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# Development of Ingenious Floor Cleaner using ARDUINO

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***Abstract*: Automation has the predominant influence on renovation of most of the household tasks to modernized automated household tasks which saves labor resource by means of time. Most of the household tasks are mechanized in current scenario. Cleaning is one of the crucial and essential work. Technical improvement in computational efficiency, artificial intelligence and robotics provide a strong platform for mechanization. One such technology is ingenious floor cleaner. Ingenious floor cleaner using ARDUINO works in automatic and manual control modes along with vacuum cleaning and wet mopping exercise. In automatic mode, both sweeping and mopping, only mopping and only sweeping are possible.Arduino UNO is the widely used recognized board which pedals the entire progress. Bluetooth module HC05 assists controlling the robot in manual control and ultrasonic sensor assists for obstacle detection in automatic mode. This Ingenious floor cleaner can reach the corners of the cleaning space in effective manner. The robotic cleaners can be deployed in assisting labor in floor cleaning works at homes, hotels, restaurants, offices, hospitals etc.,***

***Keywords: Arduino UNO, Bluetooth, Ultrasonic sensors.***

## I. INTRODUCTION

Mechanization makes the household routine works to labor-saving, comfort and swift. One among the routine, laborious task is floor cleaning. Different mechanized floor cleaners are procurable in the market. Ingenious floor cleaner will have prominent merits like time efficient, convenient for people with mobility issues, etc. Various research works were published in the technology advancement in the area of embedded systems [1]-[11]. In this perspective, vacuum cleaner robot [1] is established for making sweeping process much easier. Dual mode vacuum cleaner is constructed in [2]. Smart floor cleaner – Sweepy is designed to work both in autonomous and manual controlled cleaning process which is used to facilitate and achieve the task of cleaning [3].Some floor cleaners can accomplish only sweeping. Some robotic vacuum cleaners can do mopping alone. Few robotic floor cleaners do dry and wet cleaning [5]. Robot is controlled by using Bluetooth module and as well as Smartphone based application that deals with a Smartphone accelerometer controlled differential steering algorithm is proposed in [4]. Various robotic vacuum cleaners are available in the market are overpriced and turbulent. Since the existing vacuum cleaners in the market are noisy, most of the cleaning works in the hospital like scenario are done laboriously.

The dominant objective of this work is to design and implement a prototype of noise free vacuum floor cleaner robot with water level indicator which works under two modes with the effectively to clean the corners of the rooms. In this work, a mechanism of robotic vacuum cleaner which operates in wet mopping and vacuum cleaning mode is proposed. This prototype is designed by using Arduino Mega, laser TOF sensor, servo motor, motor driver L298N, ultrasonic sensor, and vacuum suction unit and to achieve the goal of this project. This ingenious floor cleaner using Arduino which has two cleaning modes of execution namely, autonomous and manual mode. A switch is provided for user's flexibility to switch from one mode to another. Manual mode is operated via mobile phone application. In automatic mode, three special operations are included namely, mopping and sweeping, only mopping and only sweeping. The main merit of this robotic cleaner is that it can reach corners effectively. Also, low level of water in the tank is being indicated for the betterment of cleaning process.

## II. COMPONENTS REQUIRED

The hardware and software requirements for the design and implementation of ingenious floor cleaner are given below.

### A. Hardware Requirements

1. Arduino UNO
2. Bluetooth HC05
3. Ultrasonic Sensor
4. Motor driver unit
5. Geared DC motor
6. DC motor
7. Water pump motor
8. Vacuum motor
9. Servo motor
10. Power supply

### B. Arduino UNO

The whole system progress is owned by the Arduino UNO R3 microcontroller panel.

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This microcontroller is an open source board implemented on the ATmega328 chip with 14 pins dedicated for digital input/output, 6 pins available for analog input, Onboard ceramic resonator of 16 MHz, separate port for USB provision, inbuilt DC power jacket, an ICSP header and one reset button to reset the operation of microcontroller as depicted in Figure 1.

It comprises the whole thing desired to assist the microcontroller. The power supply is carefully chosen automatically either via the USB connection or from an external source

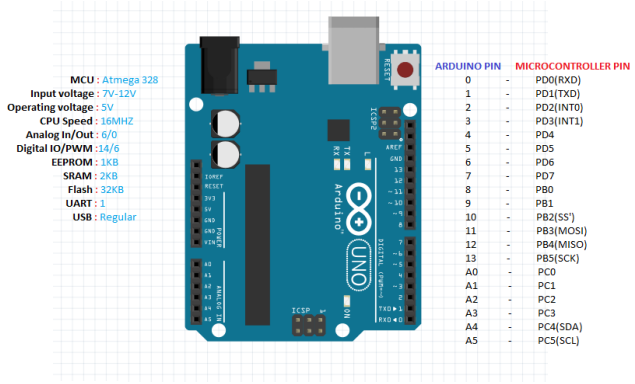


**Figure 1. The Arduino Uno R3 Microcontroller Board**

### C. Bluetooth Module

Due to its economical and salient features, HC05 Bluetooth Module which is shown in Figure 2 is opted to create Wireless Serial Communication. Bluetooth protocol adapts the MAC address of the device and establishes the connectivity between two devices using their MAC address.

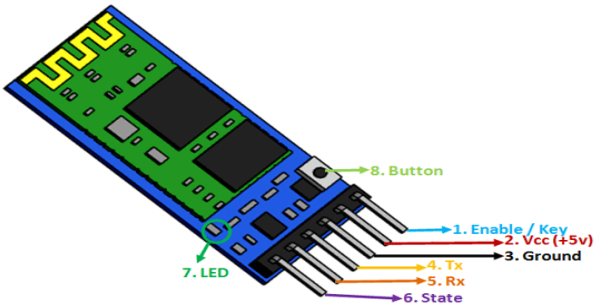


**Figure 2. The Bluetooth Module**

The emphasized technical features of HC-05 are outlined below.

- Operating Voltage and Current: 4V to 5V &30mA
- Range: <100m
- TTL companionable
- Satisfies IEEE 802.15.1
- Easily associate with laptop or mobile with Bluetooth
- Baud rate feasibility: 9600, 19200, 38400, 57600, 115200, 230400, 460800

### D. Ultrasonic Sensor

HC-SR04 Ultrasonic sensor module can be used for object detection in order to perform better cleaning of floors by using ingenious floor cleaner. More specifically it is used to measure the distance between robot and object. The sensor guides eight 40 KHz square wave pulses. These pulses will be observed if they reach air or else reflected back. The sensor automatically senses the returning signal as a high level pulse on the echo pin. The length of this pulse determines the time taken by the signal from triggering to the return echo. The sensor works by means of the formula for the measurement of the distance as given below in (1).

$$\text{Distance} = \text{Speed} \times \text{Time} \qquad (1)$$

Since the normal speed of ultrasonic signal at room nature is 330m/s, distance can be measured by the time measurement from the sensor. The circuit which is incorporated will measure the time period from trigger to return back for the ultrasonic wave. The conceptual illustration for the measurement of distance using ultrasonic sensor is depicted in Figure 3.

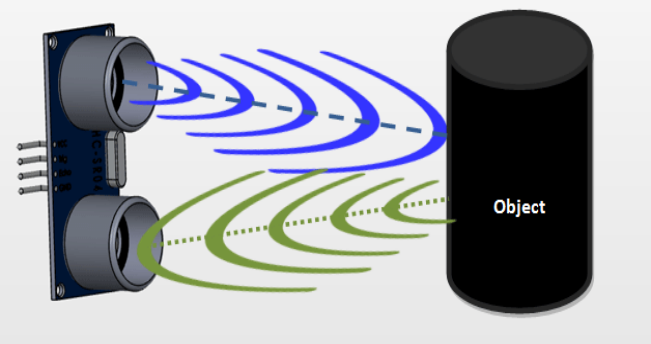


**Figure 3. Conceptual illustration for the Working of Ultrasonic Sensor**

### E. Motor Drive Module

The motor driver module in Figure 4 is designed and established based on L293D IC that permits speed control and the direction of two motors simultaneously. In this work, this driver module is used to drive wheels and mops.


**Figure 4. The Motor Driver Module**

### F. Geared DC Motor

- Operating Voltage :12V
- Speed:45RPM

These motors are available with a drill hole of 3 mm in the middle of the shaft. This is helpful to attach it to the wheels or any other mechanical units. This is used to move the wheels of the ingenious floor cleaner robot. The most dominant L298N H-bridge module with dedicated voltage regulator motor driver is used with this motor that has a voltage range between 5 and 35V DC.

### G. DC Motor

A common 12V dc motor is incorporated to drive the mops. Two DC motors are used to drive two mops. A motor driver L298N H-bridge module drives these motors.

### H. Servo Motor

Servo motor is used to change the position of the ultrasonic sensor in the ingenious floor cleaner robot which is used to identify the hurdle in its path. Tower Pro SG90 Servo-9gms Mini/Micro Motor with the following specifications is used in this ingenious floor cleaner robot.

- Operating Voltage :+5V
- Torque: 2.5kg/cm
- Rotation : 0°-180°

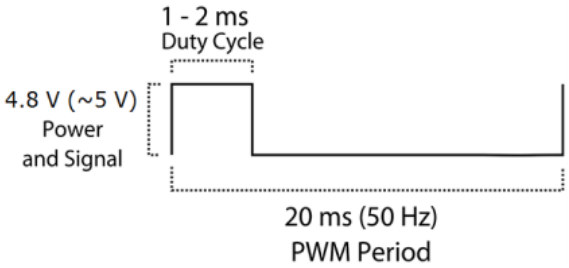


**Figure 5. Representation of the PWM signal for 20ms**

The Figure 5 depicts the PWM signal which has the Pulse width modulation period of 20 ms with a frequency of 50 Hz. The On-Time variation is from 1ms to 2ms. While the on-time is 1ms the motor rotation angle is 0°, when it is 1.5ms the motor rotation angle is 90°, and while it is 2ms motor rotation angle is 180°. Hence the motor rotation angle from 0° to 180° can be driven by on-time variation from 1ms to 2ms.

### I. Mini Submersible Pump Motor

It is very Economical, compact which is works from a voltage range of 2.5 ~ 6V and this is used in this prototype. It can suck up to 120 liters for an hour with very optimal current consumption of 220mA. Connect hose pipe to the motor outlet and submerge it in water and its being powered. At all times ensure that the water level of tank is higher than the motor unless dry run may spoil the motor because of overheating and it will also create turbulence.

### J. Vacuum Motor

A brushless DC fan blower with 12v operating range is used in this project to suck dust. AVC 9733/12V/2.4A/BA10033B12U oven exhaust blower fan violence ball depicted in Figure 6 is used in this ingenious floor cleaner robot to suck the dust.


**Figure 6. 12V DC Blower Fan**

### K. Power Supply

In order to operate the motors in the prototype two 6V, 4.5 Amps batteries are connected series to provide 12V supply. A 7805 regulator is used to provide 5V supply for Arduino board, Bluetooth module and ultrasonic sensor.

## III. SOFTWARE REQUIREMENTS

Arduino IDE, Proteus and Arduino Bluetooth Controller are the software requirements for ingenious floor cleaner.

### A. Arduino IDE

The Arduino IDE which is developed by Arduino.cc. This software is specifically used to for writing the programming code, compilation and uploading the code in the Arduino device. The Arduino IDE compatible with the languages C and C++.

### B.Proteus Design Suite

Proteus design suite which is useful to design schematics diagrams and electronic printing for the development of PCB. Proteus can be simulated with either a hex file or a debug file to the microcontroller part on the schematic and is then co-simulated with any digital and analog part interfaced to it.

### C.Arduino Bluetooth Controller

Arduino Bluetooth Controller app used to pair the android with the Bluetooth module associated to the Arduino. It permits to link in 4 different modes. Connect the Bluetooth module in controller mode. Predefined keys are dedicated with specific strings. When the specific key is pressed, the corresponding string is transmitted and the Bluetooth module connected with Arduino UNO receives the string. Remaining operations like forward and backward movement, right and left turning, mopping and sweeping are carried out by Arduino board.

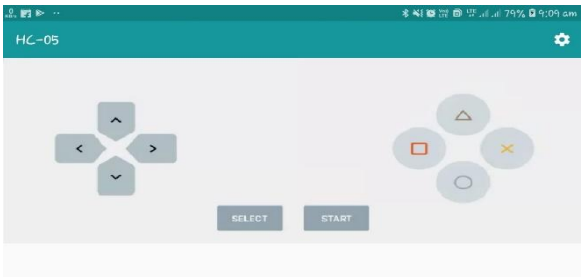


**Figure 7. Key Operations of the Arduino Bluetooth Controller App**

Key movements and its respective operations of the Arduino Bluetooth Controller app which is shown in Figure 7 are as follows:

The arrow looking upward is dedicated for forward movement, arrow looking downward is for backward movement, right arrow is for right movement, left arrow is for left movement, Triangle is for Mopping, Circle is for Stop mopping, Square is for Vacuum, Cross is for Stop vacuum and Select is for Stop.

## IV. BLOCK DIAGRAM OF INGENIOUS FLOOR CLEANER

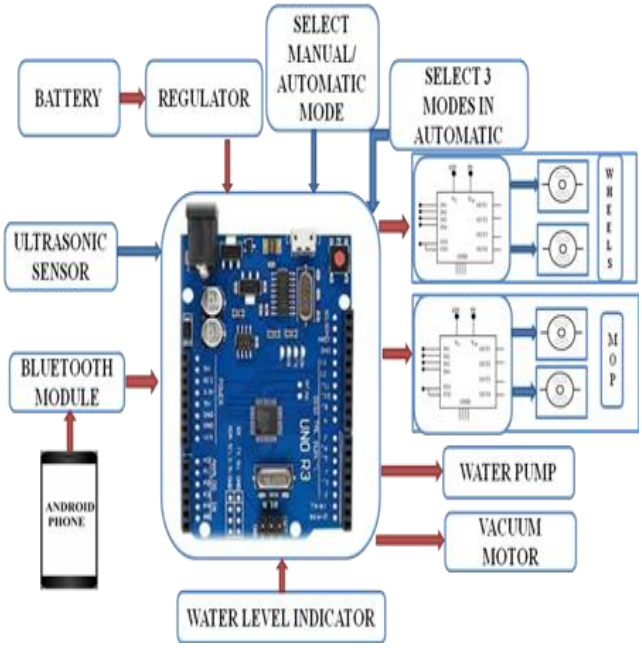


**Figure 8. Block Diagram of the Ingenious Floor Cleaner**

Block Diagram of the Ingenious Floor Cleaner is shown in Figure 8.The ingenious floor cleaner robot is designed to move freely all over the room. Arduino Uno R3 microcontroller board is interfaced with the ultrasonic sensors for the obstacle detection. Bluetooth module HC05 is interfaced to control the robotic movements. Sweeping and mopping is done as per the user's needs. The manual mode and automatic mode are selected by the user. The water pump supplies the water flow for the mopping purpose. Vacuum motor is required to suck the dust in the robot's cleaning area.

## V. METHODOLOGY

The Arduino Uno is a microcontroller board, which controls the whole process. The overall system can be operated under two modes of operation namely, human control mode and automatic mode.

### A. Human Control Mode

Human control mode can be done by means of Bluetooth sharing between the 2 devices using their MAC address. The ingenious floor cleaner robot can be manually operated using android application by pairing the mobile phone with the Bluetooth module. Different keys are pre-programmed and enabled to do many operations as per the data given. Under the human control mode, the user can operate the robot at different pattern without any constrains. Water level indication and obstacle detection are done manually by the user under the manual mode of operation.

### B. Automatic Mode

The next mode of the system operation is automatic mode of operation. Under automatic mode of operation, the robot can perform all the operations autonomously without any human support to do the needful. Ultrasonic sensor interfaced with Arduino Uno R3 microcontroller is helpful to detect the obstacle in the floor cleaning path. If the sensor detects any hurdles in its path while moving, then the robot changes its path without stopping the cleaning operation. The path of the floor cleaner is in zigzag fashion as shown in Figure 9.By this zigzag path, the robot can reach the corners efficiently and do cleaning process more effective manner. A motor driver module has been incorporated to drive the wheels of the motors and the mops at back. In the automatic mode of the ingenious floor cleaner robot there are three different operations can be performed. The three different operations of the ingenious floor cleaner robot include,

- Both sweeping and mopping
- Only sweeping
- Only mopping

These three operations can be changed through the switch provided. If the floor is highly dirty, then it needs both seeping and mopping. If the floor is with only few hand-picked dust but not with dust then it needs sweeping alone. If the floor has few tiny dust particles then it needs mopping alone. For mopping purpose water sprayer is attached to spray water automatically. A water tank is provided for water supply during the process of cleaning. There is a water level indicator that intimates about the absence of water in the tank which makes the user to check the level of water periodically.

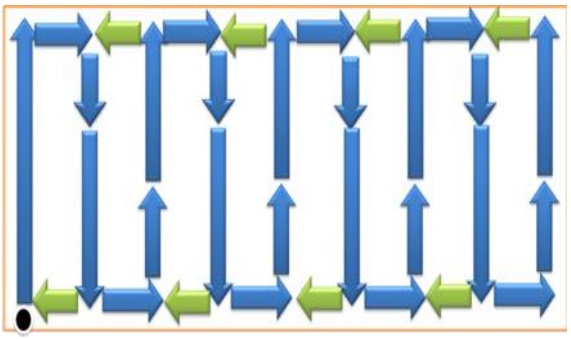

**Figure 9. Zigzag path**

## VI. PROTEUS SIMULATION RESULTS

### A. Human Control Mode

For the manual mode operation Proteus simulation is shown in Figure 10, upload the hex file in Arduino UNO library and set com port in Bluetooth HC-05 module and run the simulation.

Bluetooth module waits for the data to be received. In user's mobile, connect with the Bluetooth device and select the control mode. Click on the allotted key for specific operation. Now message will be sent to the Bluetooth module library through the specified com port. The message received by Bluetooth module is sent to Arduino module. Corresponding operation will be performed for the message from the user.

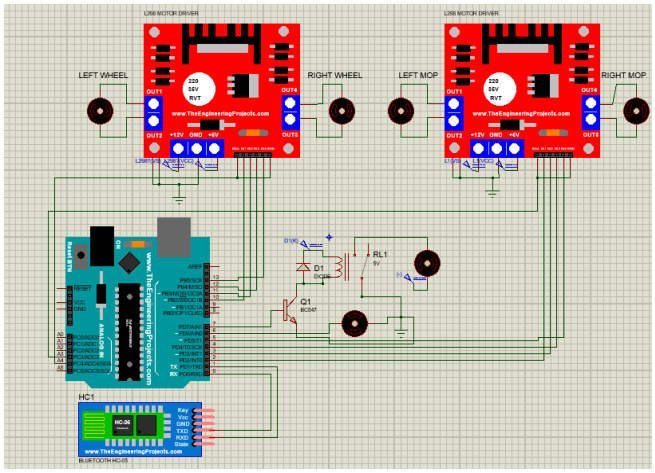


**Figure 10. Manual mode Proteus simulation**

### B. Automatic Mode

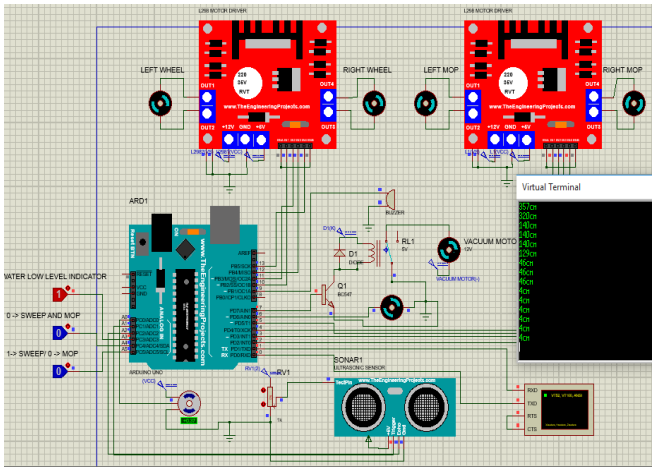


**Figure 11. Automatic mode Proteus simulation**

For automatic mode the Proteus simulation is shown in Figure 11, upload the hex file in Arduino UNO library and run the simulation. By varying the potentiometer, Ultrasonic sensor varies the time values and sends to Arduino UNO board. It calculates the distance according to the time period. Based on the distance, wheel control operation takes place automatically. Servo motor is used to change the direction of ultrasonic sensor according to the distance. By this way zigzag path is achieved. Additionally, 3 modes are changed by the switches.

- 0 to the pin A4 performs both sweeping and mopping
- 1 to the pin A4 and 0 to the pin A5 performs only mopping
- 1 to the pin A4 and 1 to the pin A5 performs only sweeping

Water level indicator is connected to the pin A3 which indicates low level presence of water. When water level goes down, buzzer will be switched on and other parts will be switched off. Figure 12 shows the Proteus simulation of both automatic mode and manual mode.

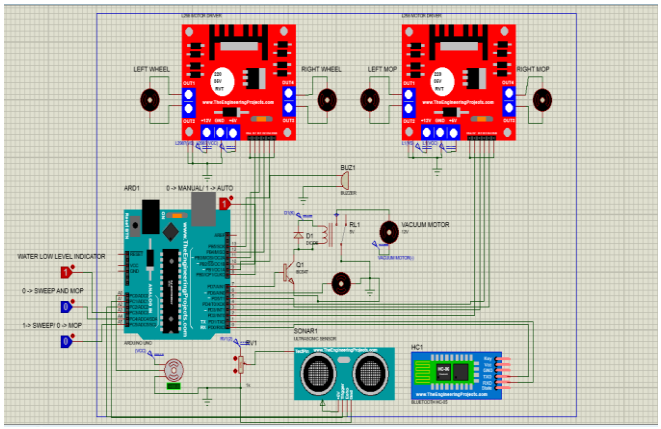


**Figure 12. Both Automatic Mode and Manual Mode Proteus Simulation**

## VII. HARDWARE IMPLEMENTATION

The ingenious floor cleaner has been designed and implemented successfully. Figure 13 shows the top view of ingenious floor cleaner and Figure 14 shows its front view.

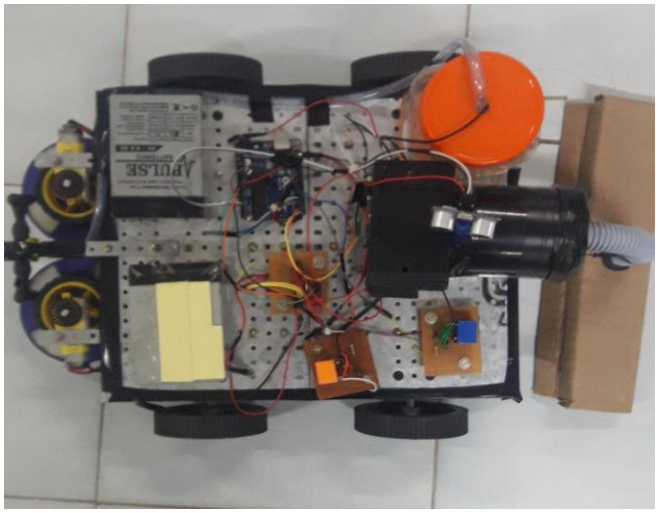

**Figure 13. Ingenious floor cleaner – Top view**

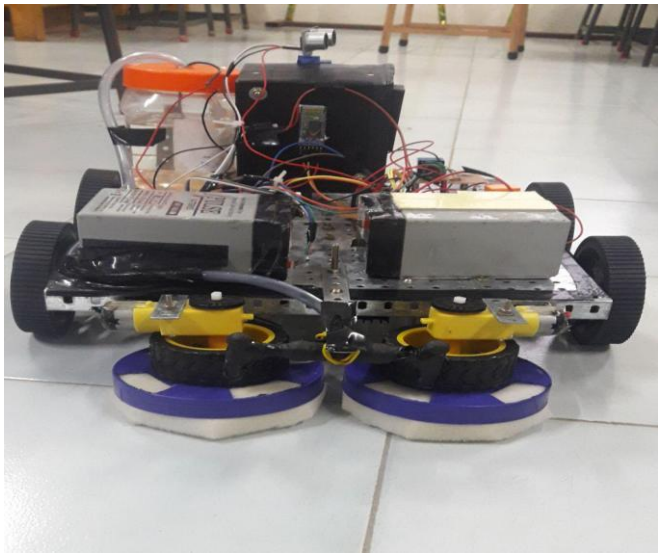

**Figure 14. Ingenious floor cleaner – Front view**

## VIII. CONCLUSION AND FUTURE SCOPE

Automation plays the major role in our daily life .since automation reduces the labor work, time and cost etc. Many automation processes in industry, hospitals and offices can be done with the help of robotics. Automating cleaning operation is one of the important process which is needed to be concentrated. This project enlightens about the advancement in vacuum cleaners. Ingenious floor cleaner operates in two modes according to the user's wish. It includes sweeping as well as mopping operations. This sweeping and mopping operation can be selected by a switch in automatic mode and in human control mode it is done through the application. This robot will efficiently reach corners. Water level indication makes this project more efficient. Advanced features like rechargeable batteries, killing disinfectant in floor using some radiation, locating the robot using GSM module can be added as a future scope. Adding floor cleaning liquid to the water in the pre calculated level may be included in future. This can be achieved by keeping the cleaning liquid tube open for a particular period. By this provision user can monitor the usage of floor cleaner liquid and wastage may be avoided. Also using fuzzy logic, stains in floor can be detected for high accuracy of cleaning.

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