A Project Report

On

DESIGN AND FABRICATION OF AUTOMATIC WHITEBOARD/GREENBOARD CLEANER

Submitted in partial fulfilment of the requirements for award of Degree

BACHELOR OF TECHNOLOGY

In

MECHANICAL ENGINEERING

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2018-2022

ANDHRA LOYOLA INSTITUTE OF ENGINEERING AND TECHNOLOGY

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CERTIFICATE

This is to certify that the project entitled **"DESIGN AND FABRICATION OF AUTOMATIC WHITEBOARD/GREENBOARD CLEANER''**, is submitted by **R.HARANADH REDDY(18HP1A0367), T.RAJESH (18HP1A0380) ,M.RAMAKRISHNA BABU(18HP1A0383), I.SIMON (18HP1A0393)** in partial fulfillment of the requirement of degree of Bachelor of Technology (B. Tech) in **Mechanical Engineering** in record of work carried by them during academic year.

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

ACKNOWLEDGEMENT

It is our privilege to express our sincerest regards to our project guide**Mr.M.SRINIVASA REDDY,** for his valuable inputs, able guidance, encouragement, and wholehearted cooperation and constructive criticism throughout the duration of our project.

We deeply express our sincere thanks to our head of the department **Dr. M. GEETHA RANI** for encouraging and allowing us to present the project at our department promises for the partial fulfillment of the requirements leading to the award of B. Tech Degree.

We would like to show our great appreciation to our principal **Dr. O. MAHESH** for this valuable statement and suggestions.

We cordially thank our Honorable Director **Rev.Fr. Dr. A. Francis Xavier S.J**. for the moral support and the excellent facilities provided

We also would like to thank the Non-Teaching staff of the Department of Mechanical Engineering, ALIET, for helping us during the Project work.

We are very happy to thank our parents for encouraging us to do this project in a smooth way by giving financial support and encouragement. Finally, we owe a lot to the teaching and non-teaching staff of the Department of Mechanical For their support in doing our project work.

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ABSTRACT

The project is about finding a real time solution for the problems caused by the chalk pieces used in the class room. To overcome the problems that are faced daily by the students and faculty, the project entitled 'Real Time Automatic Blackboard Eraser using Embedded System' has been suggested to automatically erase the blackboard. DC motors are used for the movement of the instrument. The instrument moves upward and downward erasing the board and collecting the dust automatically from the erasing material due to the vaccum. These processes are automated using microcontroller. Thus the device avoids the dust flow in the environment and thereby providing good solution for the problems faced by the student, faculty and other electronic equipments that are used inside the class room in a cost effective and time efficient way.

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LIST OF NOTATIONS

NOTATION	DESCRIPTION
Z	Number of teeth
n	Speed (rpm)
p	Pitch
V	Velocity
L	Length
r	Radius
m	Module
T	Torque
d	Pitch Diameter
P	Power
HP	Horse power
Wt	Beam strength
y	Tooth factor
b	Face width
Fr	Radial force

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CHAPTER -1

INTRODUCTION

White Board Cleaner

It is a system that is generally used to clean the whiteboard automatically with the help of duster. By the use of this automatic system we can save our time and energy. It is a new technology that is generally used now a days. A system for cleaning the whiteboard wherein a duster is mounted for longitudinal movement on the board and a hand wheel is mounted that is mechanically interconnected to a drive assembly for producing the movement of the duster in an erasing operation. It will use the Rack and Pinion mechanism to convert the rotary motion into linear motion of duster.

What is Automation?

Automation or automatic control is the use of various control systems for operating equipment's such as machinery, processes in factories, boilers and heat treating ovens and other applications with minimal or reduced human intervention. Some processes have been completely automated.

The biggest benefit of automation is that it saves labor; however, it is also used to save energy and materials and to improve quality, accuracy and precision.

Objective

There are two main objectives of doing this project. First objective is to design a low cost and user friendly whiteboard cleaner machine which can erase the board easily. This machine was created as a convenience to the user to erase the whiteboard.

Second objective is to enhance the efficiency and accuracy of the movement of duster. The purpose of this objective is to make the movement of this machine accurate although has been used many time. Another purpose of this objective is to make the machine work faster and smoothly. This aims to prevent users from bored waiting for the cleaning process to be done.

The principal object of the present automatic whiteboard duster is to provide an attachment for whiteboards in the form of a power driven erasing apparatus which can be set in operation, thus eliminating the drudgery of manually cleaning whiteboards. The utility model relates to teaching aid. The prior board has no automatic cleaning function, a teacher wastes time in erasing, and the use is not ideal. The structure is simple; the use is convenient, clean and sanitary; and the effect of saving time is good.

Purpose

There are many purposes behind the fabrication of this project, but the main purpose is hidden behind what we feel one day.

We have attended many lectures of in our class and what we always see that the instructor utilizes the whole board even every corner for writing and plotting graphs and when he completely delivers what is written on the board, then he needs more space to take learning process ahead for that it is quite difficult for him to clean the whole board in minimum time and when the instructor is doing so, students getting boared and deviates from the topic and starts chatting rather than the students has to chant what their instructor taught them. So after cleaning the board instructor needs to pay more attention on the students to get him on the track. Doing same is the difficult job for an instructor.

By seeing that an idea clicked in our mind that some mechanism or machine must be fabricated for the rubbing work which can clean the board within a couple of seconds without any obstacle so that it is easy for instructor's to concentrate well on their students.
This is our prime purpose to approach this project.

Significance

1) Reduce tiredness of teachers.
2) To avoid whiteboard left in dirty condition when a class finished.
3) To automate the whiteboard cleaning process.
4) Install automation in operations reduce time.
5) Easy and fast operation with maximum wiping area.
6) High degree of accuracy.
7) Problem of dust can be reduce.
8) Maintenance cost is less.
9) Simple in construction and operation

Working Process

As per our reviews and survey, we conclude that the automatic whiteboard cleaner machine will give satisfactory rubbing effect by converting rotary motion to linear mation of Rack and Pinion into reciprocating motion of duster.

In our project the system uses the Rack and Pinion arrangement for cleaning the whiteboard with the help of Motor. Motor transfers power to the shaft through Rack and Pinion then it is transferred to the connecting strip with duster arrangement on Pinion.

Now, considering the system is in use and the teacher wants to rub the board. When the teacher switch on the supply, current is passed to the 18V adapter and then it passes through Arduino. This ARDUINO provides signal to the driver module at a specific time interval. To drive the motor a DRIVER MODULE (L293D) has been used. It receives the signal coming from the ARDUINO & change the polarity of the motor for which the direction of the motor changes. To sense the distance and time specified by ARDUINO, a sonar sensor is used, hence the motor rotates in both clock-wise & anti-clockwise direction. Due to the rotation of the shaft of the motor, the pinion connected to it also rotates which in

turn the rack moves in translatory direction along the whiteboard. A brush holder is attached to the end of the rack with a nut & bolt. To clean the white board smoothly a brush of better quality has been used which is attached to the brush holder. The brush moves from the upper portion to the lower portion of the board and get rubbed due to the friction between board surface and brush

Advantages

- Its construction is simple and requires less maintenance.
- Low cost.
- Portable in size and easy transportable.
- Less manual work.
- Time saving project.
- Install automation in operations reduce time.
- Easy and fast operation with maximum wiping area
- High degree of accuracy.
- Problem of dust can be reduce.

CHAPTER-2

LITERATURE REVIEW

This section includes background and various systems for cleaning thewhiteboard and blackboard. Different research papers are referred to study the different systems and different mechanisms.

For teaching purpose generally blackboards are used. For effective learning blackboard is the basic thing in classroom. The powder obtained from the chalk piece while erasing the blackboard causes problem to the respiratory organ when inhaled by human. Those who are allergic to dust cannot sit near the blackboard. Other than this there are more problems related to the dust or chalk powder like hair loss, burning of eyes etc. For cleaning the board manual work has to be done by the teacher which is time consuming while taking classes. Moreover chalk dust not only harms the human but also the machines such as projectors when exposed to chalk dust there could be heat production in it.

Primitive blackboard erasers were initially wet cloths or wood planks attached with eraser materials. They were effective but made the user open to the chalk dust which may not be fatal but could cause allergies and problems to persons affected by asthma or any other breathing problems.The basic architecture always included the blackboard itself as a crucial part as well as the duster placed in different manners but with a single objective to erase the blackboard.

Billie R. Chrisp et.al stated that, a programmed duster eradicating mechanical assembly for classroom use. The development of the pole altered with the eraser was fundamentally done by manual switches. Yet, the most particular piece of the component was the plural dusters installed on the pole in order to expand the duster reach and in addition cleaning the blackboard turned out to be much simpler. The electric engines compass the entire slate in order to move the duster along it. The rollers at top and base cross

movement.[1]

Chirag Shah et.al quoted that, to make the blackboard framework with Sensors to the engines to start engine development. The component control switches were with the client. The duster moved back and forth to eradicate the writing board. When the engine begins moving the apparatus and counter rigging associated with the strung pole which then moves the pole.[2]

Sonia akhter et.al stated about rack and pinion mechanism.The system consists of Arduino, motor, rack and pinion mechanism. When the switch is on, it moves across the full width of the board and its direction is reversed automatically in order to clean the board.[3]

Tsado Jacob et.al stated that, with Sensors the engines starts . The component control switches were with the client. The duster moved back and forth to eradicate the writing board. When the engine begins moving the apparatus and counter rigging associated with the strung pole which then moves the pole.[4]

Chris Betche et.al stated that, the whiteboard cleaner will use 12v DC motor through which the DPDT switch will be operated that will induce the cleaner to move all over the board.[5]

The most developed blackboard model was outlined by **Jinzan Liu, Zhong Zeng and Lang Xu** .This blackboard deleting framework was the most progressive slate eradicating component which utilized cameras and advanced picture preparing to delete the erasable markings present on the blackboard. This was equipment and programming associated framework.

CHAPTER-3

METHODOLOGY

For the movement of the duster arm, rack and pinion arrangement are used in which the pinion wheel rolls over the fixed rack for the movement to the either side. Small sized DC motors are used here for the actuation of the mechanism. Two pairs of rack and pinion arrangement are used in the mechanism on upper and the bottom edges of the board, and both the pinions are connected with each other through a connecting strip. The connecting strip is also connected with the back strip which solves the three purposes:

1. It holds the motors on both sides so that proper balance of motor is made.
2. It also helps in making proper alignment of rack and pinion so that they run smoothly, and it also keeps the eraser arm in vertical position.
3. It fulfills the requirement of the proper mounting of electronic components and

helps in proper handling of the electric wires.

The system uses the electronic control which is obtained by Ardinuo mechanism, motor driver and Bluetooth module so that they all together help in controlling the mechanism with a mobile interface. Ardiuno plays an important role in the assembly to stop the pinion in the end and to reverse the polarity of motors so that they may go forward and return back. And repeated motion will be provided until the board is cleaned. The back connecting strip is connected to the slider by means of C clamp. It solves three purposes:

a) First it helps to prevent any lateral movement of spongy duster connecting strip and back connecting strip so proper alignment of rack and pinion is achieved.

b) Slider makes movement smoothly in longitudinal direction.

c) It helps in connecting to back strip to the slider.

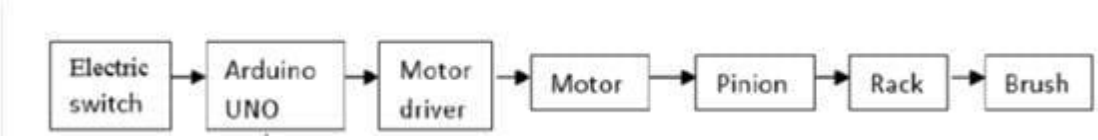


Fig: flow chart of working

Parts used in automatic whiteboard cleaner

- 8mm Linear rod
- 8mm Linear bearing
- Rack and pinion
- Bluetooth module
- Arduino uno board
- 30 rpm motor
- L293d motor drive
- Vaccum cleaner
- Connecting wires

Description of important parts

Greenboard

Fig.3. 1

A greenboard is a reusable writing surface on which text or drawings are made with the help of chalk. Greenboards were originally made of smooth, thin sheets of Resin Coated grey slate stone. Modern versions are often green because the color is considered easier on the eyes. The highest grade Greenboards are made of rougher version porcelain enameled steel (white, black, blue or sometimes other colors). Porcelain is very hard wearing and Greenboards made of porcelain usually last 10–20 years in intensive use.

FRAME

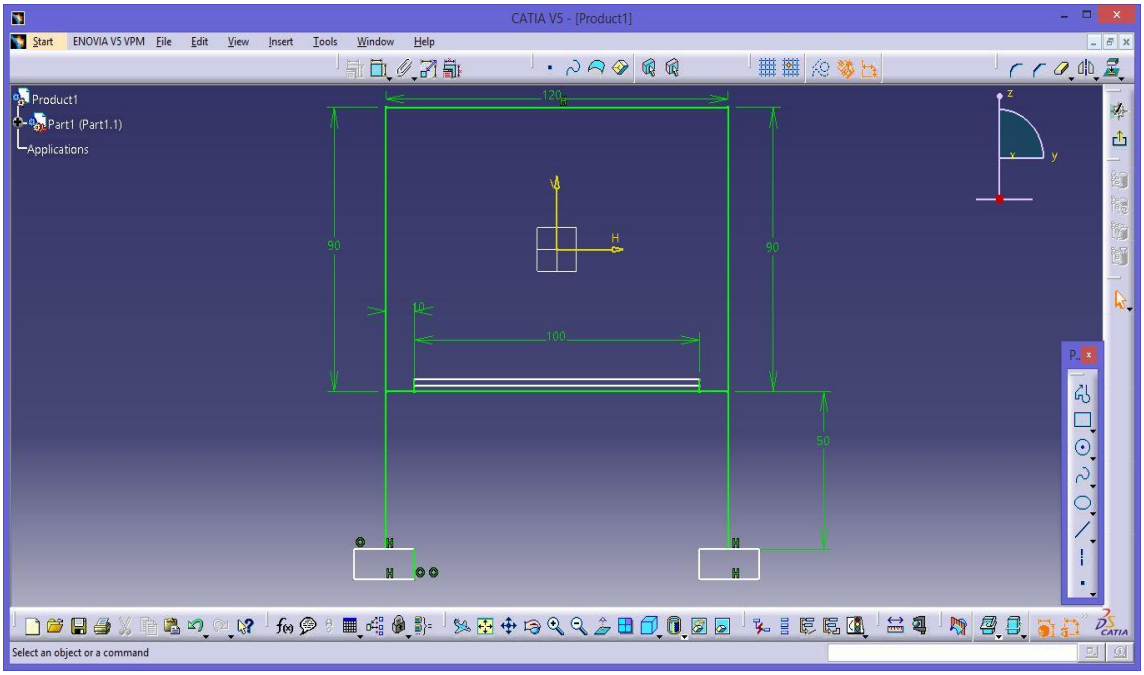


Fig.3. 2

A frame is a container that borders the perimeter of a greenboard, and is used for the protection, display, and visual appreciation of objects and imagery such as photographs,

canvas paintings, drawings and prints, posters, mirrors, shadow box memorabilia, and textiles.

8mm Linear rod

Fig.3. 3

This linear motion shaft of 8 mm in diameter and 915 mm in length is chrome plated and case hardened, and is suitable for use with linear support blocks and closed type slide units in linear motion applications. The high carbon steel shaft is chrome plated for corrosion resistance, case hardened for wear resistance, and precision ground for consistent

ball bushing radial clearance. The shaft diameter and length are specified for accurate fit and this shaft is suitable for use in applications, such as measuring systems, printing equipment, and computer numerical control (CNC).

8mm linear bearing

Dimensions :- 24mm long x 15mm outer diameter x 8mm inner diameter
Dynamic Load Rating :- 260 N
Static load rating :- 400 N
Groove Diameter :- 14.5mm outer diameter
Groove Width :- 1mm and 1.25mm

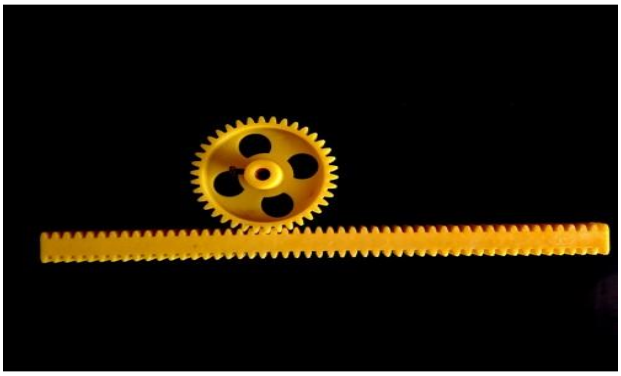
Fig.3. 4

Its intended to slide along an 8mm linear shaft, rather than rotate around it. These are very slim, and good for when you want to attach a motion carriage onto a railing without adding a lot of weight. These are very basic bearings, they're meant for a stepper-motion

controlled setup so they're not ultra-smooth. They're best used for DIY/hobby robotics projects.

Rack and Pinion

A rack and pinion is a type of linear actuator that comprises a circular gear (the *pinion*) engaging a linear gear (the *rack*), which operate to translate rotational motion into linear motion. Driving the pinion into rotation causes the rack to be driven linearly. Driving the rack linearly will cause the pinion to be driven into a rotation.



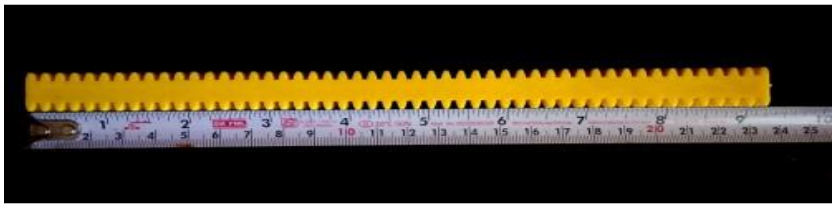


Fig.3. 5

Dimensions

Rack Length - 9 inches
Rack No. of Teeth - 50

Pinion Outer Diameter - 6 cm
Pinion No. of Teeth's - 38
Pinion Bore Diameter - 6mm

BLUETOOTH MODULE

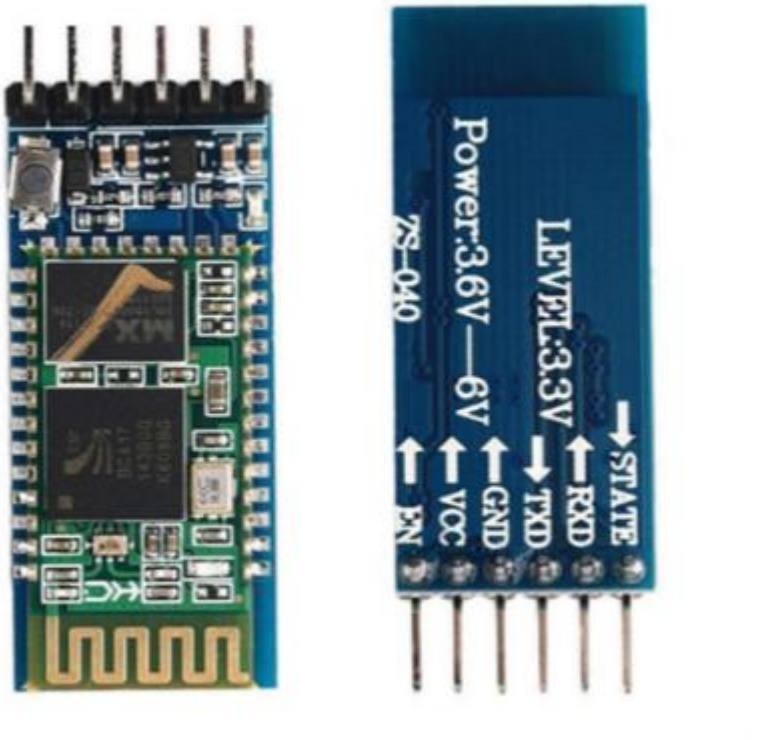


Fig.3. 6

The HC05 Bluetooth module is used as UART serial converter module and can easily transfer the UART data through the wireless bluetooth. The Bluetooth module has a Frequency: 2.4GHz ISM band, PIO control and comes with an integrated antenna and edge connector. The HC-05 bluetooth module can be used in master or slave configuration. You can use it simply for a serial port replacement to establish connection between MCU and GPS, piece to your embedded project and etc.

ARDUINO SMPS

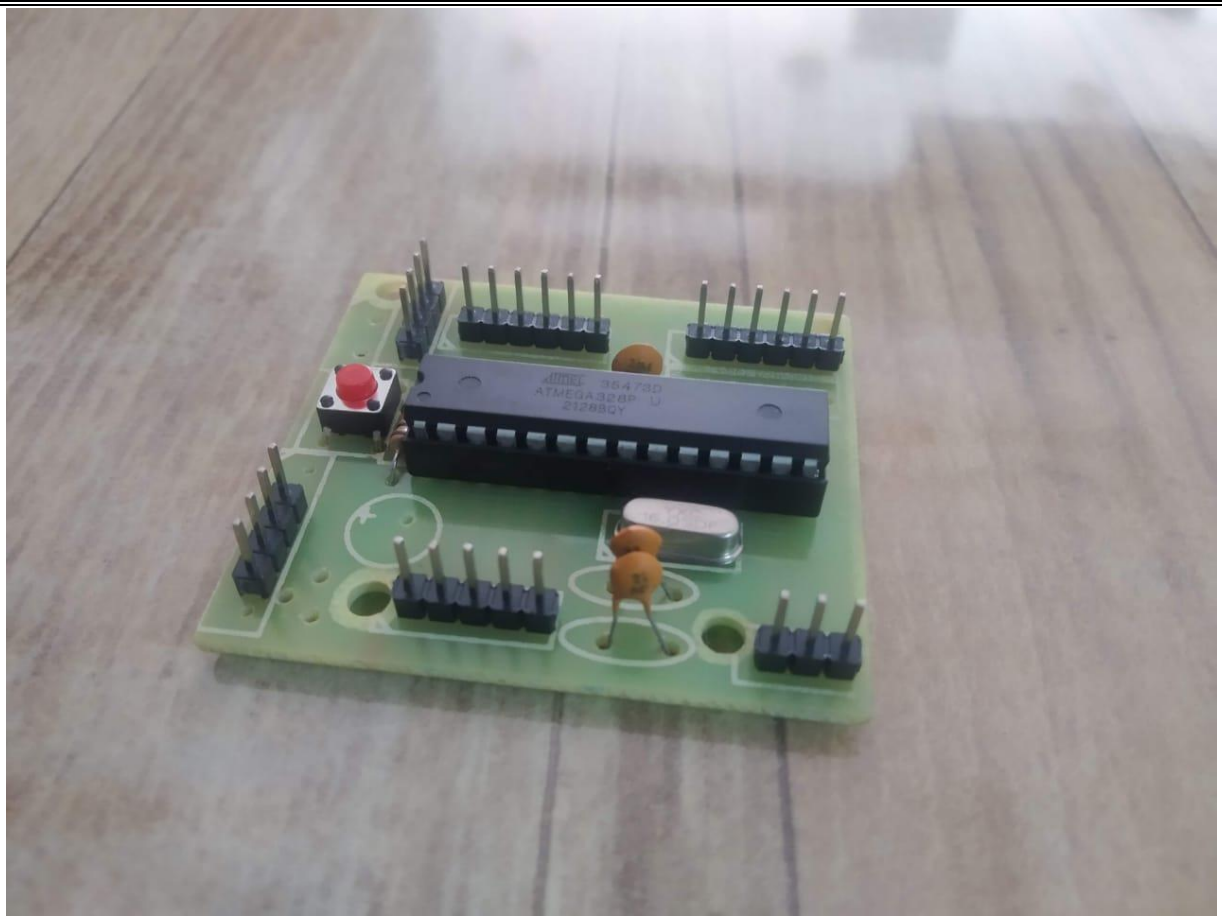


Fig.3. 7

we will use our Arduino as a control circuit for a switched-mode power supply. A switched-mode power supply (SMPS) is an electronic circuit that converts the power using switching devices that are turned ON and OFF at high frequencies. Arduino boards can operate satisfactorily on power that is available from the USB port. It provides 5V DC voltage and can be sourced from the port from a PC, wall socket adapter or portable power bank.

100 RPM MOTOR

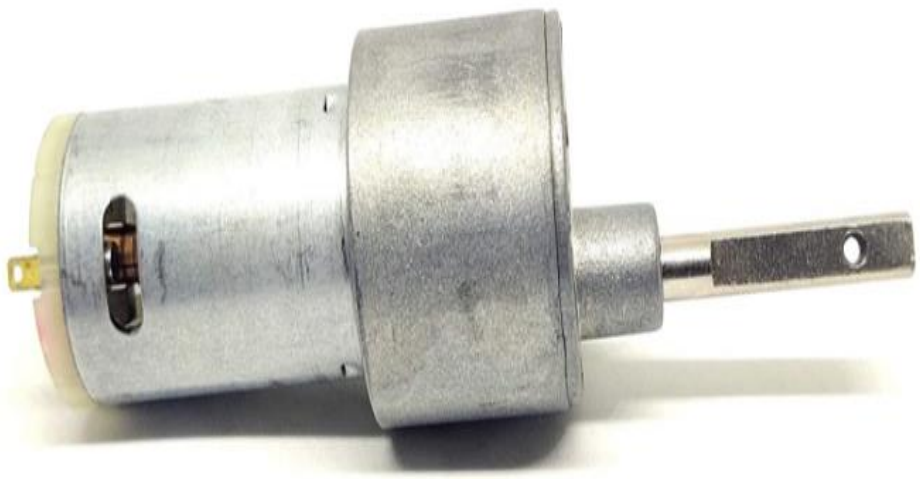


Fig.3. 8

A direct current (DC) motor is a type of electric machine that converts electrical energy into mechanical energy. DC motors take electrical power through direct current, and convert this energy into mechanical rotation.

Voltage: 6V to 18V

Current: 7 to 10 amp

It has RPM: 100

Torque Range: 10 – 15 N-m

L293D MOTOR DRIVE

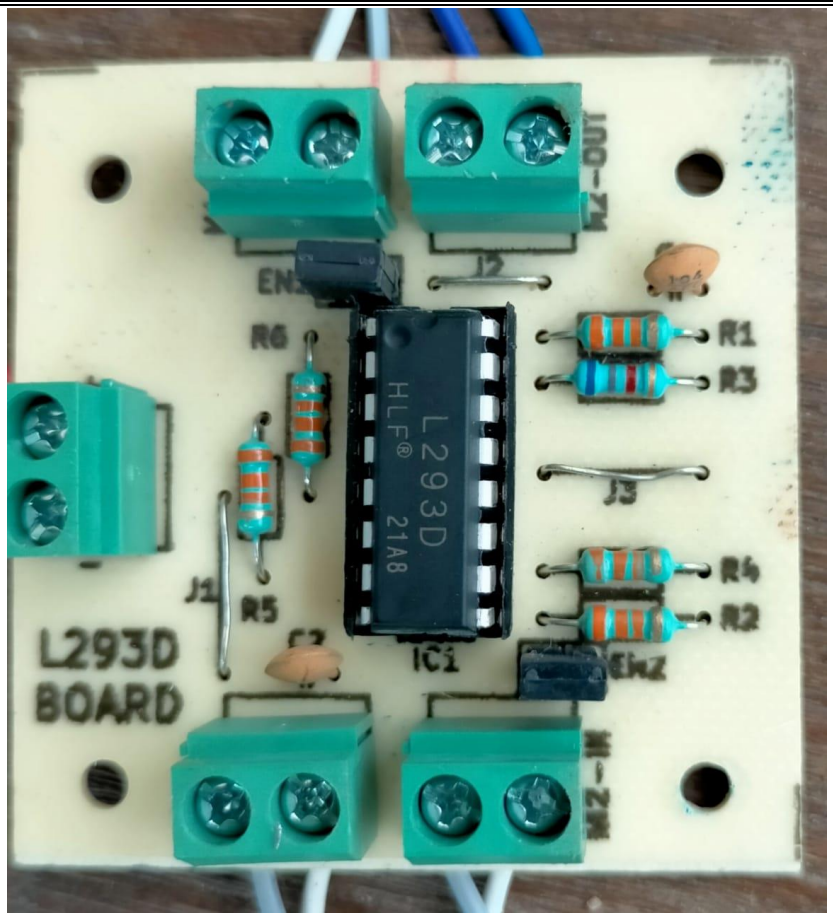


Fig.3. 9

Motor drivers acts as an interface between the motors and the control circuits. Motor require high amount of current whereas the controller circuit works on low current signals. So the function of motor drivers is to take a low-current control signal and then turn it into a higher-current signal that can drive a motor. Drive a 2-phase bipolar stepper motor or two DC motors with the L298 dual H-Bridge chip, mounted on this handy breakout board along with all necessary peripherals

It is ideal for robotic applications and well suited for connection to a microcontroller requiring just a couple of control lines per motor

It can also be interfaced with simple manual switches, TTL logic gates, relays, etc.

Weight: 30 gms can also control the 2-phase stepper motor.

VACCUM CLEANER

Fig.3. 10

A vacuum cleaner, also known simply as a vacuum or a hoover, is a device that causes suction in order to remove dirt from floors, upholstery, draperies, and other surfaces. It is generally electrically driven.

CONNECTING WIRES

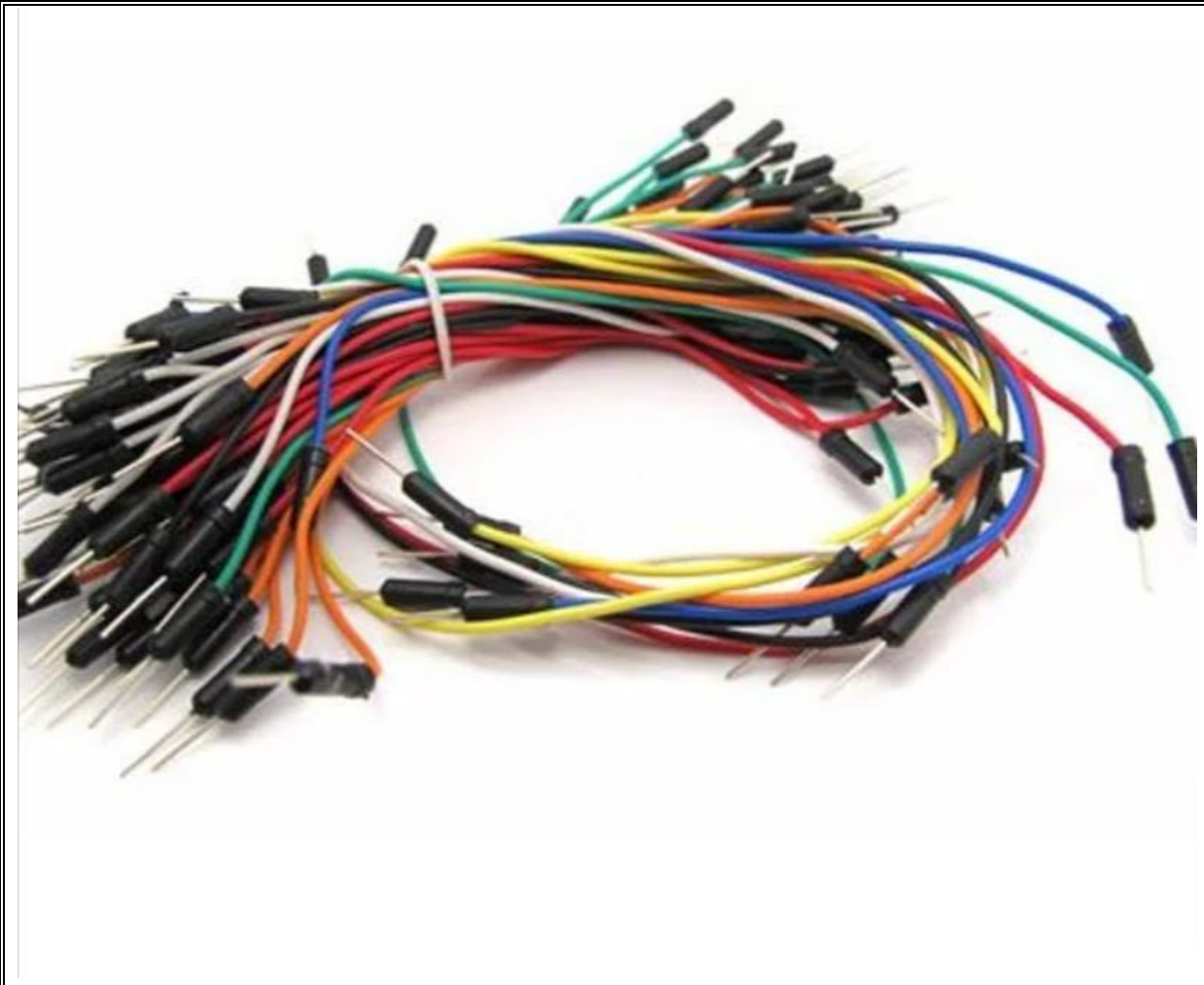


Fig.3. 11

Connecting wire conducts electricity.

The conducting wire is a component of a circuit that carries the current in the circuit. It is made out of a current conducting material like copper or tungsten.The wire is covered by an insulating material like rubber for protection as well as to avoid loss of current.Conducting wires are represented by different colours in a circuit to distinguish their function**.** Green is for grounding wire, black is for neutral and red usually is for the live wire.

QUANTITY OF PARTS USED

PARTS	QUANTITY
Linear rod	**4**
Linear bearing	**4**
Rack	**5**
Pinion	**2**
100rpm motor	**2**
Motor drive	**1**
Vaccum cleaner	**1**
Bluetooth module	**1**
Arduino board	**1**

Fabrication steps

Following were the steps taken for fabrication of the project:

1. Design analysis for the mechanism.

2. Installation of Rack on both sides.

3. Fabrication of back link, duster assembly and mounting of motors, gears and couplings.

4. Installation of sliders on the back sides.

5. Mounting of duster mechanism on the board.

6. Installation of arduino and electrical switches.

7. Connecting all the electrical devices to the duster assembly and operate through Mobile application.

8. Inspection and Testing of the final assembly.

Machines and equipments

The following machines and tools were used in the fabrication process:

1. Bench Grinding Machine
2. Hand Grinder
3. Arc Welding Machine
4. Bench Drill Machine
5. Sheet Metal Cutter
6. Pliers
7. Screwdriver
8. Hacksaw
9. Multimeter
10. Bench vice

CHAPTER 4

DESIGN AND CALCULATIONS

Selection of Motor:

To solve our purpose we selected Johnson DC Geared Motor. After analyzing different design steps and requirement of system and availability of sources.

Volt Rating = 12 volt

Max Current: 9 amp

Pmax = V * I = 108 W

Assuming P< Pmax for the calculation considering frictional and heat dissipation losses so

Taking P= 100 Watt

HP = P/735 = 0.13HP

HP = $\frac{T*RPM}{5252}$ = 7.14557pound feet

T pound feet to Nm is T/1.356 = 7.14557/1.356 = 10Nm

Torque Rating: 10-12 N-m at 100rpm.

Design of Gear

Based on the market survey and the analysis of actual need,
plastic (Acrylonitrile butadiene styrene) rack and pinion was used instead of any metallic rack and pinion. This not only reduced the overall cost of the project, but also avoided overdesigning. Based on the availability, 20˚ full depth involute gears were used.

Plastic (Static Stress) σd = 58.8 MPa

1. Module: 1.5mm
2. Pitch Circle Diameter = MZ=57mm
3. Number of Teeth: Z = 38

V = πDN/60 = 0.298 m/sec.

P = F*V implies that F = 335.57 N which is the tangential force on the gear.

Beam Strength:

Sb=m*b* σd*π *y …(1)

Where y = tooth factor

Where ‘m’ is module

Where ‘b’ is Face width

For 20˚ FDI

y = 0.154-0.912/Z …(2)

= 0.13

And face width = 13 mm

Therefore, Sb =468.28 N from relation (1).

But,

Sb = FOS. [C*F/Cv} …(3)

Where F is tangential Force

C is Service Factor = 1 (Assuming 3 hours per day and light shock load)

And Cv = Velocity Factor= 3.05/(3.05+V)

…(4)

V= 0.298 m/s already found.

Therefore, Cv = 0.91 from relation (4).

Putting the values in relation (3), we get

FOS = 1.3

Also,

Fr=F*tanφ, Where Fr is the radial force on the pinion.

F=335.57 N (already found) and φ = 20˚

Hence,

Fr = 122.14 N

Design of Eraser :

Dimension of Eraser= 48cm x 5 cm

Surface Area of Eraser

(A)= 48*5 = 0.024 m^2

Average pressure due to eraser on white board parallel to board

R= Pr*A where R is reaction force.

R= 1500*0.48*0.05

= 36N

Force required to pull the Eraser link (f)

$f = \mu * R$

$\mu = 0.4$

$f = 0.4 * 36 = 14.4$ N

This Force is needed to pull the Eraser Link

$f = 14.4$ N

Work done by this force

$W = f*d = f*d \cos 0$

$W = 14.4 * 1.2 = 17.28$ J

Time to clean the White Board (t)

$t = d/v$ seconds

where d is distance travelled and v is linear velocity of eraser link.

$t = 1.2/0.298$

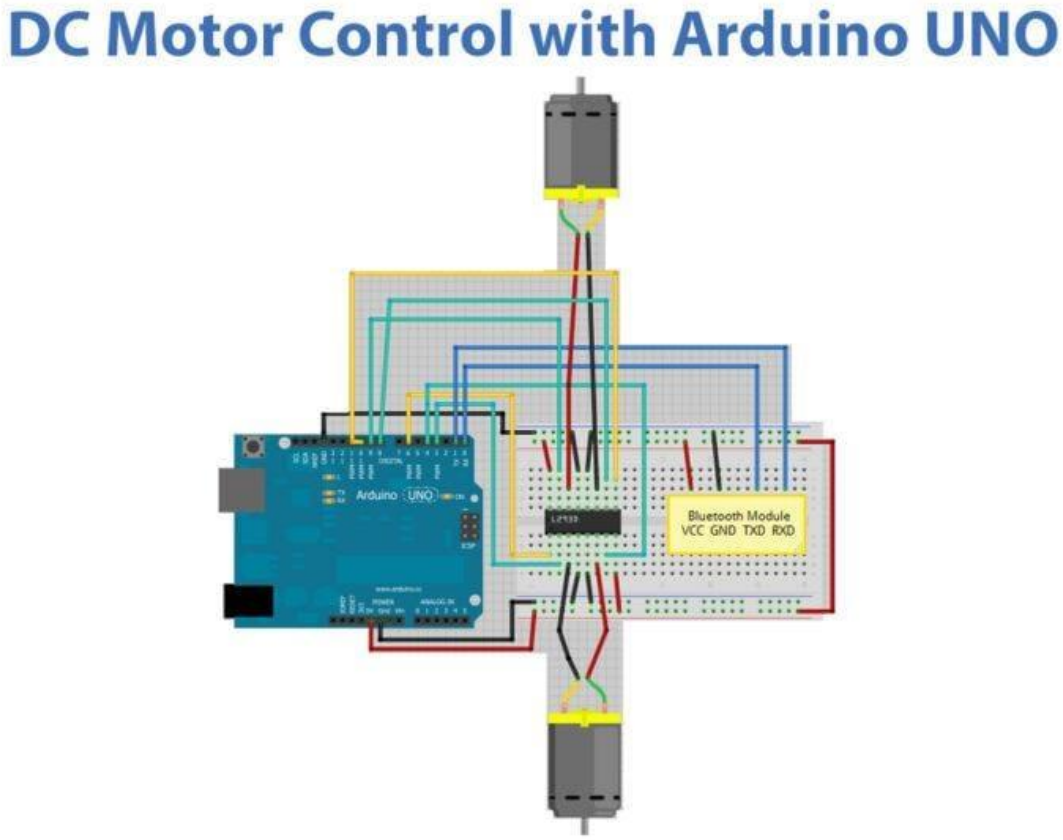
= 5-10 seconds approx.

CHAPTER 5
PROGRAMMING

```
int m1=8,m2=9,m3=10,m4=11;
int ct1,ct2,ct3,ct4,k,ct,buz=13,lt=12;
char command;
```

```
String command2;
void setup()
{
  Serial.begin(9600);

pinMode(m1,OUTPUT);pinMode(m2,OUTPUT);pinMode(m3,OUTPUT);pinMode(m4,OU
TPUT);

}

void loop()
{
  btt();

}
void btt()
{
  if(Serial.available() > 0)
  {
    command2 = Serial.readString();
    Serial.println(command2);
    if(command2=="1")
    {
     Serial.println("up1");
     digitalWrite(m1,HIGH);digitalWrite(m2,LOW);
    }
   else if(command2=="2")
   {
      Serial.println("dwn1");
      digitalWrite(m1,LOW);digitalWrite(m2,HIGH);
   }
   else if(command2=="3")
   {
      Serial.println("stop1");
      digitalWrite(m1,LOW);digitalWrite(m2,LOW);
   }
   else if(command2=="4")
   {
     Serial.println("up2");
     digitalWrite(m3,HIGH);digitalWrite(m4,LOW);
   }
   else if(command2=="5")
   {
     Serial.println("dwn2");
     digitalWrite(m3,LOW);digitalWrite(m4,HIGH);
   }
   else if(command2=="6")
   {
      Serial.println("stop2");
      digitalWrite(m3,LOW);digitalWrite(m4,LOW);
   }
  }
}
```

CIRCUIT DIAGRAM



CHAPTER-6
CONCLUSION

In new era of technology, people want something new in their life. They want every single thing they look in front of their life look sophisticated. People want something that can improve their lifestyle and help them do their job by use of robot or machine. That is why development of machine and robot is nowadays quite popular and faster in marketing. So to help and give benefit to humankind the research and development of Automatic Duster Machine is an alternative machine that can help lecturer, teacher and student to keep their duty clean a white board by using this machine.

In this project, there were some problems that occurred and must be solved to make it perfect. The problem occurs from the design is the efficiency of movement of duster machine. In order to make this machine in high performance and good condition many factor need to be considered. Development of this machine must be tough from the mechanical design, electronic design and how to control it. All factor of measurement of design must be accurate.

As conclusion, an automatic whiteboard cleaning machine was designed and fabricated using low cost material and with user friendly interface. This machine can potentially be used in class rooms to assist the teachers in keeping the whiteboards cleaned.

CHAPTER-7
FUTURE ASPECTS

Even though, automatic duster machine successfully fabricated but this machine needs some improvement to add to make this machine in high performance and comfortable to the user. Further research must be done in order to make the machine meet the specification and requirement for commercialized purpose. These are some idea for the future development of automatic white board machine.

1) Redesign the mechanical structure: in this project the design more like a prototype for this machine. To make it become reality this machine must be redesign to make it comfortable and able to apply in real world.

2) Operate in electric mode: it is an advantage when user can control the movement of duster machine by using wireless joystick user can erase the area of white board they want by control it.

3) Operate in schedule: this machine can be set up the time. It can operate automatically when we set up the time we want it work.

4) Eye of machine: we can make this machine operate with detection of dirt in whiteboard. Machine knows the location of dirty and erases it automatically.

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