ROBOT FOR FLOOR CLEANING

*

Md. Masbahul Hassan
Dept. IRE
Bangabandhu Sheikh Mujibur Rahman
Digital University,Bangladesh
Kaliakoir, Gazipur
1901014@iot.bdu.ac.bd

Sieadatun Naher Kanon Sarker
Dept. IRE
Bangabandhu Sheikh Mujibur Rahman
Digital University,Bangladesh
Kaliakoir, Gazipur
1901018@iot.bdu.ac.bd

***Abstract*—Floor cleaning robots have gained significant attention in recent years due to their ability to automate the labor-intensive task of floor cleaning. These robots are designed to navigate and clean various types of floor surfaces efficiently and autonomously, reducing the need for human intervention. This abstract provides an overview of the key components and functionalities of floor cleaning robots.The main components of a floor cleaning robot include sensors, actuators, control systems, and cleaning mechanisms. Sensors, such as infrared sensors, ultrasonic sensors, enable the robot to perceive its environment and avoid obstacles. Actuators, typically in the form of wheels or tracks, facilitate the robot's movement across the floor. The cleaning mechanism of a floor cleaning robot varies depending on the model. Some robots use rotating brushes or bristles to sweep dirt and debris into a collection bin, while others employ suction power or mopping pads for wet cleaning. The cleaning process can be further enhanced with features like water spraying, vacuuming, or scrubbing. One of the key advantages of floor cleaning robots is their ability to operate autonomously. Once the cleaning area is mapped and the robot is set in motion, it can navigate the space, adapt to changing environments, and clean the floors without constant human supervision. Many models are equipped with rechargeable batteries, allowing them to operate for extended periods without interruption. Floor cleaning robots are sophisticated machines that automate the task of floor cleaning. With their advanced sensors, intelligent control systems, and various cleaning mechanisms, they provide efficient and autonomous cleaning solutions for both residential and commercial spaces. As technology continues to evolve, floor cleaning robots are expected to become even more capable and widespread, offering enhanced features and improving the overall cleanliness and maintenance of floors.**

***Index Terms*—Arduino Uno, Bluetooth module, Ultrasonic Sensors, DC Motor and Motor Driver**

I. Introduction

Recently, many researchers are working on various types of Floor Cleaning Robot. In [ii] the purpose of this project is to clean the floors in colleges, hospitals, auditoriums, malls and workshops.The aim of this project work is to design and develop process for cleaning the floor having wet and dry surfaces. It is very useful for cleaning the wet as well as dry floors. In proposed [iii] the multiple applications provide a wide range of functions in which we can clean the pipe, scrubbing of surface for proper cleaning of the floor, remove dust and dirt from the road, provide a pick and place mechanism by which obstacles can be removed. In proposed [v] Design and Analysis of Manually Operated Floor Cleaning Machine"- The authors has been designed and analyzed manually operated floor cleaning machine. In project review [viii] they talk about "Street Cleaning Machine". It has developed the street cleaning machine by tricycle operated. In this research article .He framed a model especially for rural area. He concluded that the cleaning is less effective in streets" Floor cleaning robots are innovative and autonomous devices designed to simplify and automate the process of cleaning floors. These robots utilize advanced technologies, such as sensors, mapping algorithms, and cleaning mechanisms, to efficiently navigate and clean floor. With the objective of saving time and effort for users, floor cleaning robots offer a convenient solution for maintaining clean and hygienic floors. They eliminate the need for manual labor, allowing users to focus on other tasks or enjoy their free time while the robot takes care of the cleaning. Robot is an electromechanical machine and used for various purpose in industrial and domestic applications. Cleaning an indoor is a practical problem whose solution involves all the basic research areas in robotics and lots of common sense. In this project floor cleaning robot is based on Arduino Uno has been developed. This robot is an electric home appliance, which works in two modes as per the user convenience "Automatic and Manual". This is not a vacuum cleaner robot and it performs wet and dry cleaning operation. It works on supply voltage.In automatic mode, robot performs all tasks individually. First robot starts it moves forward and performs cleaning operation. If any object detected, the robot change the pathway automatically, does not stop and starts cleaning operation. Manual mode is performed with the help of a Bluetooth module, which gives 50m and 100m range. Motor driver circuit have been used to drive the motors. Two motors are used to drive the robot in four directions. LM293D IC has been used to drive wheel motor. Relays have been used to drive the water pump and cleaner motor. In the manual mode, user itself operates the robot. Bluetooth module transmits and receive the signal to operate the robot through android phone.

The objectives of floor cleaning robots can vary depending on the specific model and manufacturer. However, here are some common objectives that floor cleaning robots aim to achieve: The primary objective of floor cleaning robots is to provide efficient and effective cleaning of floors. They are designed to remove dirt, dust, and debris from various types of flooring surfaces, ensuring a clean and hygienic environment.
Floor cleaning robots also aim to save time for users by automating the cleaning process. Instead of manually cleaning the floors, users can simply set up the robot and let it do the work, allowing them to focus on other tasks or enjoy their free time.
These robots aim to provide a user-friendly interface, allowing users to easily control and monitor the cleaning process. This can include intuitive buttons, smartphone apps,for seamless operation and interaction.

II. LITERATURE REVIEW

In order to have a brief understanding in Bluetooth module, motor driver and Arduino the detailed literature survey is carried out. They are summarized as follows.

i. Abhishek Chakra Borty Et Al [2013] proposed the "Design of Dust Collector for Rear Wheel of Four-Wheeler" - He reported that the most significant cause of road dust to the total suspended particulate burden is vehicle travelling on paved and unpaved surfaces. Consequently data directly relating dust to road accidents are rare, but in study if dust is the cause of 10percent of these accidents casualties then the cost could amount to as much as 0.02 percent of GDP in some developing countries and total about 800 million dollar annually.

ii. Aishwarya Pardeshi [2017] proposed the "Automatic Floor Cleaner". In this project she conclude that the setup of hardware with a combination of software gives better accuracy and reduces the work load. Man power is minimized. It have Low cost. It is a Time Consuming Device Making a small machine brings a flexibility to do work.

iii. Anup Mendhe [2017] proposed the "Multipurpose Floor Cleaning Machine". He reported that the multiple applications provide a wide range of functions in which we can clean the pipe, scrubbing of surface for proper cleaning of the floor, remove dust and dirt from the road, provide a pick and place mechanism by which obstacles can be removed. This project is very helpful for the society and play a vital role in cleanliness of the country. The main motive of the project is to cover the aspects of cleanliness in the society. The multiple applications provide a wide range of functions in which we can clean the pipe, scrubbing of surface for proper cleaning of the floor. This project is very helpful for the society and play a vital role in cleanliness of the country. Imaekhai Lawrence Et Al [2012] proposed the "Evaluating Single Disc Floor Cleaners" - The evaluation has shown how the use of multiple assessment techniques can provide a comprehensive appraisal of the design, usability and musculoskeletal loading upon the operator. They suggested that the trials with a larger number of subjects would certainly strengthen the conclusions.

iv. Manya Jain [2017] proposed the "Automatic Floor Cleaner". This research facilitates efficient floor cleaning. Since in project the floor cleaner is incorporated with different devices like DC motor(s), ultrasonic sensors etc.. so it will be easy to handle it also saves time and will work automatically for cleaning purpose at homes and offices. With simple algorithm and program, the cleaner will be able to cover large floor areas as well as find its way into and out of small corners. As the cleaner traverses the room, the sweeper installed in it will manage to pick up a significant amount of dirt. Manual Sweeping might not be that effective as it will not be picking up everything in as it is not in sight but using the automatic floor cleaner it can be done easily. This research facilitates efficient floor cleaning. Since in project the floor cleaner is incorporated with different devices like DC motor(s), ultrasonic sensors etc.. so it will be easy to handle it also saves time and will work automatically for cleaning purpose at homes and offices. With simple algorithm and program, the cleaner will be able to cover large floor areas as well as find its way into and out of small corners. As the cleaner traverses the room, the sweeper installed in it will manage to pick up a significant amount of dirt. Manual Sweeping might not be that effective as it will not be picking up everything in as it is not in sight but using the automatic floor cleaner it can be done easily.

v. Ranjith Kumar Et Al (2015) proposed the "Design and Analysis of Manually Operated Floor Cleaning Machine"- The authors has been designed and analyzed manually operated floor cleaning machine. From his research he concluded that the stress level in the manually operated machine is within the safe limit.

vi. Sandeep. J. Meshram Et Al (2016) proposed the "Design and Development of Tricycle Operated Street Cleaning Machine" He has developed the street cleaning machine by tricycle operated. In this research article he framed a model especially for rural area. He concluded that the cleaning is less effective where the street seems to be very rough and damaged. It is found that the existing street cleaning machines uses petrol and diesel. It can cause pollution and also the vibration produced in the machine causes noise pollution. While manual cleaning may cause health problem as the person directly comes in contact with dust. Also, the shoulder problem due to continuously sweeping occurs.

A tricycle operated street cleaning machine seems an alternative concept for avoiding such problems enlisted in first point. The tricycle operated machine can work very efficiently with respect to covering area, time and cost of street cleaning process compared with the existing machineries. Also it is economical. It was seen while testing of machine, that the cleaning is less effective where the street seems to be very rough and damaged.

vii. M RANJIT KUMAR (2016) “The regular floor cleaning machines is most generally utilized as a part of airplane terminal stages, railroad stages, healing centers, transport stands, and shopping centers and in numerous other business places. These gadgets require an electrical vitality for its activity and not easy to use. In India, particularly in summer, there is control emergency and the vast majority of the floor cleaning machine isn’t utilized successfully because of this issue, especially in transport stands. In this work, demonstrating and investigation of the floor cleaning machine was finished utilizing appropriate financially accessible programming. From the limited component investigation, we watch that the feeling of anxiety in the physically worked floor cleaning machine is inside as far as possible”.

viii. SANDEEP. J. MESHRAM ET AL [2016] “Design and Development of Tricycle Operated Street Cleaning Machine” – He has developed the street cleaningmachine by tricycle operated. In this research article .He framed a model especially for rural area. He concluded that the cleaning is less effective in streets”.

ix. MANYAJAIN, PANKAJ SINGH RAWAT (2016) “This project is used for domestic and industrial purpose to clean the surface automatically. When it is turned on, it sucks in the dust by moving all around the surface (floor or any other area) as it passes over it.In the modern era, the automatic floor cleaner is required. Thus, the cleaner is designed in such a way that it is capable of cleaning the area reducing the human effort just by starting the cleaning unit”.

III. METHODOLOGY

Usually this kind of robots making cost are not possible to afford. At the same time this economical robotic floor cleaner has been designed mainly keeping the price margin in mind. As a result, a most efficient and agile cleaning system is developed to attain perfect cleaning rather than satisfactory cleaning achieved by a pre-existing extravagant machine. In Fig 1 shows block diagram of proposed model.An exhaustive research and comparisons with the conventional designs and performances of various kinds and make. Supervisory control over these gadgets is made so simple and cost efficient without reduction in performance.

Robot Platform: The system utilizes a robot platform equipped with wheels or tracks for smooth mobility. The robot is designed to navigate through indoor environments, such as room, hospitals or quarantine facilities, with ease.

Control Mechanisms: The robot can be controlled through multiple methods, including voice command, manual control, automatically manipulate its movements directly, or use predefined body gestures to control its actions.

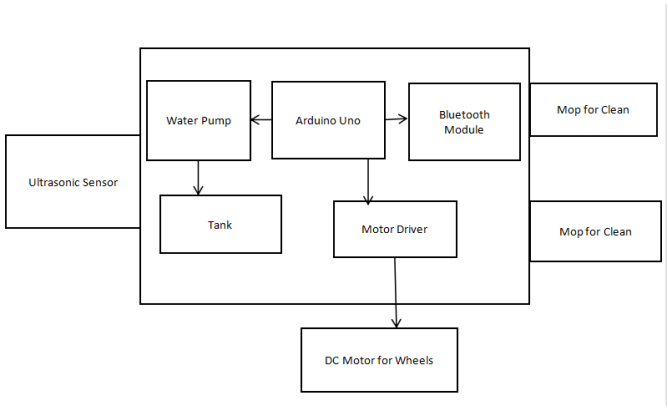

Fig. 1. Block diagram of proposed model

Remote Control and Monitoring:: The robot can be remotely controlled and monitored using a Bluetooth module and a dedicated mobile application. Users can connect to the robot using their smartphones or tablets, accessing the mobile app to issue commands, monitor the robot’s status, and control its movements and functions from a distance. This remote control feature enables caregivers and other individuals to manage the robot’s activities conveniently.

A. APPLICATIONS

We use mobile application named ”Bluetooth Control RC Car” for manually controlling this robot. In the automatic system, this robot will not move where there are obstacles, and to overcome this problem, we used bluetooth module so that we can take the robot wherever we want to clean the floor whether there is an obstacle or not A Bluetooth module in a floor cleaning robot also allows users to remotely control and monitor the robot using a smartphone or a dedicated remote control app. Users can start or stop the cleaning process, change cleaning modes, or adjust settings from a distance.

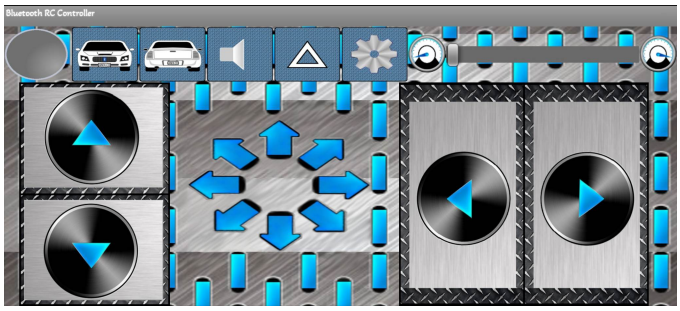

Fig. 2. Mobile Application for Controlling Robot

IV. PROPOSED MODEL

First of all when we though to do this project firstly we identify the problem which should we face. In Fig.1 we can see our primary design of the project. And then we used

sesnor,actuator, motor driver etc according to the Fig.1. We are done this machine in fully automatic and attached wet and dry cleaning mop at one robot. Working principle of our project Here, We will make a Automatic floor cleaning Robot that only costs a small fraction of the ones in the market. In this project Robot can detect the obstacles objects in front of it and can continue moving, avoiding the obstacles, until the whole room is cleaned. It has a small brush attached to it to clean both wet and dry floor.Our proposed model is compatible with a mobile application that allows users to control and monitor the robot remotely. The app provides features such as scheduling cleaning sessions, selecting specific cleaning modes, adjusting settings, and receiving cleaning progress notifications. In future we add some functionality such as The robot can also integrate with voice assistants for convenient hands-free control.

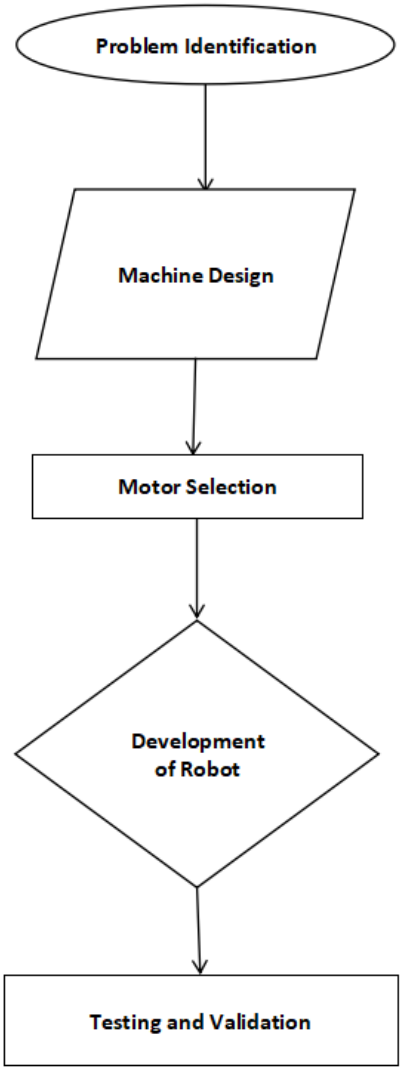

Fig. 3. Flow chart of Floor Cleaning Robot

V. EXPERIMENTAL SETUP

In our proposed Model, we build a floor cleaning robot.Ultrasonic sensor detect obstacle objects in front of it and can continue moving, avoiding the obstacles. Here, Arduino Uno play main role. We have used Arduino IDE programming language to run the system of our robot. A Bluetooth module in a floor cleaning robot allows users to remotely control and monitor the robot using a smartphone or a dedicated remote control app. Users can start or stop the cleaning process, change cleaning modes, or adjust settings from a distance. And Then, with the help of a servo motor, ultrasonic sensor moving around and detect object and keep going on. In Fig.3 we can see the circuit diagram as a experimental setup.

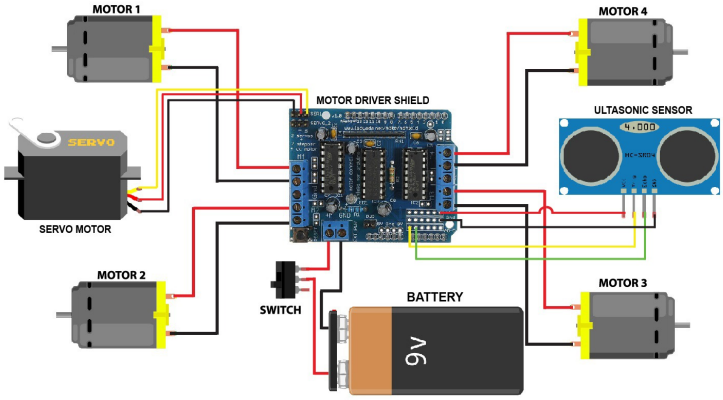

Fig. 4. Circuit Diagram

VI. MATERIALS

1. Arduino UNO: The Fig.4 shows an Arduino Uno. Arduino is an open-source electronics platform based on easy-to-use hardware and software. it is a low-cost, flexible, and easy-to-use programmable open-source microcontroller board that can be integrated into a variety of electronic projects. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. The Arduino is having the following pin configuration: There are some 28 pins for making the input and output from the Arduino board. These pins are very much helpful for the making the board do some useful work for example it can be used to take some sensor values from the sensors and make the decision based on the programming we have done on it. The board is having a ATMEGA microcontroller which is like a heart of the board.

2. ULTRASONIC SENSOR: The fig.5 shows Ultrasonic sensor emit a sound pulse that reflects of objects entering the wave field. The reflected sound, or ”echo” is then received by the sensor. Detection of the sound generates an output signal for use by an actuator, controller, or computer. The output signal can be analog or digital. Ultrasonic sensing technology

Fig. 5. Arduino UNO

Fig. 6. Ultrasonic Sensor

is based on the principle that sound has a relatively constant velocity. In this sensors are used frequently for distance measurement applications such as level control.

A special sonic transducer is used for the ultrasonic proximity sensors, which allows for alternate transmission and reception of sound waves. The sonic waves emitted by the transducer are reflected by an object and received back in the transducer sensor will switch to receive mode. The time elapsed between emitting and receiving is proportional to the object from the sensor. This sensor is most suitable for obstacle detection and it is of low cost and has high ranging capability.

3. Motor Driver L293D: The fig. 6 Motor Driver L293D is a driver board based on L293 IC, which can drive 4 DC motors and 2 stepper or Servo motors at the same time. Each channel of this module has the maximum current of 1.2A and doesn't work if the voltage is more than 25v or less than 4.5v.L293D has output current of 600mA and peak output current of 1.2A per channel [6]. Moreover for protection of circuit from back EMF output diodes are included within the IC. The output supply (VCC2) has a wide range from 4.5V to 36V, which has made L293D a best choice for DC motor driver.

The L293D IC receives signals from the microprocessor and transmits the relative signal to the motors. It has two voltage pins, one of which is used to draw current for the working of the L293D and the other is used to apply voltage to the motors.L293D IC is a typical Motor Driver IC which allows the DC motor to drive on any direction. This IC consists of 16-pins which are used to control a set of two DC motors instantaneously in any direction. It means, by using a L293D IC we can control two DC motors. As well, this IC can drive small and quiet big motors.

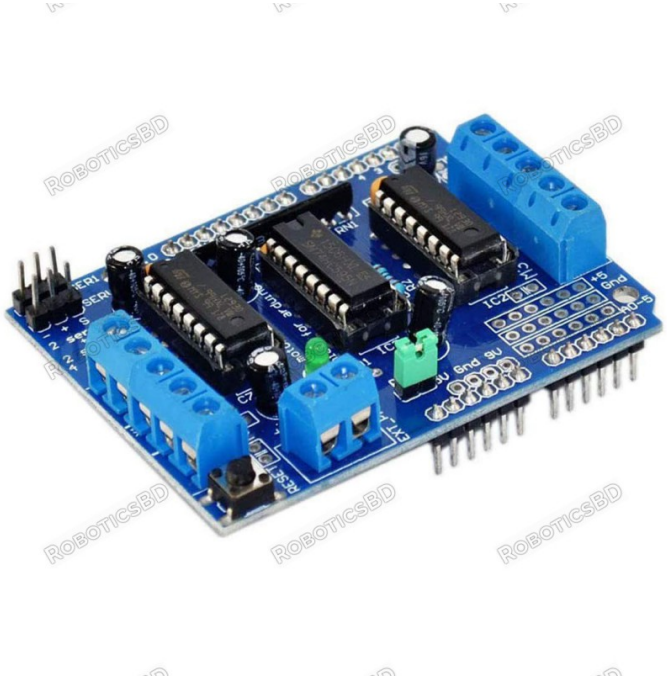

Fig. 7. Motor Driver L293D

4. DC GEAR MOTOR and WHEELS: The fig.7 shows a DC Gear Motor and Wheels. A DC motor is any of a class of rotary electrical motors that converts direct current (DC) electrical energy into mechanical energy. The most common types rely on the forces produced by induced magnetic fields due to flowing current in the coil. Nearly all types of DC motors have some internal mechanism, either electromechanical

or electronic, to periodically change the direction of current in part of the motor. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. This Gear Motor is lightweight DC geared motor which gives good torque and rpm at lower voltages. This motor can run at approximately 100 rpm when driven by a single Li-Ion cell. Great for battery operated lightweight robots. It can do reverse and forward directions. They are the magical little things that harness the power of electricity and make things move! There are 2 types of electric motors that we use regularly in our electronics kits and domestic use: DC motor and DC Geared Motor(Gear motor as referred in market terms).

Wheels are used for making robots and robotic vehicles. These Wheels can be easily coupled with Gear Motors.

Plastic Geared Motor This single shaft plastic geared motor gives good torque and rpm at lower operating voltages, which is the biggest advantage of these motors. Small shaft with matching wheels give optimized design for your application or robot.

Fig. 8. Gear Motor and Wheels

5. SERVO MOTOR A servo motor is a self-contained electrical device that moves parts of a machine with high efficiency and great precision. In simpler terms, a servo motor is a BLDC motor with a sensor for positional feedback. This allows the output shaft to be moved to a particular angle, position, and velocity that a regular motor cannot do. However, a servo motor is only one part of a closed-loop motion control system. A complete motion system includes an amplifier, control circuit, drive gears, potentiometer, shaft, and either an encoder or resolver as well as the servo motor.

Servo Motor Working Principle A servo consists of a Motor (DC or AC), a potentiometer, gear assembly, and a controlling circuit. First of all, we use gear assembly to reduce RPM and to increase torque of the motor. Say at initial position of servo motor shaft, the position of the potentiometer knob is such that there is no electrical signal generated at the output port of the potentiometer. Now an electrical signal is given to another input terminal of the error detector amplifier. Now

Fig. 9. Servo Motor

the difference between these two signals, one comes from the potentiometer and another comes from other sources, will be processed in a feedback mechanism and output will be provided in terms of error signal. This error signal acts as the input for motor and motor starts rotating. Now motor shaft is connected with the potentiometer and as the motor rotates so the potentiometer and it will generate a signal. So as the potentiometer's angular position changes, its output feedback signal changes. After sometime the position of potentiometer reaches at a position that the output of potentiometer is same as external signal provided. At this condition, there will be no output signal from the amplifier to the motor input as there is no difference between external applied signal and the signal generated at potentiometer, and in this situation motor stops rotating.

6. BLUETOOTH MODULE HC-06: The Fig.9 shows Bluetooth Module HC-06. The HC-06 is a class 2 slave Bluetooth module designed for transparent wireless serial communication. Once it is paired to a master Bluetooth device such as a PC, smartphone, and tablet, its operation becomes transparent to the user. All data received through the serial input is immediately transmitted over the air.

Arduino can communicate with other device via Bluetooth using the module HC-06 (slave). It enables the Arduino to be connected and exchange data with other devices such as Smartphone, computer or other microcontrollers.

The HC-06 Bluetooth module is permanently configured to be slave and is always in AT mode when not paired to any other device. Open Arduino IDE and go to Tools, then Serial Monitor. Set the Baud rate to 9600 and the 'line ending' to 'Both NL and CR'. Type in 'AT' without the quotes and click send.

7. 5V DC WATER PUMP : This is a low cost, small size Submersible Pump Motor which can be operated from a 2.5 6V power supply. It can take up to 120 litres per hour with very low current consumption of 220mA. Just connect tube pipe to the motor outlet, submerge it in water and power it.

8. 3.7v battery: Rechargeable lithium-ion batteries, such as the 18650 battery, boast remarkable service life when stored

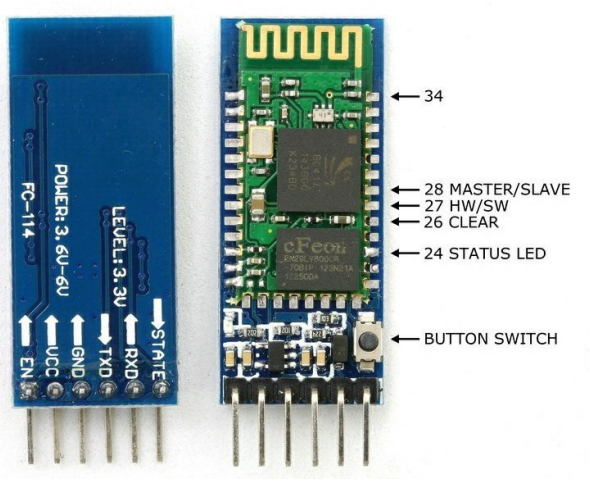

Fig. 10. Bluetooth Module HC-06

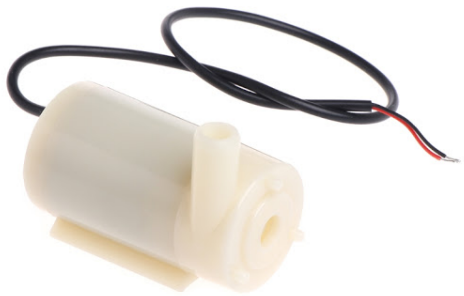

Fig. 11. 5V DC Water Pump

at 3.7V—up to 10 years with nominal loss in capacity.

Fig. 12. 3.7v battery

VII. Result and Discussion

The robot can do these basic tasks:-

- Move Forward
- Move Backward
- Turn Right
- Turn Left
- Stop (stops doing the current job)

The developed robot system with voice command,manual control, gesture recognition, and remote control capabilities has shown in Fig.13 This floor cleaning robot has two working modes. One is manual mode and other is automatic mode.In automatic mode, robot performs all control operation itself. Firstly robot starts it moves forward and perform cleaning action. Manual mode allows the users to operate the robot hardly to reach places. In autonomous mode obstacles and cliffs are not handled automatically by on board sensors and controllers.But as the user operates the robot by him in manual mode. . Overall, the system demonstrates functionality, performance, and user satisfaction, although there may be areas for improvement, such as enhancing voice and gesture recognition accuracy, addressing safety considerations, and incorporating advanced AI capabilities. The project has the potential to make a positive impact on peoplr house care, infection control, and caregiver support, and it lays the foundation for future enhancements and research in the field.

The proposed system was prototyped and tested. The system was validated using various test cases

Test Case		
Test Case Name	Test Attempts	Accuracy Results
1. Ultrasonic sensor object detection	25	99 percent
2. Water Pump	25	99 percent
3. Remote control and monitoring	25	99 percent
4. Cleaning Mechanism	25	99 percent

Test case 2 of proposed system in shown in Fig.1. Test case 1,3 and 4 of proposed system in shown in Fig 13.

We can get some benefits of this project like as:

1. One of the significant advantages of floor cleaning robots is their ability to save time.
2.Floor cleaning robots are designed to be user-friendly and easy to operate.Users can also adjust cleaning settings or select specific cleaning modes based on their preferences or the requirements of different floor.
3. Floor cleaning robots often utilize energy-efficient technologies, such as smart sensors and low-power motors.
4.Reduced Physical Strain.
5.Continuous Cleaning.

Fig. 13. Floor Cleaning Robot

VIII. Conclusion

After studying the various research papers of floor cleaning machines we have concluded that there are certain limitations in floor cleaning machines which can be worked upon. For example cleaning machines are made with an aim to clean only dry surface of the floor. This means that they are only sufficient in the summer and winter season but not in rainy season this is the major issue for cleaning the floor surface but during the rainy season floor cleaning machines are required which can perform the tasks when the surface contain moisture or little amount of water on the surface of floor. So we are developing the machine which can work in both dry and wet conditions. This machine called as dry and wet floor cleaning machine. This machine can remove the dust in summer season and also it can remove and clean the dirt, water from floor in rainy season. This robot works in two modes automatic and manual for user convenience. This proposed work provides the detection in case of any obstacle that comes in its way. An automatic water sprayer is attached which sprays water for mopping purpose for the convenience of user. User can also operate this robot manually with the help of Smartphone. It reduces the labour cost and saves time also and provides efficient cleaning. In automatic mode, the robot operates autonomously. The operations such as sweeping, mopping and changing the path in case of hurdle are performed automatically. A cheaper and user friendly automatic wet and dry floor cleaning robot can be developed with two different mode of controlling (Manual and Autonomous) using an Arduino controller with obstacle sensing functionality. With simple design and program, the cleaner will be able to cover large floor areas as well as find its way into and out of small corners easily.

Some limitations are:

i. Limited battery life, requiring frequent recharging

ii. Limited ability to clean certain types of surfaces (e.g., carpets, rugs)

iii. Difficulty in stairs and different floor heights

Future scope:

We will implement in this floor cleaning robot to add vacuum cleaner that pump the dirt and it can store easily and also Battery monitoring, self-charging. lighter body weight and to set alarm on/off time manually are the future scope of this project.

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