FABRICATION OF AN AUTOMATIC WHITEBOARD CLEANING MACHINE

A thesis report submitted to the department of mechanical engineering for the partial fulfilment of the degree of Bachelor of Science in Mechanical Engineering.

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APPROVAL

This is to certify that the project on " **Fabrication of an Automatic Whiteboard Cleaning Machine**" By Abu Talha (ID No. ME2103025513), Saklin Mostak (ID No. ME2103025515), Md. Asfak Uddin (ID No. ME2103025519), Md. Rayhan Alom Roky (ID No. ME2103025540), Md. Abu Shahad (ID No. ME210302554) has been carried out under our supervision. The project has been carried out in partial fulfilment of the requirements of the degree of Bachelor of Science (B.Sc.) in Mechanical Engineering of years of 2025 and has been approved as to its style and contents.

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DECLERATION

We hereby declare that work presented in this project is the outcome of the investigation and research work performed by us under the supervision of Md. Minhaz Uddin, Assistant Professor of Mechanical Engineering, Sonargaon University (SU). We also declare that no part of this project and thesis has been or is being submitted elsewhere for the award any degree.

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ABSTRACT

The Automatic Whiteboard Cleaning System is an innovative solution aimed at automating the process of cleaning whiteboards in classrooms, offices, and meeting spaces. This system eliminates the need for manual erasing by using a motorized cleaning mechanism controlled by a microcontroller. It consists of an Arduino-based control unit, two DC gear motors, IR sensors, a motor driver module, and a user interface with buttons and an LCD display. The cleaning roller moves across the whiteboard using a belt-driven mechanism, powered by the motors and guided by limit sensors to detect end positions. The system supports both manual and automatic modes, allowing users to initiate cleaning with the press of a button or let the system perform full-cycle cleaning autonomously. Powered by a dual-voltage power supply, the design ensures safe operation of both logic and motor components. This project demonstrates an effective use of embedded systems and electromechanical design to improve convenience and efficiency in everyday environments.

Keywords: LCD, Arduino Uno, IR sensor, DC gear motors, Power supply.

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Chapter 1 Introduction

1.1 General

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 day. 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 bevel gear, chain and sprocket mechanism to convert the rotary motion of hand wheel into linear motion of duster. 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 labour, however, it is also used to save energy and materials and to improve quality, accuracy and precision. This thesis will contribute to the understanding of some relevant principles of magnetism and how the connection and collaboration between different components affect the outcome. This will be displayed through the resulting motion and interaction with its surroundings. The purpose of the project is to create and build an automatic whiteboard eraser that will systematically work through the whole surface and successfully remove all the ink. For this type of project to become reality, the following research questions must be answered. Due to the limited time the project is running, the scope has initially been reduced with the possibility for further development. It has been decided that the robot is supposed to run on batteries to facilitate the portability Due to the first research question listed above it is of high interest to keep the weight of the prototype minimized. These weight limitations bring a number of restrictions on the project, for example in form of choice of components. Since the concept is based on magnetism, the intended surface that the prototype operates on is magnetic.

1.2 Literature Review

Automatic Whiteboard Cleaning System: The need for automation in educational and office environments has led to the development of systems that can reduce manual tasks such as cleaning whiteboards. Various efforts have been made globally to address this problem using embedded systems and mechanical automation. This literature review highlights significant past works and developments in the field of automatic whiteboard and blackboard cleaning technologies.

Arduino and Embedded Systems (Since 2005):

Arduino, introduced in Italy in 2005, revolutionized rapid prototyping in embedded systems. Its simplicity and community support made it a popular choice in educational and hobbyist automation projects. By 2010, it became a foundation for many whiteboard cleaning systems due to its GPIO flexibility, compatibility with sensors, and ease of use.

Use of IR Sensors for Position Detection (2010 – Present):

Infrared (IR) sensor modules became popular in automation projects around 2010 for detecting object proximity and edge detection. In 2015, researchers in Japan integrated IR sensors into smart cleaning robots to detect the end of a cleaning surface. In India, a project published in *IJERT (2018)* used IR sensors for board edge detection and motor reversal in a similar cleaning project.

Motorized Cleaning Mechanisms (2012 – Present):

DC gear motors (like the 25GA) became a common choice for driving linear motion in cleaning systems from 2012 onward. In 2017, students at the University of the Philippines built a motorized blackboard eraser that operated horizontally using DC motors controlled by a microcontroller. In 2020, a paper published in *International Journal of Scientific & Engineering Research (IJSER)* discussed a belt-driven whiteboard cleaner using similar hardware and control logic.

Use of L298N Motor Driver (2000 s – Present)

The L298N dual H-bridge motor driver IC has been used extensively since the early 2000s in motor control applications. Its integration into Arduino-based cleaning projects became common around 2013. MIT's Open Course Ware projects (2014) and several online engineering communities used L298N to drive both motors of whiteboard erasers efficiently.

Manual and Automatic Control Interfaces (2012 – Present):

User interface with push buttons and LCD displays became standardized in automation projects after 2012. In 2018, a group at Bangladesh University of Engineering and Technology (BUET) developed a whiteboard cleaning system with manual and automatic modes using an Arduino Uno, push buttons, and a 16x2 LCD screen.

Previous Notable Projects Worldwide:

- **Malaysia (2017):** A student project titled "Smart Whiteboard Cleaner Using Arduino" demonstrated an automatic cleaner using DC motors and IR sensors.
- **India (2020):** Engineering students at Anna University built a zigzag whiteboard cleaning prototype and presented it at a regional tech fest.
- **Japan (2019):** A semi-commercial prototype using robotic arms and suction wheels was created to clean boards automatically, controlled by a microcontroller and AI-based vision.
- **USA (2022):** At Maker Faire California, a team demonstrated a Bluetooth-enabled whiteboard cleaner using an ESP32 and mobile app, showcasing future enhancements in connectivity.

Recent Trends (2023 – Present):

More recent prototypes have begun exploring AI vision (for detecting dirt), voice-controlled automation using Google Assistant or Alexa, and IOT integration with ESP32 microcontrollers. Some even use LiDAR for surface mapping.

1.3 Objectives

The Objectives of the Automatic Whiteboard Cleaning Project clearly and concisely stated:

I. To automate the whiteboard cleaning process using Arduino, DC motors, and IR sensors to reduce manual effort.
II. To provide both manual and automatic control modes for user flexibility and convenience.
III. To ensure accurate end-position detection of the cleaning roller using IR sensors for smooth operation.
IV. To develop a cost-effective, user-friendly system suitable for classrooms, offices, and smart environments.

1.4 Methodology

a) Sensor Integration:

Step 1: Select sensors to detect dirt, marks, or ink on the whiteboard.

Step 2: Calibrate sensors to detect dirt levels.

Step 3: Integrate sensor data into the microcontroller to trigger the cleaning mechanism.

b) Movement Control:

Step 1: Design the mechanical movement system (e.g., X-Y movement with stepper motors or a moving frame).

Step 2: Implement motor control algorithms to move the cleaning mechanism along the surface.

Step 3: Program the system to cover the entire surface of the whiteboard efficiently.

c) Cleaning Mechanism:

Step 1: Attach a soft cleaning cloth or brush to the cleaning mechanism.

Step 2: Ensure the cloth or brush is aligned properly to scrub or wipe off marks as the system moves.

d) Power and Control:

Step 1: Design the power supply to ensure sufficient power for motors, sensors, and controllers.

Step 2: Implement control logic in the microcontroller to process sensor data and control the movement of motors.

The system should be able to clean the whiteboard automatically and efficiently.The performance can be improved by refining the sensor algorithms, optimizing motor control, or enhancing the cleaning mechanism.

1.5 Structure of the Project

This project book consists of five chapters. The first chapter contains the statement of the introduction, our background study for the project, Literature Review, objectives of the study in the project, Methodology, and the project organization. Chapter two contains System design and simulation. Here we describe the design of this project, block diagram and circuit diagram, working principle, background, real project, details of components, and instrument details of the whole project. Chapter three contains the Hardware implementation. Chapter four deals with the experimental results, calculations, advantages, and application of this project. In the final chapter, we discuss about future scope and conclusion of our project.

Chapter 02 System Design and Simulation

2.1 Introduction

In this chapter we describe our project block diagram, circuit diagram, project working principle and final project view.

2.2 Block Diagram

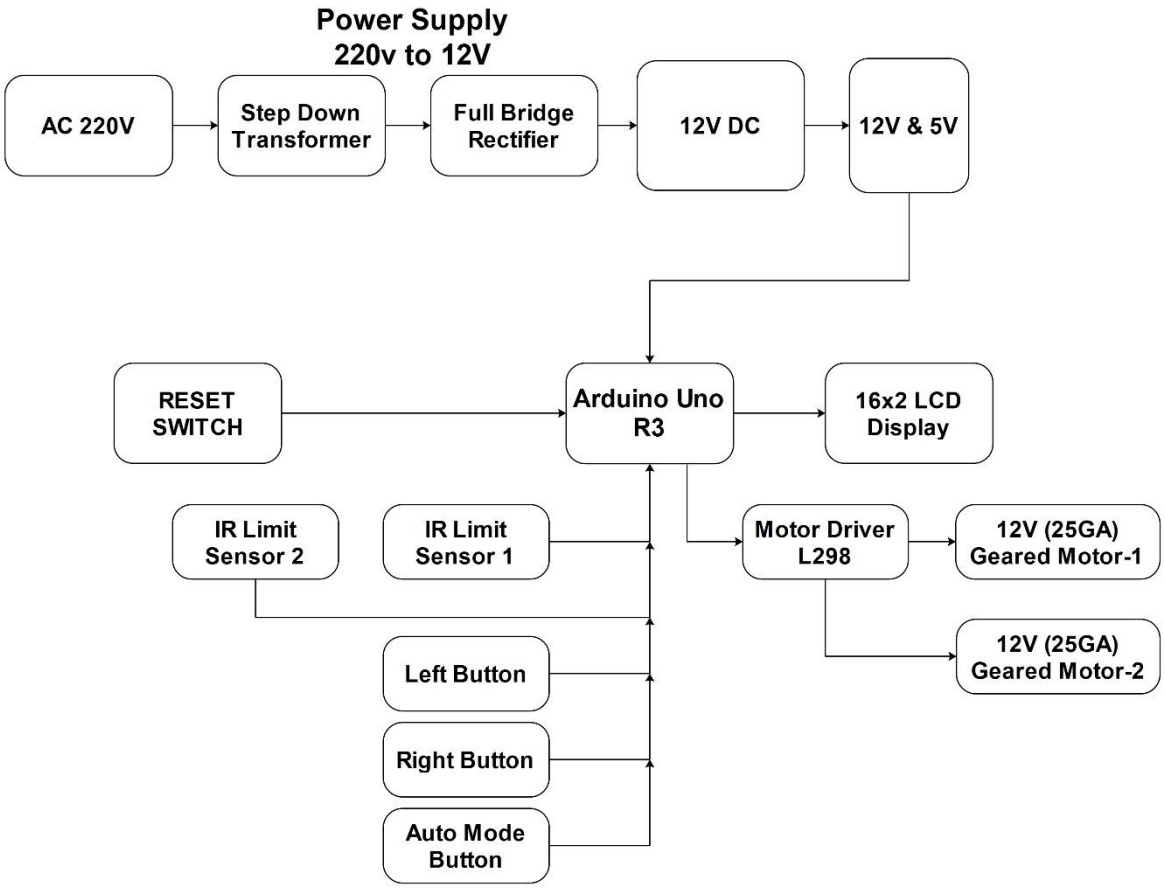


Figure 2.2: Block Diagram of Automatic Whiteboard Cleaning project.

The system starts with a 220V AC power supply, which is stepped down using a step-down transformer. This lower voltage AC is then converted to DC using a full bridge rectifier, producing a 12V DC output. The 12V DC is further regulated to supply both 12V and 5V as needed by the components in the system.

The Arduino Uno R3 acts as the brain of the system. It is powered by the regulated supply and is responsible for reading inputs, controlling outputs, and managing the overall logic of the cleaning process. Connected to the Arduino are three control buttons labeled Left, Right, and Auto Mode. These allow the user to manually control the direction of movement or initiate an automatic cleaning sequence. There is also a reset switch connected to the Arduino to restart the process if needed. Two IR limit sensors are installed on either end of the whiteboard. These sensors detect when the cleaning mechanism reaches the left or right boundary, ensuring the motors stop and reverse direction to avoid mechanical damage. The Arduino reads input from these sensors to manage motion control. The motor driver module used is the L298, which is capable of driving two 12V DC geared motors. These motors are connected to the wiper mechanism that moves across the whiteboard to perform the cleaning task. The Arduino sends control signals to the motor driver to control the direction and operation of the motors based on the button inputs or automatic sequence. A 16x2 LCD display is also connected to the Arduino to provide real-time feedback to the user. It displays information such as the system's current mode (manual or auto), motor directions, and any fault or completion messages. In operation, the user can choose to clean the board manually using the left and right buttons or press the auto mode button to let the system perform a full left-to-right and back cleaning sweep. The IR sensors ensure safe limits, and the LCD keeps the user informed throughout the process.

2.3 Working Principle

The automatic whiteboard cleaning system operates based on an embedded control mechanism using an Arduino microcontroller, which manages the movement of a duster roller across the whiteboard surface. The system integrates DC gear motors, IR sensors, a motor driver, and push buttons to perform the cleaning task efficiently. When the system is powered on, the user can choose between manual mode or automatic mode using the provided push buttons. In manual mode**,** the user can control the direction of the cleaning roller using two buttons one for forward movement and one for reverse. In automatic mode**,** once activated, the Arduino drives the motor in one direction until an IR sensor at the edge detects the end of the board. At this point, the system reverses the motor direction automatically, moving the roller to the opposite end, where another IR sensor detects the stop point. This back-and-forth movement ensures complete cleaning of the board.

The motors are driven through an L298N motor driver module, which receives signals from the Arduino to rotate the motors in the desired direction. The IR sensors are strategically placed at both ends of the board to act as limit switches, ensuring the roller stops and reverses at the correct positions. A 16x2 LCD displays the current operation mode and status, giving real-time feedback to the user.

The power supply unit converts 220V AC to 12V and 5V DC, providing the necessary voltage for the Arduino and motors.

2.4 Basic 2D Drawing of System

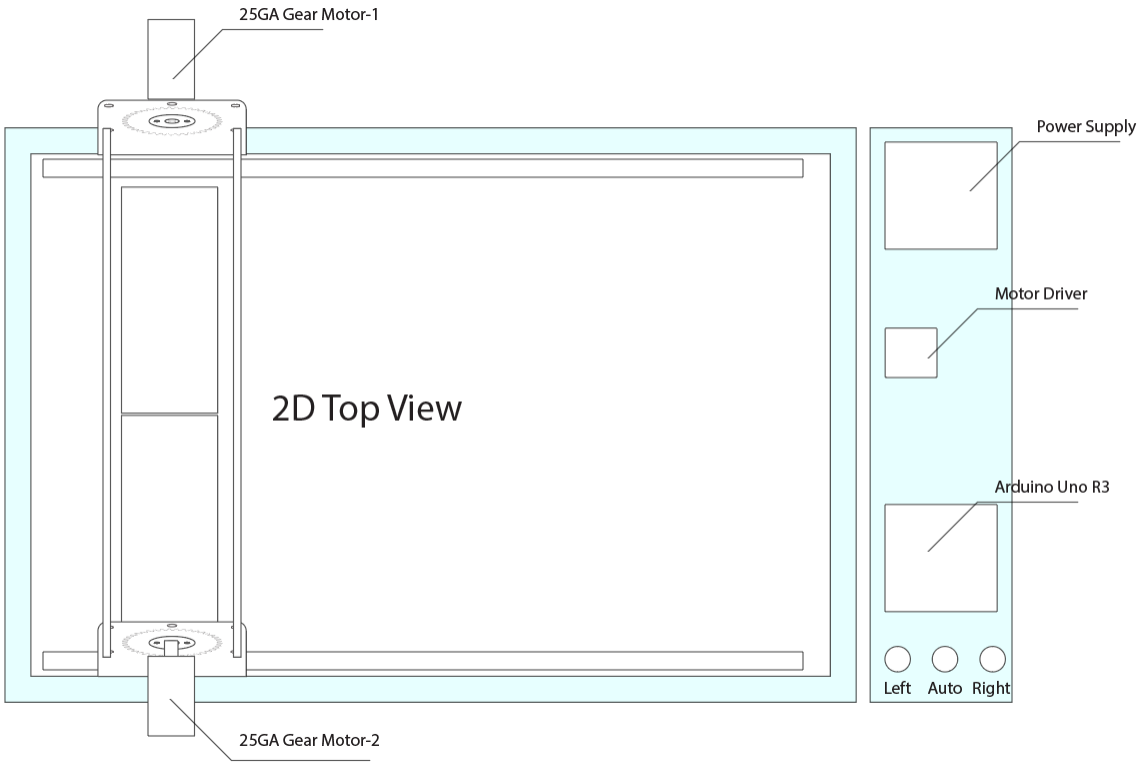


Figure 2.4: Basic Drawing of this System

This is a top-down mechanical layout of the whiteboard cleaning system. The central feature is a movable cleaning mechanism mounted horizontally across the whiteboard. The movement is achieved using two 25GA DC geared motors placed at the top-left and bottom-left corners, labelled as Gear Motor-1 and Gear Motor-2. These motors likely drive either a belt, gear rack, or threaded shaft to move the cleaning arm left and right across the board surface.

The cleaning arm spans across the width of the board and is guided along two horizontal rails or support structures to maintain alignment and stability as it moves. On the right side of the drawing is the control and electronics section, housed in a separate vertical enclosure. It includes:

- Power Supply Unit: Converts AC mains to the required DC voltages (typically 12V and 5V).
- Motor Driver Module: Most likely an L298 dual H-bridge driver that controls the two DC motors' direction and power, receiving signals from the microcontroller.
- Arduino Uno R3: The main controller responsible for interpreting button presses, limit sensor signals, and controlling motor operation.
- Push Buttons: Marked as Left, Auto, and Right, these allow manual left/right movement or initiate automatic cleaning mode.

The setup suggests that:

- Pressing "Left" or "Right" will move the cleaning arm accordingly.
- "Auto" will initiate a full sweep across the board, likely stopping at the ends using limit sensors.
- The motors on either side work together to pull or push the cleaner.

This design ensures smooth, controlled cleaning with minimal user input, and can be extended with limit switches or IR sensors (as shown in your earlier block diagram) to prevent over-travel.

2.5 Power Supply

In this project we use one 5 volt regulated power supply to convert the 220Volt ac in to 5Volt dc with the help of the 5Volt regulator circuit. First OF all, we step down the 220volt ac into 6Volt ac with the help of step down transformer.

Step down transformer step down the voltage from 220volt ac to 12Volt ac. This ac is further

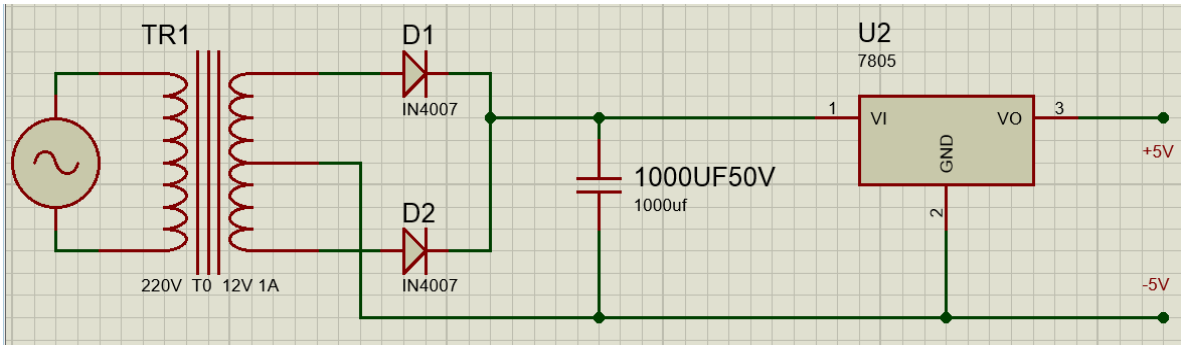


Fig -2.5: Power Supply

converted into the dc voltage with the help of the full wave rectifier circuit. Output of the diode is pulsating dc. So to convert the pulsating dc into smooth dc we use electrolytic capacitor. Electrolytic capacitor converts the pulsating dc into smooth dc. This Dc is further regulated by the IC 7805 Regulator. IC 7805 regulator provide a regulated 5Volt dc to the microcontroller circuit and LCD circuit.

As discussed in the previous section all the components required will be assembled right now to design and implement our project. A Solder, soldering wire and solder holder will be required to assemble these components according to the circuit diagram listed below.

2.6 Circuit Diagram

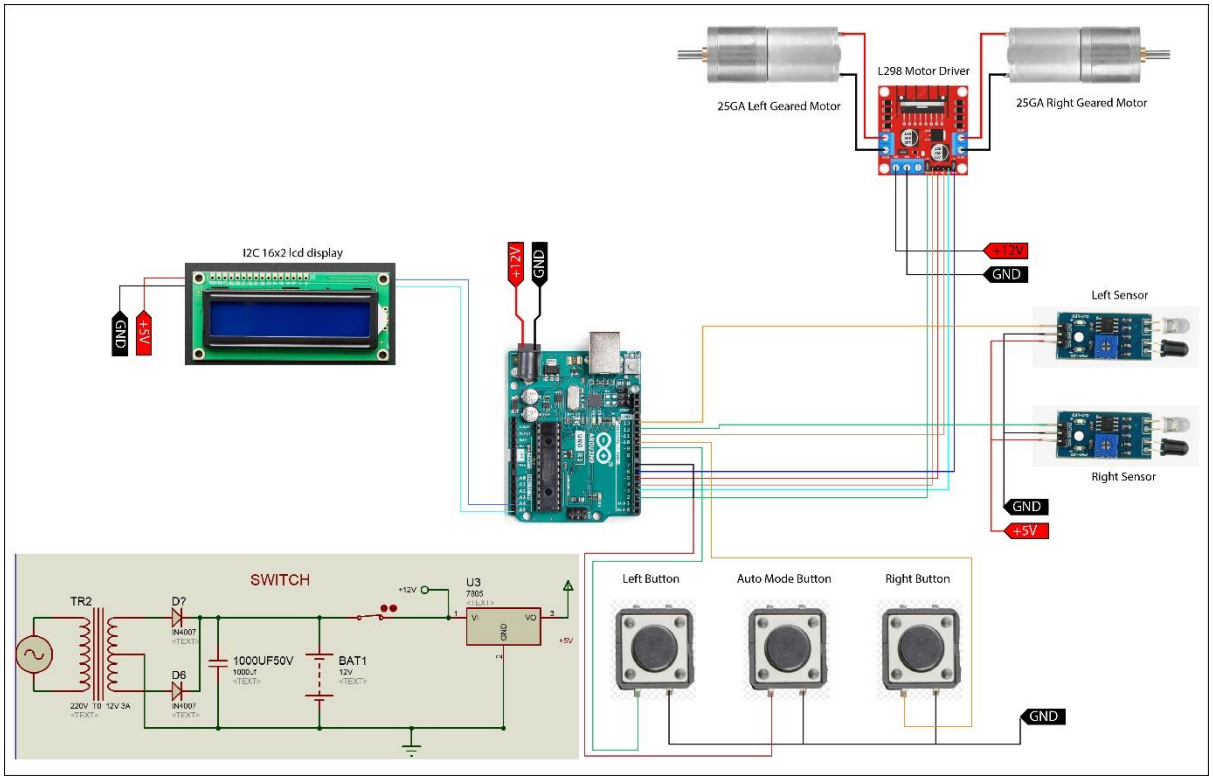


Fig -2.6: Circuit Diagram

The circuit diagram shown is for an Automatic Whiteboard Cleaning Project based on an Arduino UNO microcontroller. This system is powered by a 220V AC to 12V and 5V DC power supply. The transformer (TR2) steps down 220V AC to 12V AC, which is rectified using diodes (D6 and D7), smoothed by a 1000µF capacitor, and regulated by a 7805 voltage regulator (U3) to provide 5V DC. This regulated 5V powers the Arduino, IR sensors, and LCD display, while the 12V output is used to power the motors through the L298 motor driver. The Arduino UNO serves as the main controller. It receives input from three push buttons the left and right buttons allow manual control of the duster's direction, while the middle button enables automatic mode. In auto mode, the Arduino starts the duster's motion and uses two IR sensors (left and right) to detect when the cleaning roller has reached either end of the whiteboard. These sensors act like limit switches to reverse the motor direction.

The L298N motor driver receives control signals from the Arduino and drives two 25GA geared DC motors, one on each side of the cleaning roller. These motors are connected to a rack and pinion mechanism or belt that moves the duster horizontally across the board.

An I2C 16x2 LCD display is connected to the Arduino and shows messages like the current mode (manual or automatic) and motor status (running left, right, or stopped). Overall, when powered on, the system allows the user to either manually control the cleaning or initiate an automatic cleaning cycle, where the Arduino drives the motor until an IR sensor is triggered, indicating the end of the whiteboard has been reached. The system then automatically reverses the direction, ensuring the entire surface is cleaned effectively.

2.7 Real View of Project

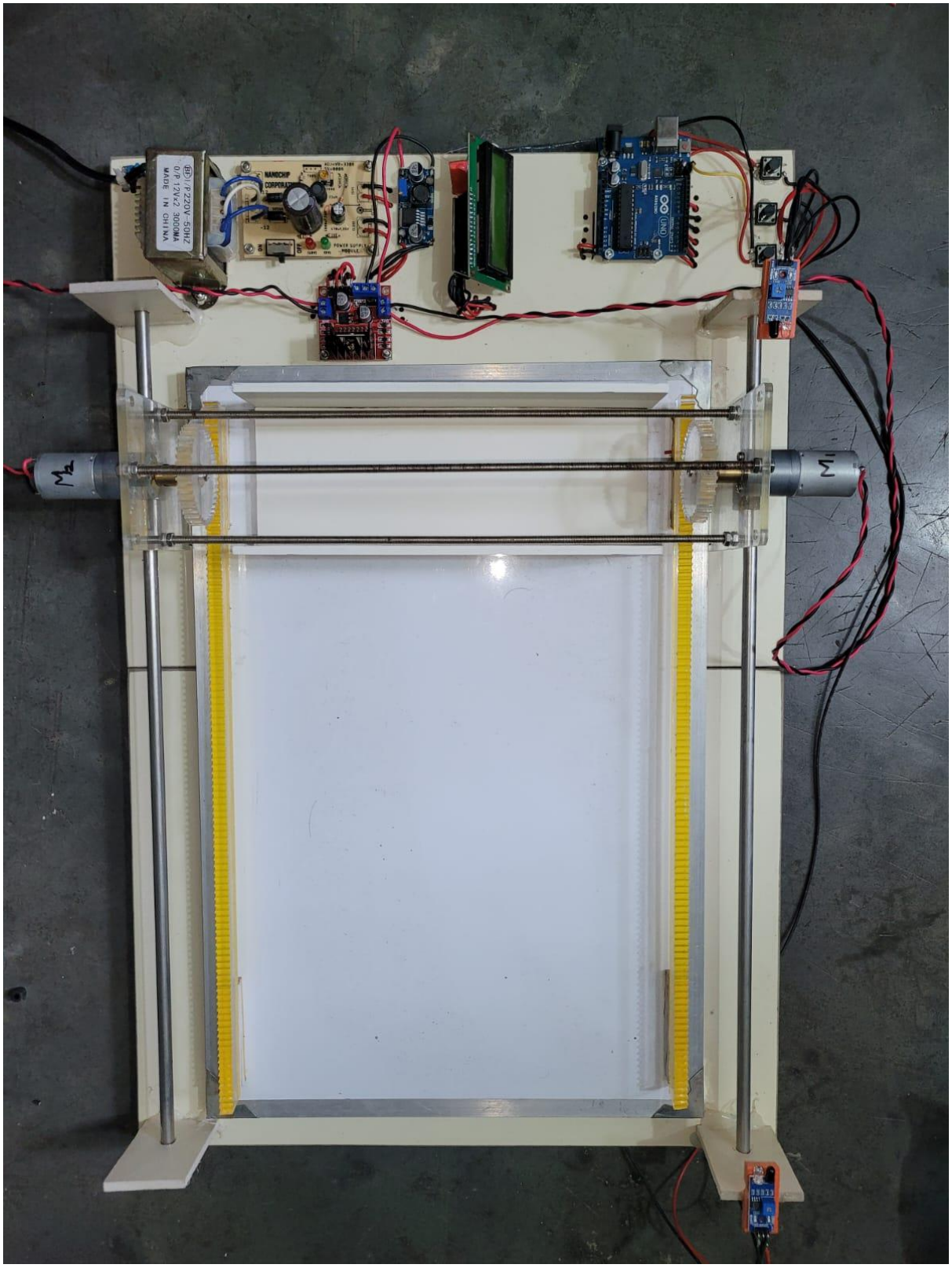


Figure 2.7: Our Project Prototype

2.8 Linear Rack and Pinion Mechanism

A spur gear meshing with a linear rack. This is a rack and pinion mechanism where rotary motion of the gear (pinion) is converted into linear motion of the rack, or vice versa.

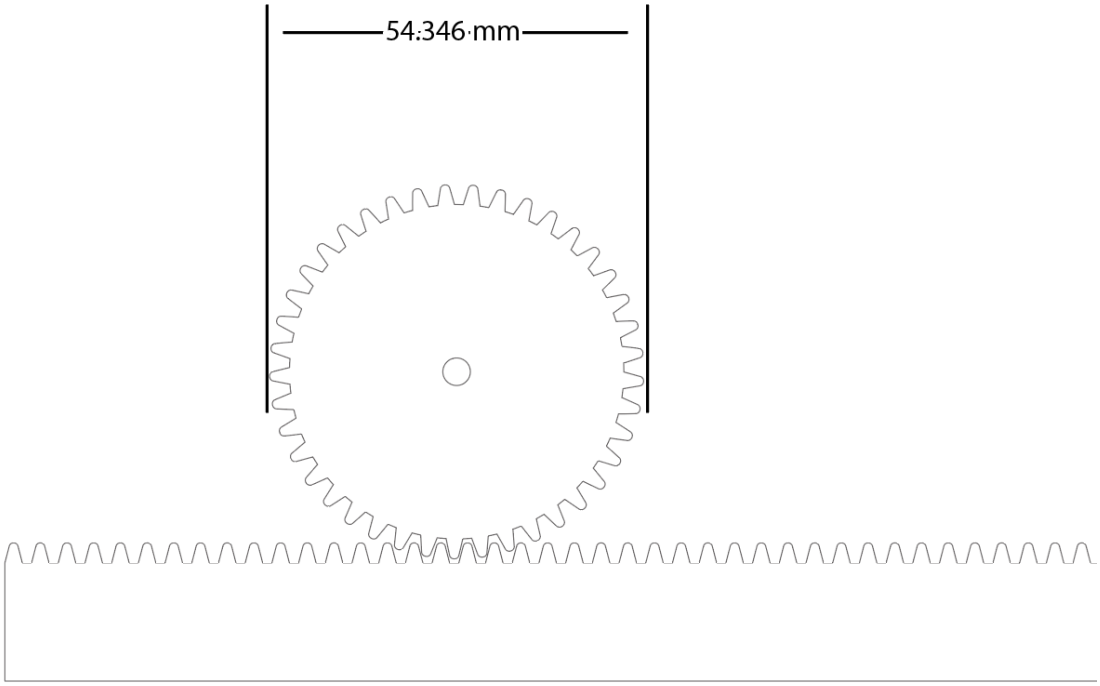


Figure 2.8: Linear Rack and Pinion Mechanism

The diameter of the gear (pinion) is labelled as 54.346 mm. This is likely the pitch diameter, which is used for gear calculations.

1. Pitch Diameter (DP):

This is given as:

DP=54.346 mm

2. Circular Pitch (p):

The circular pitch is the distance from one tooth to the corresponding point on the next tooth, measured along the pitch circle:

$p=\pi \cdot m.p$

Where mm is the module (a measure of the size of the gear teeth).

To find the module**,** you need to know either:

- The number of teeth (N)**,** or
- The circular pitch from direct measurement.

But we can rearrange the pitch diameter formula:

$$D_p = m \cdot N \Rightarrow m = \frac{D_p}{N}$$

If we can count the number of teeth on the gear in the image (let's say 36 teeth as a rough count from visual estimation), then:

$$m = \frac{54.346}{36} \approx 1.51 \text{ mm}$$

3. Linear Distance per Gear Rotation:

In a rack and pinion system, one full rotation of the gear moves the rack a distance equal to the gear's circumference**:**

$$\text{Linear travel per rotation} = \pi \cdot D_p = \pi \cdot 54.346 \approx 170.69 \text{ mm}$$

So, Motor rotates this gear once, the rack moves approximately 170.69 mm

Chapter 3 Hardware Implementation

3.1 Introduction

This Project has worked on the Hardware section. Hardware is the most visible part of any information system. Here, our main hardware is 12V DC Power supply, Roller 25GA 100RPM geared motor, Arduino Uno R3, LCD 16x2 Display module, Motor Driver L298, IR Sensor module, White Board, Wire, Cable Tie, Switch, Chamber Material, etc. This equipment will be attached and made properly.

3.2 Components List and Costing:

No	Components Name	Quantity	Unit Price	Total Price (TK)
01	LCD Display	1	300	300
02	IR Sensor module	2	200	400
03	Motor Driver L298	4	200	800
04	Power board	1	240	240
05	100RPM DC geared motor	2	300	600
06	Arduino microcontroller board	1	450	450
10	Linear Motion Bearing	1	150	150
11	Whit board	1	250	250
12	Geared motor linear	2	150	300
13	Connecting wire	30	5	150
14	220V Power supply	1	200	200
15	8mm SS rode	1	50	50
16	4mm Stainless Steel Threaded Rod	1	230	230
Total=				**4,410**

3.3 Arduino Uno R3

The Arduino Uno R3 is a microcontroller board based on the ATmega328.It has 14(Fourteen) digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

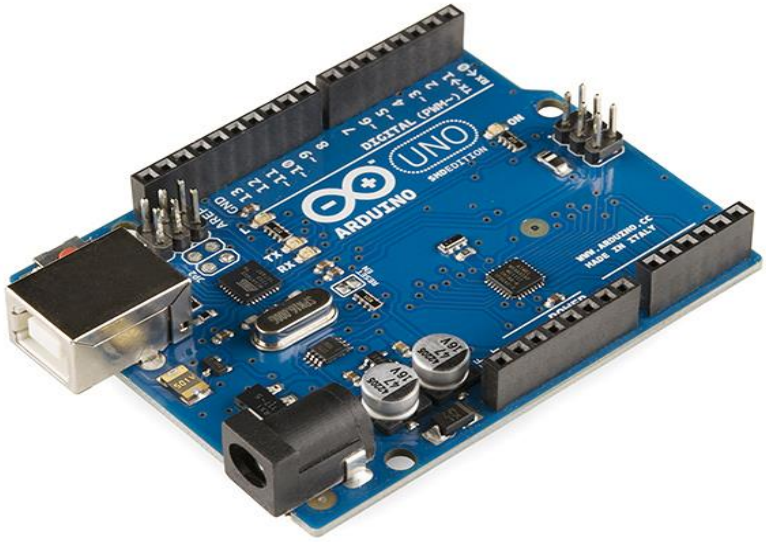


Fig: 3.3: Arduino Uno R3

For the sake of simplicity, we will make groups of pins with similar functionalities.

Power Pins there are four power pins viz. one VIN pin & three 3.3V pins. The VIN pin can be used to directly supply the Arduino Uno R3 and its peripherals, if you have a regulated 5V voltage source. The 3.3V pins are the output of an on-board voltage regulator. These pins can be used to supply power to external components.

GND is a ground pin of Arduino Uno R3 development board.

I2C Pins are used to hook up all sorts of I2C sensors and peripherals in your project. Both I2C Master and I2C Slave are supported. I2C interface functionality can be realized programmatically, and the clock frequency is 100 kHz at a maximum. It should be noted that I2C clock frequency should be higher than the slowest clock frequency of the slave device.

GPIO Pins Arduino Uno R3 has 17 GPIO pins which can be assigned to various functions such as I2C, I2S, UART, PWM, IR Remote Control, LED Light and Button programmatically. Each digital enabled GPIO can be configured to internal pull-up or pull-down, or set to high impedance. When configured as an input, it can also be set to edge-trigger or level-trigger to generate CPU interrupts.

ADC Channel The Node MCU is embedded with a 10-bit precision SAR ADC. The two functions can be implemented using ADC viz. Testing power supply voltage of VDD3P3 pin and testing input voltage of TOUT pin. However, they cannot be implemented at the same time.

UART Pins Arduino Uno R3 has 2 UART interfaces, i.e. UART0 and UART1, which provide asynchronous communication (RS232 and RS485), and can communicate at up to 4.5 Mbps. UART0 (TXD0, RXD0, RST0 & CTS0 pins) can be used for communication. It supports fluid control. However, UART1 (TXD1 pin) features only data transmit signal so, it is usually used for printing log.

SPI Pins Arduino Uno R3 features two SPIs (SPI and HSPI) in slave and master modes. These SPIs also support the following general-purpose SPI features:

- 4 timing modes of the SPI format transfer
- Up to 80 MHz and the divided clocks of 80 MHz
- Up to 64-Byte FIFO

SDIO Pins Arduino Uno R3 features Secure Digital Input/output Interface (SDIO) which is used to directly interface SD cards. 4-bit 25 MHz SDIO v1.1 and 4-bit 50 MHz SDIO v2.0 are supported.

PWM Pins The board has 4 channels of Pulse Width Modulation (PWM). The PWM output can be implemented programmatically and used for driving digital motors and LEDs. PWM frequency range is adjustable from 1000 µs to 10000 µs, i.e., between 100 Hz and 1 kHz.

Control Pins are used to control Arduino Uno R3. These pins include Chip Enable pin (EN), Reset pin (RST) and WAKE pin.

- EN pin – The Arduino Uno R3 chip is enabled when EN pin is pulled HIGH. When pulled LOW the chip works at minimum power.
- RST pin – RST pin is used to reset the Arduino Uno R3 chip.
- WAKE pin – Wake pin is used to wake the chip from deep-sleep.

Technical specifications:

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pin	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB(ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz

The ATmega328 is a single chip micro-controller created by Atmel and belongs to the mega AVR series. Today the ATmega328 is commonly used in many projects and autonomous systems where a simple, low-powered, low-cost micro-controller is needed. Perhaps the most common implementation of this chip is on the popular Arduino development platform, namely the Arduino Uno and Arduino Nano models. Key features of this device is as below.

- 28-pin AVR Microcontroller
- Flash Program Memory: 32 k bytes
- EEPROM Data Memory: 1 k bytes
- SRAM Data Memory: 2 k bytes

- I/O Pins: 23
- Timers: Two 8-bit / One 16-bit
- A/D Converter: 10-bit Six Channel
- PWM: Six Channels
- RTC: Yes with Separate Oscillator
- MSSP: SPI and I²C Master and Slave Support
- USART: Yes
- External Oscillator: up to 20MHz

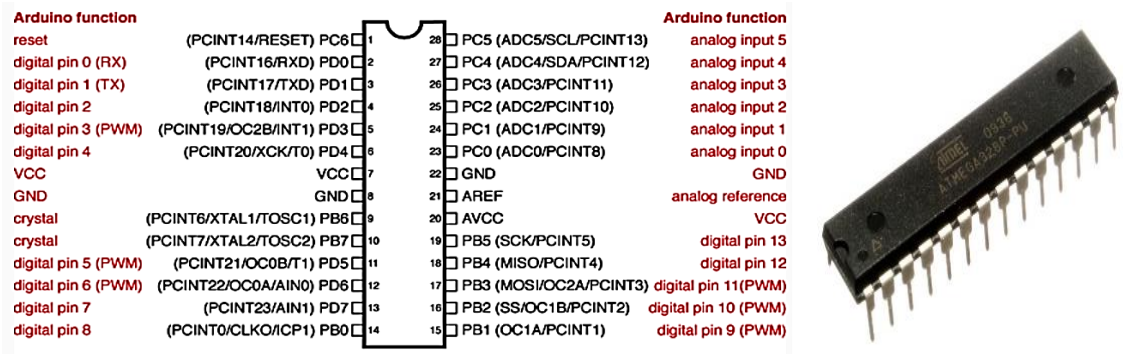


Fig: 3.2: ATMEGA328P-PU chip to Arduino Pin Mapping

3.4 Power Supply

A bridge rectifier circuit is a common part of the electronic power supplies. Many electronic circuits require rectified DC power supply for powering the various electronic basic components from available AC mains supply. We can find this rectifier in a wide variety of electronic AC power devices like home appliances, motor controllers, modulation process, welding applications, etc.

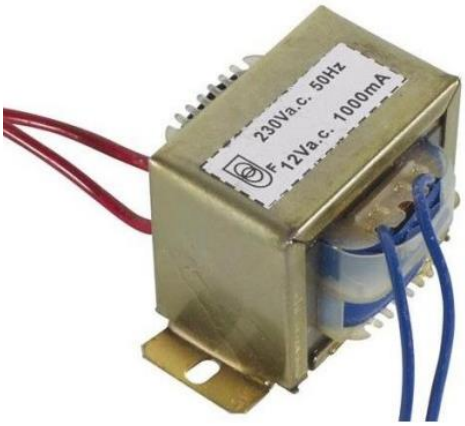


Fig: 3.4.1 220/12V Transformer

The bridge rectifier circuit diagram consists of various stages of devices like transformer, Diode Bridge, filtering and regulators. The first stage of the circuit is a transformer which is a step-down type that changes the amplitude of the input voltage. Most of the electronic projects uses 230/12V transformer to step-down the AC mains 230V to 12V AC supply. Next stage is a diode-bridge rectifier which uses four or more diodes depending on the type of bridge rectifier.

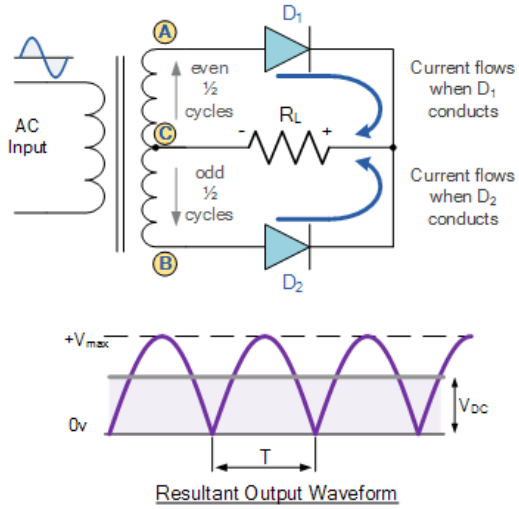


Fig: 3.4.2 Output Waveforms of 220V/12V rectifier

Choosing a particular diode or any other switching device for a corresponding rectifier needs some considerations of the device like Peak Inverse Voltage (PIV), forward current If, voltage

ratings, etc. It is responsible for producing unidirectional or DC current at the load by conducting a set of diodes for every half cycle of the input signal.

Since the output after the diode bridge rectifiers is of pulsating nature, and for producing it as a pure DC, filtering is necessary. Filtering is normally performed with one or more capacitors attached across the load, as you can observe in the below figure wherein smoothing of wave is performed. This capacitor rating also depends on the output voltage.

3.5 Voltage Regulator IC 7805

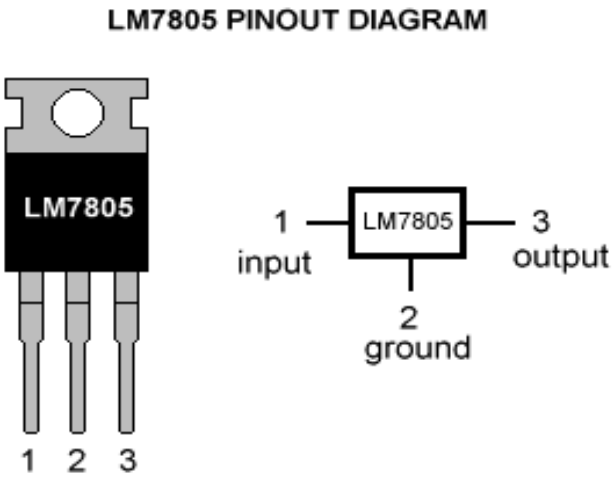


Fig: 3.5. LM7805 pin out diagram

As we require a 5V we need LM7805 Voltage Regulator IC.

7805 IC Rating:

Input voltage range 7V- 35V

Current rating I_c = 1A

Output voltage range $V_{Max=5.2V}$, $V_{Min=4.8V}$

3.6 Vero board

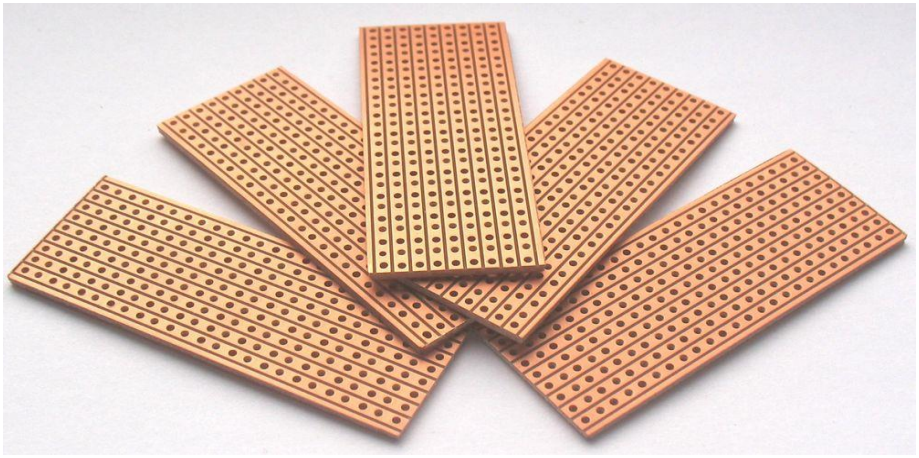


Fig: 3.6 Vero board

Vero board is a brand of strip board, a pre-formed circuit board material of copper strips on an insulating bonded paper board which was originated and developed in the early 1960s by the Electronics Department of Vero Precision Engineering Ltd (VPE). It was introduced as a general-purpose material for use in constructing electronic circuits - differing from purpose-designed printed circuit boards (PCBs) in that a variety of electronic circuits may be constructed using a standard wiring board.

3.7 Automatic Seed Sowing System



Fig: 3.7 Automatic Seed Sowing System

The roller mechanism used in your Automatic Whiteboard Cleaning Project, driven by two 25GA 100RPM geared DC motors labelled M1 and M2, mounted on either side of the whiteboard frame.

- **Twin Shaft Rods**:
  Two parallel steel shafts support and guide the roller frame, ensuring smooth linear movement across the whiteboard.
- **Duster Mounting**:
  A cleaning roller or duster is attached to the transparent frame that slides left and right to clean the whiteboard.
- **Gear and Belt System**:
  The yellow rack-and-pinion (gear track) setup converts the rotary motion of the motors into linear motion. Each motor drives a gear that meshes with the gear strip fixed along the side rails.
- **25GA 100RPM Geared Motors**:
  These motors provide high torque at a controlled 100 RPM, ideal for moving the cleaning roller slowly and smoothly.
- **25GA** refers to the motor's diameter (25 mm), a compact yet powerful option for such mechatronic applications.
- **100 RPM** ensures the roller moves at a moderate speed, balancing cleaning efficiency and motor strain.
- **Synchronized Operation**:
  The Arduino controls both motors simultaneously via the L298N motor driver. When operating in automatic mode, the motors drive the roller in one direction until an IR sensor triggers, then reverse it for a complete cleaning cycle.

3.8 LCD Display (16x2)

LCD (Liquid Crystal Display) is an electronic display module and find a wide range of applications. A 16x2 LCD display is a very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A **16x2 LCD** means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in the 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting

the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about the internal structure of an LCD.

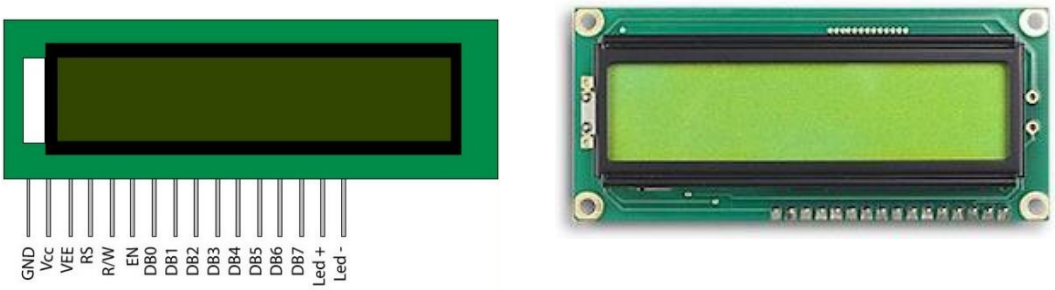


Fig: 3.8 LCD Display

Pin Description:

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	V_{EE}
4	Selects command register when low, and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0 DB1 DB2 DB3 DB4 DB5 DB6 DB7
8	Backlight V_{CC} (5V)	Led+
9	Backlight Ground (0V)	Led-

3.9 L298 Motor Driver

Here is the explanation of the L298 Motor Driver Module using bullet points:

Dual H-Bridge Driver:

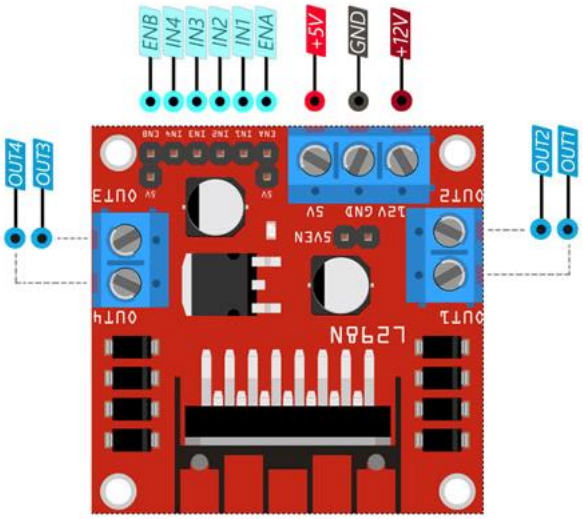


Fig: 3.9 L298 Motor driver module

- The L298N is a dual H-bridge motor driver IC, meaning it can control the direction and speed of two DC motors or one stepper motor independently.
- **Voltage and Current Handling**:
  It can handle motor voltages from 5V to 46V and current up to 2A per motor channel, making it suitable for small to medium-sized motors.
- **Control Inputs**:
  - IN1 and IN2 control Motor A
  - IN3 and IN4 control Motor B

    These inputs are connected to a microcontroller (like Arduino) to set motor direction.
- **Enable Pins**:
  - ENA enables/disables Motor A

ENB enables/disables Motor B

These pins can also receive PWM signals to control motor speed.

3.10 IR Sensor Module



Fig: 3.10 IR Sensor Module

Arduino 5V IR Sensor Module Specifications

Feature	**PIR Motion (HC-SR501)**	**IR Proximity (TCRT5000)**	**IR Receiver (TSOP38238)**	**IR Beam Break (KY-008)**
Operating Voltage	5V-12V (5V optimal)	3-5V (5V compatible)	2.5-5.5V (5V ideal)	5V only
Current Draw	65µA (idle), 8mA active	20mA (LED) + 5mA output	0.5mA (standby)	30mA (LED)
Output Type	Digital (TTL)	Digital (TTL)/Analog	Digital (demodulated)	Digital (TTL)
Detection Range	3-7m (adjustable)	1-25mm	10-15m (remote)	10-30cm
Response Time	0.3-5s (adjustable)	<10ms	<100µs	Instant
Interface	Single digital pin	Analog/Digital pin	Digital pin	Digital pin
Modulation	N/A	N/A	38kHz carrier	N/A
LED Indicator	Yes (red)	Yes (red/green)	No	Yes (IR emitter)
Dimensions	32×24×18mm	15×10×5mm	17×10×7mm	18×15×10mm
Special Features	Sensitivity & delay pots	Ambient light compensation	NEC protocol support	Requires reflector

Arduino Connection Guide:

IR Proximity Sensor:

VCC → 5V

OUT → Arduino Pin

GND → GND

3.11 25GA 100 RPM geared motor

A gear motor (or geared motor) is a small electric motor (AC induction, permanent magnet DC, or brushless DC) designed with an integral (non-separable) gear reducer (gearhead) attached. The end shield on the drive end of the motor (light blue, below) is designed to provide a dual function. The side facing the motor provides the armature/rotor bearing support and a sealing provision through which the integral rotor or armature shaft pinion passes. The other side of the motor end shield provides multiple bearing supports for the gearing itself, and a sealing and fastening provision for the gear housing (orange, below).



Fig: 3.11 25GA 100 RPM geared motor

DC motor were the first form of motor widely used, as they could be powered from existing direct current lighting power distribution systems. A DC motor's speed cam be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but it's a lightweight brushed motor used for portable power tools and appliances.

Parameter	**Specification**
Motor Type	Permanent Magnet DC Geared Motor
Gearbox Type	Spur/Planetary (typically metal gears)
Output RPM	100 RPM (±10%) at rated voltage
Rated Voltage	6V or 12V DC (verify model-specific)
No-Load Current	60-100 mA
Stall Current	500-800 mA (varies by model)
Rated Torque	2-3 kg.cm (0.2-0.3 Nm)
Stall Torque	5-8 kg.cm (0.5-0.8 Nm)
Gear Ratio	~1:120 to 1:150 (varies by model)
Shaft Type	D-shaped or round (6mm diameter)
Shaft Length	10-15 mm

Electrical Characteristics

Parameter	Value
Operating Voltage Range	3V (min) - 12V (max)
Rated Power	1.5W - 3W
Encoder Option	Some models include quadrature encoder
Rotation Direction	Reversible (flip polarity to reverse)

Mechanical Specifications

Parameter	Value
Body Diameter	25mm (standard "GA" size)
Length (without shaft)	~40mm
Weight	150-200 grams
Gear Material	Metal (brass/steel) or nylon
Bearing Type	Sleeve or ball bearing
Mounting Holes	M2 or M3 threaded holes (front flange)

Performance Characteristics

Parameter	Value
Efficiency	~60-70%
Start Voltage	1.5V (minimum)
Noise Level	<45 dB (at rated load)
Lifespan	500-1000 hours (continuous operation)

Thermal Specifications

Parameter	Value
Operating Temperature	-10°C to +60°C
Max Winding Temp	+85°C (before damage occurs)

Connection Details

Wire Gauge	22-24 AWG
Connector Type	JST, bare wires, or terminal blocks
Standard Wire Length	15-20 cm

Typical Applications

Robotics (wheel drives, robotic arms)

Automation (conveyor belts, feeders)

DIY Projects (camera sliders, automatic doors)

Educational Kits (Arduino/RPI motor projects)

Chapter 4 Result and Discussion

4.1 Results:

The Automatic Whiteboard Cleaning Machine project demonstrated successful functionality during testing. The cleaning roller, powered by two 25GA 100RPM geared motors, was able to travel smoothly across the whiteboard surface and effectively remove marker ink. The infrared sensors placed at both ends of the track accurately detected the roller's position, ensuring the system could automatically reverse direction without requiring manual intervention. In manual mode, the user could control the direction of the roller using physical push buttons, which responded reliably and offered smooth operation. The automatic mode performed full cleaning cycles, with the Arduino Uno correctly processing sensor input and sending appropriate control signals to the L298N motor driver module. The motor driver supplied sufficient current to the motors and operated within safe temperature and voltage ranges. The 16x2 LCD display provided real-time feedback about the system's operating mode and direction of movement, adding user-friendly visibility to the process. The roller mechanism maintained good contact with the whiteboard, and the overall cleaning process was efficient and consistent. This confirms that the project meets its primary goal of reducing manual effort in cleaning whiteboards while maintaining reliable performance.

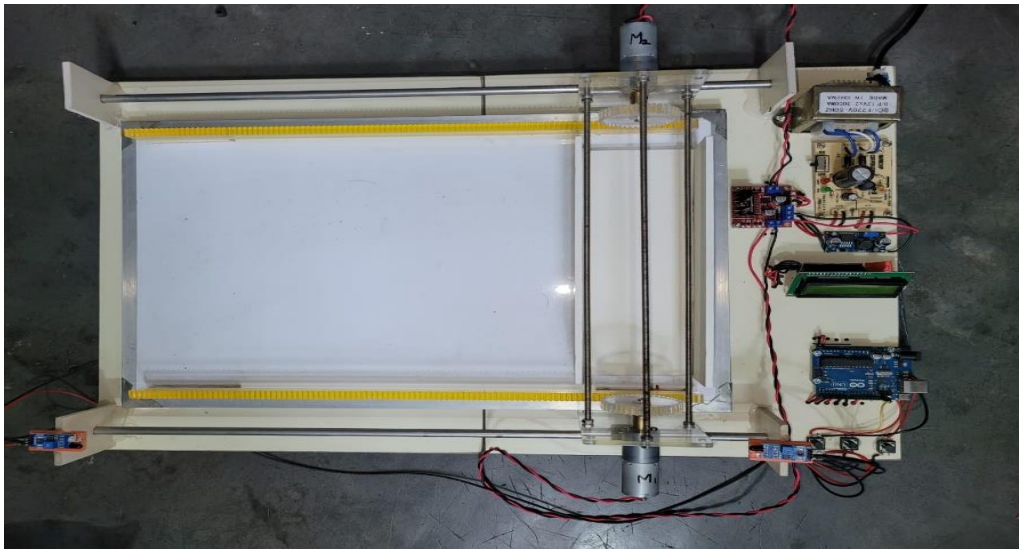


Fig: 4.1: Automatic Whiteboard Cleaning Machin

4.2 Cleaning Roller speed:

Given:

- **Pitch diameter of gear (pinion)** = 54.346 mm
- **Linear travel per full gear rotation** = π × 54.346 ≈ **170.69 mm**
- **Motor speed** = 100 RPM (rotations per minute)

Linear Speed Calculation

Each rotation of the gear moves the rack 170.69 mm.
So, at 100 RPM:

$$\text{Linear speed} = 100 \times 170.69 = 17,069 \text{ mm/min}$$

Converting to mm/sec:

$$\text{Linear speed} = \frac{17,069}{60} \approx 284.48 \text{ mm/sec}$$

Final Result:

- **The rack (and therefore the wiper)** will move **approximately 284.48 mm/sec** at full speed.

4.3 Data Table:

The teachers waste time in erasing the whiteboard in classroom as the previous board has no automatic cleaning function.

Table 1. Time taken for Manual Whiteboard Cleaning and using Automatic Cleaner Reading Time (second).

Serial No.	**Manual Whiteboard (second)**	**Automatic Cleaner(second)**
1	8.50	4.77
2	8.90	4.50
3	9.00	4.13
Average	**8.80**	**4.46**

4.4 Discussion:

The prototype system demonstrated a reliable and effective approach to automating the task of whiteboard cleaning. During testing, the duster roller successfully traveled across the whiteboard, driven by two 25GA 100RPM geared motors, and removed marker ink consistently in a single pass. The inclusion of infrared (IR) sensors at both ends of the whiteboard allowed the system to detect the roller's position accurately, enabling automatic reversal without requiring user involvement. This ensured continuous and complete cleaning coverage.

In manual mode, the system responded accurately to user input via the control buttons, allowing full manual override or assistance when needed. The automatic mode operated as intended, completing full cleaning cycles with proper stops and directional changes. The L298N motor driver delivered steady current to the motors and remained within safe thermal and electrical limits, confirming its suitability for this application.

The Arduino Uno acted as the control unit, efficiently processing sensor data and issuing motor commands. The 16x2 LCD displayed relevant operational information, making the system user-friendly and transparent in its actions. The mechanical design of the roller and its mounting ensured firm and consistent contact with the board surface, which is critical for effective cleaning.

Overall, the system worked reliably under both manual and automatic modes, reducing the time and effort typically required for whiteboard cleaning. These results validate the effectiveness of the proposed design and highlight its potential for real-world implementation in classrooms, offices, and conference rooms.

Chapter 5 Conclusion

5.1 Conclusion

The Automatic Whiteboard Cleaning Machine has proven to be an efficient and practical solution for replacing the manual effort of cleaning whiteboards. Based on experimental results, the system effectively reduces cleaning time by nearly 50% compared to manual methods. At higher motor speeds, the cleaning process becomes significantly faster while maintaining accuracy and coverage. The use of IR sensors ensures precise detection of the roller's position, and the L298 motor driver module, combined with an Arduino controller, provides smooth and reliable motor operation. This system is especially beneficial in educational institutions and office environments where frequent board cleaning is required, ultimately saving time, minimizing human effort, and enhancing operational efficiency. The project demonstrates the successful integration of mechanical design and embedded electronics to solve a real-world problem.

5.2 Advantages

- **Time-saving**: The system cleans the whiteboard faster than manual cleaning, increasing class or meeting efficiency.
- **Labour-saving**: No human effort is required for cleaning; ideal for schools, offices, or smart classrooms.
- **Consistency**: Provides uniform and complete cleaning without leaving residue, unlike inconsistent manual wiping.
- **User-friendly operation**: With a simple button-based or automated control system, it is easy for anyone to operate.

5.3 Disadvantages

- **Initial cost**: The setup may have a higher upfront cost compared to traditional manual boards.
- **Power dependency**: The system relies on continuous power supply to function, which may be a limitation during outages.

5.4 Application:

- School.
- College.
- University
- Training Institute.

5.5 Future Scope:

- In the future it can be improved by using more sensors.
- Add Bluetooth or Wi-Fi capability for remote operation via smartphone or remote control, increasing user convenience.
- Incorporate both dry and wet cleaning options to handle different types of marker stains and ensure a more thorough cleaning.
- Use a real-time clock (RTC) module to schedule automatic cleaning at specific times during the day without user intervention.
- Integrate rotary encoders or limit switches for precise position tracking and improved motion control of the cleaning roller.
- Replace the 16x2 LCD with a larger display or touchscreen to provide better interaction and display system status clearly.
- Redesign the hardware to be more compact and modular for easier installation, maintenance, and integration in different environments.
- Optimize the motor and gear system to reduce noise and increase energy efficiency for smoother operation.
- Add a system to collect the dust or ink residues after cleaning to avoid mess and improve hygiene.

REFERENCES

These references include previous research, technical resources, and components commonly used in similar automation and robotics systems:

1. S. B. Gawande, S. V. Golait, and P. R. Deshmukh, "A Review on Design and Development of Automatic Whiteboard Cleaner," *International Journal of Innovative Research in Science, Engineering and Technology (IJIRSET)*, Vol. 4, Issue 6, June 2015.
2. A. P. Ghadge, A. R. Adhav, S. S. Jadhav, and N. D. Patil, "Automatic Smart Whiteboard Cleaner," *International Journal of Research in Engineering, Science and Management (IJRESM)*, Vol. 3, Issue 4, April 2020.
3. Arduino. "Arduino UNO Rev3." https://store.arduino.cc/usa/arduino-uno-rev3 (Accessed 2024).
4. L298N Motor Driver Module Datasheet, STMicroelectronics, https://www.st.com/en/motor-drivers/l298.html (Accessed 2024).
5. M. R. Arya and A. Khanna, "Automation Using Arduino: Smart Cleaner System," *International Journal of Computer Applications*, Vol. 182, No. 35, November 2018.
6. R. Sharma, P. Jain, and A. Goel, "Smart Whiteboard Cleaner Using IoT," *International Journal of Scientific Research in Engineering and Management (IJSREM)*, Vol. 6, Issue 2, February 2022.
7. D. Smith and J. Turner, *Robotics and Automation Handbook*, CRC Press, 2019.
8. M. J. Kranz, "Automated Classroom Technologies: A Study on Smart Boards and Cleaning Systems," *IEEE Conference on Educational Technology and Automation*, 2021.
9. K. Patel, R. Mehta, and A. Shah, "Design and Implementation of Automatic Duster for Whiteboard," *International Research Journal of Engineering and Technology (IRJET)*, Vol. 6, Issue 3, March 2019.
10. S. Gupta, "Low-cost Automation in Classrooms: An Arduino Based Approach," *International Journal of Engineering Research & Technology (IJERT)*, Vol. 7, Issue 12, December 2018.
11. A. Jadhav, R. More, and V. Kulkarni, "Automated Whiteboard Cleaner Using IR Sensors and DC Motors," *International Journal of Science and Research (IJSR)*, Vol. 9, Issue 1, January 2020.