robots of this kind can cost more making it an unaffordable choice. At the same time this economical robotic floor cleaner has been designed mainly keeping the price margin in mind. As a result, a most efficient and agile cleaning system is developed to attain perfect cleaning rather than satisfactory cleaning achieved by a pre-existing extravagant machine. This project resulted in the outcome of exhaustive research and comparisons with the conventional designs and performances of various kinds and make. Supervisory control over these gadgets is made so simple and cost efficient without reduction in performance. By minimizing human intervention, the newly designed economical robotic floor cleaner paves a new way in innovating inexpensive, at the same time better home appliances. Ease of use and simple interface makes this project a most useful device in this busy and smart worldof today. With the aim of keeping our robot as simple as possible, while able to perform the initial goals, i.e. a vacuum cleaner robot able to clean a room or a house with the minimum human assistance, we choose components which are discussed following.

4. COMPONENTS

4.1 Mechanical Components:

Mechanical components consist of Frame, Aluminum sheet and vacuum cleaner body. Combination of all these parts makes a complete prototype for testing, as shown in Figure. Before fabrication, complete CAD Model was designed using commercially available software.

4.1.1 Chassis

The base of the body comprises of Aluminum sheet, Aluminum rods and plastic wheels with rubber ring on them for gripping purpose.All components areinstalled on lower side of sheet so that center of gravityshould be lower and robot would be stable.

Specifications

Length x Width x Height: 300 x 280 x 75 mm

Aluminum Bar: 10 x 10 mm & 1 mm thick

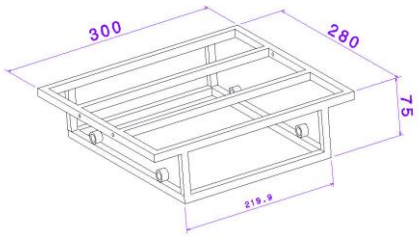


Fig -1: CHASSIS

4.1.2 Vacuum Cleaning Assembly

Vacuum cleaning and dirt disposal mechanism consists of DC motor, centrifugal compressor, U clamp for fixing motor, HEPA filter. Centrifugal compressor with DC motor placed inside PVC Pipe by wooden block & clamps. The whole assembly results in narrow tunnel from front side and broad compartment at back side.

Specifications

Total Length of Body: 275 mm

Diameter of Dustbin: 50 mm

Length of Dustbin: 135 mm

Inlet Dia. of Blades: 30 mm

Outlet Dia. of Blades: 60 mm

Blade Thickness: 5 mm

4.1.3 Wet cleaning attachment:

To perform wet cleaning, we attached simple attachment at rear end of our robotic floor cleaner. It is a cotton cloth attached toa sheet made up of foam with the help of Velcro. It is washable as well as replaceable.

Fig -2: WET CLEANING ATTACHMENT

4.1.4 T-Slot

To provide efficient dry cleaning purpose, we attach T-Slot at suction pipe. It helps to clean more surface area at on stroke

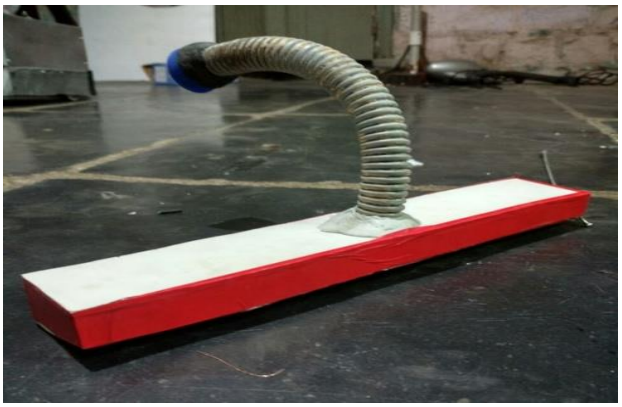


Fig -3: T-SLOT

4.2 Electronic Circuitry

The robot floor cleaner will be equipped with some standard parts. These are the batteries, and electrical motors, and Arduino. A short calculation has been done to decide these parts. Subsequently by trial and error we determine the necessary sizes of the parts and characteristics. The vacuum cleaner must have more sucking power and then must have power left for driving around; Based on these requirements we decide the specifications for the battery and a motor and choose Arduino Mega.

4.2.1 Compressor Motor

We selected compressor motor of following specifications.
Specifications: 12V 60W 5A

4.2.2 Locomotive Motor

By trial & error method we selected motor of 60rpm. For the better control over the movement of the robot 2-wheel drive mechanism is selected. Results of trial & error method are tabulated below.

Table -1: MOTOR SELECTION

TYPE [RPM]	45	60	100
SPEED [m/s]	0.141	0.188	0.314
REMARK	Slow	Moderate	Fast

4.2.3 Battery:

After selecting the motors, we calculated total power required for driving whole mechanism.

$$Total\ Power\ Required = \sum VI$$

Where, V= Voltage

I= Current

Power required for compressor = 12*5=60W

Power required for locomotive motors = 2*12*0.5=12W

Power required for Arduino = 1*12=12W

Hence, Total Power required = 84W

Considering use of compressor, Arduino circuit & motor drive we selected 11.1V 2200mAh Lithium-Polymer battery

4.2.4 Arduino Mega

The Arduino Mega is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Mega 2560 board is compatible with most shields designed for the Uno and the former boards Duemilanove or Diecimila.

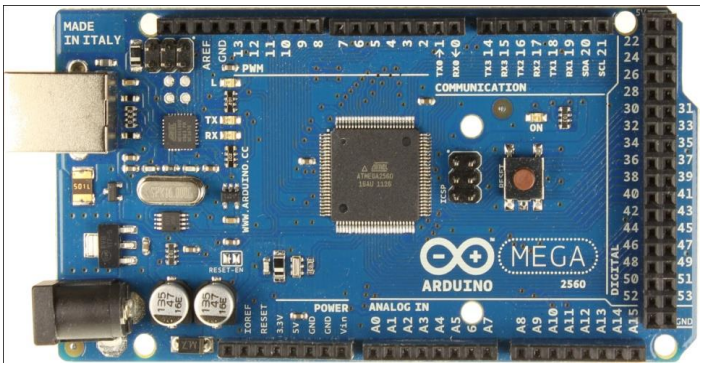


Fig -4: ARDUINO MEGA

4.2.5 Ultrasonic sensor HC-SR04

The HC-SR04 ultrasonic sensor uses sonar to determine distance to an object like bats do. It offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package. From 2cm to 400 cm or 1" to 13 feet. It operation is not affected by sunlight or black material like Sharp rangefinders are (although acoustically soft materials like cloth can be difficult to detect). It comes complete with ultrasonic transmitter and receiver module.

Fig -5: ULTRASONIC SENSOR HC-SR04

4.2.6 Motor driver L298N dual channel

The L298N Dual H-Bridge Motor Driver is a low cost motor driver board that can be used to drive two robot motors. It uses the popular L298N Dual H-Bridge Motor Driver chip and is powerful enough to drive motors from 5-35 Volts at up to 2 Amps per channel. The flexible digital input controls allow each motor to be fully independent with complete control over speed direction and braking action. This board provides a handy 5V regulator that can be used to power other circuitry such as your robot's microcontroller. Its modular design is easily adapted to a wide variety of robot controllers including the popular Arduino family.

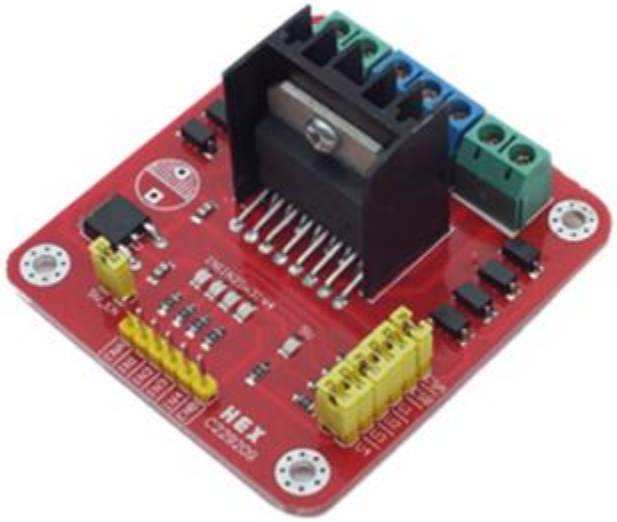


Fig -6: MOTOR DRIVER L298N DUAL CHANNEL

4.2.7 Tower Pro SG90 9g Servo Motor

Tiny and lightweight with high output power. Servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds but smaller. You can use any servo code, hardware or library to control these servos. Good for beginners who want to make stuff move without building a motor controller with feedback & gear box, especially since it will fit in small places. It comes with a 3 horns (arms) and hardware.

Fig -7: TOWER PRO SG90 9G SERVO MOTOR

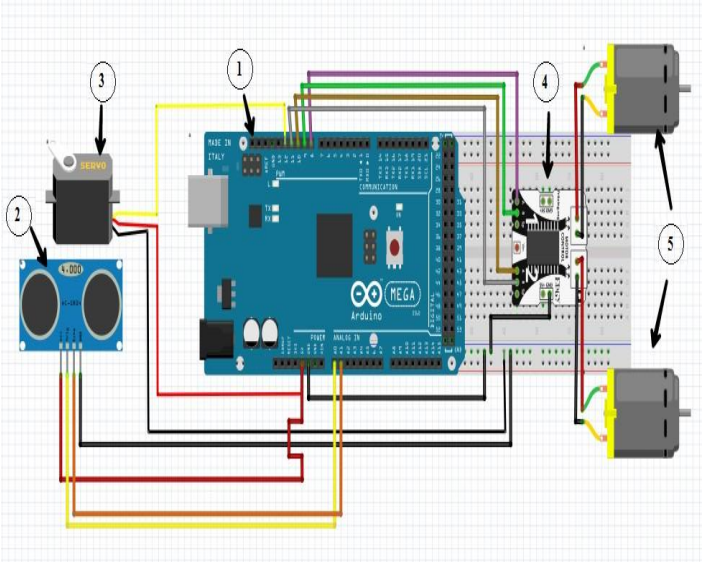
5.STEPS INVOLVED IN DESIGN & FABRICATION OF ROBOTIC FLOOR CLEANER

5.1 Design & fabrication of Vacuum cleaner body and installation of motors

Considering indoor application, we select the motor which creates that much vacuum by trial and error method. From this analysis we found a motor with centrifugal compressor from portable car vacuum cleaner and also provide a dustbin inside. For clamping of vacuum cleaner we fix the broad compartment at backside by using U clamp. After deciding dimensions of all components we decided dimensions for

chassis which assembles all parts and carries all stresses without distortion. For structure of chassis we selected square pipe of aluminum of 10*10 mm cross section and 1 mm thickness. Using rivets and nut bolts we clamped all components on chassis.

5.2 Arduino circuit building



1. Arduino Mega 2560
2. Ultrasonic Sensor
3. Servo Motor
4. L298N Motor Driver
5. DC Motor

Fig -8: ARDUINO CIRCUIT BUILDING

1. Connect RH motor to out1 & out2 of L298N.

2. Connect LH motor to out3 & out4 of L298N

3. Connect pin in1, in2, in3, in4 of L298N to pin 8,9,10,11 of Arduino.

4. Connect input of servo to pin no. 12 of Arduino & give supply to servo through 5V pin of Arduino.

5. For ultrasonic sensor, connect trigger pin to A0, and echo pin to A1 of Arduino. Connect Vin of ultrasonic sensor to 5V pin of L298N.

6. Draw common ground form L298N, Ultrasonic Sensor, Servo motor & connect it to GND pin of Arduino.

7. Connect Vin of Arduino & 12V pin of L298N to positive terminal of battery.

8. Connect GND pin of Arduino to negative terminal of battery.

5.3 Flow chart

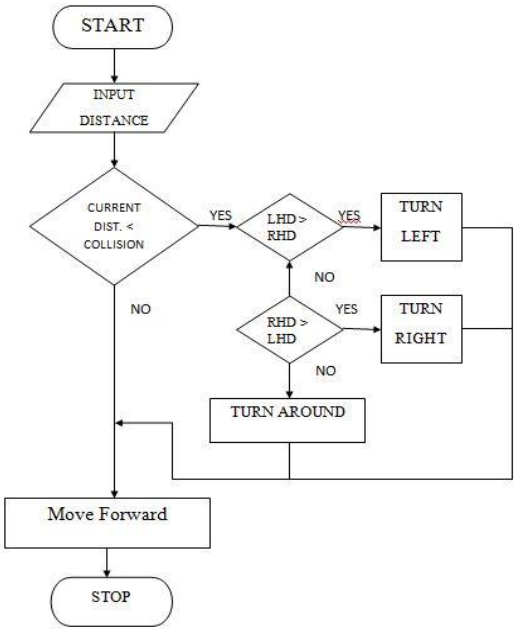


Fig -9: FLOW CHART

5. RESULTS:

After testing we recorded results of our product which are discussed below

1) We performed both dry and wet cleaning for indoor application.

2) Simultaneous cleaning & mobility mechanisms are possible.

3) The robotic cleaner successfully avoids obstacles and finds its way most of the times.

6. CONCLUSION & FUTURE SCOPE :

The objective of this project is to make a vacuum cleaning robot which is autonomous and of user friendly interface. Through this project we learned things design and manufacture of chassis, design of Arduino circuits and steps involved in development of any product.

Advantages of Robotic Vacuum cleaner

1) The robotic vacuum cleaner saves effort to get your floor cleaned.

2) Cheaper as compared to Market available products

3) Portable & compact in size

4) Low maintenance

Features of this robot can be enhanced with addition of total automatic working using Bluetooth/Wi-Fi module, Battery

monitoring, self-charging, and to set alarm on/off time manually are the future scope of this project.

Fig -10: SEMI AUTOMATIC ROBOTIC FLOOR CLEANER

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