Ahsanullah University of Science & Technology

Department of Computer Science & Engineering

Cleaning Robot

CSE 3216
Microcontroller Based System Design Lab

Submitted By:

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Objective: Households of today are becoming more smarter and automated. A growth is predicted and the adoption of domestic robots is evolving. Cleaning robot is a compact robotics system which provides floor cleaning service in room and big offices reducing human labor. Our robot is designed to clean floors with vacuum cleaner. The purpose of this project is to design and implement a vacuum robot autonomous and manual via mobile application. Basically as a robot it eliminates human error and provide cleaning activity with much more efficiency. If we clean the floor manually then there is a possibility that the operator will leave some portion of the floor. Also due to manual labor involved this is time consuming and irritating to clean the floor. Also in big offices floor area is very huge and the people involved there for cleaning purpose cannot clean it much more efficiently. This is where the robot comes as an advantage. Also the robot is small and compact in size. So we can carry it and place it wherever we can on the house. Also in industries the robot is very cost effective as compared to manual labor involved. The flexibility, time saving and efficiency make the robot a clean choice for cleaning the floor. People with disability can use cleaning robot as an alternative for expensive housekeeping services. Technological advancement has made robots more intelligent and they are able to detect different amount of dirt at different spots.

The technological innovation and modernization in the field of robotics, increase in demand, and smaller size of cleaning robot as compared to traditional robots are factors propelling the growth of the world cleaning robot market. However, low battery life and lack of durability robotic vacuum cleaners are hindering factors of the market. On the other hand, development of small and user-friendly robots would create opportunities for the growth in the market.

Components:

The following parts and tools are required for building this project:

Parts:

● 2x 200rpm Geared motors

 ● 2x Wheels for motors

● 1x Arduino UNO

● 1x GSM Modulo

● 1x L293D motor driver board

 ● 1x 12V Lipo 1100 MAA rechargeable battery

 ● 1x Lipo charger

- 2x TIP122 NPN power transistors

- 1x n-channel MOSFET

- Vacuum cleaner

- Male-male/ female-female/ male-female jumper wires

- Male/female headers

- Bread board

- Plywood base

Tools:

- Soldering iron solder

- Soldering paste

- Soldering Led

- Soldering stand

- Hot glue gun and glue sticks

- Pliers

- Paper cutter

- Tape

Hardware Components:

AUTOMATION: We have to automate the robot so that it will roam freely on the floor to avoid all the obstacles. We have to also provide a microcontroller in which we have to feed the code so that it will work as a brain of the robot. Also we have to give a proper power source and proper motor for regulating the sprinkling of the robot and motor driver for controlling the direction and speed of motor connected to the wheel.

Arduino UNO :

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists of other components such as crystal oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.The 14 digital input/output pins can be used as input or output pins by using pinMode(), digitalRead() and digitalWrite() functions in arduino programming. Each pin operates at 5V and can provide or receive a maximum of 40mA current, and has an internal pull-up resistor of 20-50 KOhms which are disconnected by default. Out of these 14 pins, some pins have specific functions as listed below:

- **Serial Pins 0 (Rx) and 1 (Tx):** Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.
- **External Interrupt Pins 2 and 3:** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- **PWM Pins 3, 5, 6, 9 and 11:** These pins provide an 8-bit PWM output by using analogWrite() function.
- **SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK):** These pins are used for SPI communication.
- **In-built LED Pin 13:** This pin is connected with an built-in LED, when pin 13 is HIGH – LED is on and when pin 13 is LOW, its off.
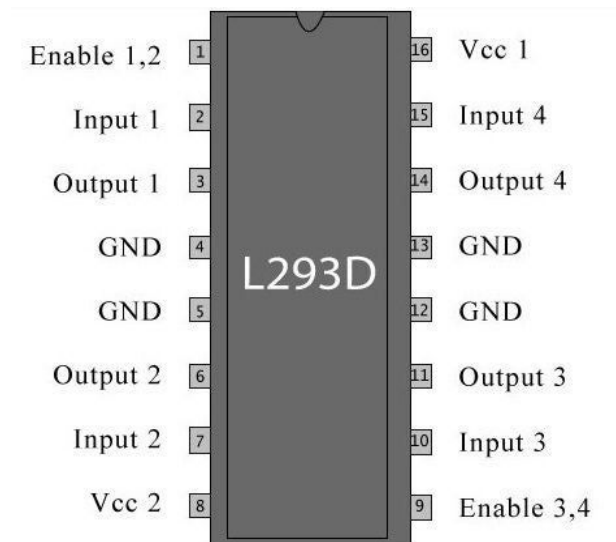
Along with 14 Digital pins, there are 6 analog input pins, each of which provide 10 bits of resolution, i.e. 1024 different values. They measure from 0 to 5 volts but this limit can be increased by using AREF pin with analog Reference() function.

Analog pin 4 (SDA) and pin 5 (SCA) also used for TWI communication using Wire library. Arduino Uno has a couple of other pins as explained below:

AREF: Used to provide reference voltage for analog inputs with analogReference() function.

Reset Pin: Making this pin LOW, resets the microcontroller.

Arduino function				Arduino function
reset	(PCINT14/RESET) PC6 □ 1	28 □ PC5 (ADC5/SCL/PCINT13)		analog input 5
digital pin 0 (RX)	(PCINT16/RXD) PD0 □ 2	27 □ PC4 (ADC4/SDA/PCINT12)		analog input 4
digital pin 1 (TX)	(PCINT17/TXD) PD1 □ 3	26 □ PC3 (ADC3/PCINT11)		analog input 3
digital pin 2	(PCINT18/INT0) PD2 □ 4	25 □ PC2 (ADC2/PCINT10)		analog input 2
digital pin 3 (PWM)	(PCINT19/OC2B/INT1) PD3 □ 5	24 □ PC1 (ADC1/PCINT9)		analog input 1
digital pin 4	(PCINT20/XCK/T0) PD4 □ 6	23 □ PC0 (ADC0/PCINT8)		analog input 0
VCC	VCC □ 7	22 □ GND		GND
GND	GND □ 8	21 □ AREF		analog reference
crystal	(PCINT6/XTAL1/TOSC1) PB6 □ 9	20 □ AVCC		VCC
crystal	(PCINT7/XTAL2/TOSC2) PB7 □ 10	19 □ PB5 (SCK/PCINT5)		digital pin 13
digital pin 5 (PWM)	(PCINT21/OC0B/T1) PD5 □ 11	18 □ PB4 (MISO/PCINT4)		digital pin 12
digital pin 6 (PWM)	(PCINT22/OC0A/AIN0) PD6 □ 12	17 □ PB3 (MOSI/OC2A/PCINT3)		digital pin 11(PWM)
digital pin 7	(PCINT23/AIN1) PD7 □ 13	16 □ PB2 (SS/OC1B/PCINT2)		digital pin 10 (PWM)
digital pin 8	(PCINT0/CLKO/ICP1) PB0 □ 14	15 □ PB1 (OC1A/PCINT1)		digital pin 9 (PWM)

Digital Pins 11,12 & 13 are used by the ICSP header for MOSI, MISO, SCK connections (Atmega168 pins 17,18 & 19). Avoid low-impedance loads on these pins when using the ICSP header.

Figure: Arduino Uno pin diagram

Motor Driving IC L239D:

A motor driver is an integrated circuit chip which is usually used to control motors in autonomous robots. Motor driver act as an interface between Arduino and the motors . The most commonly used motor driver IC's are from the L293 series such as L293D, L293NE, etc. These ICs are designed to control 2 DC motors simultaneously. L293D consist of two H-bridge. H-bridge is the simplest circuit for controlling a low current rated motor. We will be referring the motor driver IC as L293D only. L293D has 16 pins.

a)Four H-Bridges: Two L293D Motor driver chips

b) L293D is rated at 0.65A per bridge (1.20A peak) with thermal shutdown protection, Motor Voltages from 4.5VDC to 16VDC. (up to 36V if C6 and C7 are upgraded)

c) Up to 4 bi-directional DC motors with individual 8-bit speed selection (256 speeds)

d) Up to 2 stepper motors (unipolar or bipolar)

e) Pull down resistors keep motors disabled during power-up

 f) Separate Logic and Motor power connections

g) Terminal block connectors for motors and power

h) 2 connections for 5V 'hobby' servos

Pin No. - Pin Characteristics

- 1 - Enable 1-2, when this is HIGH the left part of the IC will work and when it is low the left part won't work.

- 2 - INPUT 1, when this pin is HIGH the current will flow though output 1

- 3 - OUTPUT 1, this pin should be connected to one of the terminal of motor

- 4,5 - GND, ground pins

- 6 - OUTPUT 2, this pin should be connected to one of the terminal of motor

- 7 - INPUT 2, when this pin is HIGH the current will flow though output 2

- 8 - VCC2, this is the voltage which will be supplied to the motor.

- 16 - VCC1, this is the power source to the IC. So, this pin should be supplied with 5 V

- 15 - INPUT 4, when this pin is HIGH the current will flow though output 4

- 14 - OUTPUT 4, this pin should be connected to one of the terminal of motor

- 13,12 - GND, ground pins

- 11 - OUTPUT 3, this pin should be connected to one of the terminal of motor

- 10 - INPUT 3, when this pin is HIGH the current will flow though output 3

- 9 - Enable 3-4, when this is HIGH the right part of the IC will work and when it is low the right part won't work.

POWER SUPPLY: It requires 12 volt dc in order to provide regulated 12V dc voltage to controller use 7805 power supply circuit here two batteries of 9V are used one is to run the motor and the other is give as power supply circuit.

Microcontroller:

Microcontroller is the brain of robot where program is written and sensors are connected as input and actuators as output. The controlling of the robot is governed by various algorithms like fuzzy controller, machine learning based practices and artificial neural network based algorithms. Depending upon the environment value received to the controller it eliminates the error and transits from one state to another. Basically there are two types of controllers ,one is continuous controller and another is PID based controller .Continuous controller is more direct and less effective while PID controller is more advanced and varies according to the current state and gives efficient result.

Motor Driver:

L293D is a typical Motor driver or Motor Driver IC which allows DC motor to drive on either direction. L293D is a 16-pin IC which can control a set of two DC motors simultaneously in any direction. It means that you can control two DC motor with a single L293D IC. Dual H-bridge Motor Driver integrated circuit(IC).

There are 4 input pins for l293d, pin 2,7 on the left and pin 15 ,10 on the right as shown on the pin diagram. Left input pins will regulate the rotation of motor connected across left side and right input for motor on the right hand side. The motors are rotated on the basis of the inputs provided across the input pins as LOGIC 0 or LOGIC 1.

In simple we need to provide Logic 0 or 1 across the input pins for rotating the motor.

Let's consider a Motor connected on left side output pins (pin 3,6). For rotating the motor in a clockwise direction the input pins has to be provided with Logic 1 and Logic 0.

• Pin 2 = Logic 1 and Pin 7 = Logic 0 | Clockwise Direction

• Pin 2 = Logic 0 and Pin 7 = Logic 1 | Anticlockwise Direction

• Pin 2 = Logic 0 and Pin 7 = Logic 0 | Idle [No rotation] [Hi-Impedance state]

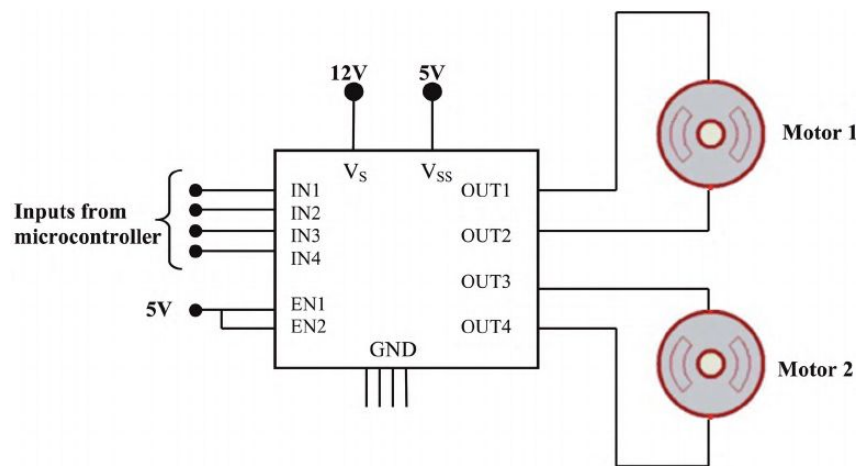• Pin 2 = Logic 1 and Pin 7 = Logic 1 | Idle [No rotation]

Figure:I293D Motor Driver

DC Gear Motor:

A gear motor is an all-in-one combination of a motor and gearbox. The addition of a gear head to a motor reduces the speed while increasing the torque output. The most important parameters in regards to gear motors are speed (rpm), torque (lb-in) and efficiency (%). In order to select the most suitable gear motor for your application you must first compute the load, speed and torque requirements for your application. ISL Products offers a variety of Spur Gear Motors, Planetary Gear Motors and Worm Gear Motors to meet all application requirements. Most of our DC motors can be complimented with one of our unique gearheads, providing you with a highly efficient gear motor solution.
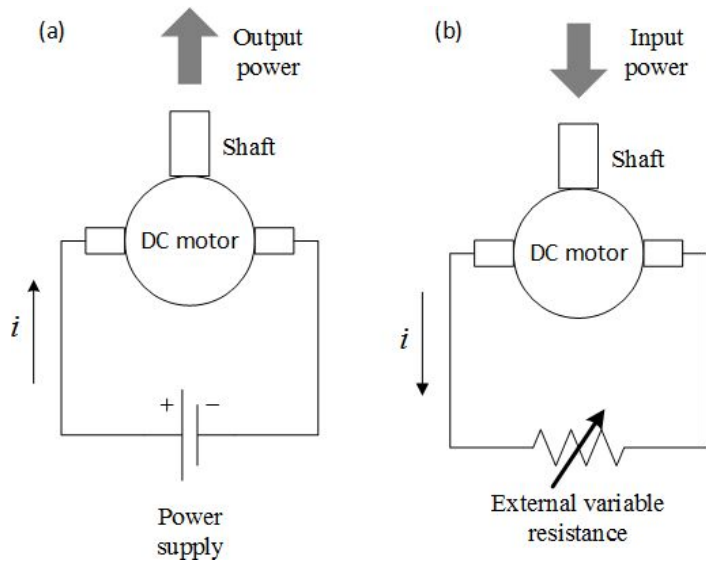
Figure: DC gear motor

GSM Modulo:

GSM (Global System for Mobile) / GPRS (General Packet Radio Service) TTL-Modem is SIM900 Quad-band GSM / GPRS device, works on frequencies 850 MHZ, 900 MHZ, 1800 MHZ and 1900 MHZ. It is very compact in size and easy to use as plug in GSM Modem. The Modem is designed with 3V3 and 5VDC TTLinterfacing circuitry, which allows User to directly interface with 5V Microcontrollers (PIC, AVR, Arduino, 8051, etc.) as well as 3V3 Microcontrollers (ARM, ARM Cortex XX, etc.). The baud rate can be configurable from 9600- 115200 bps through AT (Attention) commands. This GSM/GPRS TTL Modem has internal TCP/IPstack to enable User to connect with internet through GPRS feature. It is suitable for SMS as well as DATAtransfer application in mobile phone to mobile phone interface. The modem can be interfaced with a Microcontroller using USART (Universal Synchronous Asynchronous Receiver and Transmitter) feature (serial communication).
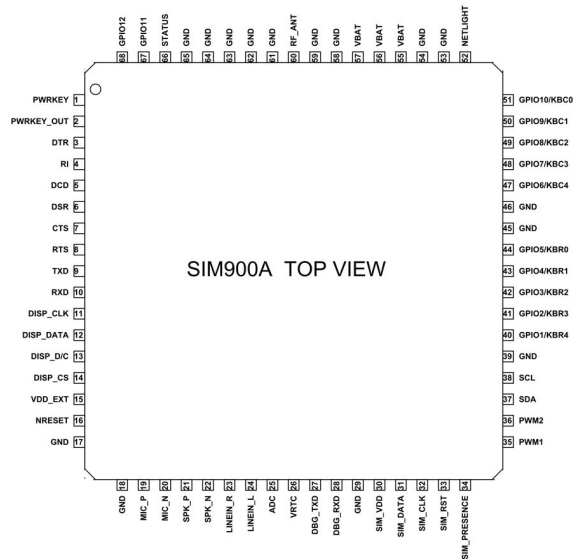
Figure: GSM Modulo

BreadBoard: A breadboard is a solderless device for temporary prototype with electronics and test circuit designs. Most electronic components in electronic circuits can be interconnected by inserting their leads or terminals into the holes and then making connections through wires where appropriate. The breadboard has strips of metal underneath the board and connect the holes on the top of the board.

Figure: BreadBoard

2N6660:

2N6660 is an enhancement-mode (normally-off) transistor that utilizes a vertical DMOS structure and a well proven silicon-gate manufacturing process. This combination produces a device with the power-handling capabilities of bipolar transistors, and the high input impedance

and positive temperature coefficient inherent in MOS devices. Characteristic of all MOS structures, this device free from thermal runaway and thermally-induced secondary breakdown. Vertical DMOS FETs are ideally suited to a wide range of switching and amplifying applications where very low threshold voltage, high breakdown voltage, high input impedance, low-input capacitance, and fast switching speeds are desired.
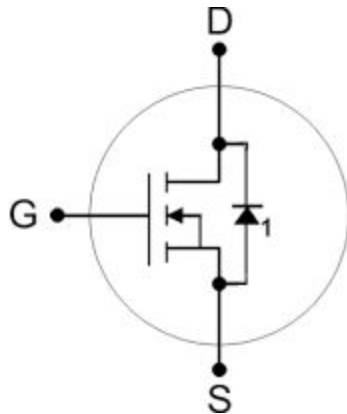
Figure: 2n6660 Mosfet

Vacuum Cleaner : vacuum cleaner, also known simply as a vacuum, is a device that causes suction in order to remove debris from floors, upholstery, draperies and other surfaces. It is generally electrically driven. The dirt is collected by either a dustbag or a cyclone for later disposal. Vacuum cleaners, which are used in homes as well as in industry, exist in a variety of sizes and models—small battery-powered hand-held devices, wheeled canister models for home use, domestic central vacuum cleaners, huge stationary industrial appliances that can handle several hundred litres of dust before being emptied, and self-propelled vacuum trucks for recovery of large spills or removal of contaminated soil. Specialized shop vacuums can be used to suck up both dust and liquids.

Figure:Vacuum Cleaner

Rechargeable Battery:

A battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices such as flashlights, mobile phones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode.

Software Components:

Arduino: Arduino is an open-source electronics platform based on easy-to-use hardware and software. 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. You can tell your board what to do by sending a set of instructions to the microcontroller on the board.

Proteus Design Suite: The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

Description Of Equipment:

This system demonstrate the GSM controlled robot car that can be used for cleaning purpose. The car can be controlled by sending messages as instructions from mobile phones.
The system is built based on arduino platform as the decision making task is to be performed by microcontroller. The arduino platform is then connected with other peripherals to perform certain task.

GSM Module: The GSM module is directly connected to the arduino to send and receive data. The GSM send and receive data that is sent from the mobile phone. When a message is received, it is stored in some location of SIM. This data is then read by the arduino microcontroller and processed to control the robot car.

Motor Driver: Motor driver is connected to the arduino platform and with which dc gear motors are interfaced. As arduino pins can not provide sufficient current to run the motors, motor driver

is used to drive the motor with sufficient current as per the instructions received from the arduino microcontroller.

DC Gear Motors: DC gear motors are connected with the motor driver to provide mechanical energy to move the robot car. The motor can be rotated in either direction and to change the direction of the car and speed was controlled using PWM control of arduino.

Vacuum Cleaner: Vacuum cleaner is connected through a n-channel MOSFET to be driven with high current. As arduino pin can not supply high current a MOSFET is used to run the vacuum cleaner as per the instruction from the arduino microcontroller.

Design:
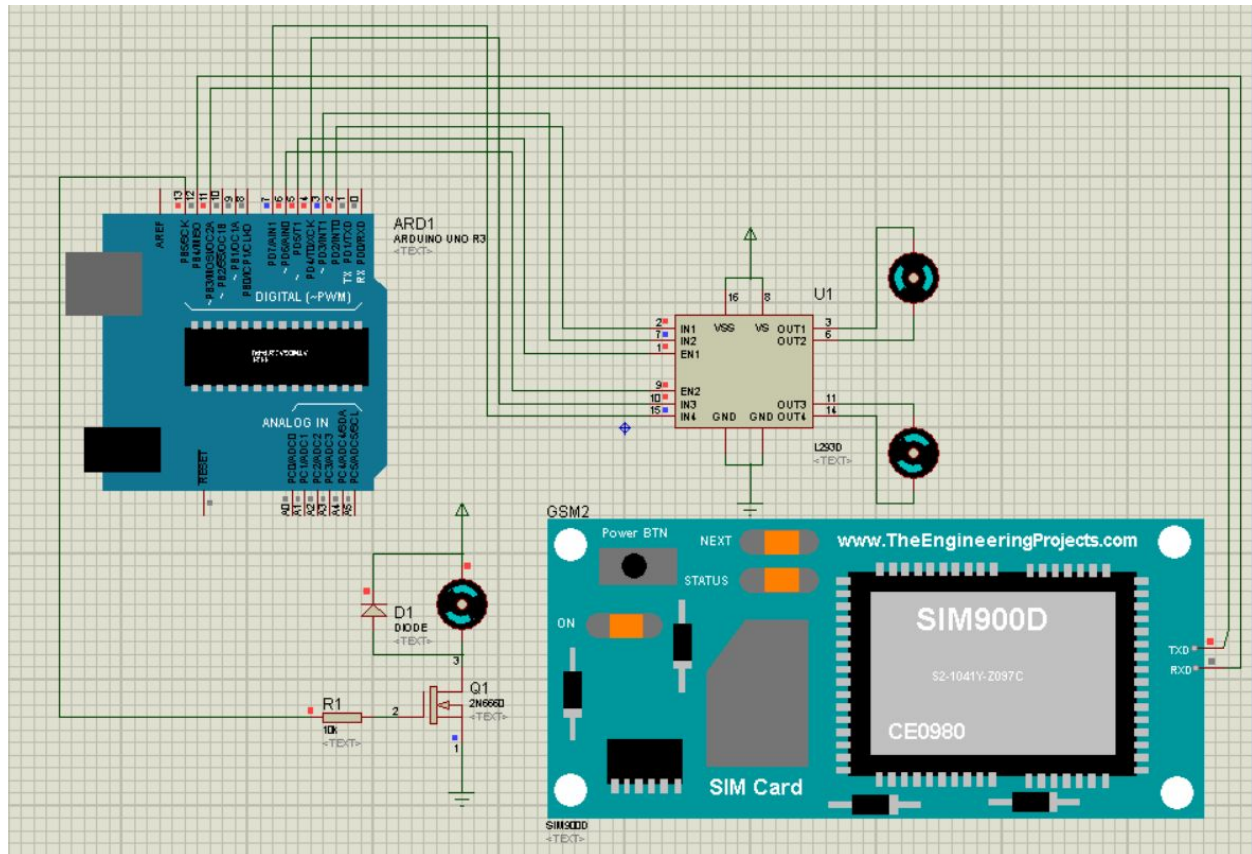
Figure: Diagram in Proteus

Society Purpose:

With the society becoming more dependent on technical equipment, the use of hardware is increasing for every aspect. If we look closely at our day to day life at home , we will see that much time,energy and money is consumed by cleaning process. This "Cleaning Robot" will make the task easier for all the people.

1. No Need for Manual Operation

If we suffer from mobility issues or physical ailments, a robot vacuum is the perfect cleaning device for us. Not only does it improve your cleaning routine, but it does so without putting in any extra strain on you or your situation. Simply turn it on and let it clean.

Robotic vacuums are also great for elderly individuals who may be suffering from arthritis or joint pain. Many of these vacuums can be preset to clean when needed, and they typically require very little maintenance.

2. No Time, No Problem

In our busy and, oftentimes, overwhelming world, the majority of consumers are charged with the task of raising families, building a career, and maintaining an active social life. These daily activities, obviously, take precedence over cleaning, which in turn creates a pressing need for a quick and convenient way to vacuum.

Since robotic vacuums can clean on their own without any supervision, they can save you an astonishing amount of time. This is the perfect vacuum cleaner for all the busy folks. Because we don't have to oversee these devices, we can turn them on before we leave the house. This allows us to devote more time to activities that we love and enjoy, yet still come home to a clean home.

3. Automatically Adjusts to Different Surfaces

Different floor surfaces require different vacuum settings. This is why many robot vacuums are equipped with sensors that detect changes in floor surfaces. There is no need to think about carpet, wood, and tile when you use these machines; they automatically adjust.

4. Can Clean When We Aren't Home

Now we can, with a bit of help from a robotic vacuum. While we already discussed how it can help those with little time for vacuuming, it's worth pointing out that some robot vacuums can be programmed to automatically start cleaning at specified times of the day.

Aside from the initial set up, we are completely hands-off. This can be especially helpful during vacations, business trips, and other occasions where we will be away from home for extended

periods of time. This is one of the main reasons why we should consider buying a robot vacuum.

5. Low Maintenance

When compared to manual vacuums, robotic vacuum cleaners require only a minimal amount of maintenance. These machines are typically constructed of higher quality materials and are built to serve you for years to come.

Our only job is to periodically replace the bag or empty the container, as well as keep our floor clear of clutter and other potentially damaging objects. These are the only two maintenance tasks that we will be required to perform during the life of your machine.

6. Fits Into Tight Spaces

Many consumers complain about not being able to vacuum in hard-to-reach or tight spaces, but once you purchase a robotic vacuum, this problem will disappear completely. Due to their compact size, robotic vacuums can clean smaller spaces that are typically off-limits to manual vacuums.

These areas include all of the corners, nooks, and crannies that your traditional vacuum may not be able to get to without using an extension of some kind. When you employ a robot vacuum, your floors will receive an extensive and thorough cleaning in a relatively short period of time.

7. Other Benefits

Robotic vacuums, especially the more expensive models, offer a wealth of benefits to consumers. Many of these models claim to offer better cleaning features than traditional models. A few of these technologically-advanced features include:

- **Longer Life-Span:**
  Because they require less maintenance, robot vacuums have a reputation of lasting longer than other types of vacuums. This won't always be the case, as some brands and models are better than others. But as a whole, these units will last for a long duration of time.
- **Smart Home Connectivity:**
  Just like the majority of smart home appliances, many robot vacuums have the ability to stay connected to our home, allowing us to control it remotely with a smartphone or tablet.

Future Scope:

Robotics vacuum cleaners have been produced for a few years now, but the technology of these devices is still developing rapidly. Many companies are trying to improve the sale of robotic vacuum cleaners and expect the sale ratings to rise in the future.

It is certain that things will change in the future. For a better applications, changes have to be considered as well as made too. If possible, we will design a new vacuum cleaner in the near future. In this section changes in the environment, technology and economy are predicted.

- Robotics vacuum cleaners are the subject of our discussion today, focused on the technology impacting the cleaning sector and the future of cleaning itself. Multinational corporations are currently releasing various robotic vacuum cleaners, that is honestly appears large, clumsy and slightly like mini spaceships. However, we cannot criticise the innovation that has the potential to completely change the face of the cleaning industry and our role within it.
- The future of robotics function does not simply lies in new hoovers. Robotics may shift into our everyday cleaning task, possibly cleaning our homes and folding our clothes.
- Smart cleaning technology is also changing the industry, implementing new equipment to help achieve the best clean and hygiene. These methods may also be better for the environment, reducing water and chemical usage. Accuracy may be strengthened, labour productivity and safety standard raised.
- We will also be able to use the same vacuum for house cleaning as well as cleaning outside of it.
- In a few years , we could set a vacuum cleaner to do its job while we are on vacation thousands of miles away.

Procedure In Details:
- The GSM module was connected to the arduino through tx and rx pin of GSM module with pin 10 and 11 of arduino. As SoftwareSerial.h library allow to connect except the tx and rx of arduino.
- The input pins of the motor driver were connected with the arduino and the output pins were connected to the dc gear motors. EN1 and EN2 pins were connected with the arduino PWM pins 5 and 6 respectively. IN1, IN2, IN3 and IN4 were connected with arduino pin 2, 3, 4 and 7 respectively.
- The output pins of motor driver OUT1 and OUT2 were connected to the terminals of the left hand side motor and the OUT3 and OUT4 were connected to the terminals of right hand side motor.
- To control the vacuum cleaner, a n-channel MOSFET was connected with the arduino microcontroller. The gate of the MOSFET was connected with pin 13 of the arduino. The vacuum cleaner was connected with the drain terminal and a free-wheeling diode connected parallel to the vacuum cleaner.
- Then the arduino, GSM module, motor driver and MOSFET was energized with external power supply and the robot is driven by two high speed motors with gears.

- To receive the serial data from the GSM module SoftwareSerial.h library was used. The message from the GSM was received byte wise and stored in a sting.
- As per the information stored in the string, the motor was driven sending information from arduino through the motor driver to the motor.
- The vacuum cleaner was controlled by sending instructions from arduino to the MOSFET. Then the vacuum cleaner was driven by the MOSFET with high current.
- A arduino program was implemented to receive the message using GSM module and to control the robot car as per the information of the message.
- The cleaning performance of our robot was tested on a smooth floor where there was floor some dry waste and the floor was efficiently cleaned within some moments.
- It should be noted that the robot was built to stay very close to ground to enable more suction and detect small obstacle. Any obstacle that could not be detected must be higher than 1.5cm which is essentially not a threat to the robot navigation.

- To control the car , we need to send message .Here are the instructions:

- F: Forward
- B : Backward
- S: Stop
- L: Left
- R: Right
- C: Clean

  After configuring the buttons if we press specific buttons the robot will move.

- Forward: Pressing 'F' button will make the robot go forward direction. The left and right motors will get HIGH on their positive connected pins and move forward. The negative pins will get LOW voltage.
- Backward: Pressing 'B' button will make the robot go on Reverse direction. The left and right motors will get LOW on their positive connected pins and HIGH on negative pins which will make them go on reverse direction.
- Stop: If we press the stop button the robot will stop moving. The motors will get LOW on their pins and the motors will stop.
- Left: After pressing the 'L' button the robot will go on the left side with the right side motors moving on forward direction and left side motor won't move. For this, Left motors will get LOW on their pins while right motor will get HIGH on positive pin.
- Right: After pressing the 'R' button the robot will go on the right side with the left side motors moving on forward direction and right side motor won't move. For this, right motors will get LOW on their pins while left motor will get HIGH on positive pin.
- Clean:After Pressing the 'C' button the robot will start cleaning the floor with vacuum . For this, we will make the vacuum pin HIGH .

Budget:

| Equipment	Quantity	Rate(In taka)	Price (In taka)
200rpm Geared motors	2	300	600
Wheels for motors	2	70	140
150rpm Plastic geared motors and wheels	1	50	50
Arduino UNO	1	750	750
L293D motor driver board	1	150	150
12V Lipo 1100 MAA rechargeable battery	1	1000	1000
GSM Module	1	2500	2500
Soldering iron solder	1	150	150
Hot glue gun	1	250	250
Breadboard	2	50	50
Glue sticks	2	20	40
Male/female headers	1	20	20
Male-male/ female-female/ male-female jumper wires	80	3	240
USB Vacuum Cleaner	1	800	800

Total cost of the parts: 6440 Taka

Contribution:

In our group, there are four team members who were participated in this project development activities. Each team member of our group try to improve skills and technical competence to increase the probability of project deliverables in the context of decreasing cost , improving

quality and productivity.The skills and competencies of each group member helps a lot to perform the project work more efficiently. During our project work, we also tried to reduce our staff turnover.   We also defined times in which team members could participate in project development activities. The full project work was done equally by our four group members and we try to improve our team cohesiveness which contributes to an increased level of the overall project performance. Moreover, all the team members tried to focus on performing the project work as a team and during this time we work as synergy.

Members Contribution

16.02.04.028
27.0%

16.02.04.015
22.0%

16.02.04.022
22.0%

16.02.04.025
29.0%
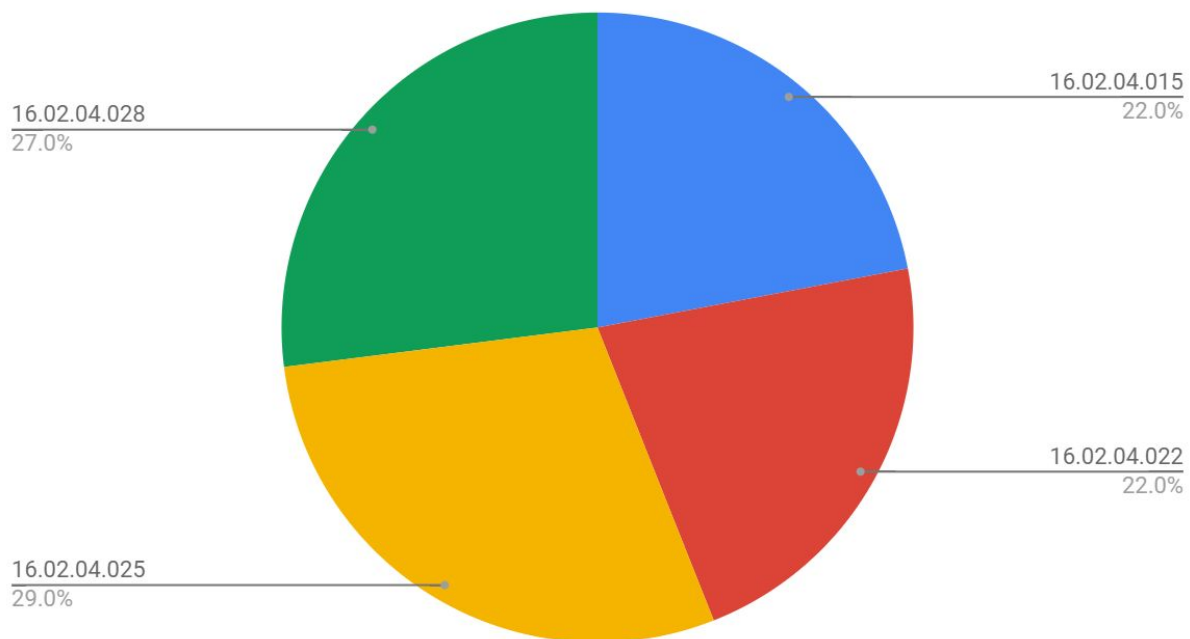
Conclusion:
The Product developed is definitely a very important product in robotics and floor cleaning area .The robots developed uses vacuum cleaner which ultimately provides lots of vibration and power loss in the system.There is definitely current scope for improvement and optimization till the most effective product is being developed. Definitely it has very huge potential. Also we can use 1 vacuum pump instead of two so that it will be cost effective and very energy saving product with less vibration and much control over the robot. This is also very handy in portability. 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.