A Project Report

on

DIRT DEFENDER CEILING FAN

Submitted in partial fulfillment of the requirements

for the award of degree of

BACHELOR OF TECHNOLOGY

in

Information Technology

by

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(NAAC 'A' Grade & NBA Accredited- ECE, EEE, CSE & IT)

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DECLARATION

We hereby declare that the work presented in this project entitled **"DIRT DEFENDER CEILING FAN"** submitted towards completion of Major Project in IV year II sem of B.Tech IT at "BVRIT HYDERABAD College of Engineering for Women", Hyderabad is an authentic record of our original work carried out under the esteemed guidance of Ms. D. Sangeetha, Assistant Professor, Department of Information Technology.

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CERTIFICATE

This is to certify that the Project report on **“ DIRT DEFENDER CEILING FAN ”** is a bonafide work carried out by **P.Neela (20WH1A1202), K.Mounika (20WH1A1222), B.Anika (20WH1A1232)** and **P. Akshitha (20WH1A1260)** in the partial fulfillment for the award of B.Tech degree in **Information Technology, BVRIT HYDERABAD College of Engineering for Women, Bachupally, Hyderabad** affiliated to Jawaharlal Nehru Technological University, Hyderabad under my guidance and supervision.

The results embodied in the project work have not been submitted to any other university or institute for the award of any degree or diploma.

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ABSTRACT

Dirt Defender Ceiling Fan system, a revolutionary approach to simplify the upkeep of ceiling fans commonly found in homes and commercial spaces. In response to the persistent issue of fan blades accumulating dust and debris, which can not only diminish their efficiency but also present a daunting cleaning task, this innovative system employs cutting-edge technology and design features to provide a practical solution. The heart of the system lies in its ability to autonomously detect dust accumulation through specialized sensors, akin to the way our eyes perceive things. When these sensors identify a significant amount of dust on the fan blades, they promptly send a message to a dedicated mobile app specifically tailored for self-cleaning ceiling fans. Users are then empowered to take control with a simple tap on the app, initiating the cleaning process. This operation relies on clever mechanical components that employ small brushes or rubber wipers to gently and effectively clean the fan blades, ensuring they remain dust-free. What sets this system apart is its integrated dust collection mechanism, wherein the removed dust is efficiently stored in a designated container. This collected dust can be effortlessly released at the user's discretion, eliminating the need for manual cleaning and the associated hassles.

Keywords: Self-cleaning ceiling fans, Specialized sensors, Cutting-edge technology, Cleaning task, Integrated dust collection, User control.

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1. INTRODUCTION

The Dirt Defender Ceiling Fan system represents a groundbreaking innovation set to redefine the realm of fan maintenance. This visionary system introduces a transformative approach to preserving the cleanliness and efficiency of ceiling fans, seamlessly blending state-of-the-art technology with pragmatic design principles.

Addressing the enduring challenge of dust accumulation on fan blades, this system pioneers a revolutionary method by harnessing specialized sensors that mimic the perceptual capabilities of the human eye. These sensors autonomously detect the buildup of dust, marking a significant departure from traditional manual inspection methods.

By harnessing the power of a dedicated mobile application, users are bestowed with unprecedented control over the cleaning process. With a simple tap on their mobile device, users can initiate the cleaning cycle, thereby eliminating the labor-intensive and time-consuming task of manual intervention.

The system's ingenious mechanical components, such as small brushes or rubber wipers, work in harmony to deliver gentle yet remarkably effective cleaning. This meticulous cleaning regimen optimizes fan performance and longevity without inconveniencing users with complex maintenance procedures.

Moreover, the integration of an innovative dust collection mechanism represents a paradigm shift in fan upkeep. By efficiently storing removed dust in a designated container, the system offers users unparalleled convenience, ensuring a hassle-free experience in maintaining pristine fan blades.

1.1. Motivation

The motivation driving the development of the Dirt Defender Ceiling Fan system stems from the inherent challenges of maintaining ceiling fans. Dust accumulation on fan blades poses a significant issue, impacting both fan efficiency and the arduousness of cleaning. Recognizing the inconvenience and time-consumingnature of traditional cleaning methods, this innovative system is designed to simplify the maintenance process by proactively detecting dust accumulation through advanced sensors.

This proactive approach not only streamlines fan upkeep but also contributes to sustainability by reducing energy wastage associated with dust-laden blades. Moreover, by incorporating user-friendly controls via a dedicated mobile app and integrating a smart dust collection mechanism, the system aims to alleviate the burden of manual cleaning while ensuring optimal fan performance. Ultimately, the motivation behind the Dirt Defender Ceiling Fan system is to redefine fan maintenance, offering users a hassle-free and efficient solution that enhances fan longevity and performance.

1.2. Objective

The primary objective driving the development of the Dirt Defender Ceiling Fan system is to redefine and streamline the maintenance process of ceiling fans. This innovative system aims to revolutionize fan upkeep by utilizing cutting-edge technology, including specialized sensors, to autonomously detect dust accumulation on fan blades. Through this proactive approach, the system seeks to reduce the need for manual cleaning, ensuring optimal fan performance while prolonging the fan's lifespan. Additionally, the integration of a dedicated mobile app empowers users to effortlessly initiate the cleaning process with a simple tap, providing a user-friendly experience. The system's mechanical components, such as brushes or wipers, facilitate gentle and effective cleaning, optimizing fan efficiency without requiring constant user intervention. Moreover, the innovative dust collection mechanism efficiently stores removed dust, eliminating the inconvenience of manual cleaning and enhancing the overall convenience of fan maintenance. Ultimately, the objective of the Dirt Defender

Ceiling Fan system is to introduce a comprehensive, technology-driven solution that simplifies fan upkeep, extends fan longevity, and ensures optimal performance in residential and commercial settings

1.3. Modules

1) Sensor Module
2) Cleaning Mechanism
3) Telegram bot Module

2. LITERATURE SURVEY

The information regarding the user's experience with existing ceiling-fan cleaning tools is obtained and few new designs are proposed for addressing the user's problems. A user survey was performed. From the result, it's been observed that the user felt some pain/ discomfort in certain body regions like the neck, shoulder, and arm, as well as a major strain on the lumbar area. The other major concerns were also observed such as reachability, ease of usage, and ease of implementation (interactions with the product) while using the existing ceiling-fan cleaning tools/equipment [1]. The existing manual cleaning system's limitations, such as human effort, sluggishness, and the risk of accidents are outlined, and the proposed solution involving a scissor lift mechanism actuated by a lead screw arrangement and controlled by an Atmega 16A microcontroller is proposed.[2] The system description details the methodology of cleaning the fan blades and the components involved, such as the microcontroller, motors, proximity sensors, electromagnet, and cleaning brush [3]. A comprehensive overview of a smart home automation system using Arduino as the master controller is provided. While the specific focus of the paper is on security systems, temperature sensing, and voice control, the principles and components discussed can be adapted for developing self-cleaning fans [4]. The Arduino board, along with various sensors and actuators, can be utilized to monitor the cleanliness of the fan blades and trigger a cleaning mechanism when necessary. The low-cost and open-source nature of the proposed system makes it a viable option for developing self-cleaning fans with added functionality [5]. The objective is to develop an IOT-enabled automatic vacuum cleaner using Arduino that can be controlled by using smartphone. Additionally, this robot is equipped with HC-SR04 ultrasonic sensors that can detect walls, obstacles, and cliffs. When there are obstacles in front of the robot, its movement will be modified according to the Arduino Mega algorithm. With the addition of a wireless ESP8266 receiver module, the robot can be controlled wirelessly via a smartphone running the Blynk application. The user can choose between two modes of automatic cleaning, or they can control it manually. By incorporating these elements , we can create an IoT-enabled ceiling fan cleaning system that of fers advanced features and seamless control through a smart phone application [6]. Wireless Sensor Networks (WSN) in home automation are explored, emphasizing their integration into smart home systems for enhanced convenience and effi ciency. Extensive research in this domain showcases the evo lution of cleaning systems, highlighting the transition from traditional vacuum cleaners to advanced, compact, and less intrusive smart devices suitable for office, public spaces, and homes. Within the context of smart cleaning devices, robotics and autonomous navigation systems have been extensively studied, focusing on algorithms, sensors, and mapping tech niques that enable autonomous movement and environment mapping [7]. Furthermore, literature reviews emphasize user centric studies, emphasizing user preferences, usability, and satisfaction factors when using smart cleaning appliances. Discussions also encompass challenges faced in achieving full autonomy, efficiency, and scalability in smart vacuum cleaners, while exploring future directions such as enhancing navigation, optimizing cleaning algorithms, and integrating emerging technologies to further improve performance [8]. An in-depth examination of existing research on automated cleaning systems is conducted, particularly emphasizing their application in high-rise structures with glass facades. This survey explores the challenges inherent in manual cleaning processes and highlights the risks involved for human work ers, underscoring the need for safer and more efficient solutions [10]. It reviews prior studies on robotic cleaning systems, focusing on their mechanisms for traversing vertical glass surfaces, including structural designs, pneumatic systems, suction technologies, and control mechanisms. Moreover, the survey recognizes the expanding relevance of robotics in addressing maintenance issues in smart buildings and identifies potential applications beyond high-rise structures, such as in the cleaning of large solar panels. We can also adapt these traversing technologies and control mechanisms into our project [11]. An investigation is conducted into au tonomous cleaning robots, focusing on their climbing mech anisms, control systems, vacuum technologies, safety features, battery management, and future prospects. It explores existing research on robots designed for cleaning, specifically addressing their capabilities on vertical surfaces like glass, while delving into control mechanisms, suction systems, and motion planning algorithms vital for efficient cleaning which can be incorporated into our dirt defender ceiling fan system. Additionally, it scrutinizes safety measures like fraud detection, emphasizes battery efficiency for prolonged operations, and highlights challenges and potential research avenues for enhancing these autonomous glass cleaning systems [12]. This construction of a cleaning robot is focused, which provides wireless remote monitoring services [13]. Through modifying a commercial cleaning robot, various environment sensors, vision and networking capability are added to the system. It has many advantages over the traditional cleaning robot. This whole system consists of an IP camera, a computer, and a control board that drives motors on the cleaning robot. Besides, there are many sensors equipped on the robot, so it can measure surroundings and upload the data to the Appserv web server through Wi-Fi. The user can access the data in the server by using web browser [14]. Moreover the user can also control the robot remotely with mobile app. We can include the remote control feature into our system [8]. The computer functions were replaced with the ESP32 microcontroller, and the website server as well as the application interface was replaced with the Telegram BOT. The ESP32 microcontroller [15] was chosen because its function is almost the same as a computer, while the Telegram BOT can be used free of charge. This study focuses on testing the success rate of the system in responding to commands given via the Telegram BOT, with the type of command connecting the Telegram BOT with ESPCam, turning on or off the LED flash, taking pictures, and the combination [16]. Based on the tests that have been carried out for all existing command combinations, with each test being repeated 25 times, it was found that the success rate of the system reached 84.67BOT serves as the interface for controlling our IoT-enabled [17] cleaning system(Dirt Defender Ceiliing fan), emphasizing its free availability and user-friendly command-based interac tion. It highlights the security provided by HTTPS (HTTPSecure) in communication between the ESP32 board and the Telegram Bot API server: Data Encryption: HTTPS encrypts data during transmission, preventing unauthorized access to sensitive information.[18] Authentication: It verifies the server's identity using digital certificates, ensuring that the client communicates with the legitimate server and not a malicious entity. Data Integrity: HTTPS maintains data integrity by detecting any tampering or modification of data, ensuring that trans mitted data remains unchanged. Overall, HTTPS ensures a secure and trustworthy connec tion, protecting against eavesdropping, data manipulation, and impersonation attempts.[19]. The automatic solar panel cleaning system based on Arduino for dust removal can serve as a model for developing a self-cleaning ceiling fan. By adapting the two-step cleaning mechanism and the use of easily accessible components, a similar system can be designed for ceiling fan blades. The use of a wiper for dust removal, along with the integration of a microcontroller for control, can be applied to a ceiling fan for self-cleaning purposes . The proposed system aims to address the gradual decrease in solar panel efficiency due to dust accumulation, particularly in dry or desert areas, and is found to operate with an efficiency of 87-96% for different types of sand. The hardware implementation includes the use of easily accessible components such as a solar panel, microcon troller (Arduino Uno), metallic DC gear motor, buck boost converter, and motor drive module, with the system being controlled by a microcontroller and a light dependent resistor (LDR) for sunlight tracking. By leveraging the principles and components outlined in the paper, a self-cleaning ceiling fan can be developed to improve efficiency and reduce maintenance requirements [20].

3. SYSTEM DESIGN

3.1 Proposed System

The proposed Dirt Defender Ceiling Fan system offers a groundbreaking solution to the perennial problem of ceiling fan maintenance. Utilizing state-ofthe-art technology, this innovative system is designed to simplify the upkeep of both residential and commercial ceiling fans. At the core of its functionality are specialized sensors, reminiscent of human eyes, adept at autonomously detecting dust buildup on fan blades. Once significant accumulation is detected, these sensors communicate with a dedicated mobile app, empowering users to trigger the cleaning process effortlessly. This process involves ingeniously designed mechanical components employing gentle brushes or rubber wipers to effectively remove dust from the fan blades. What distinguishes this system is its integrated dust collection mechanism, efficiently storing the removed debris in a designated container. This collected dust can be conveniently disposed of at the user's convenience, eliminating the laborious manual cleaning traditionally associated with ceiling fan maintenance.

3.2 Architecture

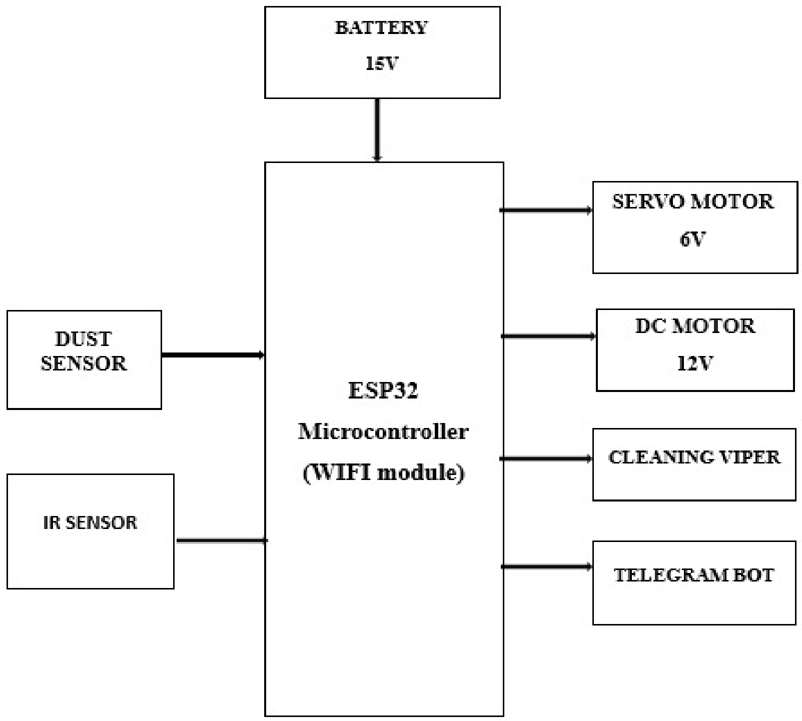

Figure 3.2: Dust-Free Delight Architecture

3.3 Software and Hardware Requirements

Software

i) Telegram bot

ii) IDE: Arduino

Hardware

i) Operating System: Windows 11

ii) Processor - Intel Core i3

iii) Memory(RAM) - 8 GB

iv) Hard disk: 1TB

v) Transformer

vi) ESP32

vii) Servo SG90

viii) DC Motor

ix) Motor Driver

x) IR Sensor

xi) LDR Sensor

xii) Battery

xiii) LM2596 Regulator

3.4 Hardware Design

3.4.1 Power Supply

The power supply section is the section which provide +5V for the components to work. As shown in Figure 3.4.1, IC LM7805 is used for providing a constant power of +5V.

The ac voltage, typically 220V, is connected to a transformer, which steps down that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also retains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

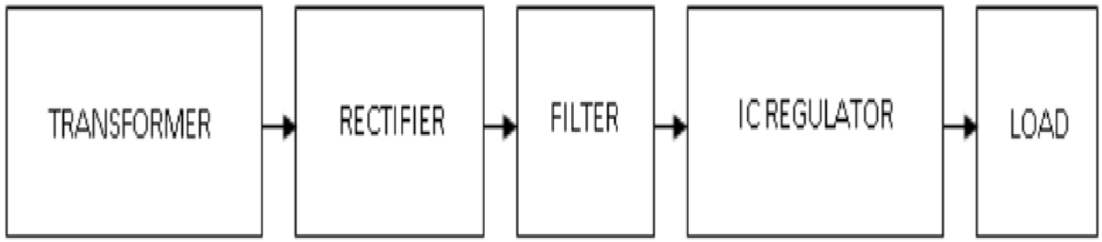

Figure 3.4.1: Power Flow

3.4.2 Transformer

Transformers convert AC electricity from one voltage to another with little loss of power as illustrated in Figure 3.4.2. Transformers work only with AC and this is one of the reasons why mains electricity is AC.

Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in India) to a safer low voltage.

The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils; instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up.

The transformer will step down the power supply voltage (0-230V) to (0- 6V) level. Then the secondary of the potential transformer will be connected to the bridge rectifier, which is constructed with the help of PN junction diodes. The advantages of using bridge rectifier are it will give peak voltage output as DC.

- Rectifier: There are several ways of connecting diodes to make a rectifier to convert AC to DC. The bridge rectifier is the most important and it produces full-wave varying DC. A full-wave rectifier can also be made from just two diodes if a centre-tap transformer is used, but this method is rarely used now that diodes are cheaper. A single diode can be used as a rectifier but it only uses the positive (+) parts of the AC wave to produce half-wave varying DC
- Bridge Rectifier: When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners. Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. the positive potential at point A will forward bias D3 and reverse bias D4. The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow. One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.
    - The main advantage of this bridge circuit is that it does not require a special centre tapped transformer, thereby reducing its size and cost.
    - The single secondary winding is connected to one side of the diode bridge network and the load to the other side as shown below.
    - The result is still a pulsating direct current but with double the frequency.
- Smoothing: Smoothing is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from the rectifier is falling. The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output.

- Voltage Regulators: Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

  A fixed three-terminal voltage regulator has an unregulated dc input voltage, Vi, applied to one input terminal, a regulated dc output voltage, Vo, from a second terminal, with the third terminal connected to ground.

  The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts. Voltage regulator ICs are available with fixed (typically 5, 12 and 15V) or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection').

  Many of the fixed voltage regulator ICs has 3 leads and look like power transistors, such as the 7805 +5V 1Amp regulator. They include a hole for attaching a heat sink if necessary.

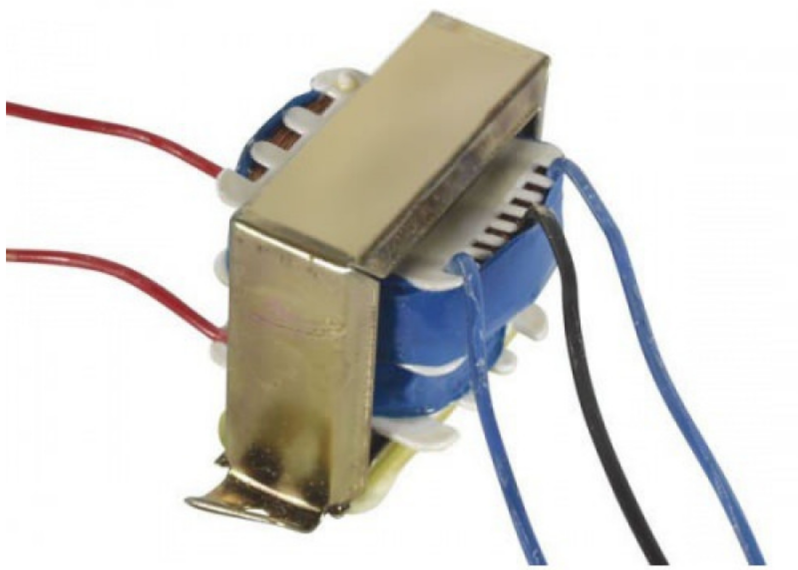

Figure 3.4.2: Transformer

3.4.3 ESP32

ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth. As shown in Figure 3.4.3, The ESP32 series employs either a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variations, Xtensa LX7 dual-core microprocessor or a single-core RISC-V microprocessor and includes built-in antenna switches, RF balun, power amplifier, low noise receive amplifier, filters, and power- management modules. ESP32 is created and developed by Espressif Systems, a Shanghai- based Chinese company, and is manufactured by TSMC using their 40 nm process. It is a successor to the ESP8266 microcontroller.

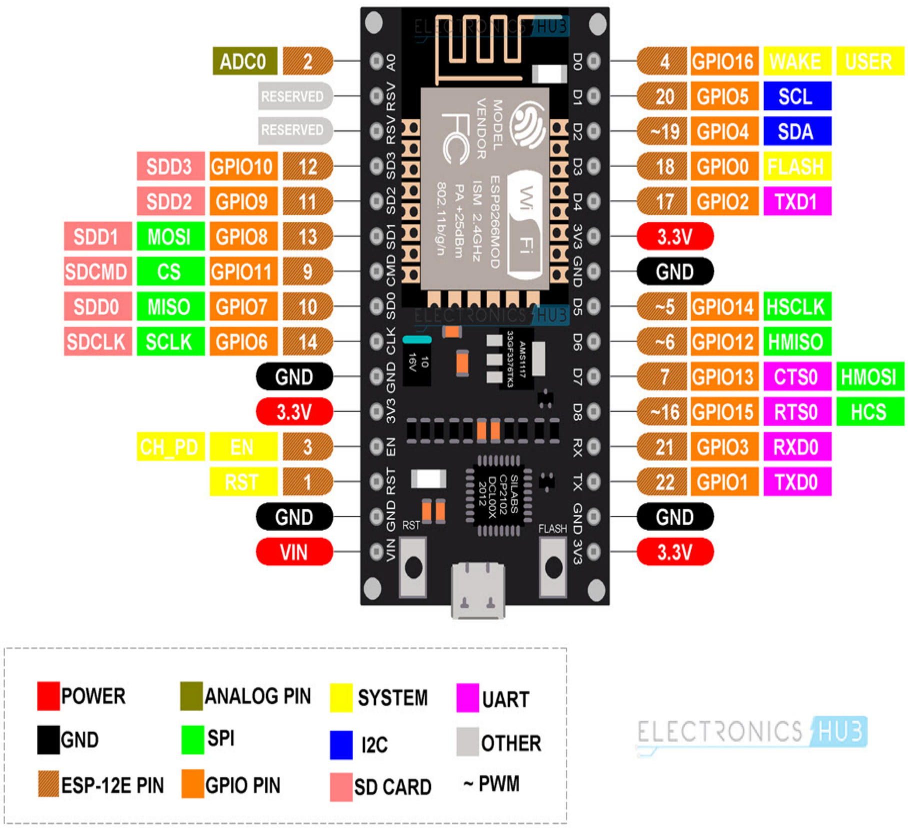

Figure 3.4.3: ESP32 Controller

3.4.4 Servo SG90

The SG90 servo, a prevalent miniature actuator, features diminutive dimensions (approximately 23mm x 12mm x 29mm) yet delivers noteworthy torque of 1.5 to 2.5 kg/cm and operates at a speed of 0.1 to 0.2 seconds per 60 degrees rotation without a load, as shown in Figure 3.4.4. Operating within a 4.8V to 6V voltage range, it relies on a small DC motor intricately connected to reduction gears, facilitating precise positioning aided by a potentiometer feedback mechanism. Controlled via pulse width modulation (PWM) signals ranging from 1ms to 2ms, this servo is extensively used in radio-controlled models, robotics, and automation, offering a rotational span of approximately 180 degrees to enable accurate angular adjustments, making it a favored choice for diverse applications in hobbyist projects and small-scale mechanisms.

Figure 3.4.4: Servo SG90

3.4.5 DC Motor

A DC motor in simple words is a device that converts direct current(electrical energy) into mechanical energy, as illustrated in Figure 3.4.5. It's of vital importance for the industry today. A DC motor is designed to run on DC electric power. Two examples of pure DC designs are Michael Faraday's homo-polar motor (which is uncommon), and the ball bearing motor, which is (so far) a novelty. By far the most common DC motor types are the brushed and brushless types, which use internal and external commutation respectively to create an oscillating AC current from the DC source—so they are not purely DC machines in a strict sense. We in our project are using brushed DC Motor, which will operate in the ratings of 12v DC 0.6A. The speed of a DC motor can be controlled by changing the voltage applied to the armature or by changing the field current. The introduction of variable resistance in the armature circuit or field circuit allowed speed control. Modern DC motors are often controlled by power electronics systems called DC drives.

Figure 3.4.5: DC Motor

3.4.6 Motor Driver

L293D IC shown in the figure 3.4.6, generally comes as a standard 16-pin DIP (dual-in line package). This motor driver IC can simultaneously control two small motors in either direction; forward and reverse with just 4 microcontroller pins (if you do not use enable pins).

Some of the features (and drawbacks) of this IC are :

1. Output current capability is limited to 600mA per channel with peak output current limited to 1.2A (non-repetitive). This means you cannot drive bigger motors with this IC. However, most small motors used in hobby robotics should work. If you are unsure whether the IC can handle a particular motor, connect the IC to its circuit and run the motor with your finger on the IC. If it gets really hot, then beware... Also note the words ”non-repetitive”; if the current output repeatedly reaches 1.2A, it might destroy the drive transistors.

2. Supply voltage can be as large as 36 Volts. This means you do not have to worry much about voltage regulation.

3. L293D has an enable facility which helps you enable the IC output pins. If an enable pin is set to logic high, then state of the inputs match the state of the outputs. If you pull this low, then the outputs will be turned off regardless of the input states

4. The datasheet also mentions an ”over temperature protection” built into the IC. This means an internal sensor senses its internal temperature and stops driving the motors if the temperature crosses a set point

5. Another major feature of L293D is its internal clamp diodes. This flyback diode helps protect the driver IC from voltage spikes that occur when the motor coil is turned on and off (mostly when turned off)

6. The logical low in the IC is set to 1.5V. This means the pin is set high only if the voltage across the pin crosses 1.5V which makes it suitable for use in high frequency applications like switching applications (upto 5KHz)

7. Lastly, this integrated circuit not only drives DC motors, but can also be used to drive relay solenoids, stepper motors etc

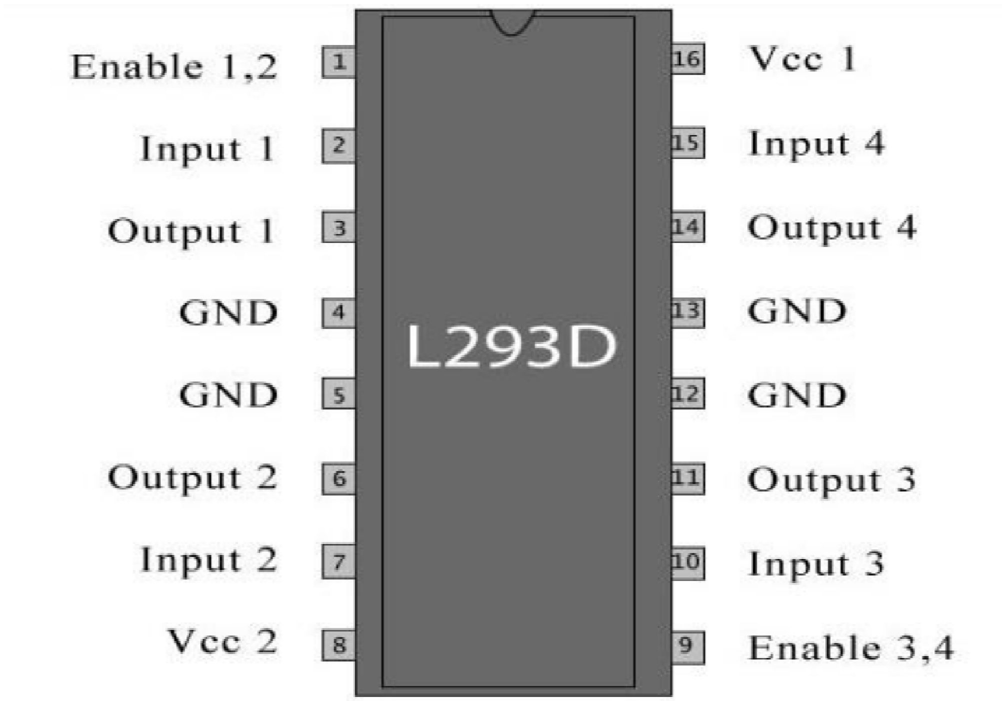

Figure 3.4.6: L293D Motor Driver

It works on the concept of H-bridge. H-bridge is a circuit which allows the voltage to be flown in either direction. As you know voltage need to change its direction for being able to rotate the motor in clockwise or anticlockwise direction, Hence H-bridge IC are ideal for driving a DC motor. In a single l293d chip there two h-Bridge circuit inside the IC which can rotate two dc motor independently. Due its size it is very much used in robotic application for controlling DC motors. Given below is the pin diagram of a L293D motor controller. There are two Enable pins on l293d. Pin 1 and pin 9, for being able to drive the motor, the pin 1 and 9 need to be high. For driving the motor with left H-bridge you need to enable pin 1 to high. And for right H-Bridge you need to make the pin 9 to high. If anyone of the either pin1 or pin9 goes low then the motor in the corresponding section will suspend working.

It’s like a switch.

Working of L293D:

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

Voltage Specification:

VCC is the voltage that it needs for its own internal operation 5v; l293D will not use this voltage for driving the motor. For driving the motor it has a separate provision to provide motor supply VSS (V supply). L293d will use this to drive the motor. It means if you want to operate a motor at 9V then you need to provide a Supply of 9V across VSS Motor supply.

The maximum voltage for VSS motor supply is 36V. It can supply a max current of 600mA per channel. Since it can drive motors Up to 36v hence you can drive pretty big motors with this l293d.

VCC pin 16 is the voltage for its own internal Operation. The maximum voltage ranges from 5v and up to 36v.

3.4.7 Battery

A battery is a device consisting of one or more electrochemical cells that convert stored chemical energy into electrical energy. We use a 12V battery, as shown in Figure 3.4.7. Batteries are another way to produce electricity. They are smaller and more safe. Batteries have one end that is positive and one end that is negative. For batteries to work, you need to make sure you put them in the right way. Batteries have become a common power source for many household and industrial applications.

There are two types of batteries: primary batteries (disposable batteries), which are designed to be used once and discarded, and secondary batteries (rechargeable batteries), which are designed to be recharged and used multiple times. Batteries come in many sizes, from miniature cells used to power hearing aids and wristwatches to battery banks the size of rooms that provide standby power for telephone exchanges and computer data centers.

A battery is a device that converts chemical energy directly to electrical energy. It consists of a number of voltaic cells; each voltaic cell consists of two half-cells connected in series by a conductive electrolyte containing anions and cations. One half-cell includes electrolyte and the electrode to which anions (negatively charged ions) migrate, i.e., the anode or negative electrode; the other half-cell includes electrolyte and the electrode to which cation (positively charged ions) migrate, i.e., the cathode or positive electrode. In the redox reaction that powers the battery, cations are reduced (electrons are added) at the cathode, while anions are oxidized (electrons are removed) at the anode. The electrodes do not touch each other but are electrically connected by the electrolyte. Some cells use two half-cells with different electrolytes. A separator between half-cells allows ions to flow, but prevents mixing of the electrolytes

Batteries are classified into two broad categories, each type with advantages and disadvantages.

- Primary batteries irreversibly (within limits of practicality) transform chemical energy to electrical energy. When the initial supply of reactants is exhausted, energy cannot be readily restored to the battery by electrical means.
- Secondary batteries can be recharged; that is, they can have their chemical reactions reversed by supplying electrical energy to the cell, restoring their original composition.

Some types of primary batteries used, for example, for telegraph circuits, were restored to operation by replacing the components of the battery consumed by the chemical reaction. Secondary batteries are not indefinitely rechargeable due to dissipation of the active materials, loss of electrolyte and internal corrosion.

Primary batteries can produce current immediately on assembly. Disposable batteries are intended to be used once and discarded. These are most commonly used in portable devices that have low current drain, are used only intermittently, or are used well away from an alternative power source, such as in alarm and communication circuits where other electric power is only intermittently available.

Secondary batteries must be charged before use; they are usually assembled with active materials in the discharged state. Rechargeable batteries or secondary cells can be recharged by applying electric current, which reverses the chemical reactions that occur during its use. Devices to supply the appropriate current are called chargers or rechargers.

Figure 3.4.7: 12-volt Battery

3.4.8 LDR Sensor

The Light Dependent Resistor (LDR) sensor is a key component in our IoT-enabled cleaning system, playing a vital role in detecting ambient light levels, as shown in Figure 3.4.8. This sensor's resistance changes based on the intensity of light, allowing the system to assess whether cleaning is necessary based on the dust accumulation's impact on light penetration. By utilizing the LDR sensor, our system can intelligently determine opti mal cleaning schedules, ensuring efficient and timely maintenance of ceiling fan blades without unnecessary cleaning cycles.

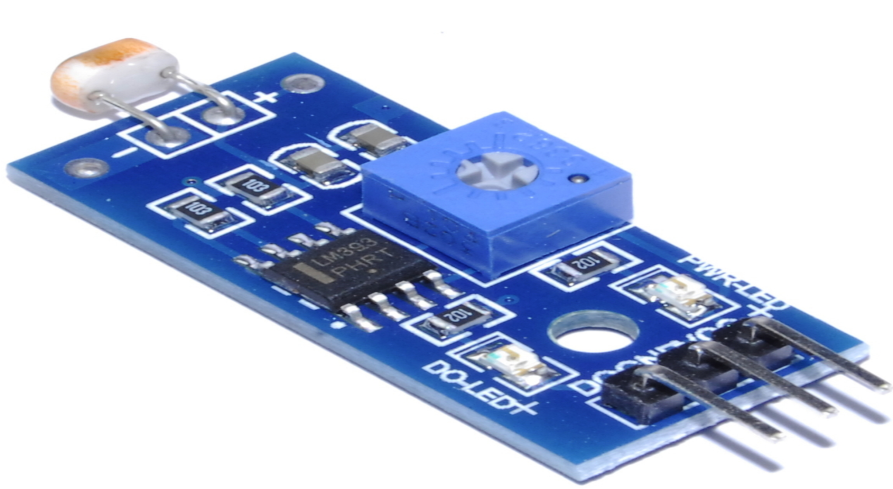

Figure 3.4.8: LDR Sensor

3.4.9 IR Sensor

The Infrared (IR) sensor is a pivotal component in our IoT-enabled cleaning system, serving as an essential tool for detecting obstacles and edges during the cleaning process, as shown in the figure 3.4.9. This sensor emits and receives infrared radiation, enabling the system to accurately identify objects in its path and adjust its cleaning trajectory accordingly. By leveraging the capabilities of the IR sensor, our system enhances its efficiency and safety, ensuring thorough cleaning while avoiding collisions and potential damage to both the device and surrounding environment.

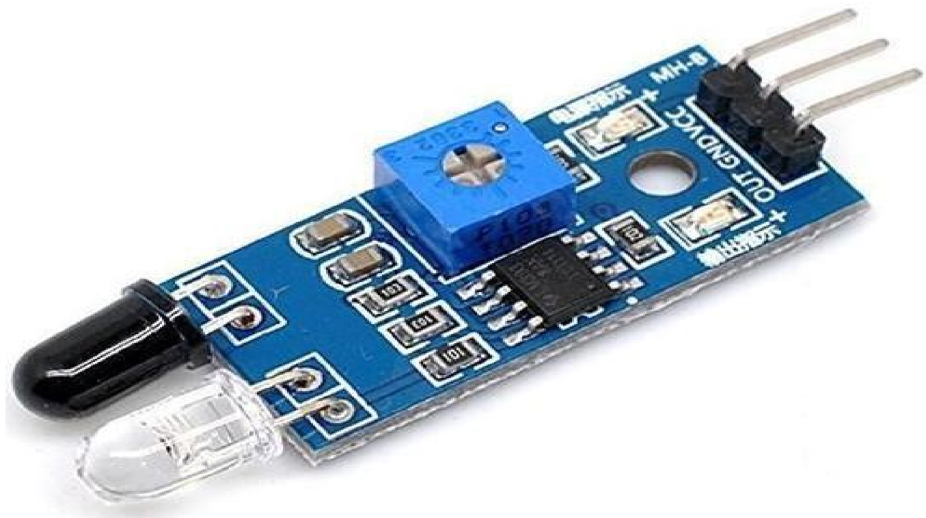

Figure 3.4.9: IR Sensor

3.4.10 LM2596 Regulator

The LM2596 regulator is mono lithic integrated circuit ideally suited for easy and convenient design of a step– down switching regulator (buck converter), as shown in figure 3.4.10. It is capable of driving a 3.0 A load with excellent line and load regulation. This device is available in adjustable output version and it is inter nally compensated to minimize the number of external components to simplify the power supply design. Since LM2596 converter is a switch– mode power supply, its efficiency is significantly higher in comparison with popular three– terminal linear regulators, especially with higher input voltages. The LM2596 operates at a switch ing frequency of 150 kHz thus allowing smaller sized f ilter components than what would be needed with lower frequency switching regulators. Available in a standard 5– lead TO– 220 package with several different lead bend options, and

D2PAK surface mount package. The other features include a guaranteed 4 % tolerance on out put voltage within specified input voltages and output load conditions, and 15 % on the oscillator frequency. External shutdown is included, featuring 80 A (typical) standby current. Self protection features include switch cycle– by– cycle current limit for the output switch, as well as thermal shutdown for complete protection under fault.

Figure 3.4.10: LM2596 Regulator

3.5 Software Design

3.5.1 Arduino Software

We need to download the Arduino Software package for your operating system. When we've downloaded and opened the application you should see something like this, as shown in Figure 3.5.1.1.

Figure 3.5.1.1: Arduino IDE

This is where you type the code you want to compile and send to the Arduino board.

- Plug your ESP32 board as illustrated in Figure 3.5.1.2. and wait for the drivers to install (or install manually any that might be required)

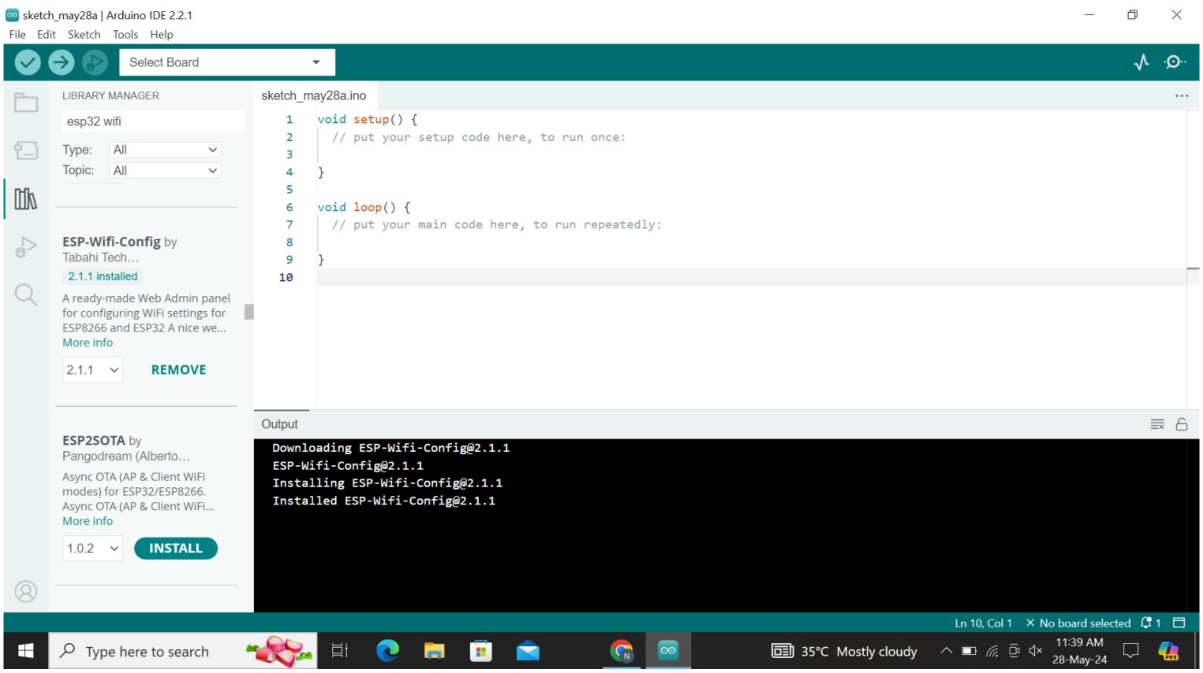

Figure 3.5.1.2: ESP32 Installation

- Start Arduino IDE
- Select your board in Tools > Board menu, as shown in the below figure 3.5.1.3.

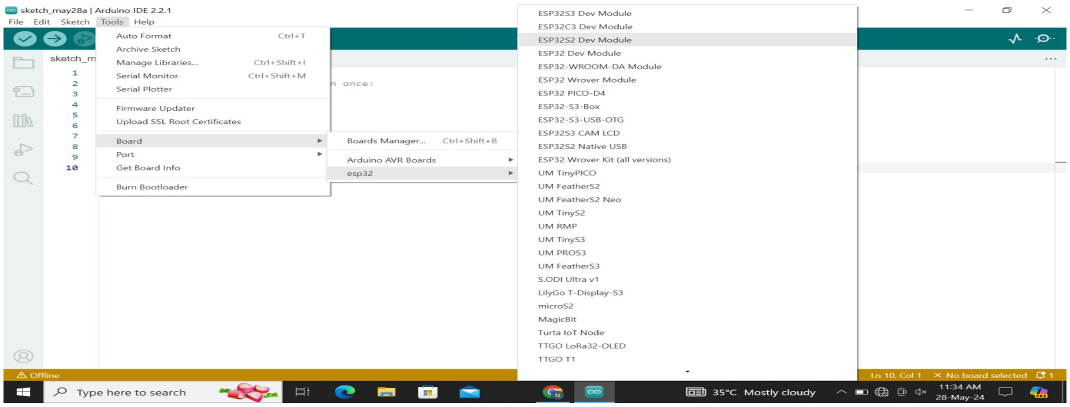

Figure 3.5.1.3: Board Selection

- Select the COM port that the board is attached to, as illustrated in the below figure 3.5.1.4.

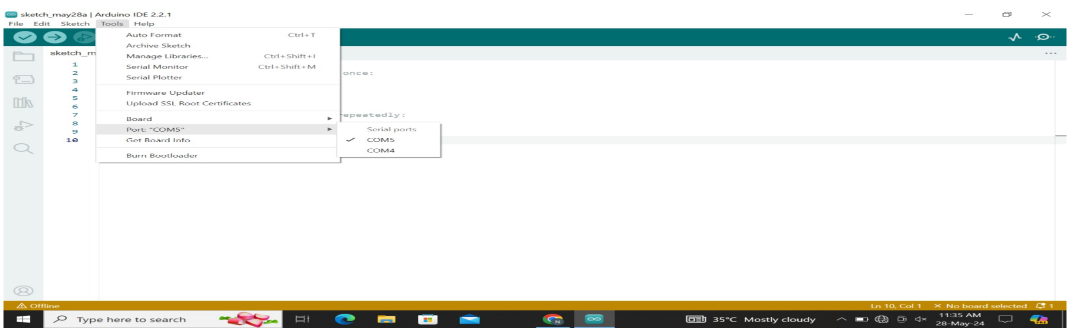

Figure 3.5.1.4: Port Selection

- Compile and upload (You might need to hold the boot button while uploading)

3.5.2 Telegram bot

We've incorporated a Telegram bot, as shown in figure 3.5.2 for system control, simplifying the process. This bot acts as a convenient interface, enabling users to manage the system remotely using Telegram, a messaging app. By sending simple commands through the bot, such as adjusting lighting or checking system status, users can swiftly and easily control the functionalities of the system, enhancing accessibility and user-friendliness. This integration allows for seamless interaction with the system, making it more convenient and efficient for users to operate and monitor the functionalities through a familiar messaging platform.

The Telegram Bot API utilizes HTTPS via the WiFiClientSecure library in our Arduino code, ensuring a secure and encrypted communication channel between our device and the Telegram servers. This allows our Arduino-based application to send and receive messages to and from Telegram users or groups securely over the internet.

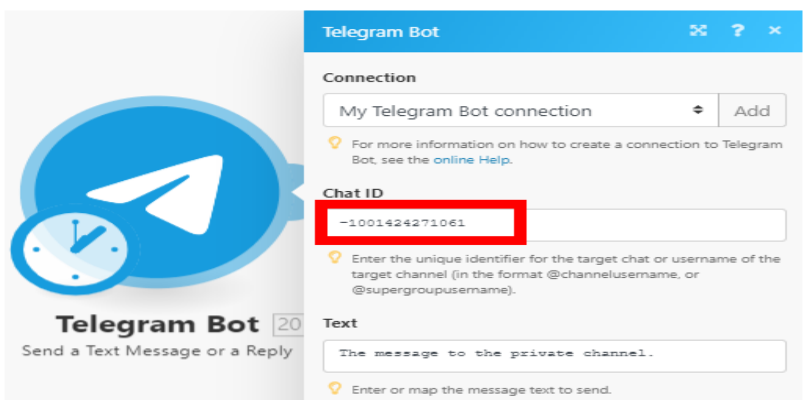

Figure 3.5.2: Telegram bot

4. METHODOLOGY

4.1 System Modules

4.1.1 Sensor Module

The Dirt Defender Ceiling Fan system integrates advanced dust detection sensors that function akin to human eyes, perceiving and assessing dust accumulation on fan blades. These specialized sensors are strategically mounted on the fan blades, ensuring accurate and timely detection of dust and debris. The sensors operate autonomously, continuously monitoring the fan blades' cleanliness status. Once a significant amount of dust is detected, the sensors promptly send a signal to the system's control unit, triggering the cleaning process.

- Dust Detection Sensors (LDR Sensor): These sensors are crucial components of the cleaning system, as they detect the accumulation of dust on fan blades. They are typically mounted on the fan blades themselves to ensure accurate and timely detection.
- Edge Detection Sensors (IR Sensor): The Infrared (IR) sensor is a pivotal component in our IoT-enabled cleaning system, serving as an essential tool for detecting obstacles and edges during the cleaning process. This sensor emits and receives infrared radiation, enabling the system to accurately identify objects in its path and adjust its cleaning trajectory accordingly.

4.1.2 Communication Protocols

To facilitate seamless data transmission from the sensors to the control unit and the dedicated mobile app, the system employs robust communication protocols. These protocols ensure reliable and real-time communication, allowing users to stay informed about the fan's cleaning status and take prompt action when needed. The integration of these communication protocols enhances the system's responsiveness and user experience.

- Communication Protocols: The Telegram Bot API utilizes HTTPS Protocol, as shown in figure 4.1.2. via the WiFiClientSecure library in our Arduino code, ensuring a secure and encrypted communication channel between our device and the Telegram servers. This allows our Arduino-based application to send and receive messages to and from Telegram users or groups securely over the internet.

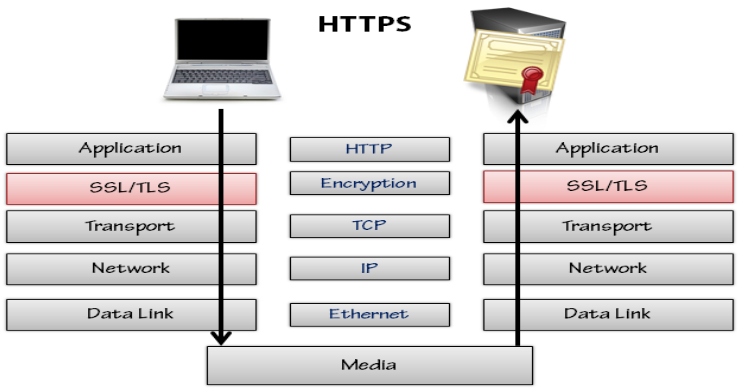

Figure 4.1.2: HTTPS Protocol

4.1.3 Cleaning Mechanism

The cleaning mechanism of the Dirt Defender Ceiling Fan system is designed for optimal efficiency and effectiveness. It features mechanical components such as duster strategically positioned to clean the fan blades thoroughly. When activated, these components move along the fan blades, gently removing dust and debris without causing any damage. The cleaning process is orchestrated by a motor control system, which regulates the movement and speed of the cleaning components, ensuring comprehensive cleaning coverage.

4.1.4 Dust Collection Mechanism

An innovative feature of the Dirt Defender Ceiling Fan system is its integrated dust collection mechanism. As the cleaning components remove dust from the fan blades, the collected dust is efficiently stored in a designated container within the system. This container is designed for easy removal and disposal of the accumulated dust. Users have the flexibility to release the collected dust at their discretion, eliminating the need for manual cleaning and simplifying maintenance tasks.

4.1.5 Telegram bot Module

In addition to the dedicated Android mobile app, the system offers integration with popular messaging platforms like Telegram. The Telegram bot module acts as an interface, allowing users to remotely monitor the fan's cleaning status and initiate cleaning processes using simple commands. This integration enhances accessibility and user-friendliness, providing a familiar platform for users to interact with the system effortlessly. By using wifiClientServer library.
Overall, the Dirt Defender Ceiling Fan system revolutionizes ceiling fan maintenance by combining advanced sensors, intelligent cleaning mechanisms, and user-friendly interfaces.

4.1.6 Algorithm

The algorithm outlines the sequence of steps followed by the cleaning system to detect dust accumulation and initiate cleaning actions. Here's a detailed breakdown of each step:

- Step 1 - Initialization of Sensor, Motors, and IoT:
  Upon system startup, the sensor module, motor control system, and IoT (Internet of Things) connectivity are initialized. This includes calibration of sensors, motor positioning, and establishing communication channels.
- Step 2 – Checking if Sensor Gets Triggered:

The system continuously monitors the dust detection sensors to check if they are triggered by the presence of dust on the fan blades. This real-time monitoring ensures prompt responsiveness to dust accumulation.

- Step 3 – Update Servo Motor Position:

  If the sensors detect dust, the system updates the position of the servo motors. Servo motors are used to control the movement of cleaning components, such as brushes or wipers, ensuring they are directed towards the areas with dust accumulation.

- Step 4 – Direct Sensor Trigger Moves Cleaning Robot:

  If a sensor is directly triggered by dust accumulation in a specific direction, the cleaning robot is moved in that direction. This targeted approach optimizes cleaning efficiency by focusing on areas with higher dust concentrations.

- Step 5 – Stop:

  Once the cleaning robot has completed its cleaning cycle or if no further dust accumulation is detected, the system stops the cleaning process. This helps conserve energy and ensures that the cleaning robot operates only when necessary.

By following this algorithm and leveraging the functionalities of each system module, the dust cleaning robot can effectively detect and remove dust from fan blades, providing improved air quality and system performance. The integration of the Telegram bot module further enhances user convenience and system accessibility, making it easier for users to monitor and control the cleaning process remotely.

5. IMPLEMENTATION

5.1 Circuit Diagram

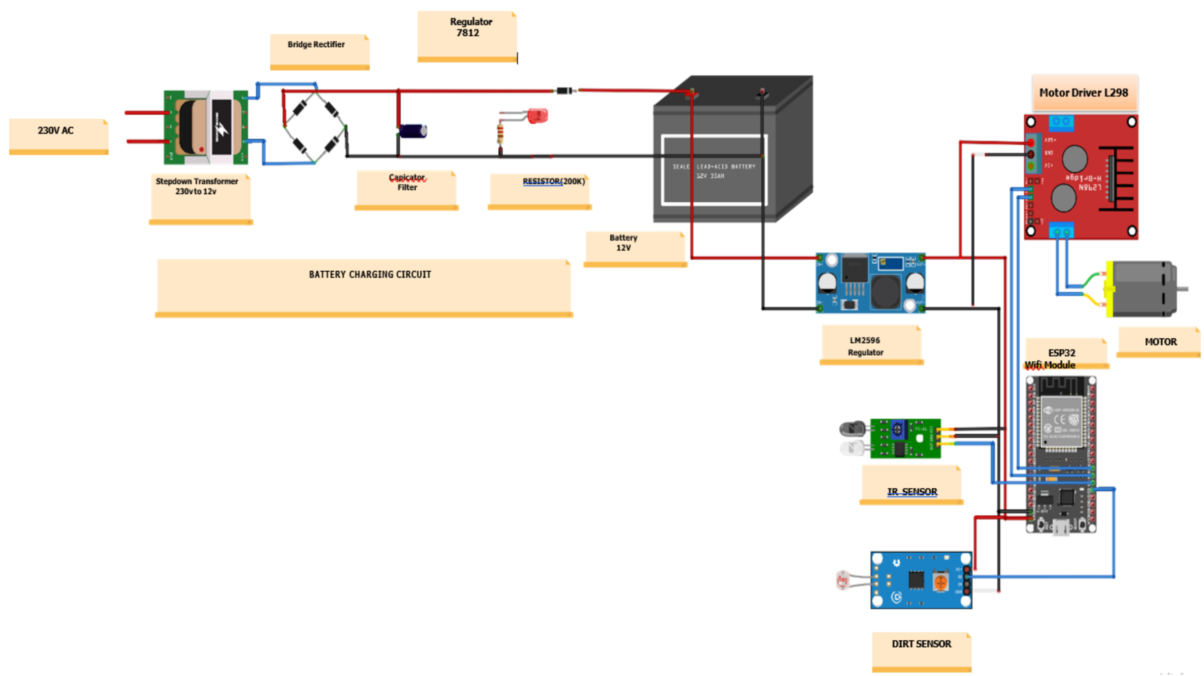

Figure 5.1: Dust-Free Delight Circuit Diagram

5.2 Flowchart

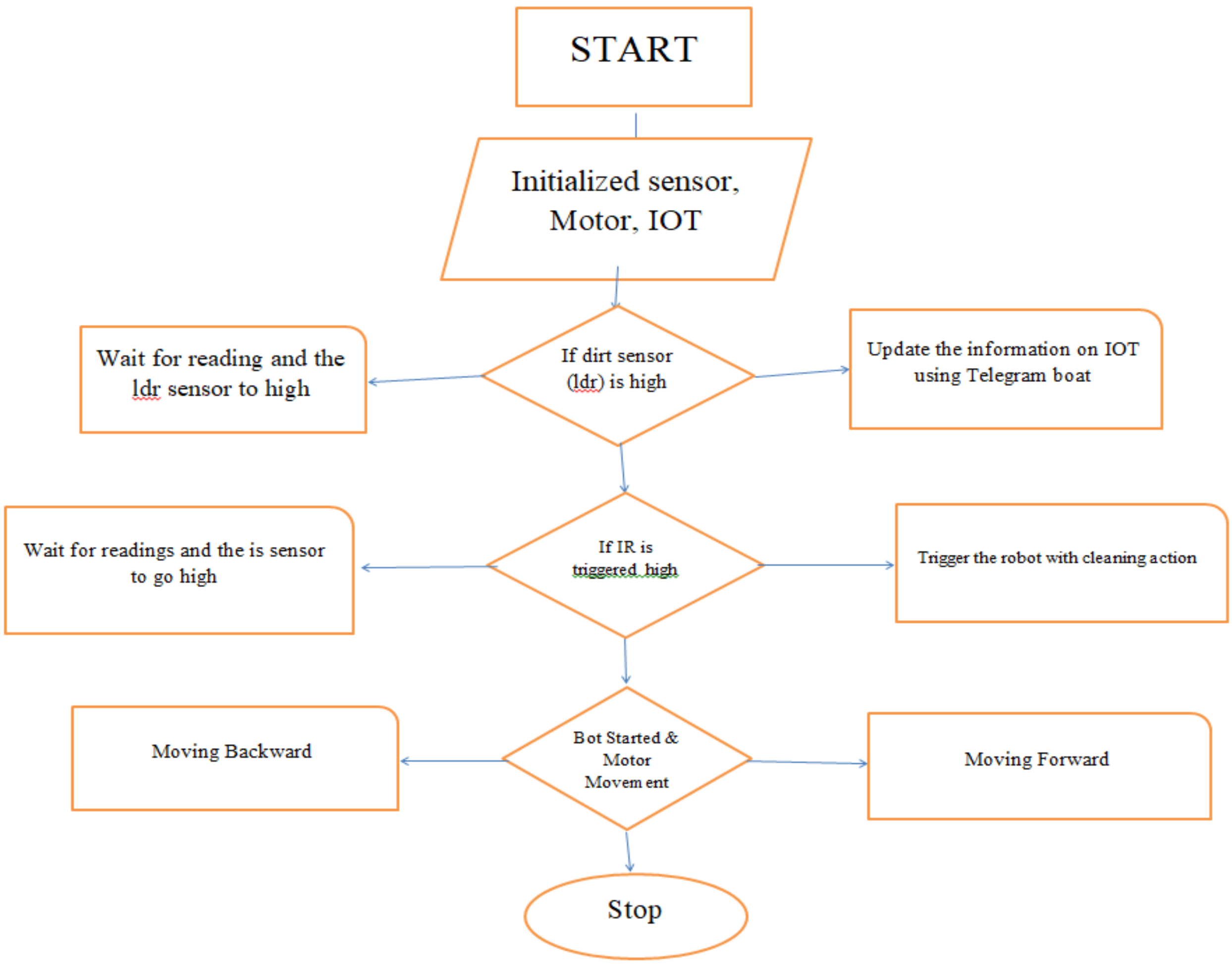

Figure 5.2: Dust-Free Delight Flowchart

5.3 Procedure

1. Connect Dusters above and below the ceiling fan blade, with a wheel which drives forward and backward which is combined with DC Motor and ESP32.

2. Attach servo motors to the cleaning mechanism (Wheel). Ensure proper wiring and connection to the ESP32 for control via motor drivers.

3. Mount the dust detection sensors(LDR) and edge detection sensors(IR) on the fan blades. Connect the sensors to the ESP32 microcontroller for data transmission.

4. Use 12V battery to supply power to the system.

5. The code begins by including several libraries necessary for the project: WiFi, WiFiClientSecure, UniversalTelegramBot, ArduinoJson, and Servo. These libraries provide functionality for connecting to WiFi networks, communicating with Telegram Bot API, handling JSON data, and controlling servo motors.

6. The network credentials (WiFi SSID and password) are defined for connecting the ESP32 board to the local WiFi network. This enables internet connectivity, allowing the ESP32 to communicate with the Telegram Bot API server.

7. The Telegram Bot token and chat ID are defined to initialize the Telegram bot. The bot is set up using the provided token, and the chat ID specifies which chat or user the bot will respond to.

8. Various hardware pins are defined for connecting components to the ESP32 board. This includes pins for LDR (Light Dependent Resistor), motor control (motorP and motorN for motor polarity), IR sensor, and a servo motor.

9. When LDRState is HIGH dust is detected , the bot sends a message to the user, and if the /cleannowçommand is received, the flag is set to 1, indicating that cleaning should start. When

the /cleanstopçommand is received, the flag is set to 0, indicating that cleaning should stop. The servo motor is also controlled to move back and forth during the cleaning process.

10. The movement of the cleaning components forward and backward is controlled through the motorP and motorN pins And when an edge is detected it stops the motion. Forward Motion is achieved by setting motorP to HIGH and motorN to LOW and reverse for Backward Motion.

5.4 Code

```
#include <WiFi.h>
#include <WiFiClientSecure.h>
#include <UniversalTelegramBot.h>
#include <ArduinoJson.h>
#include <Servo.h>

// Network credentials
const char* ssid = "dell";
const char* password = "12345678";

// Initialize Telegram BOT Token and Chat ID
#define BOTtoken "5982198371:AAEL3cD2U6IyORf9zlOD_sl5-X85MXyhKbc"

// #define CHAT_ID "1328704992"
#define CHAT_ID "2129129685"

WiFiClientSecure client;
UniversalTelegramBot bot(BOTtoken, client);
```

```
const int LDR      = 13;

const int motorP   = 2;
const int motorN   = 4;

const int IRsensor = 5;

static const int servoPin = 21;

int LDRState0     = 0;
int irsensorstate = 0;
int flag=0;

int botRequestDelay = 1000;
unsigned long lastTimeBotRan;

Servo servo1;

void setup() {

   Serial.begin(115200);

   pinMode(LDR, INPUT);

   pinMode(motorP, OUTPUT);
   pinMode(motorN, OUTPUT);
```

```
   servo1.attach(servoPin);

   WiFi.mode(WIFI_STA);
   WiFi.begin(ssid, password);

   // Add root certificate for api.telegram.org
   client.setCACert(TELEGRAM_CERTIFICATE_ROOT);
   bot.sendMessage(CHAT_ID, "Bot started up", "");
}

void loop() {
   if (millis() > lastTimeBotRan + botRequestDelay)  {
     int numNewMessages = bot.getUpdates(bot.last_message_received + 1);

     while(numNewMessages) {
     Serial.println("got response");
     handleNewMessages(numNewMessages);
     numNewMessages = bot.getUpdates(bot.last_message_received + 1);
     }

     lastTimeBotRan = millis();
    }

  LDRState0     = digitalRead(LDR);
  irsensorstate = digitalRead(IRsensor);

  if(LDRState0 == HIGH)
```

```
  {
    String message = "Dirt Detected\n";
    message = message + "/cleannow' to turn on cleaning\n";
    message = message + "/cleanstop' to turn off cleaning\n";
    bot.sendMessage(CHAT_ID, message, "");
  }

  if(flag==1)
  {
    irsensorstate=digitalRead(IRsensor);
    while(irsensorstate==LOW)
    {
      irsensorstate=digitalRead(IRsensor);
      digitalWrite(motorP,HIGH);
      digitalWrite(motorN,LOW);
    }
      digitalWrite(motorP,LOW);
      digitalWrite(motorN,LOW);
      // bot.sendMessage(CHAT_ID, "Cleaning complete", "");
  }
  Serial.println(flag);

}

void handleNewMessages(int numNewMessages) {

    for (int i=0; i<numNewMessages; i++) {
```

```
String chat_id = String(bot.messages[i].chat_id);
if (chat_id != CHAT_ID){
  bot.sendMessage(chat_id, "Unauthorized user", "");
  continue;
}

String text = bot.messages[i].text;
Serial.println(text);

String from_name = bot.messages[i].from_name;

if (text == "/start") {
  String welcome = "Welcome, " + from_name + ".\n";
  welcome += "Use the following commands\n\n";
  welcome += "/cleannow' to turn on cleaning \n";
  welcome += "/cleanstop' to turn off cleaning \n";
  bot.sendMessage(chat_id, welcome, "");
}

if (text == "/cleannow") {bot.sendMessage(chat_id, "Cleaning Now", "");
                          //  digitalWrite(motorP,HIGH);
                          //  digitalWrite(motorN,LOW);
                          flag=1;
                         }
if (text == "/cleanstop") {bot.sendMessage(chat_id, "Cleaning Stop", "");
                          //  digitalWrite(motorP,LOW);
                          //  digitalWrite(motorN,LOW);
```

```
                    for(int posDegrees = 0; posDegrees <= 180; posDegrees+
                    +) {
                            servo1.write(posDegrees);
                            Serial.println(posDegrees);
                            delay(20);
                        }

                    for(int posDegrees = 180; posDegrees >= 0; posDegrees-
                    -) {
                            servo1.write(posDegrees);
                            Serial.println(posDegrees);
                            delay(20);
                        }
                  flag=0;
                  }

                }
    }
```

6. RESULTS & DISCUSSIONS

6.1 Results

The implementation of the Dirt Defender Ceiling Fan system has yielded significant and positive results, as shown in figure 6.1 in simplifying fan upkeep:

- The specialized sensors autonomously detect dust accumulation on fan blades, ensuring timely cleaning interventions and maintaining optimal fan performance.
- Through a dedicated mobile app, users have gained control over the cleaning process with a simple tap, enhancing convenience and user experience, as illustrated in figure 6.2.
- The system's mechanical components, such as small brushes or rubber wipers, effectively remove dust from fan blades without causing damage, ensuring efficient cleaning and prolonging fan lifespan.
- The system's integrated dust collection mechanism efficiently stores removed dust in a designated container, eliminating the need for manual cleaning and reducing maintenance efforts.

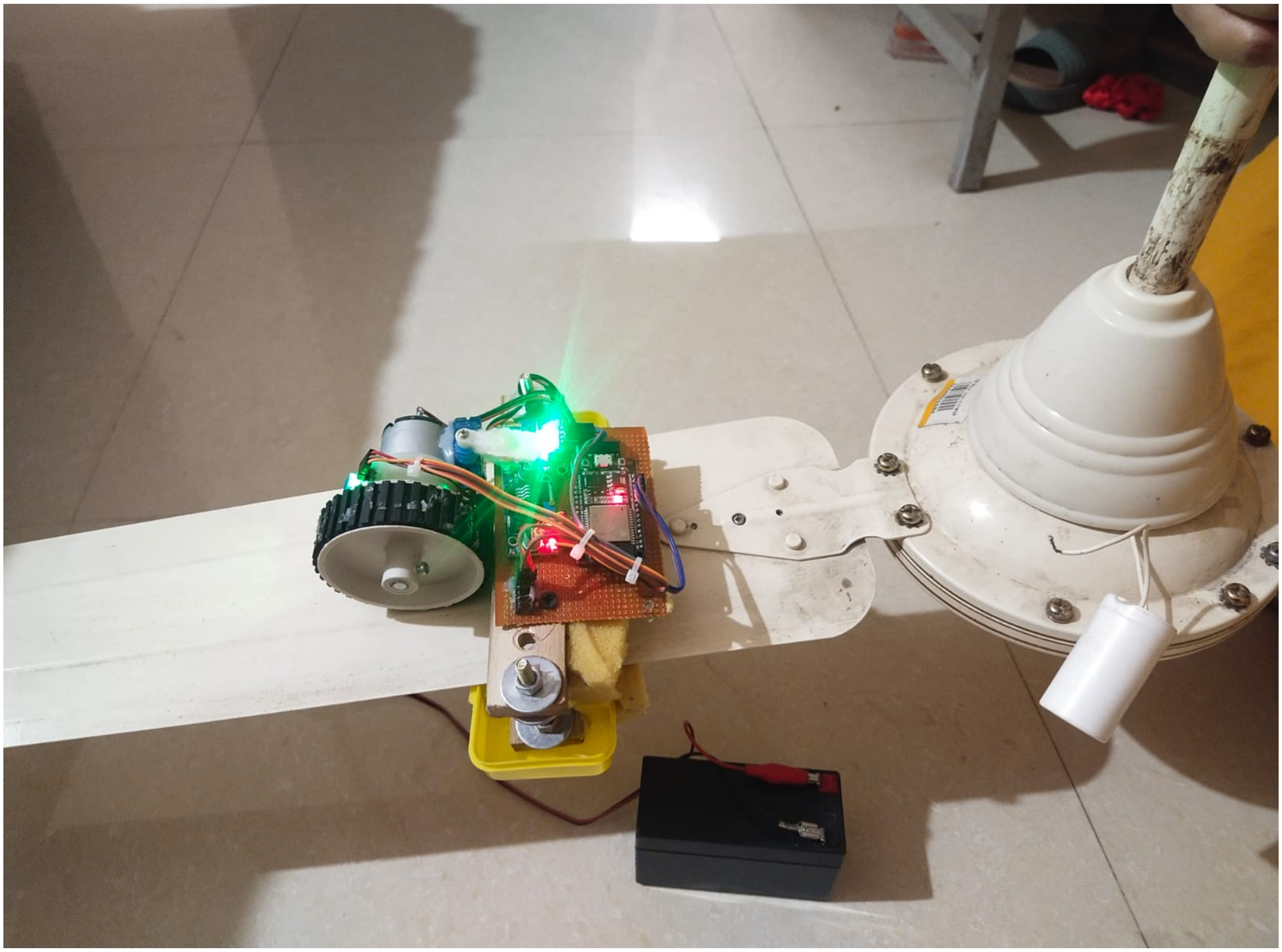

Figure 6.1: Dust-Free Delight Prototype

6.2 Discussions

The successful implementation of the Dirt Defender Ceiling Fan system opens up discussions on several key points:

- Technological Advancements: The system's utilization of cutting-edge technology, including specialized sensors and a dedicated mobile app, showcases advancements in home appliance maintenance, making fan upkeep more efficient and user-friendly.
- User-Centric Design: The system's focus on user empowerment and convenience reflects a shift towards user-centric design in household technologies. By simplifying cleaning processes and providing control at the users' fingertips, the system enhances overall user satisfaction.
- Efficiency and Sustainability: The system's efficient cleaning mechanism and integrated dust collection contribute to resource conservation and sustainability. By reducing manual cleaning efforts and optimizing maintenance processes, the system minimizes waste and promotes energy efficiency.
- Future Applications and Innovations: The success of the Dirt Defender Ceiling Fan system paves the way for future innovations and applications in home appliance maintenance. Similar technologies may be developed for other household devices, further enhancing convenience and automation in everyday tasks.

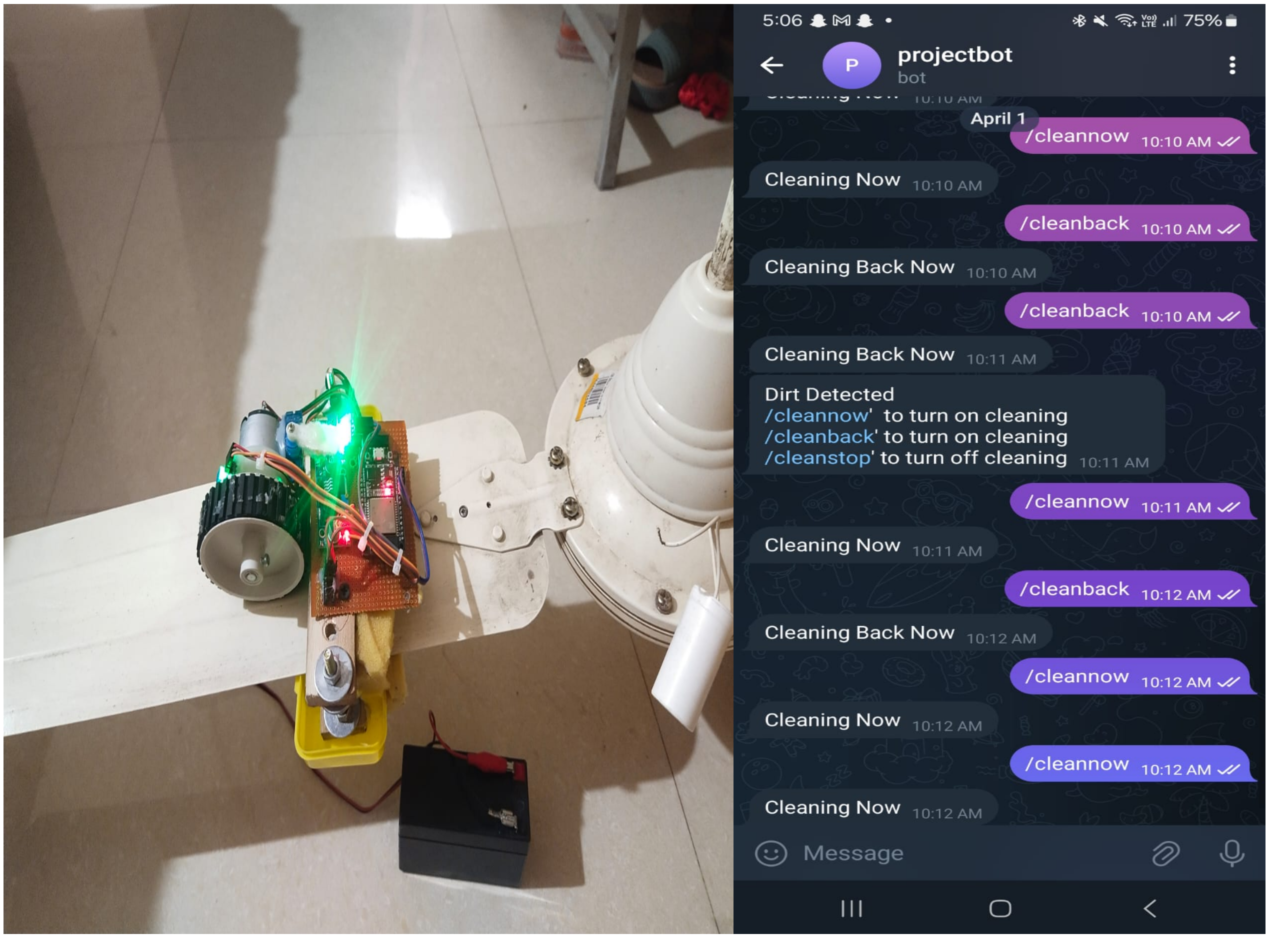

Figure 6.2: Cleaning mechanism is activated and notification got in Telegram bot

6.3 Advantages

- Reduces the time and effort required for manual cleaning.
- Minimizes exposure to dust, which can cause allergies and respiratory issues.
- Keeps ceiling fans running efficiently by preventing dust buildup, potentially reducing energy consumption.
- Maintains a higher standard of cleanliness, particularly in environments where hygiene is critical.

6.4 Disadvantages

- Limited Range: One of the limitations of this project is its limited range, which may restrict its effectiveness in large spaces or buildings with multiple fan installations. Additional infrastructure or signal boosters may be required to overcome this limitation and ensure comprehensive coverage.
- Maintenance: IoT-enabled devices often require firmware updates, software maintenance, and periodic hardware checks to ensure proper functionality, which adds to the maintenance overhead.

6.5 Applications

- Industries Sector: The Dirt Defender Ceiling Fan system finds application in industries where large-scale ceiling fan maintenance is required. It can automate fan cleaning processes in manufacturing plants, warehouses, and industrial facilities, reducing manual labor and ensuring optimal fan performance.
- Remote Monitoring: The system is ideal for remote monitoring applications, allowing users to check fan status, dust levels, and cleaning schedules from anywhere using the mobile app. This feature is beneficial for property managers, facility operators, and homeowners who want to manage multiple fans remotely.

7. CONCLUSIONS & FUTURE SCOPE

7.1 Conclusion

The implementation of the cleaning mechanism within the Dirt Defender Ceiling Fan system marks a significant step forward in revolutionizing fan maintenance. The integration of an autonomous detection system with specialized sensors allows for accurate identification of dust accumulation, triggering a user-controlled cleaning process through a dedicated mobile app. The ingenious mechanical components, including small brushes or rubber wipers, effectively remove dust from fan blades, ensuring they remain debris-free. Additionally, the integrated dust collection system enhances convenience by storing removed particles in a designated container for easy disposal, showcasing a blend of innovative technology and practical design.

However, further real-world testing and user feedback will be essential to fine-tune and assess the system's efficacy in diverse environments before its full-scale deployment. Future advancements in dust collection and removal systems, such as increased storage capacity, improved disposal methods, upgraded filtration for better air quality, advanced sensors for adaptive cleaning, self-maintenance features, and energy-efficient designs, aim to enhance user-friendliness and effectiveness in maintaining cleaner indoor spaces.

7.2 Future Scope

1. Increased Storage Capacity: Enhancing the dust collection system's storage capacity will reduce the frequency of emptying and disposal, improving user convenience.

2. Improved Disposal Methods: Implementing advanced disposal methods, such as automated or self-sealing containers, will streamline the maintenance process further.

3. Upgraded Filtration for Better Air Quality: Integrating advanced filtration mechanisms will

contribute to maintaining cleaner indoor air quality by capturing finer particles.

4. Advanced Sensors for Adaptive Cleaning: Developing sensors capable of adaptive cleaning based on real-time data will enhance the system's efficiency and effectiveness.

5. Self-Maintenance Features: Introducing self-maintenance features, such as automated cleaning schedules or self-diagnostic capabilities, will minimize manual intervention and ensure optimal system performance.

6. Energy-Efficient Designs: Continued focus on energy-efficient designs, including optimized motor control and power management, will contribute to sustainability and reduced operating costs.

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