CHAPTER 1

INTRODUCTION

The research and development of an autonomous mobile robot and a Manual Phone Application Control prototype able to vacuum cleaning a room or even an entire house is not a trivial challenge. In order to tackle such a task, so that it could be completed in six weeks (the duration of the course), some simplifications and assumptions were made to the designers initial idea of an “ideal” autonomous/manual vacuum cleaner. In this way, some functional requirements that would improve the robot performance were not taking into account due either to their inherent complexity or to their mechanical implications. These robots operate semi- or fully autonomously to perform services useful to the well-being of humans and equipment. An Arduino-based vacuum cleaner is a cleaning device that is powered and controlled by an Arduino microcontroller. The Arduino board is programmed to control the motors, sensors, and other components that make up the vacuum cleaner. This allows for a high degree of customization and control over the cleaning process, making it possible to program the vacuum cleaner to clean specific areas, adjust the suction power, and even navigate around obstacles. Additionally, an Arduino-based vacuum cleaner can be connected to other devices and systems, such as a smartphone or a home automation system, to provide remote control and monitoring capabilities. This makes the vacuum cleaner not only a practical cleaning tool, but also a fun and educational project for makers and hobbyists interested in robotics and home automation.

A vacuum cleaner, commonly referred to as a vacuum or a hoover, is a machine that creates suction to take dirt off of surfaces like floors, couches, draperies, and other objects. Typically, electricity is used to power it. Either a dust bag or a cyclone collects the dirt for subsequent di sposal. Small battery-powered hand-held vacuum cleaners, wheeled canister models for home use, domestic central vacuum cleaners, enormous stationary industrial machines that can hold hundreds of litters of dirt before being emptied, and self-propelled vacuum trucks for cleanup of significant spills or removal of contaminated soil are all different sizes and models of vacu um cleaners that are used in both homes and industry. Both solid objects and liquids can be sucked up using specialized shop vacuums. The performance of a vacuum cleaner can be mea sured by several parameters.

An obstacle avoidance robot is an autonomous robot that can move through its environment a nd avoid obstacles in its route without any human involvement. It is outfitted with sensors that identify obstacles in its path and algorithms that allow it to decide how to avoid them. The robot can be built to work in a range of conditions, from straightforward inside settings to challenging outdoor terrains. As they can travel through unfamiliar environments and avoid potential dangers, these robots are frequently utilised in applications including surveillance, exploration, and transportation

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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 be- tween 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 simple project's main purpose is to create an Arduino-based vacuum cleaner that is an autonomous device .These devices can reduce the amount of cleaning we need to do on a daily basis. We can effectively reduce physical effort and time we spend keeping our floors clean with the help of a robot vacuum.

The use of robotics in everyday life has been growing rapidly in recent years, and one area where this technology is becoming increasingly popular is in the realm of cleaning. smart vacuum cleaners have been on the market for several years, but advances in sensor technology and microcontrollers are enabling the development of increasingly sophisticated and capable devices. This project aims to develop a robotic vacuum cleaner that uses three ultrasonic sensors and an Arduino Uno microcontroller to navigate around obstacles and walls in a room while efficiently cleaning the floor. The ultrasonic sensors provide accurate distance measurements, allowing the vacuum cleaner to detect and avoid obstacles and walls. The Arduino Uno serves as the brain of the robotic vacuum cleaner, processing the sensor data and sending signals to the motor to change direction as needed. The goal of this project is to create a functional and effective robotic vacuum cleaner that can demonstrate the potential of using advanced technologies to solve everyday problems. By exploring the capabilities of ultrasonic sensors and microcontrollers, we hope to create a device that can make cleaning tasks easier and more efficient for individuals and families.

Smart vacuum cleaner can provide a cleaner environment and promote better health. Dust, stains, and other dirty marks in the home can be harmful to health. Using a robotic vacuum can ensure that the home is cleaned thoroughly and with high efficiency and quality, lowering the chance of being exposed to an unhealthy environment. Additionally, for individuals with joint or mobility issues, using a robotic vacuum can be beneficial to their health.A robotic vacuum is excellent at detecting boundaries. With sensors and a protective bumper, it can avoid damaging itself or furniture. It can also detect walls and steps and will automatically turn around when it encounters them

CHAPTER 2

SYSTEM DESIGN

2.1 Hardware

2.1.1 Arduino Uno:

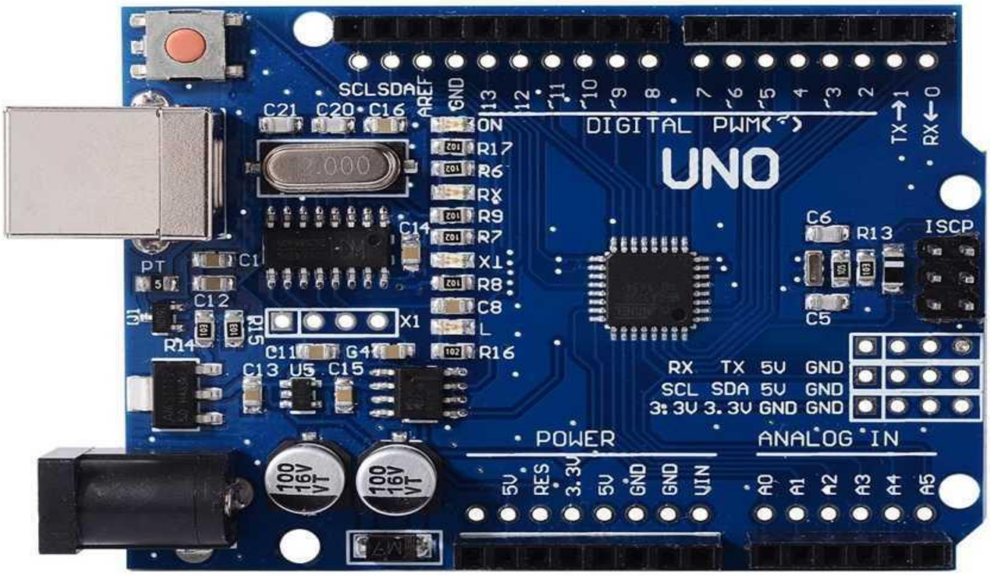

Fig. 2.1: Arduino Uno

Arduino UNO 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, a 16 MHz ceramic resonator, 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. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

Arduino UNO is a low-cost, flexible, and easy-to-use programmable open-source microcontroller board that can be integrated Into a variety of electronic projects. This board can be interfaced with other Arduino boards, Arduino shields, Raspberry Pi boards and can control relays, LEDs, servos, and motors as an output. The Arduino UNO is a standard board of Arduino. Here UNO means 'one' in Italian. It was named as UNO to label the first release of Arduino Software. It was also the first USB board released by Arduino. It is considered as the powerful board used in various projects. Arduino.cc developed the Arduino UNO board. Arduino UNO is based on an ATmega328P microcontroller. It is easy to use compared to other boards, such as the Arduino Mega board, etc. The board consists of digital and analog Input/Output pins (I/O), shields, and other circuits.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

2.1.2 Gear motor with wheels:

fig.2.2:Gear motor with wheels

A gear motor is a mechanical device consisting of an electric motor and a gearbox, differing from a DC motor for lower RPM and higher torque. Discover more.Micro Motors specializes in the manufacture of miniature gear motors, both with brushes and without brushes, and stepper motors. A gear motor is a mechanical system consisting of an electric motor and a gearbox containing a series of gears. The function of the gearbox coupled to the motor is to reduce its speed and increase its torque to do a given job at a given speed.

The addition of the gearbox on the motor and the extremely simple design that can be easily adapted to the customer’s needs, increases the usability of gear motors and makes them highly versatile in any field of mechanical automation (industrial and home automation, printers, vending machines, just to name a few applications). The motor can be with brushes, brushless, or stepper. The concept of the gear motor is inspired by the patent of the German designer and entrepreneur **Albert Obermoser**, who in 1928 invented the so-called Vorlegemotor (gear motor). Since then, the basic model has been progressively improved and new models of gear motors have been created.

2.1.3 Motor Driver:

Fig.2.3:Motor Driver

Motor driver is used to control motion of a motor and its direction by feeding current accordingly. Output of a motor driver is in digital form so it uses PWM (Pulse Width Modulation) to control speed of a motor. Motor Driver are basically current amplifiers followed by input signals.

The basic functionality of a motor driver inlcudes voltage & current control, direction control, speed control and torque control. In voltage and current control drivers regulate the amount of voltage and current supplied to the motor, in direction control the driver changes the motor's rotation direction as most DC motors changes direction by reversing the polarity of the voltage, in speed control driver adjusts the input voltage or using pulse-width modulation (PWM) motor drivers can control the motor's speed and in torque control motor drivers can also regulate the torque produced by the motor.

2.1.4 Ultrasonic Sensor:

Fig.2.4:Ultrasonic Sensor

An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e. the sound that humans can hear). Ultrasonic sensors have two main components: the transmitter (which emits the sound using piezoelectric crystals) and the receiver (which encounters the sound after it has travelled to and from the target).

Ultrasonic sensors are used primarily as proximity sensors. They can be found in automobile self-parking technology and anti-collision safety systems. Ultrasonic sensors are also used in robotic obstacle detection systems, as well as manufacturing technology. In comparison to infrared (IR) sensors in proximity sensing applications, ultrasonic sensors are not as susceptible to interference of smoke, gas, and other . An ultrasonic sensor is an electronic device that measures the distance of a target object by emitting ultrasonic sound waves, and converts the reflected sound into an electrical signal. Ultrasonic waves travel faster than the speed of audible sound (i.e. the sound that humans can hear). Ultrasonic sensors have two main components:

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In order to calculate the distance between the sensor and the object, the sensor measures the time it takes between the emission of the sound by the transmitter to its contact with the receiver. The formula for this calculation is <u>D = ½ T x C</u> (where D is the distance, T is the time, and C is the speed of sound ~ 343 meters/second). For example, if a scientist set up an ultrasonic sensor aimed at a box and it took 0.025 seconds for the sound to bounce back, the distance between the ultrasonic sensor and the box would be:

2.1.5. Motors

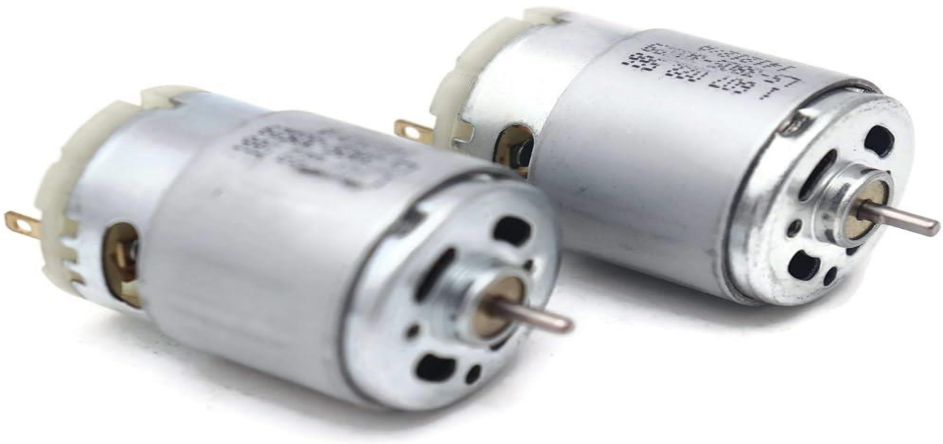

Fig.2.5:Motor

Motors are the primary actuators for any system. They move the entire vehicle in the desired direction. The motors have two poles that have to be given supply to rotate it. Among the two poles, one has to get the required power supply while the other gets the ground. Due to opposite charges given to them, the core starts rotating in the desired directing giving the output. This is the basic operation for any motor. The motors for durability and usability in their system is what we are basing our data on. These motors can be run at their max power since our system will have a battery which can provide the system with 24V of power. Desired motion like and left turns can be achieved by powering the poles accordingly. Due to our design objectives to produce better suction power and a better cleaning effort all together, the team decided to choose one motor for the whole design to keep cost down while improving performance. Desired motion like and left turns can be achieved by powering the poles accordingly. Due to our design objectives to produce better suction power and a better cleaning effort all together, the team decided to choose one motor for the whole design to keep cost down while improving performance.

2.1.6 Servo Motor:

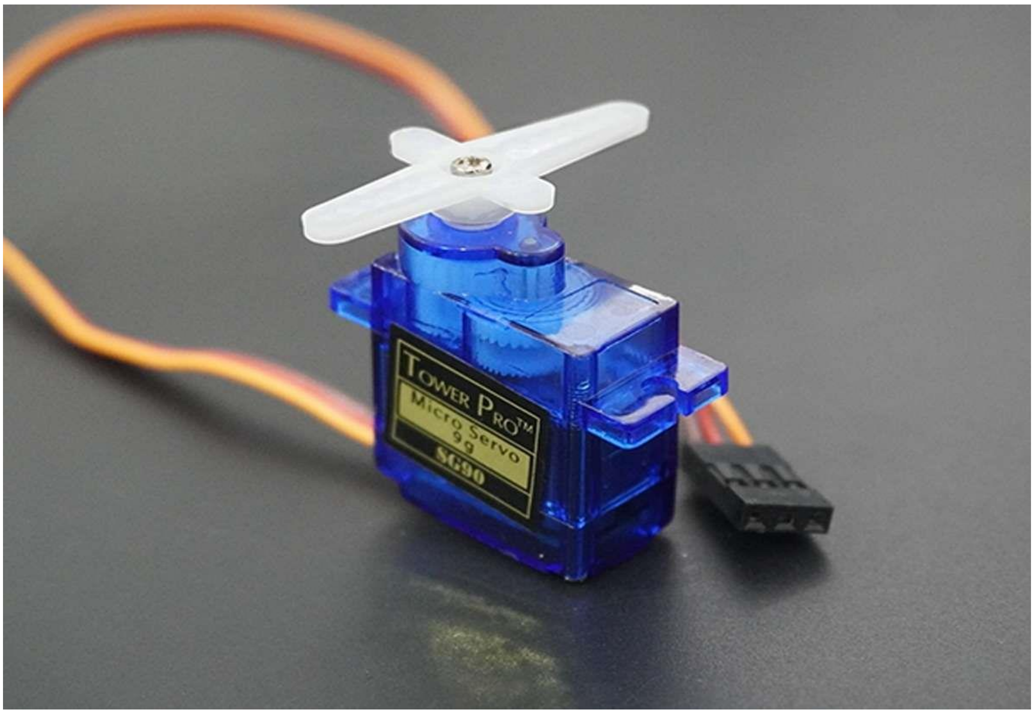

Fig.2.6: Servo Motor

A servo motor is a rotary actuator that allows for precise control of angular position. It consists of a motor coupled to a sensor for position feedback. It also requires a servo drive to complete the system. The drive uses the feedback sensor to precisely control the rotary position of the motor. Learn more about what is a servo motor in our Technologies Explained series.

A servo motor is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servo motors to rotate with great precision. If you want to rotate an object at some specific angles or distance, then you use a servo motor. It is just made up of a simple motor which runs through a servo mechanism. If motor is powered by a DC power supply then it is called DC servo motor, and if it is AC-powered motor then it is called AC servo motor. For this tutorial, we will be discussing only about the DC servo motor working. Apart from these major classifications, there are many other types of servo motors based on the type of gear arrangement and operating characteristics.

CHAPTER 3

WORKING PRINCIPLES

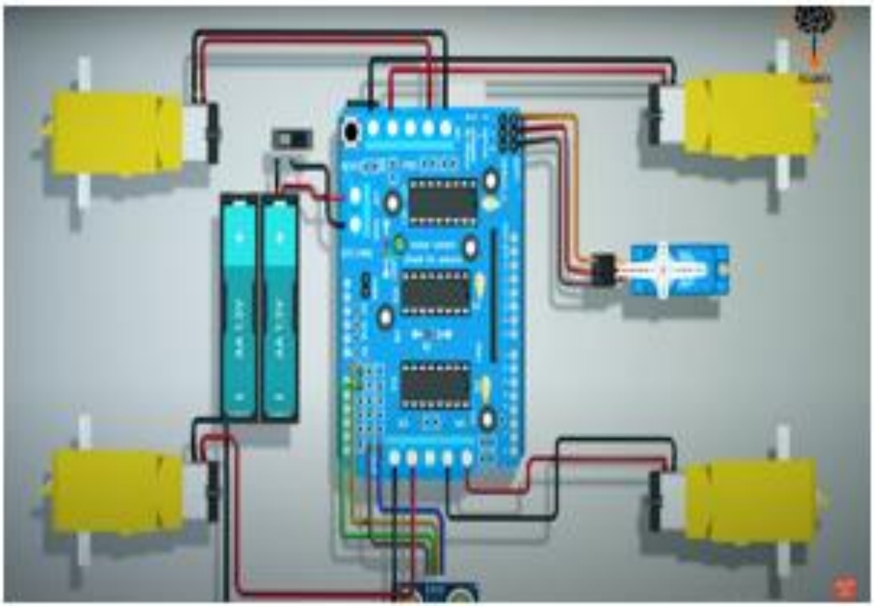

Fig.3.1: Circuit Diagram

The Programmed Arduino Uno with power from the battery will work as the main micro controller for the product which will enable the product to go in destined direction . The servo motor makes the Ultrasonic sensor rotate. The ultrasonic sensor is placed for detection purposes. When it detects the obstacle in its path, it will take a turn and will choose its own way where there are no obstacles. A fan is placed, which works to catch the tiny dirt particle from the floor and store it in the bottle. The Programmed Arduino Uno with power from the battery will work as the main micro controller for the product which will enable the product to go in destined direction . The servo motor makes the Ultrasonic sensor rotate.

3.1 Sensors:

- **Infrared Sensors:** Detect obstacles and cliffs (stairs or drops) to prevent collisions and falls.
- **Ultrasonic Sensors:** Measure the distance to objects to navigate around them.
- **Touch Sensors:** Detect physical contact with objects to adjust the path.
- **Gyroscope and Accelerometer:** Help maintain orientation and measure movement.
- **Optical Sensors:** Track movement by detecting changes in the surface beneath.

3.2 Navigation System:

- **Mapping Algorithms:** Create and update a map of the cleaning area using data from the sensors.
- **Localization:** Determine the robot's position within the mapped area, often using Simultaneous Localization and Mapping (SLAM) technology.
- **Path Planning:** Calculate the most efficient cleaning route based on the map and current position.

3.3 Power System:

- **Rechargeable Battery:** Powers the vacuum and needs periodic recharging.
- **Docking Station:** The vacuum returns here to recharge automatically.

3.4 Control System:

- **Onboard Processor:** Manages sensor data, navigation algorithms, and cleaning tasks.
- **User Interface:** Allows manual control and programming, often via a smartphone app or remote control.
- **Connectivity:** Wi-Fi or Bluetooth for remote operation and integration with smart home systems.

3.5 Working Process:

1) **Initial Setup**:
- The user sets up the charging dock in an accessible location.
- The vacuum cleaner is charged and connected to a mobile app, if available, for initial setup.

2) **Mapping and Navigation**:
- When the vacuum is turned on, it uses its sensors (like infrared, LIDAR, or cameras) to map the room.
- It navigates in a systematic pattern, often starting with the perimeter and then cleaning in a back-and-forth or spiral pattern to cover the entire area.

3) **Cleaning**:
- The vacuum's brushes and rollers agitate and lift dirt from the floor.
- The suction motor pulls the dirt into the dustbin.
- The dirt sensors can detect heavily soiled areas and make the vacuum go over them multiple times.

4) **Obstacle Avoidance**:
- The obstacle detection sensors help the vacuum detect and avoid obstacles.
- If the vacuum hits an obstacle, it will re-route itself and continue cleaning.

5) **Returning to Dock**:
- Once the battery is low or the cleaning cycle is complete, the vacuum uses its sensors and memory to navigate back to the charging dock.
- It docks itself and starts recharging.

6) **Maintenance**:
- The user needs to empty the dustbin and clean the filters regularly.
- Brushes and rollers should be checked for entangled hair and debris.

CHAPTER 4

METHODOLOGY

4.1 Design

4.1.1 RC CAR

The RC car designed is shown in Fig. 9 . 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]

4.1.2 Vacuum Cleaner

Vacuum cleaner is made up of 1.25L water bottle, CPU fan, pipe, tape, gauze bandage, batteries and switch.

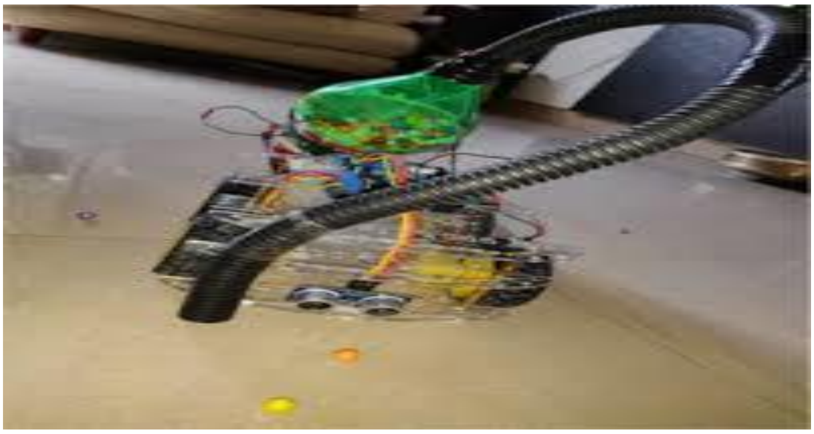

Fig.4.1: Smart Vacuum Cleaner

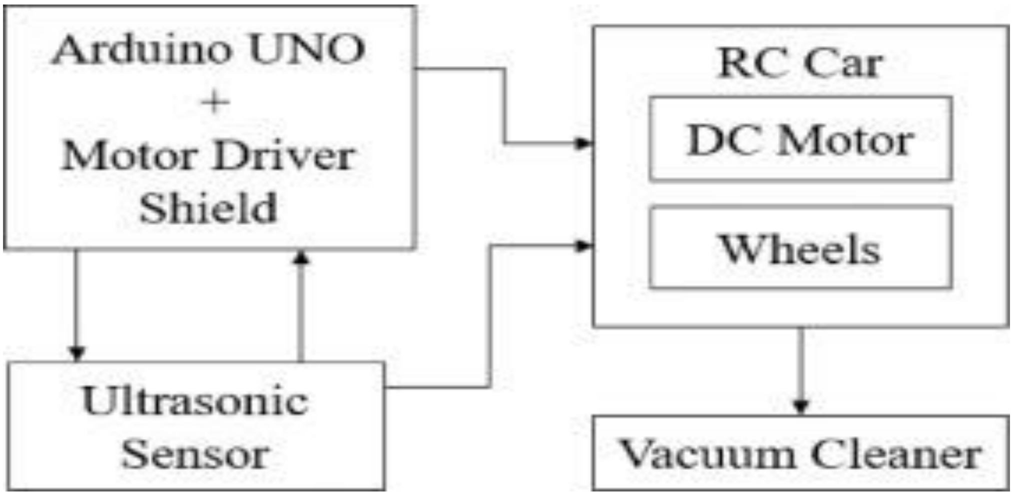

Fig.4.2: Block diagram

The vacuum cleaner is shown in Fig 10 . 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. 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 methodology of a smart vacuum cleaner integrates advanced navigation and mapping, multiple sensors, efficient cleaning mechanisms, power management, intelligent software, user-friendly interfaces, and regular maintenance to provide an autonomous and effective cleaning solution. Each component and technology plays a crucial role in ensuring that the vacuum can clean efficiently and autonomously while adapting to different environments and user needs.

4.1.3 Navigation and Mapping

Smart vacuum cleaners use advanced navigation systems to move around and clean the environment. The primary technologies include:

- **LIDAR (Light Detection and Ranging):** Uses laser sensors to create a detailed map of the surroundings.
- **SLAM (Simultaneous Localization and Mapping):** Combines data from sensors to build a map and track the vacuum's location within that map.
- **Cameras and Vision Systems:** Some models use cameras to recognize objects and navigate around obstacles.

4.1.4 Sensors and Data Collection

Smart vacuums are equipped with various sensors to collect data about the environment:

- **Obstacle Detection Sensors:** Infrared, ultrasonic, or bumper sensors to detect and avoid obstacles.
- **Cliff Sensors:** Detects stairs or drops to prevent the vacuum from falling.
- **Dirt Sensors:** Identify areas with higher dirt concentration to adjust cleaning intensity.

4.1.5 Cleaning Mechanisms

The cleaning process is facilitated by multiple components:

- **Brushes and Rollers:** Agitate and lift dirt from different floor types.
- **Vacuum Suction:** Draws in dirt and debris into a dustbin.
- **Filters:** HEPA or other filters to trap fine dust and allergens.

4.1.6 Power Management

Efficient power management is crucial for the operation of smart vacuums:

- **Rechargeable Batteries:** Typically lithium-ion batteries for longer runtime.
- **Charging Docks:** The vacuum automatically returns to the dock to recharge when the battery is low

CHAPTER 5

IMPLEMENTATION AND RESULT

9V 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 col- lision 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. Table 2 shows the comparison between the existing and the designed algorithm. In the existing prototypes, through an application, there will be an interaction between the model and the user. 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.

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The implementation of a smart vacuum cleaner is a comprehensive process that requires careful planning, design, and testing. It involves selecting the right hardware components, developing advanced navigation and cleaning algorithms, building prototypes, conducting thorough testing, refining the design, setting up manufacturing, and ensuring quality assurance. Once launched, ongoing support and updates are crucial to maintaining product performance and customer satisfaction.

This basic implementation covers the fundamental aspects of a smart vacuum cleaner using Arduino Uno. For a more advanced version, consider adding features like additional sensors, more sophisticated path planning algorithms, and a more efficient dust collection system. The integration of these components will enhance the functionality and performance of your smart vacuum cleaner.

5.1 Step-by-Step Implementation:

5.1.1 Build the Chassis:

- Assemble the chassis using a frame that can hold the Arduino, motors, sensors, and dust collection mechanism.
- Attach the DC motors with wheels and a caster wheel for stability.

5.1.2 Set Up Motor Control:

- Connect the DC motors to the motor driver (L298N).
- Connect the motor driver to the Arduino Uno.
- Ensure the motors are connected to the power supply.

5.1.3 Add Ultrasonic Sensors:

- Mount the ultrasonic sensors on the front and sides of the chassis for obstacle detection.
- Connect the ultrasonic sensors to the Arduino Uno (trigger and echo pins).

5.1.4 Integrate Infrared Sensors (Optional):

- Place infrared sensors at the bottom of the chassis for line detection or cliff detection.
- Connect these sensors to the Arduino.

5.1.5 Connect the Dust Collection Mechanism:

- Attach a small vacuum fan or dust collection unit to the chassis.
- Connect it to a power supply and control it via the Arduino if necessary.

5.1.6 **Power Supply**:

- Connect a battery pack to power the Arduino, motors, and sensors.
- Ensure the voltage requirements are met for all components.

5.1.7 **Programming the Arduino:**

- Write a program to control the motors, read sensor data, and implement basic navigation algorithms.
- The program should handle obstacle detection and avoidance.

This basic implementation covers the fundamental aspects of a smart vacuum cleaner using Arduino Uno. For a more advanced version, consider adding features like additional sensors, more sophisticated path planning algorithms, and a more efficient dust collection system.

Results:

Fig.5.1 Left Turn

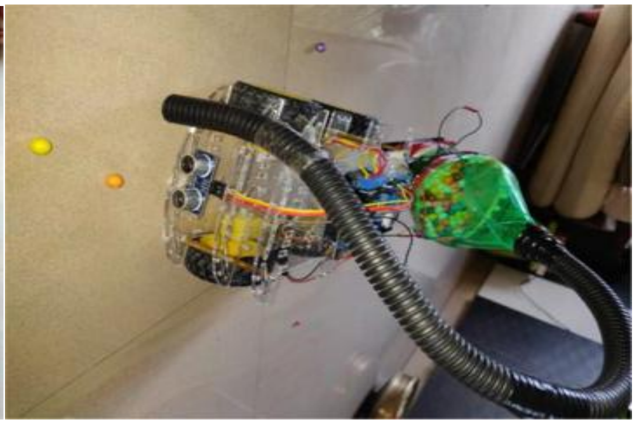

Fig.5.2 Collecting Dust

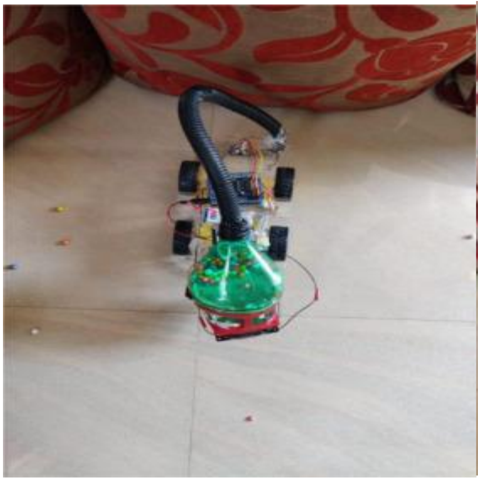

Fig. 5.3 Forward moment   Fig. 5.4 Prototype

5.2 Navigation System

Navigation system is nothing but the way, the robotic vacuum cleaner plans to plot a path and avoids the obstacles for itself. Here we have planned to deploy six ultrasonic sensors where one at the bottom front and other three in sides, in the front and the fifth and sixth one to be placed at the back so that proper detection of corners, walls and obstacle can be achieved and hence the robotic vacuum can move forward properly. Figure 3, represents the algorithm used for obstacle avoidance during the operation of automatic vacuum cleaning robot.

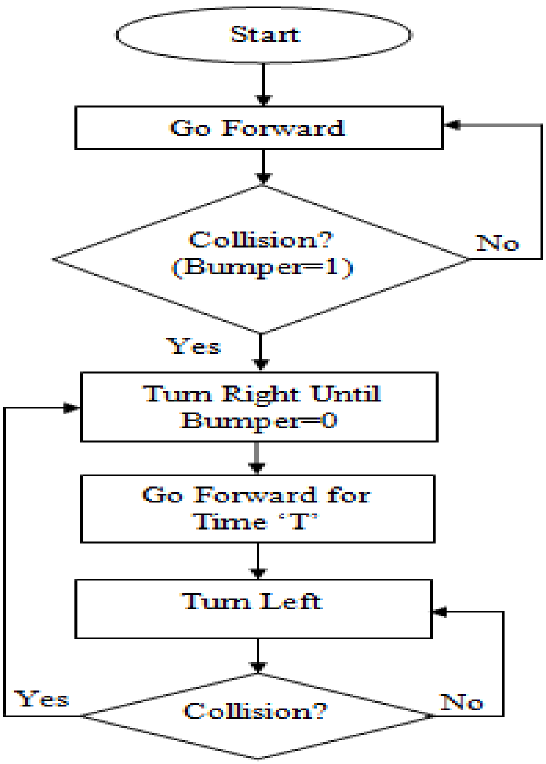

Fig.7.1 flow chart

A basic path and an obstacle placed in the path of the robotic vacuum cleaner then the robotic vacuum cleaner has to avoid it and run along the same path again such that the obstacle is avoided and the path is also not disturbed. Also considering a basic living room, it might have objects such as sofa and television. The robotic vacuum cleaners to move under them, the sensors have to be placed in a vertical way such that measuring the height of such particular obstacles so that it can go underneath them and we have decided to imply this too. So only particular obstacles will be avoided and others will be explored by the robot to achieve proper cleaning of the room . Navigation system is nothing but the way, the robotic vacuum cleaner plans to plot a path and avoids the obstacles for itself. Here we have planned to deploy six ultrasonic sensors where one at the bottom front and other three in sides. This is a basic outline of creating a navigation system for a smart vacuum cleaner using an Arduino Uno. The complexity can be increased based on the desired functionality, such as more sophisticated navigation algorithms, better obstacle detection, and integration with other systems.

CHAPTER 6

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 be- tween 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. project's main purpose is to create an Arduino-based vacuum cleaner that is an autonomous device. These devices can reduce the amount of cleaning we need to do on a daily basis. We can effectively reduce the physical effort and time we spend keeping our floors clean with the help of a robot vacuum.

In conclusion, the project to create a smart vacuum powered by Arduino has been constructed and put into use successfully. The core control system of the vacuum cleaner is an Arduino, which enables a number of intelligent features including obstacle recognition, autonomous navigation, and wireless network Although the stated goals of the current project have been met, there is still plenty of room for improvements and developments. Potential regions for growth in the future include Map-making and path planning: Using cutting- edge algorithms and sensors, a vacuum cleaner can map its surroundings and devise an ideal path for cleaning.

This research facilitates efficient floor cleaning with sweeping and mopping operations. This robot works in two modes automatic and manual for user convenience. This proposed work provides the hurdle detection in case of any obstacle that comes in its way. The obstacle detection range is 1ft. RF modules provide wireless communication between remote and robot and their range is 50m.

A mechanical setup is designed with the synergies of pneumatics and electronics to provide efficient cleaning system both at ground and as well as window levels. This contemporary design helps to overcome the limitations of the existing technologies and surpass them in terms of robot capability, modularity and payload. These components determine how well the dirt is collected. As of now, we feel that by adding brushes and increasing the motor size will do the job. Instead of the one brush underneath Roomba, we will be using two brushes to maximize cleaning on each side of the robot. This research facilitates efficient floor cleaning with sweeping and mopping operations. This robot works in two modes automatic and manual for user convenience. This proposed work provides the hurdle detection in case of any obstacle that comes in its way. The obstacle detection range is 1ft. RF modules provide wireless communication between remote and robot and their range is 50m

6.1 Cleaning with artificial intelligence (AI):

Using artificial intelligence to analyse the type of filth on the surface and modify the vacuum cleaner's cleaning approach as necessary. Integration with smart home systems: Making it possible for the vacuum cleaner to work seamlessly and more effectively with other smart home appliances and systems, such as voice assistants, home automation hubs or security systems.

6.2 Multiple floor cleaning:

Designing the vacuum with capabilities like multi-level mapping or the capability to negotiate stairs will enable it to manage numerous floors or complex floor plans. Energy efficiency and battery optimisation: Investigating ways to reduce the vacuum cleaner's energy usage and increase the lifespan of its batteries by using power management strategies or effective motors.

6.3 Noise reduction:

Using noise reduction techniques to reduce the vacuum cleaner's operational noise will make it more user-friendly. Cloud connectivity and data analysis Implementing cloud connectivity to store cleaning data and analyse that data to generate individualised cleaning recommendations or maintenance alerts. 8. Robustness and durability: Enhancing the vacuum cleaner's overall build quality and strength will assure its long-term dependability and durability. Investigating ways to reduce the vacuum cleaner's energy usage and increase the lifespan of its batteries by using power management strategies or effective motors.

6.4 Future Scope:

6.4.1 Advanced Navigation Algorithms:

- Implementing more sophisticated algorithms such as SLAM (Simultaneous Localization and Mapping) to create a map of the cleaning area and navigate more efficiently.
- Utilizing machine learning techniques for better decision-making and adaptability to different environments.

6.4.2 Improved Obstacle Detection:

- Adding more sensors or advanced sensors like LIDAR or cameras for better obstacle detection and avoidance.
- Integrating sensor fusion techniques to combine data from multiple sensors for more accurate environmental perception.

6.4.3 Battery Management and Charging:

- Implementing battery monitoring systems to track battery levels and optimize cleaning routes based on available power.
- Designing an automatic charging dock that the vacuum cleaner can navigate to when the battery is low.

6.4.3 Enhanced Cleaning Mechanisms:

- Developing more efficient and powerful vacuum and brush systems to improve cleaning performance.
- Adding features like dirt detection to focus on dirtier areas.

6.4.4 Wireless Communication and Control:

- Integrating wireless communication modules (e.g., Wi-Fi, Bluetooth) to allow remote control and monitoring via smartphone apps.
- Enabling firmware updates over the air for continuous improvement and feature addition.

6.4.5 User Interface and Experience:

- Designing a user-friendly interface for setting cleaning schedules, selecting cleaning modes, and monitoring cleaning progress.
- Implementing voice control integration with smart home assistants like Amazon Alexa or Google Assistant.

6.4.6 Safety and Reliability:

- Enhancing safety features to ensure the vacuum cleaner operates reliably in various environments without causing damage or getting stuck.
- Conducting extensive testing to improve the robustness and longevity of the system.

CONCLUSION

In this project Smart Vacuum Cleaner has been implemented. It was works on a pre-defined code inserted in Arduino UNO. Whenever RC car encounters any obstacle, it turns to the side where the distance be- tween 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. he project's main purpose is to create an Arduino-based vacuum cleaner that is an autonomous device. These devices can reduce the amount of cleaning we need to do on a daily basis. We can effectively reduce the physical effort and time we spend keeping our floors clean with the help of a robot vacuum, The project to create a smart vacuum powered by Arduino has been constructed and put into use successfully. The core control system of the vacuum cleaner is an Arduino, which enables a number of intelligent features including obstacle recognition, autonomous navigation, and wireless network Although the stated goals of the current project have been met, there is still plenty of room for improvements and developments. Potential regions for growth in the future include Map-making and path planning: Using cutting- edge algorithms and sensors, a vacuum cleaner can map its surroundings and devise an ideal path for cleaning.

In conclusion, the smart vacuum cleaner project has successfully achieved its objectives of creating a prototype that combines intelligence, automation, and efficiency in household cleaning. Through the integration of sensors, navigation algorithms, and user-friendly interfaces, the smart vacuum cleaner demonstrates promising potential in simplifying cleaning tasks and enhancing user experience. While further refinement and optimization may be necessary for commercial deployment, the project lays a solid foundation for future developments in smart home technology and robotics. Overall, the smart vacuum cleaner project represents a significant step forward in leveraging technology to improve everyday household chores and enhance the quality of life for users.

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