CHAPTER 1

AIM / OBJECTIVE OF THE PROJECT

1. AIM / OBJECTIVE OF THE PROJECT

The aim of our project is that robot should climb on wall as well as on ceiling with the help of suction motor and geared motors. The control of the robot will be wireless using Bluetooth technology and the camera mounted on the robot should send video signals to pc/control room wirelessly so that it can be used for surveillance purpose.

The objective of our project is to control four DC geared Motors using Arduino and it's Bluetooth shield. The control of the suction motor is independent using PWM and frequency controller circuit so that if once the suction motor starts it can't be stopped wirelessly.

As voltage and current requirement of dc geared motors are 12 volts and up to 800mA respectively thus there is need of introducing driver IC L293D between Arduino and motors to control geared motors.

The 1035 gram robot can carry 150 grams additional weight with it.

CHAPTER 2

LITERATURE SURVEY

2. LITERATURE SURVEY

The technique of climbing in the wall by robots was invented in 90's by Japan. In those days these robots were used for the purpose of cleaning ship-hull, fire brigades, inspection. But due to its less adhesion capacity it could not be used in large scale. SRI presented an overview of its electro adhesion technology at the IEEE International Conference on Robotics and Automation (ICRA), May 23, 2008 at the Pasadena Conference Center in Pasadena, Calif. In 2009 , Ross Miller invented an Rock-climbing-Axel rover which was capable of climbing in almost on any kind of rocks on other planets. He did his research in NASA. Development of a wall-climbing robot using a tracked wheel mechanism. Hwang Kim, Dongmok Kim, Hojoon Yang, Kyouhee Lee, Kunchan Seo,Doyoung Chang and Jongwon Kim* *School of Mechanical and Aerospace Engineering, Seoul National University.* Even in India research is done on wall climbing robot and a stair-case climbing robot is produced which is capable of remote diffusion of bombs.

CHAPTER 3

INTRODUCTION

3. INTRODUCTION

Since the end of the 80's, wall climbing robots were examined for different types of application scenarios all over the world. At the end of the 80's and the beginning of the 90's in Japan several national projects concerning climbing robots for specific application scenarios have been developed. These include cleaning robots for glass walls, ship hull cleaning robots, rescue robots for fire brigades, inspection robots for tanks and walls. Most of the developments were stopped because there still exists adhesion problems. Also the cost for the development of such machines were too high. At the end of the 90's mainly in Europe, several different prototype machines have been developed for different types of applications like the inspection of pipes and ducts in the petrochemical industry, maintenance and inspection work in the construction and nuclear industry or cleaning robots for huge glass walls.

This project is a Arduino based wall climbing robot which can be controlled using wireless remote PC(Bluetooth technology). The main aim is to control the movements of robot during its climb on wall, and to send video signals form camera mounted on robot to control room with the help of wireless technology. This robot can easily climb on plane as well as rough walls.

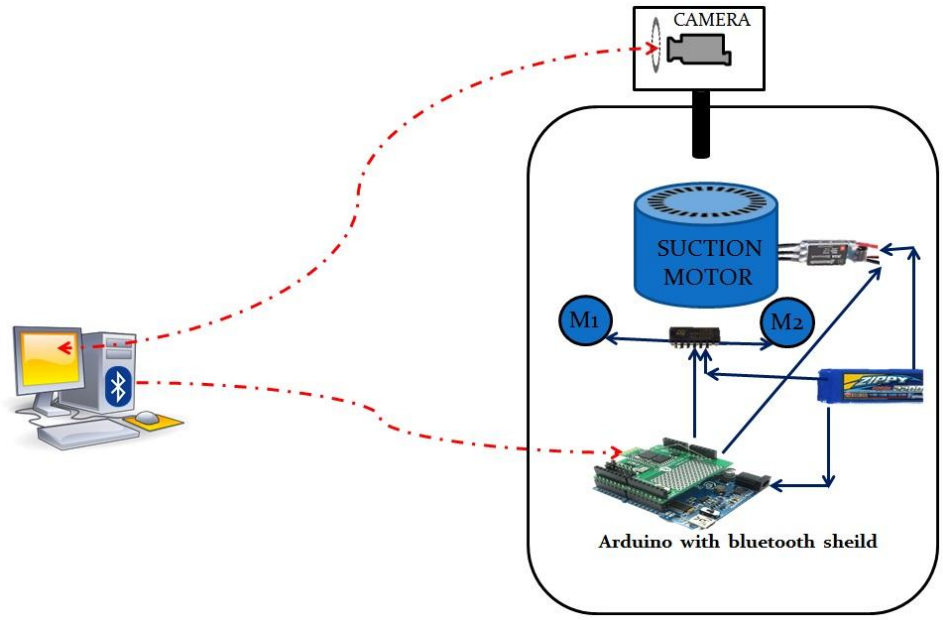


Fig 3.1

- The robot is assembling of 1 suction motor which is at centre, 4 geared motors, Arduino kit with it's Bluetooth sheild, L293D circuit, Lipo battery, 30 Amp ESC, kit of 555 and camera.
- The Arduino Bluetooth sheild communicates with the computer Bluetooth and passon the signals to Arduino.
- Arduino read that signal and send corresponding control signals to L293D motor driver and then motors run accordingly.
- 12 Volt, 2200mAh Lipo battery is used to provide power to all the circuits.
- The module of camera is independent of other circuits and it directly communicates with the pc to send video signals.
- The 555 circuit is used to control the ESC (motor speed) by varying frequency and PWM signal.

CHAPTER 4

EXPLANATION OF PROJECT

4. EXPLANATION OF PROJECT

This project is smart assembling of 3 different projects.

i. Climbing of robot on the wall

ii. wireless control of robot and

iii. Wireless video transmission from robot to pc/ control room.

4.1 CLIMBING OF ROBOT ON THE WALL

4.1.1 CONCEPT OF ADHESION

Suction motor is used for sticking purpose. The vacuum motor works on the **Bernoulli's principle**.

Principle:

Bernoulli's principle states that, "for an in viscid flow, an increase in the speed of the fluid occurs simultaneously with a decrease in pressure or a decrease in the fluid's potential energy."

Bernoulli's equation can be generalized as:

$$\tfrac{1}{2}\rho v^2 + \rho g z + p = \text{constant}$$

Where,

$q = \tfrac{1}{2}\rho v^2$ = kinetic energy per unit volume

ρ g z = Potential energy per unit volume

P = Pressure energy

Further this equation leads to the equation:

P.V= Constant

Where, P= pressure and V= velocity.

Thus with increase in velocity there is automatic decrease in pressure.

4.1.1.1 Mechanical structure for adhesion

The outer part of the suction motor i.e. exhaust inner circumference never touches the wall and always be at a distance of 5-7mm so it can create a very powerful low pressure vortex when fan starts. Due to this low pressure vortex a force from high pressure to low pressure is generated which acts directly perpendicular towards the wall. This force becomes the sticky force for the wall climbing robot.

Suction motor is assembly of 3 things.

a. 3800KV brushless DC motor
b. 64mm ducted fan
c. Cylindrical exhaust having length 52mm & diameter of 78mm

Fig 4.1

Fig: assembly of motor, fan and exhaust

- 64mm ducted fan is fixed into the shaft of the 3800KV motor and the set of fan and motor is fixed within cylindrical cap.
- The diameter of the suction motor is 78mm and it is fixed at center of 220 X 175mm acrylic base.
- This acrylic base is kept at distance of 5-7mm with the help of wheels.
- When suction motor starts in clockwise direction, air from the wall side starts coming in cylindrical exhaust with high speed. With increase in speed of suction motor the air speed between the wall and acrylic base also increases.
- Figure shows where low pressure area is created and in which direction force is generated.

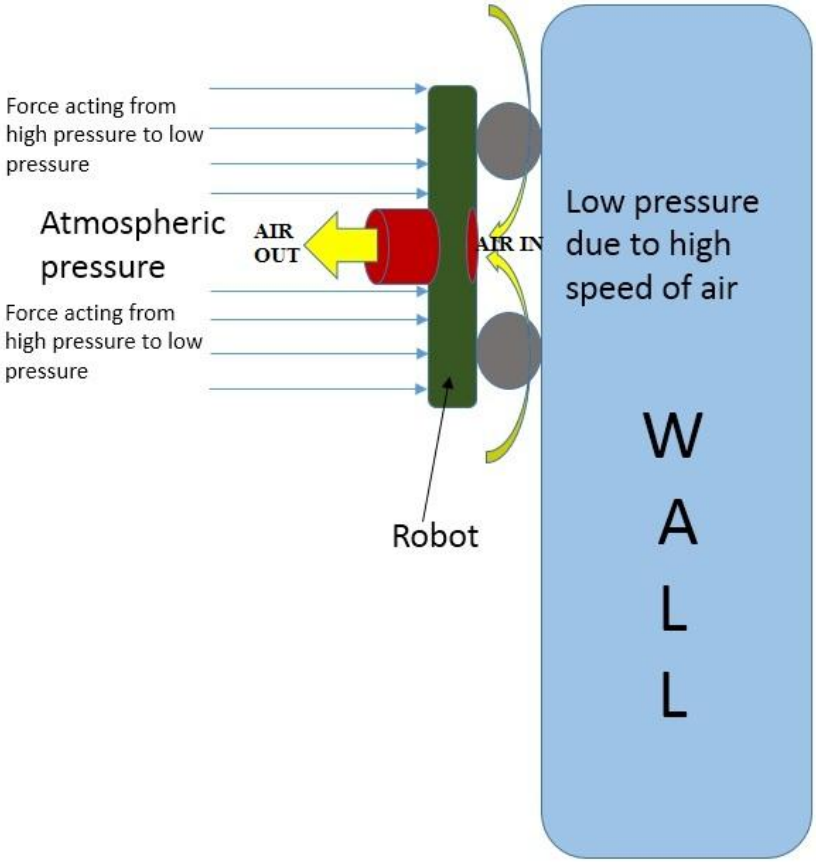


Fig 4.2

Fig. it shows the direction of flow of air and the direction of generated force.

- Due to high speed of air, a low pressure area is created between wall and robot base. But the pressure on the other side of robot i.e. top surface, is atmospheric pressure which is much greater than that low pressure.
- This pressure difference leads to a force from high pressure to low pressure and this generate force is perpendicular and towards to the wall.

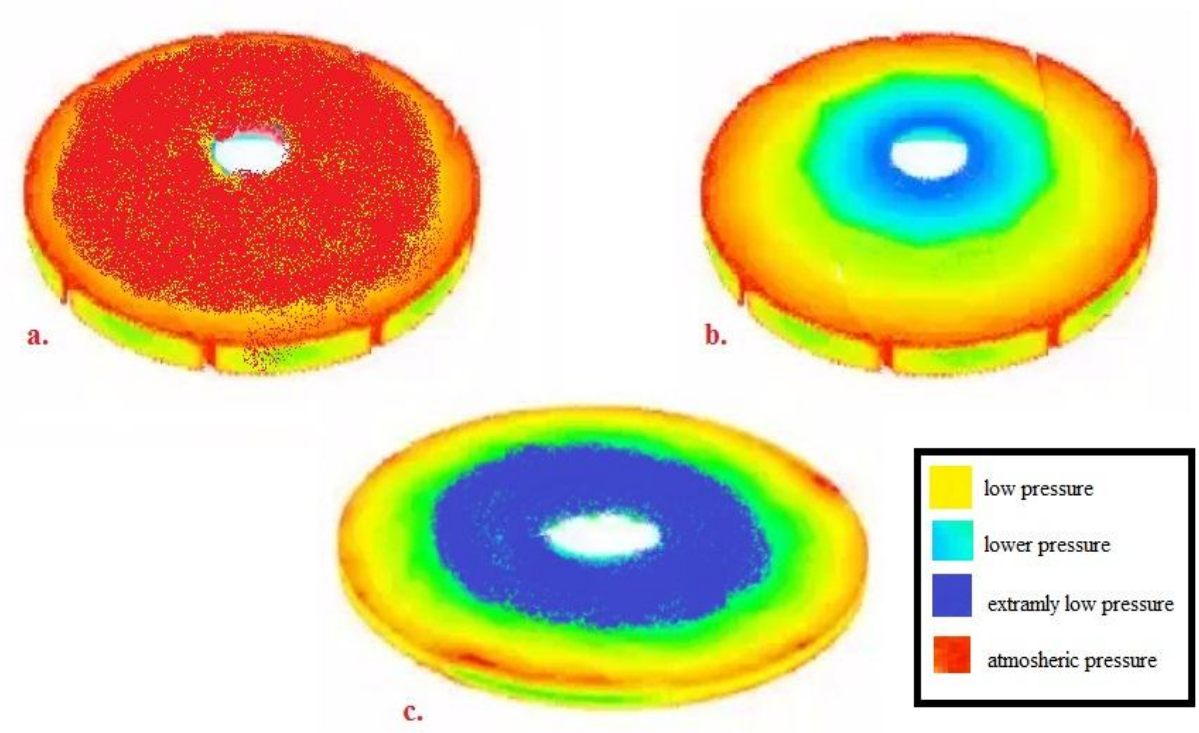


Fig 4.3

Fig. pressure change in area between wall and robot due to different states of suction motor

a. When suction motor is not running
b. When suction motor starts
c. When suction motor is at its maximum speed

4.1.1.2 CONCEPT OF FRICTION

Next important point of adhesion is concept of **friction**. As the robot has to stick to vertical wall as well as ceiling and it has to move on it, thus in case of vertical wall the friction between robot's wheel and the wall, becomes important.

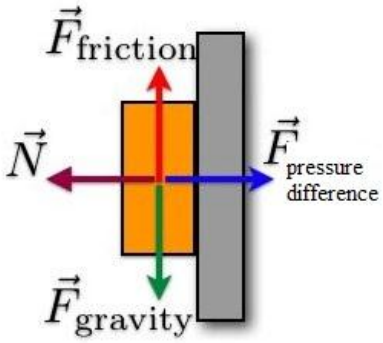


Fig 4.4

$$F_k = \mu_k N$$

μ_k = coefficient of friction (always less than 1)

N = normal force acting on it.

Here N is equal to the net force acting on robot due to pressure difference.

- Friction is the only force which opposes the force due to gravity i.e. "mg" ('m' is mass of the robot and 'g' acceleration due to gravity).
- Thus friction should be sufficient enough to counter the force due to gravity.

- The wheels of the robot is made of rubber to increase the frictional force. The coefficient of friction of rubber on different surfaces are different. The list is as follows.

Materials and Material Combinations		Frictional Coefficient	
		μ_s	μ_k
Rubber	Cardboard	0.8	0.5
Rubber	Dry Asphalt	0.9	0.5
Rubber	Wet Asphalt	0.75	0.25
Rubber	Dry Concrete	0.85	0.6
Rubber	Wet Concrete	0.75	0.45

Table 4.1

- For practical application taking the value of coefficient of friction less than the theoretical value. Taking μ = 0.35.

Calculation to determine required pressure difference:

Total weight of the robot = 1035 gram

= 1.035 kg

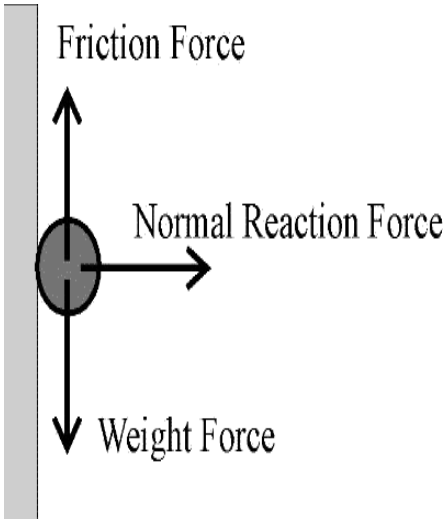


Fig 4.4

W_g = Force on robot due to gravity = (mass) * (acceleration due to gravity)

= 1.035 * 9.81 Newton

= 10.15335 Newton … equation (i)

N = Normal reaction force

= force generated due to pressure difference

F_r = Frictional force

= μ.N

To stick the robot on wall, $\mathbf{F_r = W_g}$ …equation (ii)

$N = A * (P_2 – P_1)$

= A * P

Where A = area of the robot's base

P_2 = Atmospheric pressure

P_1 = Pressure between wall and robot's base

P = Pressure difference

A= .02 * .15

= .03 m^2

N = 0.03 P … equation (iii)

$F_r = \mu . N$

= 0.35 * N

= 0.35* 0.03 P (from equation (iii))

= 0.0105 P …equation (iv)

Using equation (ii)

$F_r = W_g$

0.0105 * P = 10.15335 (from equation (i) & (iv))

P = 966.98 Pascal

- This is the minimum pressure difference be created to stick the robot on wall.

$P_2 - P_1 = 966.98$ Pascal

P_1 =(101325 -966.98) Pascal (1 Atm = 101325 Pascal)

=100358 Pascal

P_1 = 0.9904565 Atm

- To generate this much pressure the vacuum motor must rotate at minimum speed of **25000 rpm**.

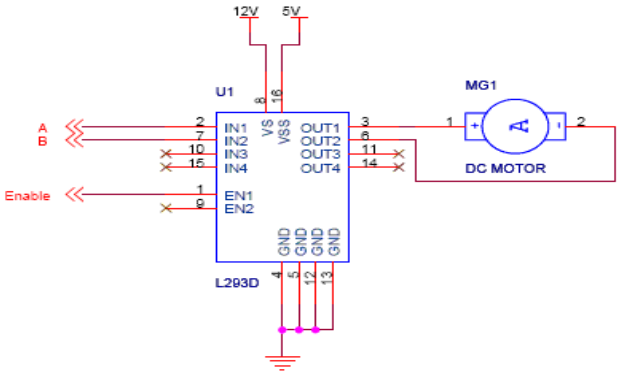
4.1.2 MOVEMENT OF ROBOT

To control 4 DC motors L293D motor driver is interfaced

between Arduino and motors. L293D has output current of 600 mA and peak output current of 1.2 A. The actual requirement of this driver IC depends on the type of motor used. As the current and voltage requirements of the geared motors are high because the motor have to bear considerable load on it thus we are using this driver IC.

4.1.2.1 L293D

L293D is a dual H-Bridge motor driver, So with one IC we can interface two DC motors which can be controlled in both clockwise and counter clockwise direction and if you have motor with fix direction of motion the you can make use of all the four I/Os to connect up to four DC motors. L293D has output current of 600mA and peak output current of 1.2A per channel. 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.



Truth Table

A	B	Description
0	0	Motor stops or Breaks
0	1	Motor Runs Anti-Cloclwise
1	0	Motor Runs Clockwise
1	1	Motor Stops or Breaks

For above truth table, the Enable has to be Set (1). Motor Power is mentioned 12V, but you can connect power according to your motors.

Fig 4.5

4.1.2.2 Concept of H-Bridge

The name "H-Bridge" is derived from the actual shape of the switching circuit which control the motion of the motor. It is also known as "Full Bridge". Basically there are four switching elements in the H-Bridge as shown in the figure below.

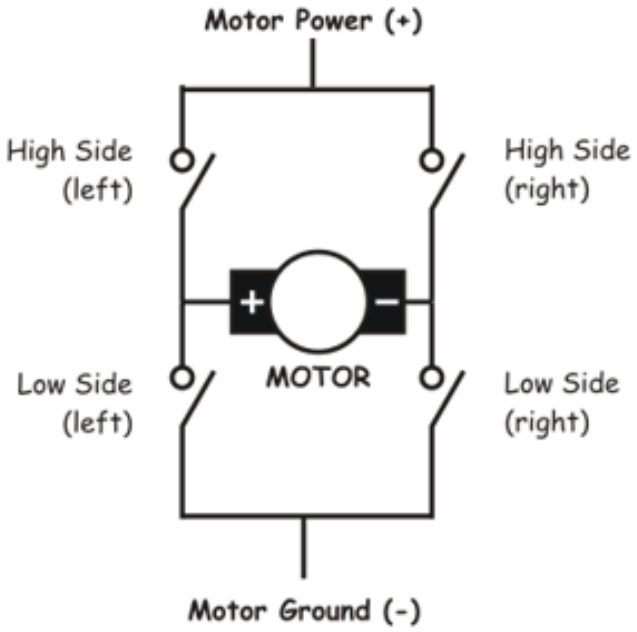


Fig 4.6

As you can see in the figure above there are four switching elements named as "High side left", "High side right", "Low side right", "Low side left". When these switches are turned on in pairs motor changes its direction accordingly. Like, if we switch on High side left and Low side right then motor rotate in forward direction, as current flows from Power supply through the motor coil goes to ground via switch low side right. This is shown in the figure below.

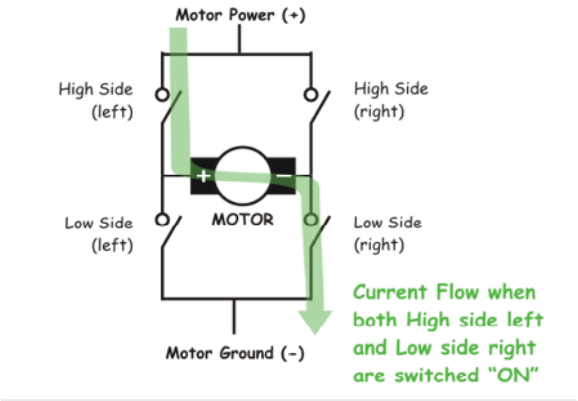


Fig 4.7

Similarly, when you switch on low side left and high side right, the current flows in opposite direction and motor rotates in backward direction. This is the basic working of H-Bridge.

4.1.3 CIRCUIT DIAGRAM

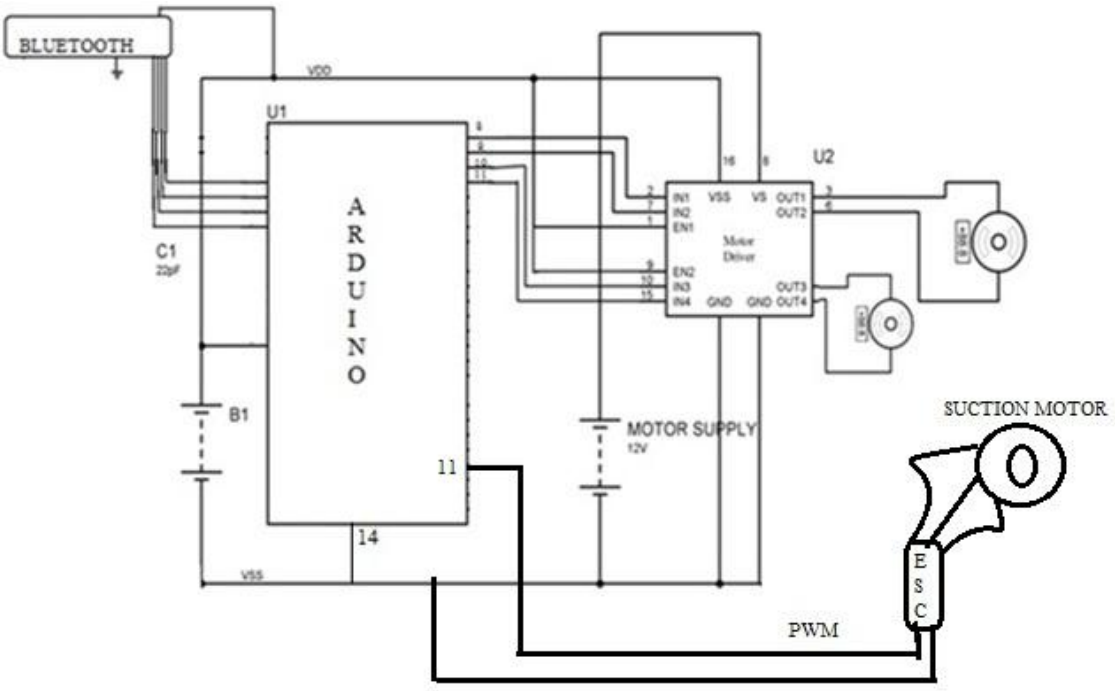


Fig 4.8

- Bluetooth shield of Arduino having a on chip antenna connects with the computer's Bluetooth and it acts as wireless sandwiching between Arduino and computer.
- As explained earlier L293D is required to drive geared DC motors thus digital pins 8, 9, 10 & 11 of Arduino is connected to pin no. 2, 7, 10 & 15 of L293D motor driver.
- Pin no. 14 of Arduino is ground.
- Pin no. 3, 6 & 11, 14 are connected to geared motors.

4.2 WIRELESS CONTROL OF ROBOT

For wireless control of robot, Arduino Duemilanove and Bluetooth shield is used. The Bluetooth shield operates at a baud rate of 38400. The robot can be controlled by pressing different keys from keyboard. 'W', 'S', 'A', 'D' keys are used to move robot UP, DOWN, LEFT & RIGHT respectively. To stop the robot, key 'F' should be pressed.

4.2.1 ARDUINO

Arduino is an open-source single-board microcontroller software designed to make the process of using electronics in multidisciplinary projects more accessible. The hardware consists of a simple open hardware design for the Arduino board with a processor and on-board input/output support. The software consists of a standard programming language compiler and the boot loader that runs on the board. Arduino is connected to the computer in which Bluetooth shield acts as an interface between the Arduino and computer. The Arduino communicates with computer through Bluetooth shield. For making the robot move forward, character 'w' is pressed on pc. It would recognize this as a command and forward it to the Bluetooth shield. Similarly we can send different commands to Arduino. On receiving these characters, Bluetooth shield sets the appropriate pins of Arduino which in turn sets the pins of L293D.

Steps for pairing Arduino with pc for the first time

1. Include softwareserial library into program.
2. Define pin no.6 on Arduino as RxD using ‘int’ fuction.
3. Define pin no.7 on Arduino as TxD.
4. Creates new software serial object on selected pins using Softwareserial Bt().
5. Define loop for initializing Arduino
6. Start function.
7. Define baud rate for serial communication between Arduino and pc through USB ‘Serial.begin()’.
8. Define RxD as input using function ‘pinMode()’.
9. Define TxD as output.
10. Call function for initializing Bluetooth connection.
11. End function.
12. Define function for initializing Bluetooth connection.
13. Start function.
14. Set Bluetooth shield baud rate to default baud rate of 38400 using function ‘Bt.begin()’.
15. Set Bluetooth shield to work in slave mode by making STWMOD=0.
16. Set Bluetooth shield name as wallclimbingbot STNA=XXX.
17. Permit paired device to connect to Bluetooth shield by making STOAUT=1.
18. Disable auto connection to Bluetooth shield by making STAUTO=0.
19. Give delay of 2seconds by using function ‘delay()’.
20. Make the slave Bluetooth inquirable by making INQ=1.
21. Give delay of 2seconds.
22. Print 'Bluetooth device successfully connected' by using function ‘Bt.print()’.
23. End function.

24. Define function according to which Arduino will function till it remains ON.
25. Start function.
26. Define recvChar as a character.
27. Define a loop which never ends.
28. Start loop.
29. Check if there's any data sent from the remote Bluetooth shield by using function Bt.read()..
30. If any data is detected then save it in recvChar and print it by using function 'Bt.read()'.
31. Check if there's any data sent from the local serial terminal by using function 'Serial.print()'.
32. If any data is detected then save it in recvChar and print it.
33. Close loop.
34. End function.

Final programming steps

1. Include softwareserial library into program.
2. Define pin no.6 on Arduino as RxD.
3. Define pin no.7 on Arduino as TxD.
4. Define pin no.8 on Arduino as mpin1.
5. Define pin no.9 on Arduino as mpin2.
6. Define pin no.10 on Arduino as mpin3.
7. Define pin no.12 on Arduino as mpin4.
8. Define pin no. 11 as pwm.
9. Creates new software serial object on selected pins.
10. Define loop for initialising Arduino
11. Start function.
12. Define baud rate for serial communication between Arduino and pc through usb.
13. Define RxD as input.

14. Define TxD as output.
15. Define mpin1 as output.
16. Define mpin2 as output.
17. Define mpin3 as output.
18. Define mpin4 as output.
19. Call function for initialising Bluetooth connection.
20. End function.
21. Define function for initialising Bluetooth connection.
22. Start function.
23. Set Bluetooth shield baudrate to default baudrate of 38400.
24. Set Bluetooth shield to work in slave mode.
25. Set Bluetooth shield name as wallclimbingbot.
    Bt.print("\r\n+STNA=SeeedBTSlave\r\n"); //set the Bluetooth name as "SeeedBTSlave"
26. Permit paired device to connect to Bluetooth shield.
    Bt.print("\r\n+STOAUT=1\r\n"); // Permit Paired device to connect me
27. Disable auto connection to Bluetooth shield
    Bt.print("\r\n+STAUTO=0\r\n"); // Auto-connection should be forbidden here
28. Give delay of 2seconds. delay(5000); // This delay is required.
29. Make the slave Bluetooth inquirable
30. Give delay of 2seconds.
31. Print 'Bluetooth device successfully connected'.
32. End function.
33. Define function according to which Arduino will function till it remains ON.
34. Start function.
35. Define incr as an integer and set its value as 0.
36. Define a loop which never ends.
37. Start loop.
38. Define 'val' as character and save it in data if sent from remote Bluetooth

shield.

39. If 'val' is equal to 'e' then make

    mpin1->high

    mpin2->low

    mpin3->low

    mpin4->high

40. If 'val' is equal to 'q' then make

    mpin1->low

    mpin2->high

    mpin3->high

    mpin4->low

41. If 'val' is equal to 'w' then make

    mpin1->low

    mpin2->high

    mpin3->low

    mpin4->high

42. If 'val' is equal to 's' then make

    mpin1->high

    mpin2->low

    mpin3->high

    mpin4->low

43. If 'val' is equal to 'z' then make

    mpin1->low

    mpin2->low

    mpin3->high

    mpin4->low

44. If 'val' is equal to 'x' then make

    mpin1->high

    mpin2->low

    mpin3->low

    mpin4->low

45. If 'val' is equal to 'd' then make
    mpin1->low
    mpin2->low
    mpin3->low
    mpin4->high
46. If 'val' is equal to 'a' then make
    mpin1->low
    mpin2->high
    mpin3->low
    mpin4->low
47. If 'val' is equal to 'g' then make
    mpin1->low
    mpin2->low
    mpin3->low
    mpin4->low
48. If 'val' is equal to 'i' then
    increase incr by '1'
    write value of incr on pwm pin using 'analogwrite' function
49. If 'val' is equal to 'p' then
    decrease incr by '1'
    write value of incr on pwm pin using 'analogwrite' function
50. Close loop.
51. End function.

4.2.2 BLUETOOTH SHILED

The Bluetooth Shield integrates a Serial Bluetooth module. It can be easily used with Arduino for transparent wireless serial communication. Two pins can be chosen from Arduino D0 to D7 as Software Serial Ports to Communicate with Bluetooth Shield (D0 and D1 is Hardware Serial Port). The shield also has two Grove connectors (one is Digital, the other is Analog) to install Grove modules.

Features

- Arduino compatible
- Up to10m communication distance in house without obstacle
- UART interface (TTL) with programmable baud rate (SPP firmware installed)
- Default Baud rate: 38400, Data bits: 8, Stop bit: 1, Parity: No parity
- Default PINCODE:"0000"
- A full set of configuration commands
- On board PCB Antenna
- FCC Part 15 Certificated

CONTROL OF ROBOT THROUGH BLUETOOH

Bluetooth v2.0 have been used for transferring data in a serial manner. We used a software 'SSCOM 3.2' for reading serial com ports and also sending data through them.. After Switching ON the remote Bluetooth shield this software can be used to open the corresponding serial port on Bluetooth enabled laptop and transmit or receive data through it.

4.3 WIRELESS VIDEO TRANSMISSION FROM ROBOT TO PC/ CONTROL ROOM

For wireless video transmission we are using an android phone (which is mounted on our robot) which is having wireless network function. By using application 'droidcamerax wireless' we are transmitting video signals on pc through a wireless network. As it is a wireless network, communication can also take place even if there is an obstacle in between a laptop and a robot. Internet is not required for transmitting video signals an either device.

CHAPTER 5

RESULT

5. RESULT

1. The design has enabled us to stick the robot to the vertical walls and ceiling. The robot can stick to almost any kind of walls and surfaces like brick walls, glass walls, wooden walls, etc.
2. Movement of Robot on vertical walls and ceiling can be controlled by using wireless communication (Bluetooth v2.0) through a laptop.
3. We have observed that on applying an additional weight of 150gms on robot, it can successfully carry it without losing the contact from wall.
4. Total weight of robot is 1035gms and it can successfully climb on vertical walls and on ceiling.
5. It is sending video signal to pc using the camera mounted over it.

CHAPTER 6

ANALYSIS

6. ANALYSIS

1. The adhesion capacity depends on the design of vacuum impellor and uniformity of its distance from the wall all over the surface.
2. Thus we have used a 64mm ducted fan having its outer diameter 78mm.which is creating maximum vacuum in this case.
3. The distance between robot's base and wall should be between 5-8mm to create adequate pressure. If this distance becomes greater than 8 mm then the adhesion capacity decreases and if the distance becomes smaller than 5 mm then it fails to create adequate vacuum.
4. The area between robot's base and wall should be uniform for proper adhesion.
5. There must not be any gap between suction motor and vacuum impellor i.e. it must be air tight, otherwise sufficient low pressure vortex will not be created which will lead to insufficient adhesive capacity.
6. It can carry additional weight of 150gm along with it without failure.
7. It makes lots of noise.

CHAPTER 7

APPLICATION

7. APPLICATION

1. Surveillance: It can creep up the wall and keep a close watch on someone or something as per need.
2. Counter terrorism:-It can be used for spying against terrorists without humans being actually present there and thus it reduces risks.
3. Search and rescue mission:-During earthquakes and other calamities it can be used to carry out rescue mission without endangering life.
4. Industrial application:-It can keep an eye on the ongoing processes from any place.
5. Spy operation: It can be controlled from a distance and can be used to keep a watch on the suspect.
6. Wall cleaning, ship hull cleaning etc.
7. Rescue robot for fire brigade.
8. Toys etc.

CHAPTER 8

CONCLUSION

8. CONCLUSION

1. Thus we have concluded that the suction motor, on supplying 11.7volt consumes 25A to 30A current and with the specified supply it sticks to different walls successfully.
2. If it is tilted from its sticking position or distance between robot's base and wall is increased through a distance of more than 7 mm to 8 mm it loses its grip and falls down.
3. The design till now can sustain additional weight of 150 gm.
4. To climb on a wall the robot should not completely stick to the wall instead, there should be some gap between the base of the robot and the wall, so that enough low pressure vortex can be created which will enable the robot to stick as well as move on the wall.

CHAPTER 9

FUTURE SCOPE

9. FUTURE SCOPE

1. It can be made wireless for long distances.
2. Power of adhesion can be increased by using two or more adhesion techniques at the same time.

   Ex- Suction cup +suction motor or two suction motors
3. It can be traced using GPS technology.
4. Integration of sensors in robotic foot to aid climbing behavior.

CHAPTER 10

REFERENCES

10. REFERENCES

1 SRI presented an overview of its electro-adhesion technology at the IEEE International Conference on Robotics and Automation (ICRA), May 23, 2008 at the Pasadena Conference Center in Pasadena, Calif.

2 Development of a wall-climbing robot using a tracked wheel mechanism
Hwang Kim, Dongmok Kim, Hojoon Yang, Kyouhee Lee, Kunchan Seo, Doyoung Chang and Jongwon Kim* *School of Mechanical and Aerospace Engineering, Seoul National University, SeoulKorea*(Manuscript Received July 30, 2007; Revised March 27, 2008; Accepted April 16, 2008)

3 Wall-climbing, tank-like robot
By Darren Quick, *November 1, 2011*
http://www.gizmag.com/tank-wall-climbing-robot-sfu/20341/

4 *Modeling and COntrol of an Under-actuated Miniature Crawler Robot*
By robots*Jizhong Xiao, Mark Minor, Hans Dulimarta, Ning Xi, R. Mukherjee, R. L. Tummala, , Proceedings of the 2001 IEEE/RSJ International Conference on Intelligent Robots and Systems, Maui, Hawaii, USA, OCt 29-Nov. 03, 2001*.

APPENDIX I

DATASHEET

APPENDIX II

COMPONENT LIST

COMPONENT LIST

Sr no.	Component Name	Quantity
1.	3800kv Brushless dc motor	2
2.	ESC 30A(motor driver)	1
3.	Lipo Battery 2200mAhr	1
4.	Lipo battery balanced charger	1
5.	Arduino Duemilanove	1
6.	Bluetooth Shield	1
7.	BO Motor	6
8.	3.7v Battery Rechargeable	1
9.	Acrylic sheet	15 x 20 inch
10.	Cutting of Acrylic sheet	------

11.	Wheels	4
12.	Car battery(on rent)	1
13.	L293D	2
14.	IC holder	2
15.	Wire	10 meters
16.	Tape	6
17.	Eraser	10
18.	Feviquick	10

APPENDIX III

BUDGET

BUDGET

Sr no.	Component Name	Quantity	Budget (In Rupee)
1.	3800kv Brushless dc motor	2	3200
2.	ESC 30A(motor driver)	1	1100
3.	Lipo Battery 2200mAhr	1	2000
4.	Lipo battery balanced charger	1	800
5.	Arduino Duemilanove	1	900
6.	Bluetooth Shield	1	1900
7.	Geared Motors	6	900
8.	3.7v Battery Rechargeable	1	150
9.	Acrylic sheet	15 x 20 inch	300
10.	Cutting cost		200
11.	Wheel	4	80

12.	Car battery(on rent)	1	200
13.	L293D	2	50
14.	IC holder	2	32
15.	Wire	10 meters	100
16.	Tape	6	30
17.	Eraser	10	100
18.	Feviquick	10	100
19.	Transportation	----------	3000
	Total		**15142**