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Smart Vacuum Clear Robot

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Abstract: *Manual work is taken over the robot technology and many of the related robot appliances are being used extensively also. Here represents the technology that proposed the working of robot for Floor cleaning. 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 vacuum cleaners are available on the market but only few ones implement wet cleaning of floors. The purpose of this project is to design and implement a Vacuum Robot for Autonomous dry and wet cleaning application using mop. Vacuum Cleaner Robot is designed to make cleaning process become easier rather than by using manual vacuum. The main objective of this project is to design and implement a vacuum robot prototype by using Arduino mini, Motor, Ultrasonic Sensor, and IR Sensor and to achieve the goal of this project. The whole circuitry is connected with 7.4V battery. Vacuum Robot will have several criteria that are user-friendly.*

Keywords: Vacuum Cleaner.

I. INTRODUCTION

Cleaning the environment around us is one of the important duties of each and every individual. Bigger the area to be cleaned, greater number of people will be needed. Some places will be so dirty that cleaning such areas causes huge impact on health. Due to dust present in the surroundings, people are prone to allergies, watery eyes, cold, cough, rashes etc. Vacuum cleaner can be used for domestic purposes such as to clean the floor, carpets etc. It can be used efficiently in colleges as the space is also large . In the current COVID situation since social distancing has to be maintained, a greater number of people cannot clean together. In this era where digital technology is rising rapidly, mankind is becoming more and more dependent on the same . Since majority belong to the working population, there is always a shortage of time.

Since, the Arduino can be coded to cover specific areas, moving the vacuum cleaner in the desired direction and the time taken for the same can be saved as it is possible through the car carrying it. Swachh Bharat Mission is an initiative taken by Government of India in the year 2014 to keep the surroundings clean. The main aim of this mission was to make every individual prioritize cleaning as it has huge impact on every living organism's health. This has been implemented in both rural and urban areas. At present, hand held vacuum cleaners are available in the market. Automation is still budding and smart vacuum cleaners will be a huge break-through in the industry. The new **Arduino Vacuum Cleaner** we are going to build here will be compact and more practical. On top of that, this robot will have ultrasonic sensors and an IR proximity sensor. The ultrasonic sensor will allow the robot to avoid obstacles so that it can move freely until the room is properly cleaned, and the proximity sensor will help it to avoid falling from stairs.

II. METHEDOLOGY

The project technology and components were elaborately discussed and plan made for implementation. Detailed study of requirements and functioning of various existing systems, components and its sub parts was undertaken for defining project methodology. Available technical literature and interaction with engineers working on these systems and components were carried out for finalization of efficient design at minimum cost and least time frame.

Households of today are becoming smarter and more automated. Home automation delivers convenience and creates more time for people. Domestic robots are entering homes and people's daily lives, but it is yet a relatively new and immature market. However, growth is predicted and the adoption of domestic robots is evolving. This work can be very useful in improving life style of mankind. Our aim is to design the Automatic vacuum cleaner that will help to make household work convenient and much easier. It operates in autonomous mode as well as in manual mode along with additional features like scheduling for specific time and dirt container with autodirt disposal mechanism. The flexibility, time saving and efficiency make the robot a clean choice for cleaning the floor

III. HARDWARE CONFIGURATION

3.1 Portable Vacuum Cleaner

In the component requirement section, we have talked about a portable vacuum cleaner**,** the images below show exactly that. It is a portable vacuum cleaner from amazon. This comes with a very simple mechanism. It has three parts in the bottom (a small chamber for storing the dust, the middle portion includes the motor, fan, and the battery socket on the top (there is a cover or cap for the battery). It has a DC motor and a fan. This motor is directly connected to 3V (2*1.5volt AA batteries) via a simple switch. As we are powering our robot with a 7.4V battery, we will cut the connection from the internal battery and power it from the 5V power supply. So, we have removed all the unnecessary parts and only the motor with two-wire stays. You can see that in the image below.

Fig 3.1 Portable vacuum cleaner

3.2 Driver IC L293D

L293D is a typical Motor driver or Motor Driver IC which allows DC actor to drive on either direction L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction, it means that you can control two DC motor with a single L293D IC. In a single 1.293D chip there are two b-Bridge circuit inside the IC which can rotate two de motor independently H-bridge is a circuit which allows the voltage to be flown in either direction, H-bridge IC are ideal for driving 4DC motor Due its size it is very much used in robotic application for controlling DC motor

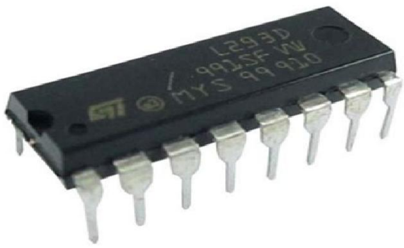

Fig 3.2 Driver IC L293D

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3.3 HC-SR04 Ultrasonic Sensor Module

Fig. 3.3 Ultrasonic Sensor Module

To detect the obstacles, we are using the popular HC-SR04 ultrasonic distance sensor or we can call it the obstacle avoidance sensors. The working is very simple, first, the transmitter module sends an ultrasonic wave which travels through air, hits an obstacle, and bounces back and the receiver receives that wave. By calculating the time with Arduino, we can determine the distance. In a previous article on Arduino Based Ultrasonic Distance Sensor project, we have discussed the working principle of this sensor very thoroughly. You can check that out if you want to know more about the HC-SR04 ultrasonic distance sensor module.

3.4 Floor Sensor (IR Sensor) for Staircase Detection

In the features section, we have talked about a feature where the robot can detect staircases and can prevent itself from falling. To do that, we are using an IR Sensor. We will make an interface between the IR sensor and Arduino. The working of the IR Proximity Sensor is very simple, it has an IR LED and a photodiode, the IR LED emits IR light and if any obstacle comes in front of this emitted light, it will be reflected, and the reflected light will be detected by the photodiode. But the generated voltage from the reflection will be very low. To increase that, we can use an op-amp comparator, we can amplify and get output. An IR module has three pins - Vcc, ground, and output. Usually, the output goes low when an obstacle comes in front of the sensor. So, we can use this to detect the floor. If for a split second, we detect a high from the sensor, we can stop the robot, turn it back or do anything we want to prevent it from falling from the staircase. In a previous article, we have made a Breadboard version of the IR Proximity Sensor Module and explained the working principle in details, you can check that out if you want to know more about this sensor.

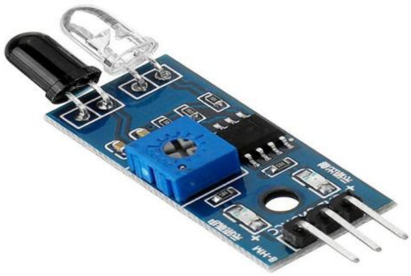

Fig.3.4 Floor Sensor (IR Sensor) for Staircase Detection

3.5 TP4056 Lithium Battery Charging Board:

The TP4056 chip is a lithium Ion battery charger for a single cell battery, protecting the cell from over and under charging. It has two status outputs indicating charging in progress, and charging complete and a programmable charge current of up to 1A.

You can use it to charge batteries directly from a USB port since the working input voltage range is 4V ~ 8V. However, remember the maximum current from a USB port is 500mA.

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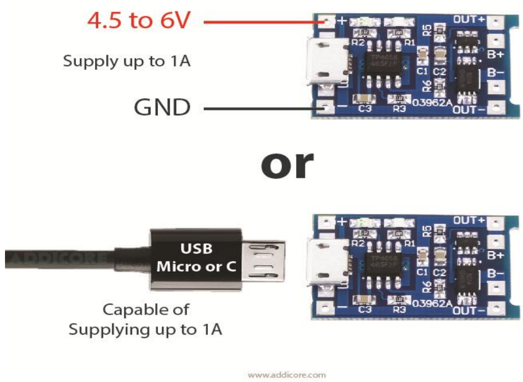

Fig.3.5 Lithium battery charging board

3.6 Jumper Wire:

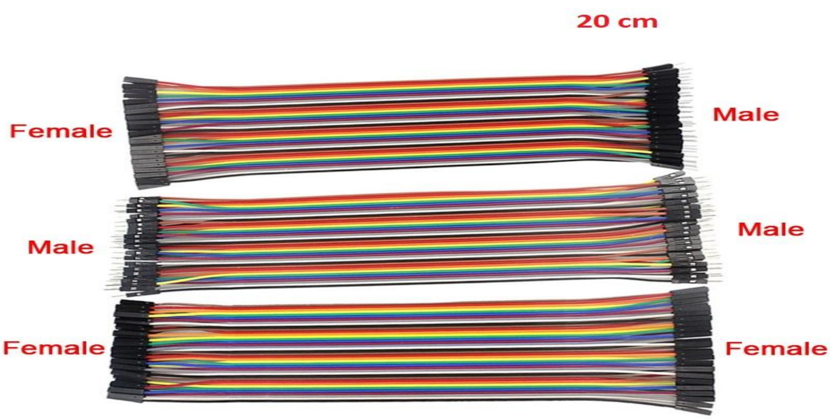

Fig. 3.6 Jumper wire

A jump wire (also known as jumper, jumper wire, jumper cable, DuPont wire or cable) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment.There are different types of jumper wires. Some have the same type of electrical connector at both ends, while others have different connectors. Some common connectors are mentioned in the figure

3.7 Lithium ion Cell:

As with most batteries you have an outer case made of metal. The use of metal is particularly important here because the battery is pressurized. This metal case has some kind of pressure-sensitive vent hole. If the battery ever gets so hot that it risks exploding from over-pressure, this vent will release the extra pressure. The battery will probably be useless afterwards, so this is something to avoid. The vent is strictly there as a safety measure. So is the Positive temperature coefficient (PTC) switch, a device that is supposed to keep the battery from overheating.

This metal case holds a long spiral comprising three thin sheets pressed together:

A Positive electrode

A Negativie electrode

A separator

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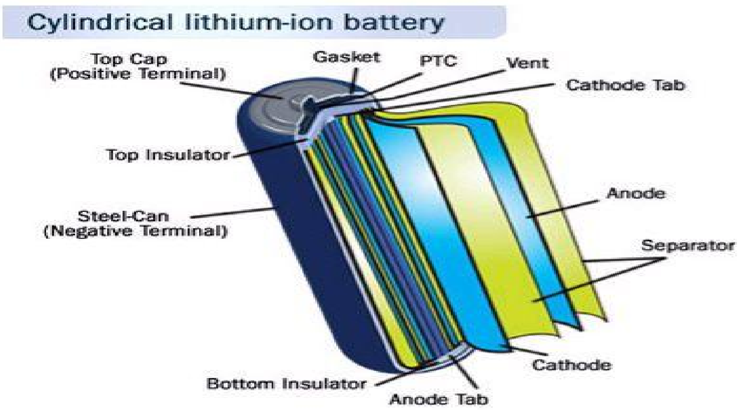

Fig.3.7 Lithium ion cell

Inside the case these sheets are submerged in an organic solvent that acts as the electrolyte. Ether is one common solvent.

The separator is a very thin sheet of microperforated plastic. As the name implies, it separates the positive and negative electrodes while allowing ions to pass through.

The positive electrode is made of Lithium cobalt oxide, or $LiCoO_2$. The negative electrode is made of carbon. When the battery charges, ions of lithium move through the electrolyte from the positive electrode to the negative electrode and attach to the carbon. During discharge, the lithium ions move back to the $LiCoO_2$ from the carbon.

The movement of these lithium ions happens at a fairly high voltage, so each cell produces 3.7 volts. This is much higher than the 1.5 volts typical of a normal AA alkaline cell that you buy at the supermarket and helps make lithium-ion batteries more compact in small devices like cell phones. See how battery work for details on different battery chemistries.

3.8 Arduino Mini

The **Arduino Pro Mini** is a microcontroller board based on the ATmega328P.

It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, an on-board resonator, a reset button, and holes for mounting pin headers. A six pin header can be connected to an FTDI cable or Sparkfun breakout board to provide USB power and communication to the board.

The Arduino Pro Mini is intended for semi-permanent installation in objects or exhibitions. The board comes without pre-mounted headers, allowing the use of various types of connectors or direct soldering of wires. The pin layout is compatible with the Arduino Mini.

There are two version of the Pro Mini. One runs at 3.3V and 8 MHz, the other at 5V and 16 MHz.

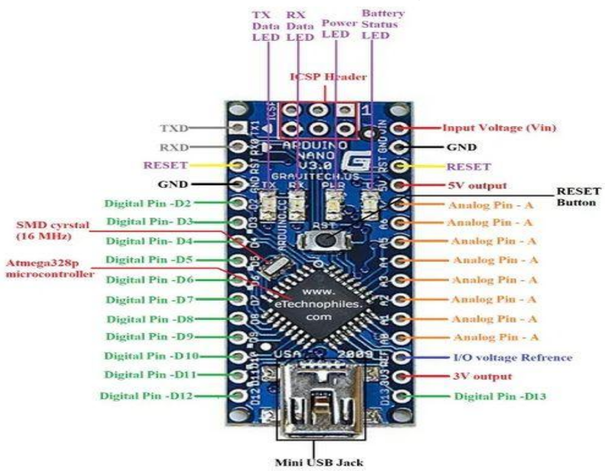

Fig. 3.8 Arduino Pro mini Pinout

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ATmega328 Microchip

The ATmega328 microcontroller is a high-speed, power-efficient AVR 8-bit microcontroller. It consists of 32 KB of flash memory for storing the program code (0.5 KB is used for storing the bootloader), 2 Kbytes of SRAM, and 1 Kbytes of EEPROM.

IV. CIRCUIT DIAGRAM OF ARDUINO BASED FLOOR CLEANER ROBOT

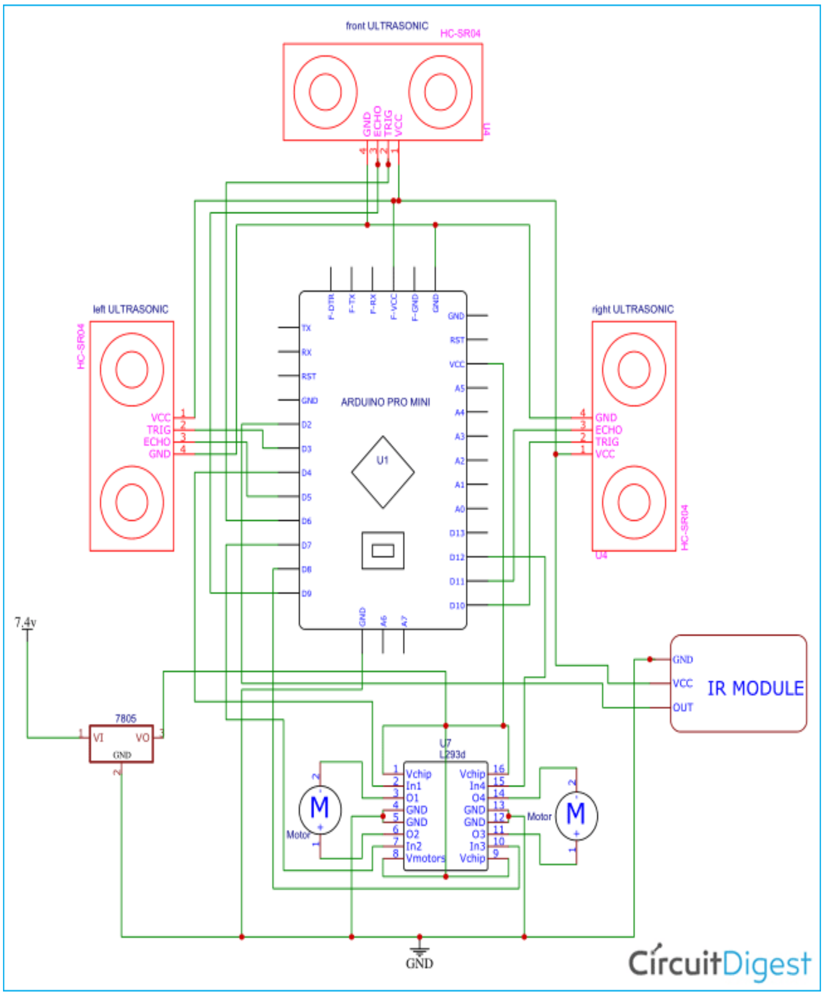

Fig .4.1 Circuit Diagram

We have three ultrasonic sensors that detect obstacles. So, we need to connect all grounds of ultrasonic sensors and connected them to common ground. Also, we connect all the three Vcc of the sensor and connect that to the common VCC pin. Next, we connect the trigger and echo pins to the PWM pins of the Arduino. We also connect the VCC of the IR module to 5V and ground to the ground pin of Arduino, the output pin of the IR sensor module goes to the digital pin D2 of the Arduino. For the motor driver, we connect the two enable pins to 5v and also the driver voltage pin to 5V because we are using 5volt motors. In a previous article, we have made an Arduino Motor Driver Shield, you can check that out to learn more about L293D Motor Driver IC and its operations. The Arduino, Ultrasonic modules, motor driver, and motors work on 5 Volt, the higher voltage will kill it and we are using the 7.4-volt battery, to convert that into 5 Volt, the LM7805 voltage regulator is used. Connect the vacuum cleaner directly to the main circuit.

4.1 Movement

Direction control 40 rpm geared motors provide the necessary forward motion on the floor, powered by 7.4V batteries and the directional control is established using a programmable microcontroller ATmega328 IC 32 bit, manually controlled using Radio Frequency transmission. Infra Red sensors are fitted on the edges for obstacle detection.

4.2 Proposed Model

We are done this machine in fully automatic and attached dry cleaning at one robot. We will make a Automatic dry floor cleaning Robot that only costs a small fraction of the ones in the market. this Robot can detect the obstacles & objects in front of it and can continue moving, avoiding the obstacles, until the whole room is cleaned. It has a small brush attached to it to clean dry floor.

Robot performs the following specifications were found:

1. Obstacle detection
2. Obstacle avoidance
3. Collision detection
4. Wet and dry cleaning operation
5. Speed controlling
6. System on automatically

For obstacle detection and to avoid obstacle ultrasonic sensor have been used. If any obstacle detected then robot change the lane automatically, does not stop and start cleaning action.

V. RESULT

- The robot which we design will facilitate efficient floor cleaning with sweeping
- It will work only in automatic mode.
- It will also provide the hurdle detection in case of any obstacles that comes in its way hurdle is detected using ultrasonic sensor.
- IR sensor also helps in detecting depth such as stair which prevent robot from falling.
- Our design will be helpful in overcoming the limitation of the existing technology, i.e. instead of zigzag movement of the robot, our system will follow straight path (edge detection).
- Along with sensor the robot also consist of vacuum cleaner and battery .

vacuum pump help in sucking dust, and this suction of dust will take place from the bottom side of model. **:**

All of the robot's functions have been tested, the obstacle and stair sensors worked, in the test that was made the robot vacuum cleaner avoided all the obstacles and stairs. The biggest problem with the prototype is that the robot goes very slow. This is because of the weight of the robot vacuum cleaner, 1 kg. With this kind of weight, the stepper motor needs high torque to make it move forward. When the stepper motors have high torque, it goes slow and when it has low torque, it goes fast. Therefore, the robot goes slow. We could solve this problem by exchanging stepper motors to bigger ones. If we had more time, we would do the exchange. On the other hand, maybe if the robot did go faster the robot could not detect the obstacle or stairs as good as it does now. Probably the robot cleaner could go a bit faster than it does now but at the same time sustain how it detects obstacle and stairs. Because of the robot vacuum cleaner weight, the bottom plate that are made of acrylic plastic and are only three mm thick is very fragile. If we had more time, it would be smart to change the materiel or have at thicker bottom plate. Because of the time limit we could not make a program that did the recommended driving pattern. Instead we made a program that was semi random. For instance this program could compare the distance between two sensors and then decide what turn it should make. This program worked fine but could be improved a lot more to make the robot cleaner be more efficient.

5.1 Challenges And Recommendations

The cleaning capacity is limited by the volume of the dustbin. This can be scaled up proportionately. Also, a bigger impeller with more clearance space between the blade and the casing is advisable as this affects the positioning and retrieval of the dustbin. The Motor shield is driven by two L293D IC; these components may become increasingly heated in operation, thus incorporation of heat-sink or more conventional cooling system will be beneficial. There is a need for a more sensors for a large scale domestic capability, for instance, a cliff sensor in case of stairs. Finally, a docking station where the robot can recharge it once its battery is drained needed to be incorporated for complete automation.

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VI. CONCLUSION

A vacuum cleaner robot has been designed, fabricated and tested. It has a disk-shape, sucks dirt via a retractable dustbin on top of which a cooling fan is mounted. The suction fan helps create vacuum that attracts dirt to the dustbin. The robot navigates with a front caster wheel and two rear wheels, and detects obstacles using the ultrasonic sensors. It is powered by 7.4V DC battery, and works continuously for half hours when the embedded battery is fully charged. The developed robot is developed is fully operational that navigates according logic. It is operated to achieve cleaning of dry dust particles with more efficiency. Since robot is wireless device it can navigatr to cover the large area. It also makes less human interaction which reduces the human work. The robot can be further used to upgrade with the functionalities such as to sense and detect as well as to move in the direction of dust which results in better cleaning, charging, self dust disposal and detecting depth such as stair which prevent robot from falling.

6.1 Scope Of Future Work

The model that is present in the report above can be optimized as much as possible. The recommended additions are:

- The chassis can be built on a PVC polymer. This will reduce the overall weight of the system
- The suction part can be automated using Programmable Logic Control for the sequence of operation The setup can be fully automated without manual interventions
- The dust can be collected using portable vacuum removal
- Germ less cleaning using UV exposure installed onϖ the vehicle.
- Criteria for interesting designs were low cost.
- The setup can be fully automated without manual interventions
- The dust can be collected using vacuum removal

The smart vacuum robot is built to collect the dry dust particles on the smooth tiles without human intervention

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