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Mini Project Report on

SMART VACUUM CLEANING ROBOT

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CERTIFICATE

Certified that the Mini Project work entitled **"SMART VACCUM CLEANING ROBOT"** is carried out by AMIT KUMAR 1AY20EC006, ATUL KHUNTIA 1AY20EC009, CHANDANI KUMARI 1AY20EC018, KUMAR ADITYA 1AY20EC040, in the partial fulfillment for the award of the degree of Bachelor of Engineering in Electronics and Communication Engineering of Visvesvaraya Technological University, Belagavi during the year **2022-2023**. It is certified that all corrections/suggestions indicated for the assessment have been incorporated in the report deposited in the departmental library. The Mini Project Report has been approved as it satisfies the academic requirement in respect of Mini Project work (18ECMP68) prescribed for the Bachelor of Engineering Degree.

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ABSTRACT

In the current hectic schedule, cleaning houses and surrounding environment is more arduous. At present, there are vacuum cleaners which require humans to handle it. Thus, there is a dire need to implement vacuum cleaner which works without human intervention. An efficient method to clean the desired area has been implemented through this project. By using this vacuum cleaner, hazardous places can be cleaned which thereby reduce risks to mankind.

This is achieved by implementing an autonomous system. Here, RC car which is embedded with a vacuum cleaner is used. This system has an ultrasonic sensor attached to it, that helps in avoiding large obstacles such as tables, chairs, walls etc. By measuring the distance via this sensor, the car takes the direction where the distance between obstacle and car is more, hence avoiding the collision with the obstacles. The vacuum cleaner is designed with a CPU fan and a pipe is attached to the mouth of the bottle. The entire system is run by batteries.

The ‘digital revolution’ of household life is underway, with technologies such as robotic vacuum cleaners (robovacs) increasingly common. Various other automated appliances are emerging and being adopted in pursuit of the ‘smart home’. Current discourses include assumptions and explicit claims that smart homes will be energy efficient and therefore more environmentally sustainable. However, smart home technologies are also presented as affording lifestyle enhancements in the areas of comfort, cleanliness, convenience, entertainment and security. Focusing specifically on one smart device – the robovac – this report aims to demonstrate how visions of cleanliness in the smart home could be counterproductive to energy reductions and household wellbeing. content analysis of smart home marketing and articles, and conversational interviews (involving home tours) with early adopters of robovacs and smart home technologies. these devices may escalate conventions of cleanliness in the home and invite supplementary energy consumption. The report concludes by providing suggestions for how energy stakeholders can respond.

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CHAPTER 1

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. [1]. Vacuum cleaner can be used for domestic purposes such as to clean the floor, car, carpets etc. It can be used efficiently in colleges as the space is also large [2]. 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 [3]. Since majority belong to the working population, there is always a shortage of time [4]. 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. In this project, an automated vacuum cleaner is designed. It consists of a RC car to which a vacuum cleaner is attached. Ultrasonic sensor is attached to the front of the car which is used to measure the distance if any obstacle is detected. If suppose there is an obstacle, the car changes its course as per the code. Vacuum cleaner consists of CPU Fan which runs by a battery. At the front of cleaner, a pipe is attached to suck the dust from the floor. The cleaner has space to collect the dust. Once it gets filled, it should be removed and cleaned manually. Vacuum cleaner will be carried on the RC car and the direction of the wheels depend on the code uploaded to the Arduino.

Dirty and messy homes can be a breeding ground for germs and bacteria. Those with dust allergies and illnesses like asthma are most affected. There are many ways of cleaning homes and the easiest way is to do it the traditional way, by dusting and using a wet cloth or a floor mop. Cleaning floors and other flat surfaces are easy using a mop, but you can't use it to clean

sofa sets, beds, mattresses and window sliders. Vacuum cleaners make cleaning everything less laborious. They are available in different shapes and sizes. Recommend thoroughly researching the subject before investing in one. This article talks about vacuum cleaners, their benefits and why every household should have one.

Vacuum cleaners are not only effective at cleaning dust and getting rid of allergens, they are also easy to use, they save time and energy. They are equipped with suction motors and filters to pull in dirt and dust. They can be categorized into hand-held, canister, vertical and robot vacuum cleaners.

A. Overview

Robots are widely used in modern industrial manufacturing, in households, entertainment, and the security sector; some robots are built and developed for various applications to support humans as companion, caretaker, or domestic support. With such wide popularity and usage of robots worldwide, it is significant to use robots to overcome the real-time problems. A major challenge the world is facing in current pandemic situation is hygiene and sanitization. Usages of autonomous robotic vacuum cleaners help us to overcome this problem.

B. Automation

“Automation is the creation and application of technologies to produce and deliver goods and services with minimal human intervention. The implementation of automation technologies, techniques and processes improve the efficiency, reliability, and/or speed of many tasks that were previously performed by humans”.

Autonomous models have two operating modes:

Open loop: In open-loop control, the control action from the controller is independent of the "process output".

Closed loop (feedback): In closed-loop control, the control action from the controller is dependent on the process output.

C. Robotics

"Robotics is the intersection of science, engineering and technology that produces machines, called robots, that substitute for (or replicate) human actions". Robotics involves design, construction, operation, and use of robots. The aim of robotics is to design machines, which can help and assist humans. Robotics is cumulation of mechanical engineering, electrical engineering, information engineering, mechatronics, electronics, bioengineering, computer engineering, control engineering, software engineering, and others. Robots are substitute for humans, which can replicate human actions. Robots are used in multipurpose real-time applications such as home automation; they can also be used in dangerous environments like radioactive environment, detection and deactivation of bomb scenario, manufacturing processes which are toxic to humans (for example, in space expeditions, underwater, in high temperature environment, and cleaning up biohazard wastes and highly contaminated waste). Robots can take on any form but some are inclined to resemble humans in appearance. This helps in the acceptance of a robot in certain replicative behaviors performed by people. Such replicative behaviors are walking, lifting, speech, cognition, or any other human activity. Robots are efficient in mimicking human actions thus help in overcoming the limited skilled labour workforce in the society.

CHAPTER 2

LITREATURE REVIEW

Mohd. Shahbaz Khan et al "Bluetooth control cleaning robot using Arduino". They have designed a robot and the robot is controlled using Bluetooth which is present at both transmitter and receiver end [1]. Vijayalakshmi M et al proposed "Smart Vacuum Robot" with progressive technology. S-curve planning is used for efficient working along with sensors to avoid obstacles [2]. Gaurav Dhariwal et al have proposed "Development of Driverless RC Car". In this report, an automatic car is built using concept of neural networks. This detects the obstacles present using sensors. Arduino and Raspberry Pi is used in this model [3]. S Yatamono et al proposed a report on "Development of Intelligent floor cleaning Robot". They have developed a smart floor cleaning Robot that can clean the place by navigating, sucking the dust and polishing the floor. The robot consists of an omni wheel which is equipped with a vacuum cleaner and floor polishing motor. It is coded in Arduino IDE by using Arduino microcontroller and it is equipped with Bluetooth so that it can work from smart phone connected via Bluetooth [4]. Sabir Hossain et al proposed "Deep Reinforcement Learning-based ROS-Controlled RC Car for Autonomous Path Exploration in the Unknown Environment". In this report, LiDAR equipped car using the concept of deep learning is discussed. The software used here is ROS and Arduino [5].R J Ong and K N F Ku Azir proposed "Low-Cost Autonomous Robot Cleaner using Mapping Algorithm based on Internet of Things (IoT)". Here, sensors are used to detect any obstacle and Arduino is used to control the robot. Mapping is applied so that the robot can clean without any huma intervention once it is switched on [6]. Anbumani V et al proposed a report "Development of Ingenious Floor Cleaner using ARDUINO". Here, different modes of cleaning available such as mopping, sweeping or both

mopping and sweeping is discussed. For controlling the robot, Bluetooth module is used and other functions are coded in Arduino. This can even clean corners of the floor [7]. Adeel Saleem et al proposed "Design and Implementation of an Intelligent dust cleaner robot for uneven and non-structural environment". In this report, a robot has been designed which stores the plan of the room and makes the working feasible. This can be used for various environments as well. It is a cost-effective system. Md. Farhanul Islam et al have proposed "Designing and Optimization of An Autonomous Vacuum Floor Cleaning Robot". Here, an economic

prototype is designed using Arduino Mega and Raspberry Pi. GPS module is also present which helps the bot to move in the right direction.

Anshu Prakash Murdan et al proposed “A smart autonomous floor cleaner with an Android-based controller”. Here, a bot is designed which can be controlled through Android. By using the application, the bot can be turned in the desired direction [10]. Amir Talebi Sheikh Sarmast et al have proposed “Designing a Smart Vacuum Cleaner in Two Modes of Remote and Automatic”. In this report, vacuum cleaner is implemented which operates automatically or through android application. If the battery percentage is less, a message is sent to the registered mobile number regarding the same. Md. Rawshan Habib et al proposed “Automatic Solar Panel Cleaning System Based on Arduino for Dust Removal”. In this report, a bot is designed to clean the solar panels using DC Motor which powers the wiper. Water is not used to clean the panels. This system’s efficiency is about 87 to 96 percent [12]. what is used by them. The detail description of the tetromino tiling algorithm and adaptive tiling scheme for segmented dirt area coverage planning described completely in this report. Some of the things discussed are tetromino tiling theory, adaptive tetromino tiling algorithm, comparison with Ttrominoes. There were two experiments performed to validate the vision-based adaptive selective area coverage scheme in their work. The initial one was conducted for validating the dirt detection algorithm with real images of dirt and images collected from dirt database and latter experiment was for validating the adaptive tiling scheme with generated dirt map. The robustness of the visual dirt detection algorithm assessed by measuring the dirt detection ratio of different surfaces with various kinds of dirt types multimedia contents to the MUs. The objective is to eventually maximize the system delivery capacity. Simulation results demonstrate that the CSF provides the best performance in terms of hit rate and system delivery capacity.

CHAPTER 3

REQUIREMENTS

3.1 Hardware

3.1.1. Arduino UNO

The key hardware of the prototype, Arduino Uno is shown in Fig 3.1.1.1. This is a microcontroller which is used for interfacing hardware and software [13]. To do the same, USB cable is required. Once the board is embedded with the code, it can be operated by a battery supply without using any PC or laptop.

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. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available

The word "uno" means "one" in Italian and was chosen to mark a major redesign of the Arduino hardware and software. The Uno board was the successor of the Duemilanove release and was the 9th version in a series of USB-based Arduino boards. Version 1.0 of the Arduino IDE for the Arduino Uno board has now evolved to newer releases.The ATmega328 on the board comes preprogrammed with a bootloader that allows uploading new code to it without the use of an external hardware programmer.

While the Uno communicates using the original STK500 protocol, it differs from all preceding boards in that it does not use a FTDI USB-to-UART serial chip. Instead, it uses the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

Microcontroller (MCU):

- IC: Microchip ATmega328P
- Clock Speed: 16 MHz on Uno board, though IC is capable of 20MHz maximum at 5 Volts
- Flash Memory: 32 KB, of which 0.5 KB used by the bootloader
- SRAM: 2 KB
- EEPROM: 1 KB
- USART peripherals: 1 (Arduino software default configures USART as a 8N1 UART)
- I2C peripherals: 1
- SPI peripherals: 1
- Operating Voltage: 5 Volts
- Digital I/O Pins: 14
- PWM Pins: 6 (Pin # 3, 5, 6, 9, 10 and 11)[11]
- Analog Input Pins: 6
- DC Current per I/O Pin: 20 mA
- DC Current for 3.3V Pin: 50 mA
- Size: 68.6 mm x 53.4 mm
- Weight: 25 g
- ICSP Header: Yes
- Power Sources:

USB connector. USB bus specification has a voltage range of 4.75 to 5.25 volts. The official Uno boards have a USB-B connector, but 3rd party boards may have a miniUSB / microUSB / USB-C connector. 5.5mm/2.1mm barrel jack connector. Official Uno boards support 6 to 20 volts, though 7 to 12 volts is recommended. The maximum voltage for 3rd party Uno boards varies between board manufactures because various voltage regulators are used, each having a different maximum input rating. Power into this connector is routed through a series diode before connecting to VIN to protect against accidental reverse voltage situations. VIN pin on shield header. It has a similar voltage range of the barrel jack. Since this pin doesn't have reverse voltage protection, power can be injected or pulled from this pin. When supplying power into VIN pin, an external series diode is required in case barrel jack is used. When board is powered by barrel jack, power can be pulled out of this pin

Figure 3.1.1.1 Arduino UNO

Arduino Uno is the most standard board available and probably the best choice for a beginner. It can directly connect the board to the computer via a USB Cable which performs the function of supplying the power as well as acting as a serial port.

Vin: This is the input voltage pin of the Arduino board used to provide input supply from an external power source.

5V: This pin of the Arduino board is used as a regulated power supply voltage and it is used to give supply to the board as well as onboard components.

3.3V: This pin of the board is used to provide a supply of 3.3V which is generated from a voltage regulator on the board

GND: This pin of the board is used to ground the Arduino board.

Reset: This pin of the board is used to reset the microcontroller. It is used to Resets the microcontroller.

Analog Pins: The pins A0 to A5 are used as an analog input and it is in the range of 0-5V.

Digital Pins: The pins 0 to 13 are used as a digital input or output for the Arduino board.

Serial Pins: These pins are also known as a UART pin. It is used for communication between the Arduino board and a computer or other devices. The transmitter pin number 1 and receiver pin number 0 is used to transmit and receive the data resp.

External Interrupt Pins: This pin of the Arduino board is used to produce the External interrupt and it is done by pin numbers 2 and 3.

PWM Pins: This pins of the board is used to convert the digital signal into an analog by varying the width of the Pulse. The pin numbers 3,5,6,9,10 and 11 are used as a PWM pin.

SPI Pins: This is the Serial Peripheral Interface pin, it is used to maintain SPI communication with the help of the SPI library. SPI pins include:

1. SS: Pin number 10 is used as a Slave Select
2. MOSI: Pin number 11 is used as a Master Out Slave In
3. MISO: Pin number 12 is used as a Master In Slave Out
4. SCK: Pin number 13 is used as a Serial Clock

LED Pin: The board has an inbuilt LED using digital pin-13. The LED glows only when the digital pin becomes high.

AREF Pin: This is an analog reference pin of the Arduino board. It is used to provide a reference voltage from an external power supply.

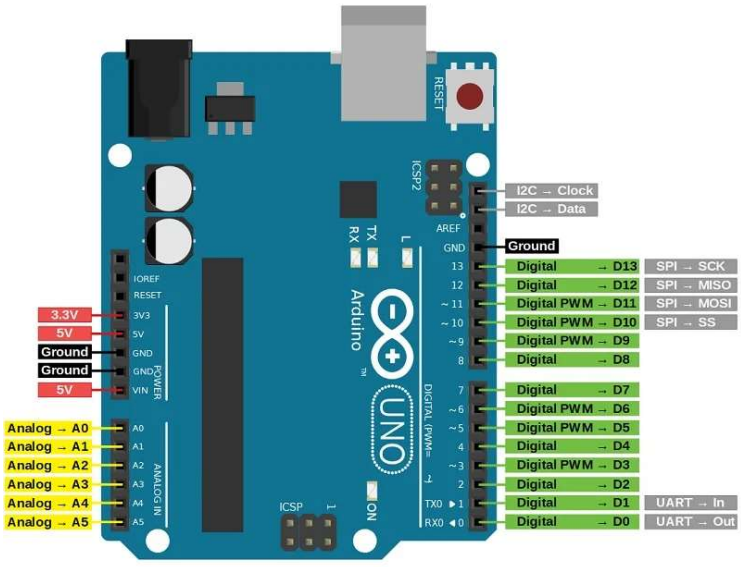

Figure 3.1.1.2 pin diagram

3.1.2. Batteries

Fig. 3.1.2 shows the heart of the prototype, 2000Mh batteries. These are cylindrical in shape and have positive and negative terminals at the top and bottom respectively which supplies power so as to make the prototype run.

A lithium-ion or Li-ion battery is a type of rechargeable battery which uses the reversible reduction of lithium ions to store energy. The negative electrode of a conventional lithium-ion cell is typically graphite, a form of carbon. This negative electrode is sometimes called the anode as it acts as an anode during discharge. The positive electrode is typically a metal oxide; the positive electrode is sometimes called the cathode as it acts as a cathode during discharge. Positive and negative electrodes remain positive and negative in normal use whether charging or discharging and are therefore clearer terms to use than anode and cathode which are reversed during charging eliminate the flammable electrolyte. Improperly recycled batteries can create toxic waste, especially from toxic metals and are at risk of fire. Moreover, both lithium and other key strategic minerals used in batteries have significant issues at extraction, with lithium being water intensive in often arid regions and other minerals often being conflict minerals such as cobalt. Both environmental issues have encouraged some researchers to improve mineral efficiency and alternatives such as iron-air batteries.

Research areas for lithium-ion batteries include extending lifetime, increasing energy density, improving safety, reducing cost, and increasing charging speed, among others. Research has been under way in the area of non-flammable electrolytes as a pathway to increased safety based on the flammability and volatility of the organic solvents used in the typical electrolyte. Strategies include aqueous lithium-ion batteries, ceramic solid electrolytes, polymer electrolytes, ionic liquids, and heavily fluorinated systems.

How does it work?

The Basics

A battery is made up of an anode, cathode, separator, electrolyte, and two current collectors (positive and negative). The anode and cathode store the lithium. The electrolyte carries positively charged lithium ions from the anode to the cathode and vice versa through the separator. The movement of the lithium ions creates free electrons in the anode which creates

a charge at the positive current collector. The electrical current then flows from the current collector through a device being powered (cell phone, computer, etc.) to the negative current collector. The separator blocks the flow of electrons inside the battery.

Charge/Discharge

While the battery is discharging and providing an electric current, the anode releases lithium ions to the cathode, generating a flow of electrons from one side to the other. When plugging in the device, the opposite happens: Lithium ions are released by the cathode and received by the anode.

Energy Density vs. Power Density

The two most common concepts associated with batteries are energy density and power density. Energy density is measured in watt-hours per kilogram (Wh/kg) and is the amount of energy the battery can store with respect to its mass. Power density is measured in watts per kilogram (W/kg) and is the amount of power that can be generated by the battery with respect to its mass. To draw a clearer picture, think of draining a pool. Energy density is similar to the size of the pool, while power density is comparable to draining the pool as quickly as possible.

Figure 1.1.2 Batteries.

3.1.3. CPU FAN

Fig. 3.1.3 shows the CPU fan used in the prototype. This is used in the vacuum cleaner which has a rating of 12 volts. It rotates at maximum of 200 rpm. As the voltage increases, rpm increases until the value reached up to 200

Computer fan is any fan inside, or attached to, a computer case used for active cooling. Fans are used to draw cooler air into the case from the outside, expel warm air from inside and move air across a heat sink to cool a particular component. Both axial and sometimes centrifugal (blower/squirrel-cage) fans are used in computers. Computer fans commonly come in standard sizes, such as 92 mm, 120 mm (most common), 140 mm, and even 200–220 mm. Computer fans are powered and controlled using 3-pin or 4-pin fan connectors.

Due to the low pressure, high volume air flows they create, most fans used in computers are of the axial flow type; centrifugal and crossflow fans type. Two important functional specifications are the airflow that can be moved, typically stated in cubic feet per minute (CFM), and static pressure. Given in decibels, the sound volume figure can be also very important for home and office computers; larger fans are generally quieter for the same CFM.

Cpu fan as Centrifugal fans:

There are three types of centrifugal fans determined by the type of fan blades:

- forward inclined blades,
- backward inclined blades, and
- straight radial blades.

The fans in your home furnace, vacuum cleaner and hairdryer are examples of centrifugal fans. They can operate against a high resistance and are typically used in local exhaust ventilation systems. The rugged radial blade centrifugal fans are the best type for exhausting heavy amounts of dust because they are less likely to become clogged or abraded by the dust.

A centrifugal fan is a mechanical device for moving air or other gas in a direction at an angle to the incoming fluid. Centrifugal fans often include a ducted housing that directs exiting air in a particular direction or across a heat sink. Such fans are also called blowers, blower fans, or cage fans (because of their resemblance to a hamster's wheel). Smaller ones used in computers

are sometimes called biscuit blowers. These fans move air from the inlet to the outlet of the rotating fan. They are typically used in duct applications to pull air through ductwork/heat exchangers or push air through similar. impeller. It can provide similar air movement from a smaller fan package and overcome higher airflow resistance compared to standard axial fans. Centrifugal fans use the kinetic energy of an impeller to move airflow, which in turn moves against the resistance created by ducts, dampers, and other components. Centrifugal fans move the air radially, changing the direction of the airflow (usually 90°). Rugged, quiet, reliable and capable of operating in a wide range of conditions. Centrifugal fans, like axial fans, are constant volume devices. So at a constant fan speed, a centrifugal fan moves a relatively constant volume of air. It's air instead of a constant mass. This means that the air velocity in the system is constant, but the actual mass of air flowing varies depending on the density of the air. These fans are not suitable for applications where a constant volume of air must be delivered, as variations in incoming air temperature and altitude can cause density variations. Centrifugal fans are not positive displacement devices and they have certain advantages and disadvantages when compared to positive displacement blowers. Centrifugal fans are more efficient, while positive displacement blowers have a lower capital cost and can achieve higher compression. ratio. Centrifugal fans are typically compared to axial fans for residential, industrial and commercial applications. Axial fans typically operate at higher airflows, operate at lower static pressures, and are more efficient. Thus, axial fans are typically used to move large volumes of air, such as warehouse exhaust and room circulation, while centrifugal fans are used to move air in ducted applications, such as residential and general office environments. will be A centrifugal fan has a drum shape consisting of many fan blades mounted around a hub. The hub rotates a drive shaft that is mounted on bearings in the fan housing, as shown in the animated illustration. Gas enters the side of the fan wheel, rotates 90 degrees, and is accelerated by centrifugal force as it flows over the fan blades and exits the fan housing.

Figure 3.1.3 cpu fan

3.1.4. DC motor and wheels

Fig. 3.1.4.1 shows one of the DC Motors used in the prototype. These motors essentially are the key components in this prototype. To make the machine move, these are required. As the voltage increases, rpm also increases. The least rpm will be at 6V and maximum at 12V.

Fig shows the wheels which are responsible for the movement of RC car. These are used to move in any specified direction. Wheels are run by a DC Motor with a pre-defined RPM. Wheels rotate in the same direction as DC Motor.

PACKAGE INCLUDES:

- 3-12V geared DC motor
- 66mm tall wheel
- Aluminum motor mount with M3 screws and nuts for mounting
- Red/black 24AWG hook wires, 15cm long
- Zip tie for strain relieving the wires

The motors are DC motors that will work between 3-12VDC. Speed of rotation will depend on the drive voltage and whether a PWM motor controller is added for speed and direction control. The tires can be mounted to either side of the motor for mounting flexibility. They are a simple press fit. The motor has 2 small screw holes with a spacing of 17.3mm that can be used for mounting. It includes an aluminum mounting bracket with two M3 x 30mm screws and nuts for attaching to the motor and two M3 x 8mm screws for mounting the bracket to the chassis.

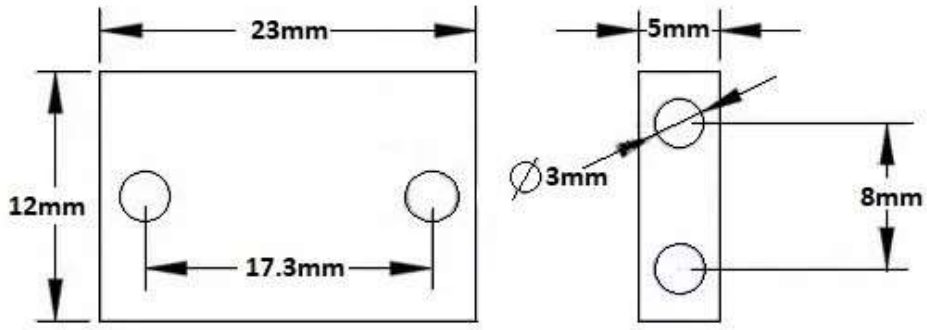

Figure 3.1.4.1 Aluminium motor Mount dimensions

The package also includes a pair of 15cm (6″) long red and black 24 AWG wires for connecting power to the two solder tabs on the motor.

Reversing these wires reverses the direction of rotation, so is somewhat arbitrary as to which color wire is soldered to which tab as the notion of 'forward' will depend on how the motor is mounted and which side of the vehicle it is on. A zip tie is included to secure the wires to the motor body after soldering them in place to help take the strain off the solder tab connections as these can break if they are repeatedly flexed.

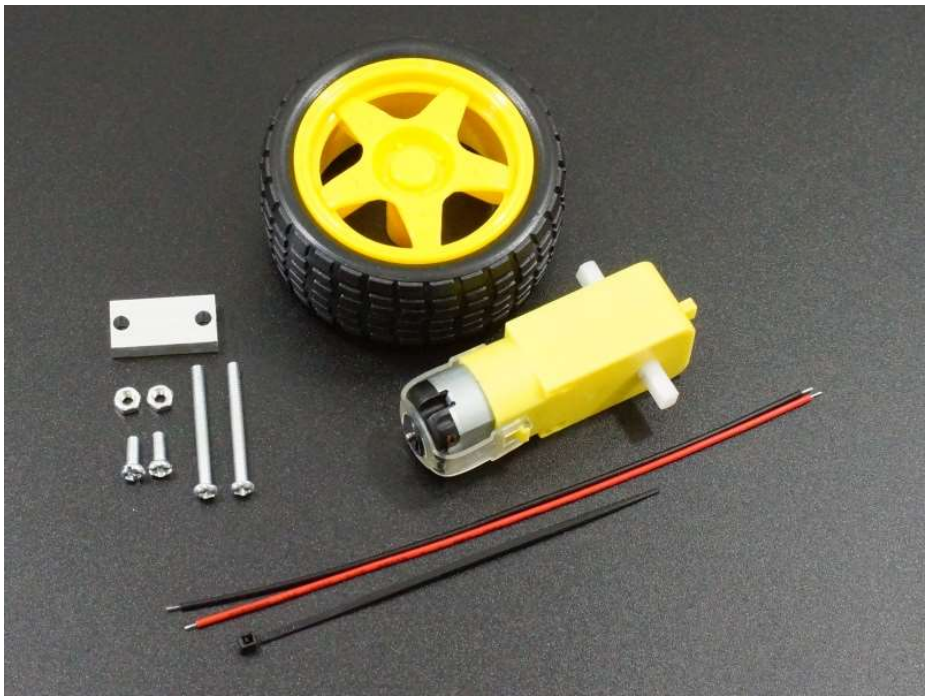

Figure 3.1.4.2 DC motor and Wheels

3.1.5. Motor driver shield

Fig. 3.1.6 shows the Motor Driver Shield. This is used to run different types of motors. L293D IC is the main IC present in this shield [14–16]. The direction and speed of motors depends on the motor shield, as the shield is embedded on Arduino UNO board and the speed and direction can be controlled by coding in Arduino IDE.

The Arduino L293D motor driver shield guide is a robobtics project that involves driving various types of motors. The most common types used for robotic applications include DC, servo, and stepper motors.

However, these motors typically cannot be driven directly by Arduino or another microcontroller. This is because of their higher current and power ratings, so motor shields or driver ICs are used instead. These shields or ICs isolate a motor's power supply and use control logic from the microcontroller circuitry.

One of the most popular motor driver shields used with Arduino is the L293D. The full-featured L293D motor driver shield can control up to four bi-directional DC motors with 8-bit speed selection, two stepper motors, and two servo motors.

Motor Driver Shield is a board which gives possibility to control 4 DC motors or 2 step motors (unipolar or bipolar) and 2 servo motors additionaly by stacking on Arduino. There are 2 L293D motor driver IC on board which means it can drive 0.6A 4 seperate DC motors or 0.6A 2 seperate step motors. You can control speed and direction of motors independently. Motor controls are done by AF Motor Library.

Features:

- 5-12V operating voltage
- L293D motor controller
- Independent control of 4 DC motor
- Independent control of 2vstep motor
- 3-pin socket for 2 servo motor
- 0,6A constant current on each channel
- Free analog input pins for sensor connections
- Compatible with Arduino Uno

- Product Dimensions: 69x53x14,3mm
- Weight: 32g

Board is sent soldered.

Power:

Motor Shield must be feeded only externaly. Because necessary motor current will mostly be over the maximum current which USB can give. External feeding can be done with adapter or battery. Adapter can be connected to 2.1mm centre positive power socket on Arduino or EXT_PWR screw terminals on driver - be carefull about polarity. But it is always advised to give power through screw terminal on driver. Because when it is given through power socket on Arduino, current which is drawing by motors will reach driver through Arduino. Since, Arduino Vin route is made for maximum 1A current when current is above 1A, Arduino board might get damaged. That is way external power should always be given through screw terminal on driver. EXT_PWR screw terminal on driver is connected to Vin pin through header which means when power connection is made through screw terminal, Arduino will get the power through Vin pin and step down it to 5V with the regulator on itself. This way, you do not need 2 different power source. But as you know Vin pin on Arduino only accepts inputs between 7V and 12V. In that case if voltage given to driver card is between 5V and 7V, Arduino will not work properly since the input voltage is below the regulator's minimum operating value.To avoid this, there is a power jumper under the driver card. This jumper connects EXT_PWR screw terminal on driver and Arduino Vin pin. If the voltage on driver is between 5V and 7V, jumper will be removed. EXT_PWR and Arduino Vin pin will be seperate and Arduino is feeded with 5V externally. If voltage given to driver card is between 7V and 12V, jumper stays the same and boards can be used. There is 3-pin servo socket on board to drive two servo motor. Servos get their 5V through 5V pin on Arduino. Small servo motors such as SG90 can be used with direct connection. But if larger servo motors will be used, 5V regulator on Arduino will not be enough. In that case, + route which goes through 3-pin servo socket should be cut and external 5V should be given to servos.

Input and Output:

Hence Motor Shield is capeable of driving number of motors, it uses a lot of pins. Shield uses all pins except this 8 pins; Pin 2, 13, A0-5. The ones who will use extra sensors with motor driver must be carefull with the pins which are left. L293 motor drivers -on board-' Dir pins controls are done by 75HC595 shift register on board. PWM pins and servos are connected directly to Arduino. AFMotor Library which is used with motor driver do all pin setting operations. So there is no need to do anything extra on those pins. Servo 1 socket is connected to Arduino Pin 10 and Servo 2 socket is connected to Arduino Pin 9.

Figure 3.1.5 Motor driver shield

3.1.6. Ultrasonic sensor

Fig. 3.1.6 shows the Ultrasonic sensor used in the prototype. This HCSR04 sensor is used for measuring distance. It uses sound waves to calculate the same. There are 4 pins – Echo, Ground, Trigger and VCC [17-19]. External controller is triggered by Trigger pin that sends ultrasonic waves whereas echo pin sends ultrasonic waves and duration it takes to travel decides the distance between the car and obstacle. VCC will take up to 5V and gives the voltage so that the sensor can run.

Ultrasonic sensing is one of the best ways to sense proximity and detect levels with high reliability. Our technical support gets emails all of the time about how our sensors work and what environments our sensors work (or don't work) in. This guide was created as an introduction to ultrasonic sensing, its principles, and how ultrasonic sensors work in your applications. An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves.An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity. High-frequency sound waves reflect from boundaries to produce distinct echo patterns.

Ultrasonic sensors work by sending out a sound wave at a frequency above the range of human hearing. The transducer of the sensor acts as a microphone to receive and send the ultrasonic sound. Our ultrasonic sensors, like many others, use a single transducer to send a pulse and to receive the echo. The sensor determines the distance to a target by measuring time lapses between the sending and receiving of the ultrasonic pulse. This is the US-100 Ultrasonic Sensor Distance Measuring Module with Temperature Compensation. The US-100 Ultrasonic Sensor can measure or detect the object in the range of 2 cm to 450 cm distance. This US-100 has 2.4V to 4.5V wide voltage input range, the static function GPIO, a serial variety of communication methods, within the band watchdog, stable and reliable. The US-100 Ultrasonic Distance Sensor Module operates from a wide voltage range and provides both digital and serial data output modes. The US-100 features accurate temperature corrected range detection. It can output the distance in millimeters using a serial data output mode. Alternatively, the distance can be calculated by measuring the amount of time that a digital output is held high.

This sensor can be used with both 3.3V and 5V microcontrollers and only consumes 2mA when idle.

Using the US-100 Ultrasonic Distance Sensor Module :

Connect the VCC and GND pins to a 2.4V-5.5V power supply. The usage of the other pins depends on the operating mode selected. Select the operating mode of the US-100 Ultrasonic Distance Sensor by using the jumper on the back of the module. When the jumper is present, the sensor outputs the distance as binary serial data, otherwise, the sensor outputs a single pulse that has a width that represents the distance measured.

Using the US-100 Distance Sensor in Serial Data Mode :

Place the shunt on the operating mode selection jumper to choose serial data mode. Attach the module to a serial port on your microcontroller/Arduino. The Trig/TX pin connects to your microcontroller's TX serial transmit line. The Echo/RX pin connects to your microcontroller's RX serial receive line. Set the microcontroller's serial port to use 9600 baud at 8-N-1 (eight data bits, no parity, one stop bit).

To start measuring the distance, output a 0x55 over the serial port and read back the two-byte distance in a high byte, low byte format. The distance returned is measured in millimeters. Use the following formula to obtain the distance as millimeters:

- Millimeters = FirstByteRead * 256 + SecondByteRead

This module can also output the temperature when using a serial output mode. To read the temperature, output a 0x50 byte over the serial port and read back a single temperature byte. The actual temperature is obtained by using the following formula:

- Celsius = ByteRead – 45

Using the US-100 Sensor in Pulse Width Mode :

Select the pulse mode by removing the shunt from the operating mode selection jumper. Connect the Trig/TX pin to a digital output on your microcontroller and the Echo/RX pin to a digital input.

To obtain a distance measurement, set the Trig/TX pin high for at least 50 microseconds then set it low to trigger the measurement. The module will output a high pulse on the Echo/RX line with a width that corresponds to the distance measured. Use your microcontroller/Arduino to

measure the pulse width using microseconds. Use the following formula to calculate the distance:

- Millimeters = PulseWidth * 34 / 100 / 2

Features:

1. It features temperature compensation.
2. It has high precision up to 1 mm
3. Provides two output modes level or UART.
4. Detecting distance is from 2 cm to 450 cm
5. TTL Trigger input
6. TTL Echo output

Figure 3.1.6.1 Ultrasonic sensor

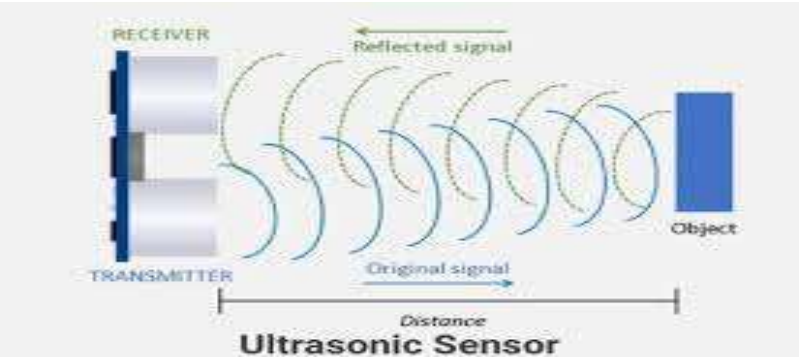

Figure 3.1.6.2 ultrasonic block diagram

3.2. Software

Fig. 3.2.7 shows 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 1.8.9.

The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards. The IDE application is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports the programming languages C and C++. Here, IDE stands for Integrated Development Environment**.**

The program or code written in the Arduino IDE is often called as sketching. It need to connect the Genuino and Arduino board with the IDE to upload the sketch written in the Arduino IDE software. The sketch is saved with the extension '.ino.'

The key features are −

- Arduino boards are able to read analog or digital input signals from different sensors and turn it into an output such as activating a motor, turning LED on/off, connect to the cloud and many other actions.
- You can control your board functions by sending a set of instructions to the microcontroller on the board via Arduino IDE (referred to as uploading software).
- Unlike most previous programmable circuit boards, Arduino does not need an extra piece of hardware (called a programmer) in order to load a new code onto the board. You can simply use a USB cable.
- Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program.
- Finally, Arduino provides a standard form factor that breaks the functions of the micro-controller into a more accessible package.

Toolbar section:

The toolbar is the most important section in the Arduino software, because it contains the tools that you will use continuously while programming the Arduino board. These tools are:

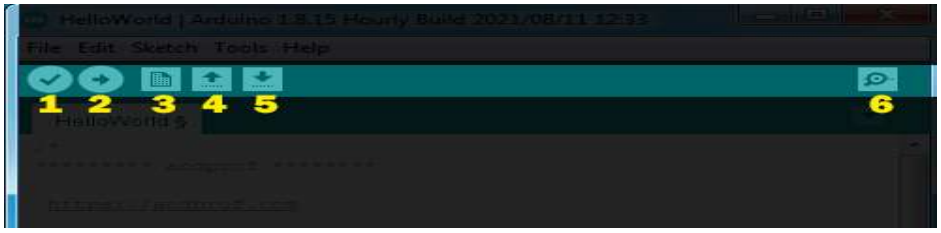

Figure 3.2.1 toolbar

1. **Verify:** this button use to review the code, or make sure that is free from mistakes.
2. **Upload:** this button is use to upload the code on the arduino board.
3. **New:** this button use to create new project, or sketch (sketch is the file of the code).
4. **Open:** is use when you want to open the sketch from sketchbook.
5. **Save:** save the current sketch in the sketchbook.
6. **Serial monitor:** showing the data which have been sent from arduino.

Code editor section:

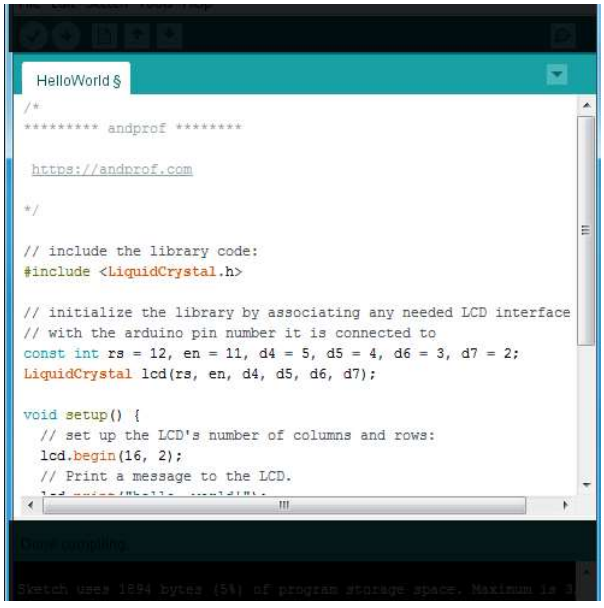

Figure 3.2.2 code editor

Code editor is liberator of codes, is the white space in the program, in which codes are been writting, and modifying on it.

Status bar section:

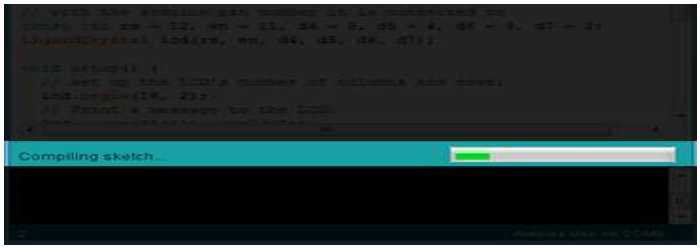

Figure 3.2.3 status bar

Status bar is a space can be found down the code editor, through it showing the status of operation's completion (compiling, uploading, … etc)

Program notifications section:

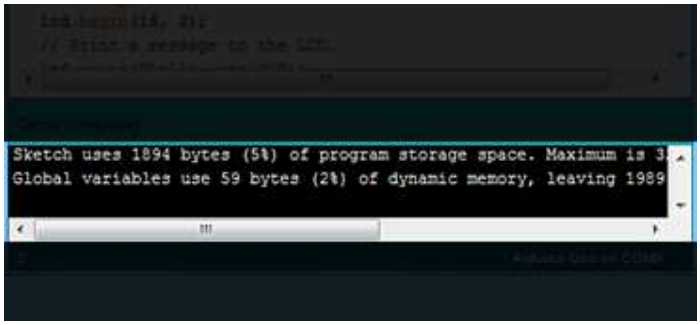

Figure 2.2.4 program notifications

Program notifications this program showing you the mistakes of codes, and some problems that can be face you during the programmation process. And clarifies to you the type of the mistake or the problem which happened and it reason.
And it presents some instruction through it, which you have to apply to process the mistake or the problem.

Serial port & Board selections:

Serial ports selections is a space in which the program showing you the type of the port which is used to connect the arduino by computer.

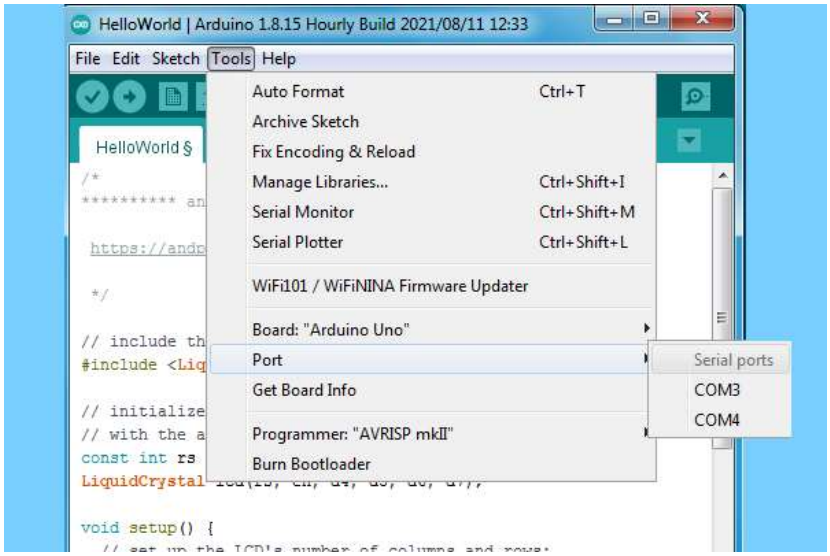

Figure 3.2.5 serial port & board selections

Serial ports:

Board selections is a space in which the program showing you the type of the arduino board.

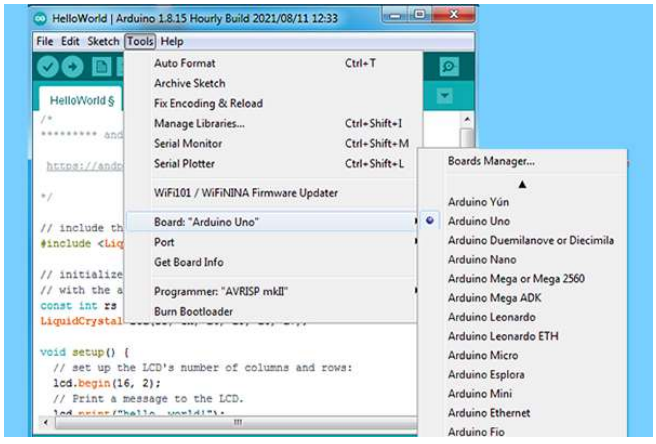

Figure 3.2.6 serial port

How to use arduino software:

After installation of electronic components by using input/output pins on arduino board. It is connected arduino board with computer by usb cable, then open arduino software.

- First thing: in the menu click on “Tools”, then click on “Board” and select arduino board which you are using.
- Second: in the menu click on “Tools” again, click on “Port” and select Serial port that connected arduino board with.
- Third: in “Code editor” write the programming code, then click on “Verify” to verify it correctness.
- Fourth: click on “Upload” to upload the code on the arduino board.

Thus, have programmed the Arduino board using the Arduino program

The Arduino IDE will appear as:

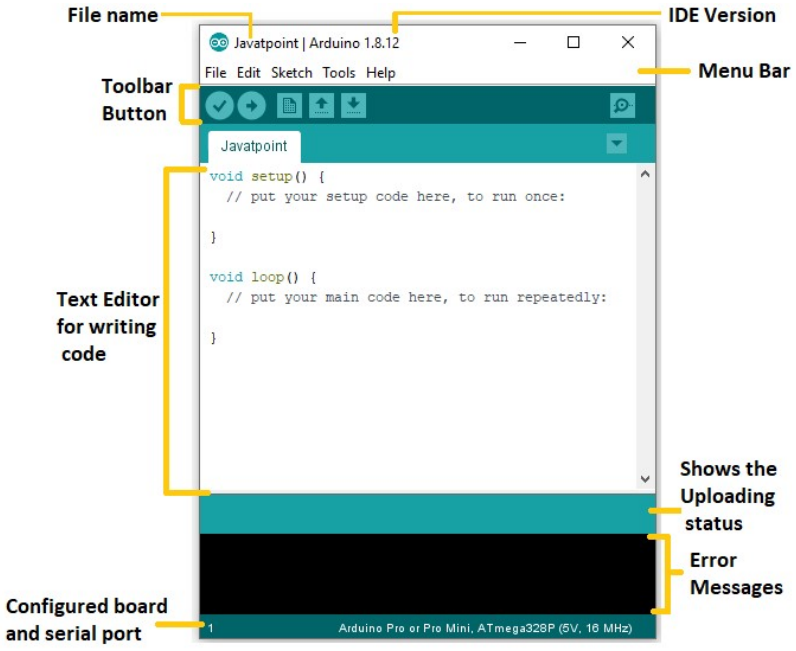

Figure 3.2.7 Arduino IDE

CHAPTER 4

Methodology

4.1. Design

4.1.1. RC car

The RC car designed is shown in Fig. 4.1.1.1. The construction of RC is as car is as follows. Acrylic sheets have holes in specific areas. To these places, using nuts and bolts, the motor is fitted, motors are attached with wheels. Motors are soldered with wires – positive and negative. RC car is built by using 4 DC motors they run with the speed provided in Arduino IDE code, it uses motor shield to work in desired speed and direction [20]. Ultrasonic sensor attached to RC car detects the distance at which obstacle is present in front of it. So, whenever it encounters any obstacles such as walls, tables, chair or any big things that cannot be considered as garbage or dust, RC car which carries vacuum cleaner changes its direction so that it won't crash and destroy itself. The code fed to the Arduino runs continuously and the cycle repeats in regular intervals whenever the obstacle is detected. The batteries are placed on the acrylic sheets [21].

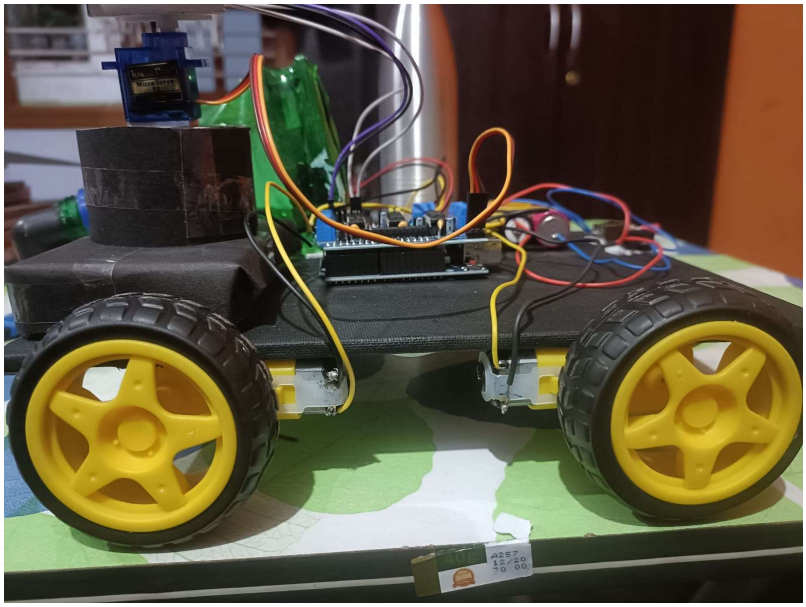

Figure 4.1.1.1 RC Car

Flow chart of RC car

Fig. 4.1.1.2 shows the flowchart of the proposed model. Here, once the car is started, the distance is measured and moves forward. If distance is less than 20cm, it turns left and right respectively to measure distance and the prototype moves where the distance is greater. The same process repeats.

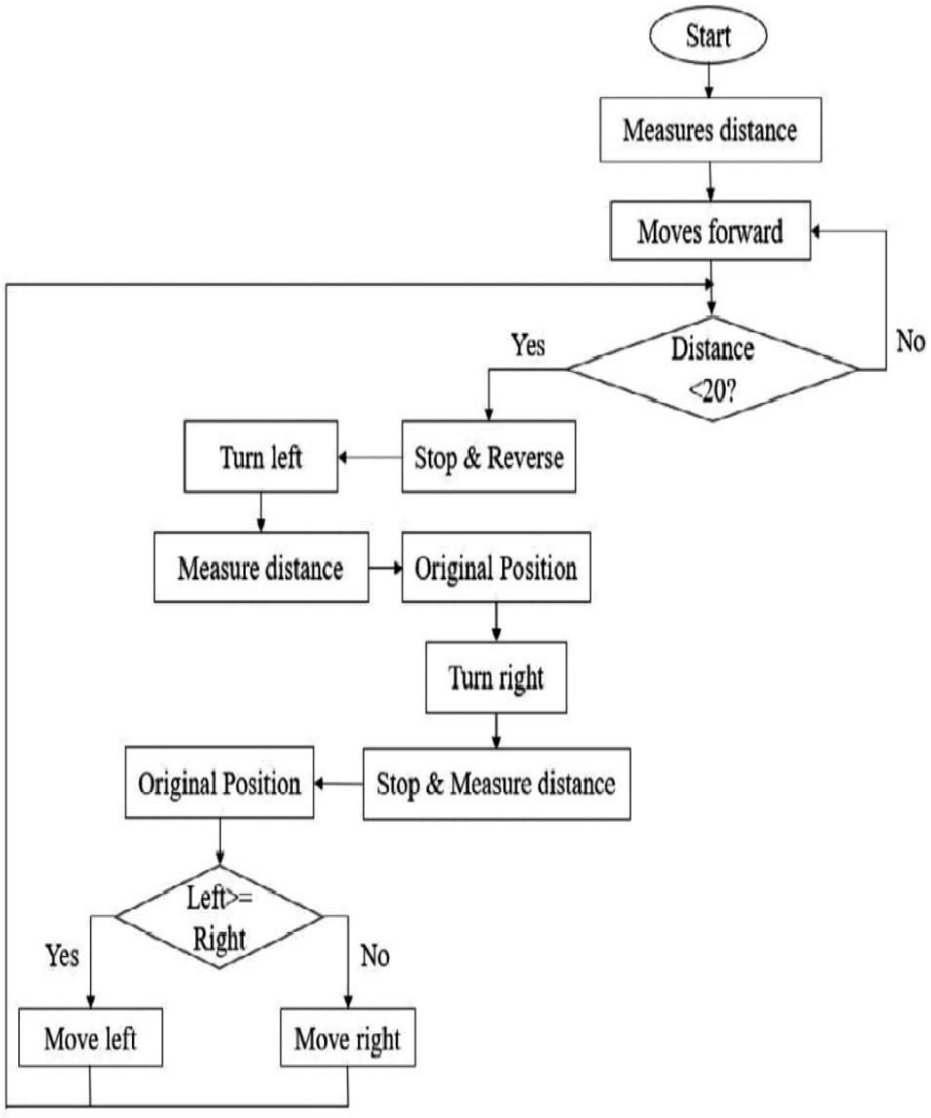

Figure 4.1.1.2 flow chat of RC car

4.1.2. Vacuum cleaner

Vacuum cleaner is made up of 1.25L water bottle, CPU fan, pipe, tape, gauze bandage, batteries and switch. The vacuum cleaner is shown in Fig 4.1.2.1. The steps to design the same is described below. Steps to create the vacuum cleaner:

1.25L water bottle is cut into half horizontally Top portion has conical and cylindrical structure, the conical structure is cut The bottle cap area is attached with a pipe as shown in the image. The length of the pipe used is 45 cm and its diameter is 1.5 cm. The other end of conical structure is covered with a gauze bandage to improve the vacuum. Now, the cylindrical part which was separated in step ii is taped with the conical part which has the gauze bandage. The other end of cylindrical structure is attached with a CPU fan It is given with a 18V supply so as to develop the required vacuum. Switch is also attached to the side

Figure 4.1.2.1 Vacuum cleaner

Flow chart of Vacuum Cleaner

When the Vacuum Cleaner is switched ON, the Fan blades turn, the air is forced forward towards the exhaust port. As the air moves forward, the density of air increases in front side of the Fan and density decreases behind the Fan. There is Pressure drop behind the Fan. Thus Pressure level in the area behind the fan drops below the Pressure level outside the Ambient Air Pressure. This creates suction, a partial Vacuum inside the Vacuum Cleaner. The Ambient Air pushes itself into the Vacuum Cleaner through the Suction Mouth as air pressure inside the Vacuum Cleaner is lower than the outside Pressure.

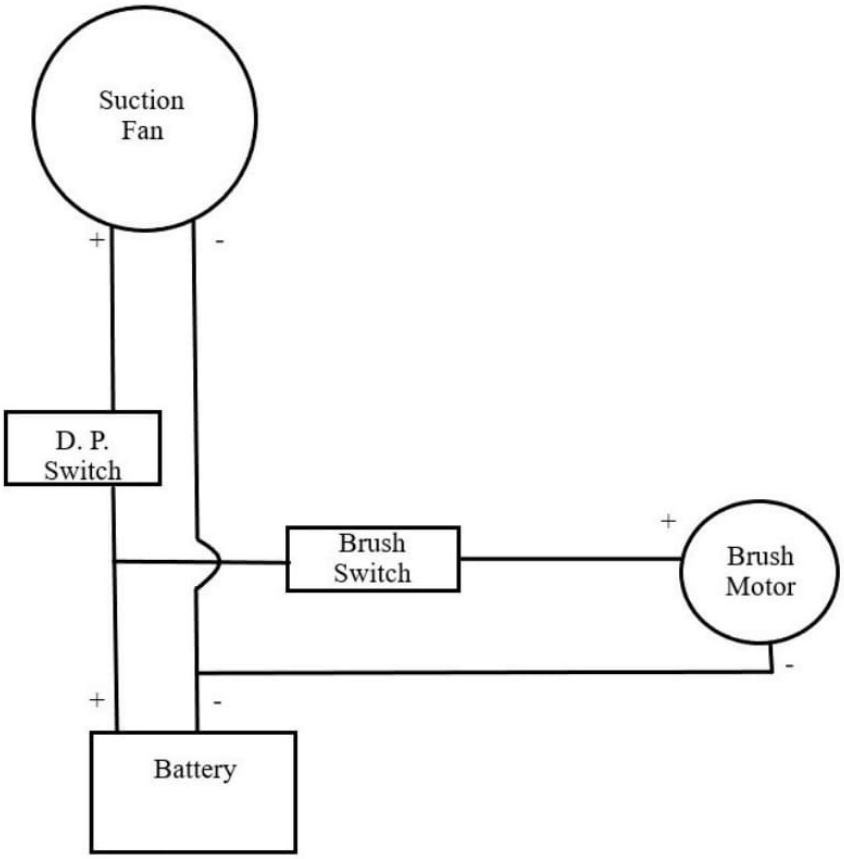

Figure 4.1.2.2 flow chart of vaccum cleaner

4.2. Block diagram

Fig. 4.2.1 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 Fig. 10.

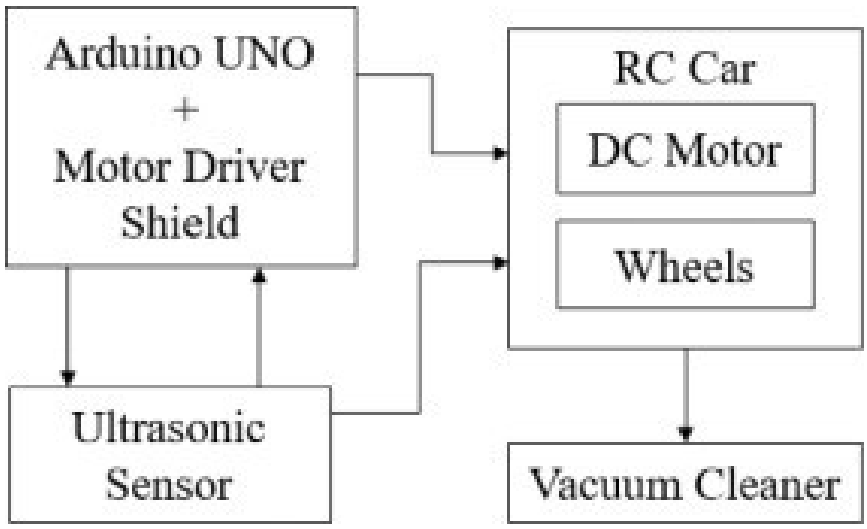

Figure 4.2.1 block diagram

4.3. Comparison

Table 1 shows the comparison between the manual mode of cleaning and automatic mode. In manual cleaning, as the word says, human is required. Whereas, in automatic mode there is no human intervention. Automatic mode is helpful as it doesn't cause any health risks.

Table 1 Comparison between manual and automatic system.

Features	Manual	Automatic(Designed Prototype)
Human intervention	Yes	No
Economic	No	Yes

CHAPTER 5

IMPLEMENTATION

Power supply will be given to both RC car and vacuum cleaner separately, once the car is started it measures the distance between obstacle and vehicle by using ultrasonic sensor, further it moves in the forward direction as per the code in Arduino IDE. If the distance is less than 20cm then RC car stops and reverses for a second and then moves towards left side and measures the distance, again it gets back to its original position. After that it turns right and stops for a second, after which it gets back to its original position. After measuring both the distances, whichever distance is greater car starts to move in that direction to avoid the collision with any objects. If there are no obstacle in its path it travels in straight direction without turning until it encounters any obstacle. The process repeats whenever there is an obstacle in the path.However, in the designed prototype, it is run through batteries and there is no human intervention needed. The algorithm is simpler and is easier to debug as well.

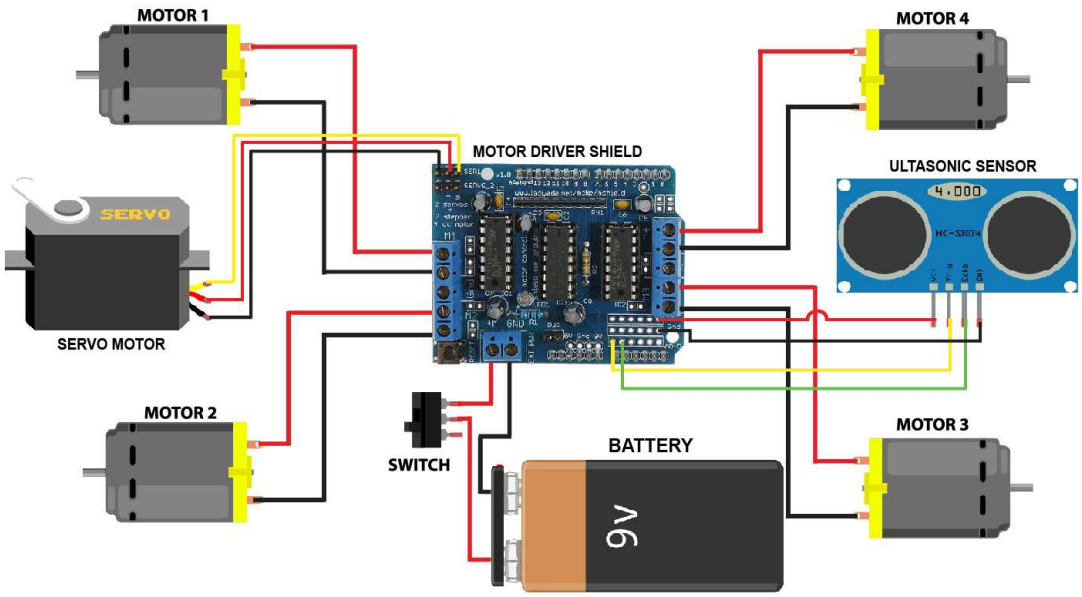

Figure 5.1 circuit diagram of rc car

The vacuum cleaner is prepared as shown in the figure 5.2 . The process of the vacuum cleaner is preparation is done as follows:

1. The bottle's bottom is first chopped off with a knife to be removed.
2. The bottle-shaped portion of a fine mesh is cut. Now wrap the net over a cardboard piece that was given a bottle-diameter cut out.
3. Attach both the cardboard piece and the net. In the bottle, place the net arrangement.
4. After putting the filter in place, take the 6V motor and, using the wooden sticks as supports, put it inside the bottle.
5. Fix the fan to the motor.
6. The bottle opening has a T-shaped aperture attached to it to extend the suction area, which allows it to clean a larger area.
7. It is provided with a 12V power in order to create the necessary vacuum. Also linked to the side is a switch. This serves as a controller for turning the vacuum cleaner ON or OFF as shown in figure 5.2.

As shown in figure 5.2, when there is a pressure difference between two places, materials flow from one place to another. The fundamental operating principle of the perfect vacuum cleaner is this phenomena. A centrifugal fan moves the air by introducing external kinetic energy to it while it turns. Negative pressure is created behind the fan as air is drawn in from behind and forced forward with it. This centrifugal fan, which is attached to a motor, is found in the ultimate vacuum cleaner. This device has connections for suction and discharge; on the suction side, a filter bag is installed prior to the hose connection. The discharge is open to the atmosphere and features a second air purifier filter. The motor and centrifugal fan both rotate when electricity is applied. All airborne particles, including cat allergen, mist, dirt, and minute solid particles, are delivered to the suction filter together with the air that is drawn into the device from the suction side. Filtered air is forced out of the discharge aperture while the particles are trapped in the filter.

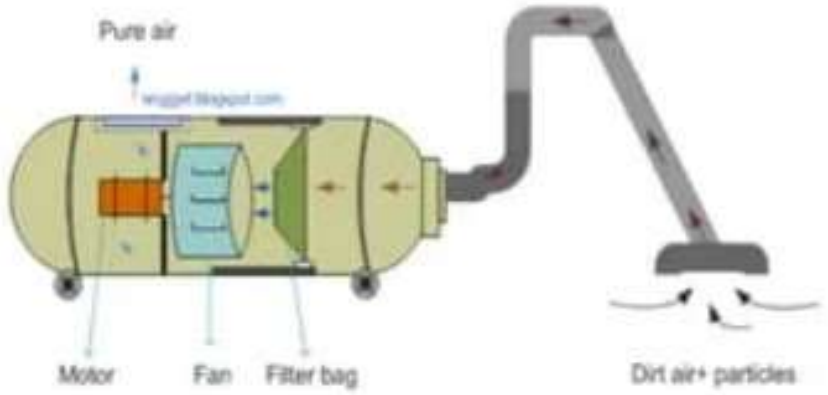

Figure 5.2 circuit diagram

APPLICATIONS

- Cleaning the dry floors
- A floor cleaning assistant at home and offices
- Can clean the inaccessible areas like underneath of sofas bed and table.
- Small particles and can be picked up efficiently.

LIMITATIONS

- Suitable only for flat surfaces.
- Semi automated.

CHAPTER 6

RESULT

Fig. 6.1 shows the obtained distance from the ultrasonic sensor. Arduino IDE contains a serial monitor and this distance is displayed in that. Here, it can be seen that the distance is continuously displayed. Once the obstacle is detected, the distance at right and left is calculated and whichever is greater, the prototype moves in that direction.

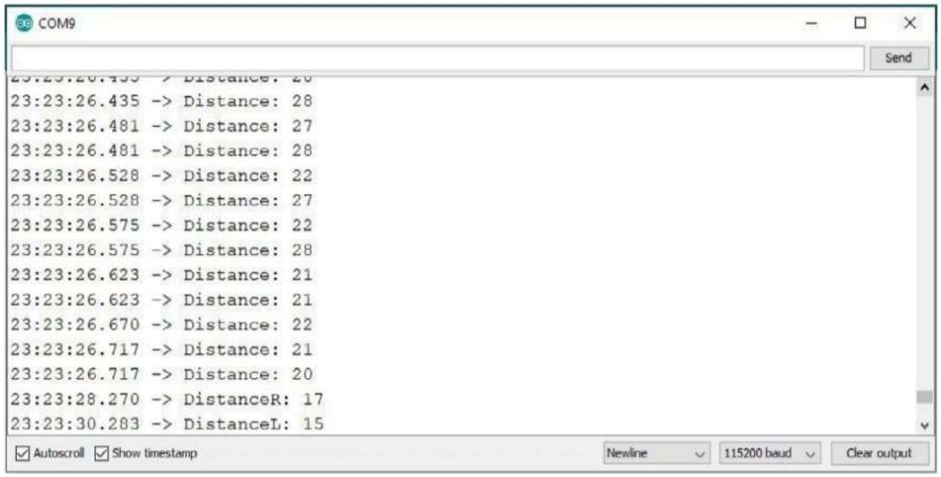

Figure 6.1 Distance measurement

Fig. 6.2 shows the final set-up of the prototype implemented.

Figure 6.2 Prototype

Fig. 6.3 shows the forward movement of vehicle. In this image, the vehicle is moving forward and stops as it encounters an obstacle present in front of it.

Figure 6.3 Forward movement

Fig. 6.4 shows the prototype turning towards left. In this image as the distance between obstacle and the vehicle is less than 20 cm, it turns left to measure the distance.

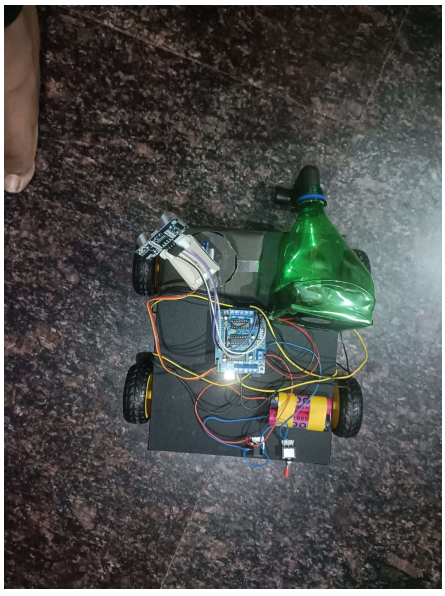

Figure 6.4 Left turn

Fig. 6.5 shows the prototype turning towards right. After turning left, it turns right and measures the available distance between vehicle and obstacle.

Figure 6.5 Right turn.

Fig. 6.6 shows the amount of dust collected in the bottle through the vacuum cleaner. Dust will be collected throughout the movement of vehicle. Here, thermocol balls collected can be seen inside the bottle.

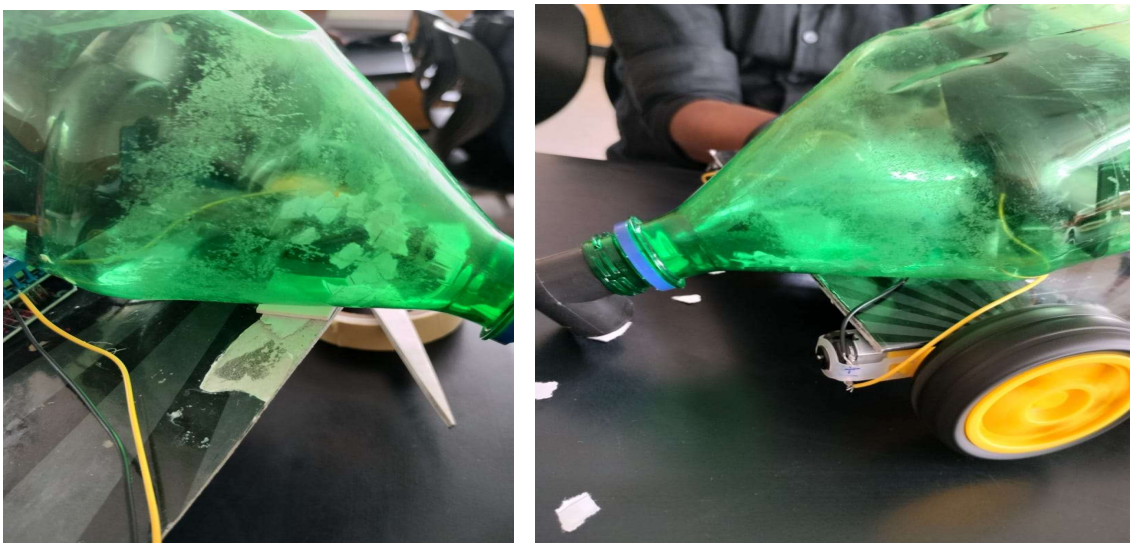

Figure 6.6 Collecting dust

CONCLUSION AND FUTURE SCOPE

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.

Households are becoming more automated, resulting in greater convenience and less time spent on home duties. While vacuum cleaners have made home cleaning easier, they are sometimes too noisy and cumbersome to be used on a regular basis. This robot shows the outcomes of the development of an autonomous mobile robot based on some new ideas that have emerged in this field over the last decade. It is capable of performing both sanitizing and vacuuming. The shape of the robot is well suited for the application, especially for a task like cleaning along a wall, around legs and in corners. Furthermore, the front panel with the sharp distance sensors is able to identify obstacles which then allow the robot to move in an obstacle free path. The developed robot is capable of dealing with a real environment in real-time. The combination of the robot's shape, its sharp distance sensor system and its algorithm play well together and make the task of cleaning and sanitizing an unknown and unstructured environment feasible. It is able to contour an environment composed of walls and corners in an acceptable time. The change in the direction and the speed of the wheels will be matched accordingly. This project was centralized keeping in mind the dust encountered in Indian households. Its sanitizing feature is specifically curate for the present pandemic. It is very helpful as it plays a vital role in cleanliness of the society.

This robot can modify in future for a better effective work and multipurpose. Efficiency of cleaning can be improved. By using IR sensor and to add other features it can make a device that perfectly work for cleaning. If add a timer than it can work for a special time with starting automatically. This floor cleaning robot is limited to clean floor stairs cannot be cleaned by this so it can be modified for cleaning of stairs. This robot can be modified for cleaning of more than one room by one robot. This robot cannot clean circular room can be programmed for cleaning every shaped room. So, these are the future scope of floor cleaning robot.

The model that is present in the report above can be optimizedas 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 vacuum removal

 Image processing technique can b implied to analyses the surface cleaning efficiency using a high quality on board camera

 Germ less cleaning using UV exposure installed on the vehicle.

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