

DESIGN AND FABRICATION OF MOTORIZED AND SELF-CEILING FAN CLEANING DEVICE

Submitted in partial fulfilment of the requirements for the award of

Bachelor of Engineering degree in

Mechanical Engineering

By

G. GNANESWARA PANDU RANGA RAO (Reg. No. 40150007)

K. RAVI KUMAR (Reg. No. 40150051)



DEPARTMENT OF MECHANICAL ENGINEERING

SCHOOL OF MECHANICAL ENGINEERING

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with grade “A++” by NAAC

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600119

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of G. GNANESWARA PANDU RANGA RAO (Reg. No. 40150007) and K. RAVI KUMAR (Reg. No. 40150051) who carried out the project entitled "**DESIGN AND FABRICATION OF MOTORIZED AND SELF CEILING FAN CLEANING DEVICE**" under our supervision from December 2023 to April 2024.



Internal Guide

Dr.M. PURUSOTHAMAN., M.E., Ph.D.,



Head of the Department

Dr.S.GANESAN., M.E., Ph.D.,

Submitted for Viva-voce Examination held on 06-04-2024



Internal Examiner



External Examiner

DECLARATION

We, G. GNANESWARA PANDU RANGA RAO (Reg. No. 40150007) and K. RAVI KUMAR (Reg. No. 40150051) hereby declare that the Project Report entitled **"DESIGN AND FABRICATION OF MOTORIZED AND SELF CEILING FAN CLEANING DEVICE"** done by me under the guidance of **Dr.M. PURUSOTHAMAN., M.E., Ph.D.** is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Mechanical Engineering.

1. G. Gnaneswar

2. K. Ravikumar

DATE: 06-04-2024

PLACE: CHENNAI

SIGNATURE OF THE CANDIDATE

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ABSTRACT

Electric ceiling fan cleaning equipment presents an innovative solution to the issue of dust accumulation on ceiling fans. Engineered with a focus on user-centered design principles, this device boasts a lightweight frame, a durable motorized brush, and a height-adjustable arm for versatility. Safety features such as obstacle detection and anti-slip mechanisms ensure user protection. Precision engineering and high-quality materials characterize its manufacturing, with optimized electric components for efficiency. Automatically adjust cleaning pressure to prevent damage to fan surfaces, while the chosen brush material effectively collects dust and is easy to clean. The choice of brush material, owing to its efficacy in dust collection and ease of post-cleaning maintenance, further accentuates the device's effectiveness. Testing demonstrates superior performance to traditional methods, with users reporting high satisfaction regarding comfort, usability, and cleaning efficacy. Beyond individual households, these devices contribute to global sustainability goals, simplifying cleaning tasks and enhancing accessibility for diverse user groups, including the elderly and those with disabilities.

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LIST OF SYMBOLS AND ABBREVIATIONS

DC	Direct current.
AC	Alternating current.
BLDC	Brushless direct current.
mm	Milli meter.
°C	Degree centigrade.
°F	Degree Fahrenheit.
W	Watts.
CFD	Computational fluid dynamics.
A/C	Air conditioner.
GHG	Greenhouse Gas.
CO ₂	Carbon Dioxide.
IAQ	Indoor air quality.
RH	Relative humidity.
PVC	Polyvinyl chloride.
IM	Induction motor.
HVLS	High – volume, low speed.

CHAPTER 1

INTRODUCTION

Ceiling fans effectively distribute air and are essential for proper ventilation in humid rooms, as they account for 6% of India's energy consumption. It evaporates sweat that is coming from the human body and provides a cooling effect. A ceiling fan is an electrical device that uses a hub to rotate the blades to circulate the air. These consist of components such as electric motors, blades, and blade irons. Ceiling fans come in many different types, including Energy Star, standard, low profile, dual motor, humid, remote control, and commercial, industrial ceiling fans. Ceiling fans are further classified into three types based on their purpose and functionality: industrial, domestic, and large. Rather than lowering the room temperature, it distributes air around your body, creating a cooler sensation. However, due to the large airflow, dust can accumulate on the fan blades.

Air circulation is significantly aided by ceiling fans, and a number of elements influence how well they operate. In this list include aerodynamics, noise reduction, fan geometry, flow field research, and structural analysis. It is crucial to build a balanced fan as the fan's shape greatly affects how well it operates. For optimal efficiency, structural analysis guarantees that the flow field is critical to air circulation. The blade design, number, and area of ceiling fans are all part of its aerodynamics. If you want to cut down on noise, you must lubricate the motor and blades carefully. Parker conducted a study on ceiling fans that operate numerically more slowly and then came up with a new design that uses less energy, has dual airflow, and makes less shaking noise. The airflow patterns of ceiling fans were examined in this work, with particular attention paid to fan.

The effectiveness of a ceiling fan is largely dependent on how its blades are constructed. PVC is used since it is lightweight. Excellent mechanical strength and low power consumption are provided by this material, which lowers power consumption. Fan shape is one of the other elements that influence fan performance. When creating completely efficient ceiling fans, researchers and

manufacturers might benefit from having a thorough understanding of elements like fan size and aerodynamics. This article's goal is to close the knowledge gap on ceiling fans by examining the literature and offering suggestions for more study in these fields. Despite being a popular and helpful piece of equipment, the lack of thorough information on a variety of ceiling fan-related topics necessitates extensive study in order to gather thorough and complete knowledge.

Ceiling fans are widely used in homes and commercial spaces, providing an efficient and cost-effective cooling solution. However, with continued use, dust and dirt can accumulate on the fan blades, which degrades air quality and causes health risks. Cleaning ceiling fans can be difficult due to their height and the need for regular maintenance, so some ceiling fans have been designed to simplify the cleaning process. This report discusses the background, importance, and progress of ceiling fan cleaning. devices and draws information from various research and studies that have developed a new brushless direct current (BLDC) motor that reduces the torque and costs of ceiling fans. This design, uses BLDC motor theory and its six-phase waveform, which allows energy savings of at least 50% compared to traditional induction motors. The grip torque can be improved by using sinusoidal back EMF and sinusoidal current.

1.1 TYPES OF CEILING FANS

Ceiling fans come in various types, each tailored to meet specific needs and preferences. Common types include.

1.1.1 *Standard Ceiling Fans*

The most prevalent and conventional kind of ceiling fans in residential settings are standard models. These fans are easily recognized by their common design, which consists of a central motor contained in the fan body and five blades linked to it. Standard ceiling fans provide efficient air circulation and cooling, making them adaptable and suitable for a variety of rooms in the house. They are available in a variety of designs, coatings, and blade materials, so homeowners can select solutions that go well with their interior decor. These fans, which are operated by wall switches or pull chains, typically have several speed settings so that the airflow can be customized to your comfort level. Standard ceiling fans are a cost-effective

and useful option for giving living rooms, bedrooms, and other interior areas a classic appearance in addition to practicality. Standard Ceiling as shown in Fig 1.1.



Fig:1.1: Standard Ceiling Fans

1.1.2 Hugger or Flush Mount Ceiling Fans

In rooms with lower ceilings, where a standard fan might dangle too low, hugger or flush-mount ceiling fans are intended. The close-to-ceiling placement of these fans, in which the blades are placed close to the ceiling surface, is what makes them unique. This design ensures efficient air circulation without sacrificing headroom, making it practical for places with limited vertical space. Hugger fans are adaptable and available in a range of styles to match different interior design aesthetics. These are common options for spaces with conventional or low ceiling heights, such as living rooms and bedrooms. Hugger ceiling fans offer both practicality and a stylish design solution for areas with height restrictions. Their small and discreet profile makes them ideal for spaces where a more streamlined appearance is required. Hugger or Flush Mount Ceiling Fan as shown in Fig 1.2.



Fig:1.2: Hugger or Flush Mount Ceiling Fans

1.1.3 Outdoor Ceiling Fans

outside ceiling fans are perfect for patios, porches, decks, and other outside places since they are made to resist the harsh conditions of outdoor locations. The materials used in the construction of these fans are resistant to humidity, wetness, and weather exposure. In order to prevent corrosion, weather-resistant materials like ABS plastic, stainless steel, or treated wood are frequently used to make motor housings and blades. To blend in with diverse outdoor aesthetics, outdoor ceiling fans are available in a variety of sizes and types. They could also have unique coatings to shield them from UV light. Certain outdoor fans come with wet ratings, which designate which outdoor circumstances they are appropriate for. These fans are a useful and fashionable addition since they cool outdoor spaces during warm weather and provide a pleasant breeze. Outdoor Ceiling Fans as shown in Fig 1.3



Fig:1.3: Outdoor Ceiling Fans

1.1.4 Energy-Efficient Ceiling Fans

The goal of designing energy-efficient ceiling fans is to use less energy while yet producing good air circulation. To increase efficiency, these fans often use cutting-edge technology like LED lights and DC (direct current) motors. Because DC motors use less energy than conventional AC motors, they are less expensive and have a less environmental effect. A lot of energy-efficient ceiling fans also have features like sophisticated controls and variable speed settings, which let customers adjust the fan's performance to suit their comfort levels. Furthermore, several models have earned the Energy Star rating, which denotes adherence to energy efficiency guidelines. Customers that choose energy-efficient ceiling fans gain long-

term from cheaper energy costs and a less environmental impact, in addition to helping with sustainability initiatives. Energy-Efficient Ceiling Fans as shown in Fig 1.4.



Fig:1.4: Energy-Efficient Ceiling Fans

1.1.5 Dual Motor Ceiling Fans

Twin motor or dual-head ceiling fans, another name for dual motor ceiling fans, are a unique and incredibly useful subset of ceiling fans. Dual motor fans, in contrast to conventional fans, have two sets of motors and blades installed on a single fixture. This unique design offers an adaptable and potent airflow solution by enabling each pair of blades to function independently. The capacity of dual motor fans to cover a greater area makes them ideal for lofts, huge rooms, and spaces with high ceilings. Furthermore, the motors' separate functioning enables each pair of blades to have a varied speed setting, giving ventilation and air circulation more control. Dual Motor Ceiling Fan as shown in Fig 1.5.



Fig:1.5: Dual Motor Ceiling Fan

1.1.6 Industrial Ceiling Fans

Strong, heavy-duty fixtures made to withstand the rigors of commercial and industrial environments are industrial ceiling fans. Due to their huge size, robust construction, and great airflow capacity, these fans are perfect for areas that need a lot of air circulation or have towering ceilings. big spaces like warehouses, factories, workshops, and gyms may benefit from improved ventilation and pleasant temperature maintenance thanks to the big blades and strong motors of industrial ceiling fans, which can move enormous volumes of air effectively. They frequently put performance and longevity over ornamental appeal in their designs, giving practicality precedence over aesthetics. Additionally, reversible airflow, variable speed control, and sturdy materials resistant to corrosion, dust, and moisture are possible features of industrial ceiling fans, guaranteeing dependable performance. Industrial Ceiling Fans as shown in Fig 1.6.



Fig:1.6: Industrial Ceiling Fans

1.1.7 Retractable Blade Ceiling Fans

The retractable blade ceiling fan is a unique and innovative design that blends functionality and elegance. These fans have a distinctive appearance because their blades retract when the fan is turned off. When switched on, the fan extends its blades outward, working similarly to a traditional ceiling fan. Any space would benefit from having a retractable fan, especially one where a normal fan's blades could be too obvious while not in use. Retractable blade ceiling fans come in a number of styles, from sleek and minimalist to more ornate and detailed, so homeowners may

choose the model that best suits their décor preferences. These fans are useful in many rooms. Retractable Blade Ceiling Fans as shown in Fig 1.7.



Fig:1.7: Retractable Blade Ceiling Fans

1.1.8 Directional Ceiling Fans

With the addition of movable or tilting blades that provide exact control over airflow direction, directional ceiling fans put a distinctive spin on conventional ceiling fan designs. Directional fans may be set to concentrate airflow in particular regions of a space, in contrast to normal ceiling fans that spread air uniformly in all directions. Because of this capability, they are especially helpful in locations like workstations or seating areas where focused airflow is required. Directional ceiling fans can lower energy usage by preventing unneeded cooling of empty spaces and increase comfort by directing air where it's most needed. They are also practical and fashionable complements to modern houses since their movable blades frequently give them a modern and adaptable appeal. Directional Ceiling Fans as shown in Fig 1.8.



Fig:1.8: Directional Ceiling Fans

1.1.9 Chandelier Ceiling Fans

Chandelier ceiling fans provide a dual-purpose solution for both lighting and air circulation by skillfully fusing the stunning looks of a chandelier with the functionality of a standard ceiling fan. Decorative lighting components are usually hanging from the fan's center in these fixtures, making them a visually arresting focal point in any space. Styles for chandelier ceiling fans range from elegant and traditional to sleek and contemporary, allowing homeowners to effortlessly match their current décor. They are perfect for rooms where comfort and design are important, such as living rooms, dining rooms, or bedrooms, because they provide ambient lighting and the useful advantages of cooling airflow during the warmer months. Chandelier ceiling fans provide style and functionality to any space with their adaptable designs. Chandelier Ceiling Fans as shown in Fig 1.9.



Fig:1.9: Chandelier Ceiling Fans

1.1.10 Rotational Ceiling Fans

For bigger areas or those with special design needs, rotating ceiling fans provide a novel way to circulate air. Rotational fans, as opposed to conventional ceiling fans, include a motor that allows the fan assembly as a whole to revolve, distributing airflow more widely around the space. By distributing air more evenly,

this rotating motion helps lessen hot spots and improve comfort levels. Furthermore, a lot of rotating ceiling fans include programmable settings that let customers alter the rotation's direction and speed to fit their tastes. Because of their adaptability and practical design, rotating ceiling fans are both aesthetically beautiful and practical solutions for a variety of contexts. They improve air circulation and also provide visual interest to the space they occupy. Rotational Ceiling Fans as shown in Fig 1.10.



Fig:1.10: Rotational Ceiling Fans

1.1.11 Remote-controlled Ceiling Fans

Compared to conventional ceiling fans, remote-controlled ceiling fans provide more functionality and easier operation. Users no longer need to reach for a wall switch or pull chain to change the fan's speed, direction, or occasionally even the illumination when they have a remote control. Installing this extra convenience in bedrooms, living rooms, or dining areas where rapid changes are needed is especially helpful for spaces with high ceilings. Many remote-controlled ceiling fans have many speed settings, so users may adjust the airflow to suit their comfort levels. Further features that provide users even more control over the fan's functioning include sophisticated settings and programmable timers seen in some models. All things considered, remote-controlled ceiling fans are a popular option

for both residential and business areas since they blend contemporary ease with functionality. A remote-control ceiling fan as shown in Fig 1.11



Fig:1.11: Remote-controlled Ceiling Fans

1.2 BENEFITS OF USING A CEILING FAN CLEANING DEVICE

1.2.1 Save time and effort.

If you don't have the proper equipment, cleaning your ceiling fans may be challenging and time-consuming. Instead of using a chair as support or a ladder to ascend, a ceiling fan cleaning gadget may make the task quick and simple.

1.2.2 Improve air quality.

Dust, pollen, and other particles that gather on the blades of your ceiling fan may be expelled back into the atmosphere when it is turned on. Utilizing a ceiling fan on a regular basis will reduce the quantity of airborne allergens in your home, resulting in cleaner air for you and your family to breathe.

1.2.3 Extend the life of your fan.

Maintaining clean ceiling fan blades will assist to keep the fan from breaking down and prolong its lifespan.

1.2.4 Energy saving

Examine the energy-saving benefits that come with using a ceiling fan cleaning tool. Draw attention to the fact that a build-up of dust and debris on fan blades can reduce their efficiency and raise their energy consumption. Think about the increased airflow, less stress on the fan motors, and better performance that comes with routine cleaning. Talk about the advantages of employing a specialized cleaning tool to reduce maintenance requirements, guarantee peak fan performance, and optimize energy savings over time. Investigate the possible economic advantages and environmental advantages of consuming less energy in homes and businesses.

1.3 CEILING FAN CLEANING METHODS

The height of ceiling fans and the buildup of dust on their blades make cleaning them a difficult undertaking. A number of tools and techniques have been created to make this procedure easier while maintaining the cleanliness and functionality of the fans. These are a few techniques and kinds of ceiling fan cleaners.

1.3.1 Traditional Hand cleaning

To manually clean the fan blades, use an extension pole or ladder along with a microfiber cloth or duster. Although this technique works well, it could take some time and effort, particularly for high ceilings. Traditionally, ceiling fan blades are manually cleaned with a ladder, a microfiber cloth, or a duster. Although it works well, it can be labor-intensive and time-consuming since it involves reaching high places. Frequent dusting guarantees better air quality and maximum fan efficiency.

Analyze if using traditional hand cleaning methods to maintain ceiling fans can result in energy savings. Examine the effects on energy usage by manually clearing dust and debris from fan blades. Take into account elements like increased motor performance, less friction, and better airflow that come from routine cleaning. Examine the energy savings that result from enhanced air circulation and less stress on fan motors, which improve interior temperature management. Talk about the

advantages and disadvantages of hand cleaning techniques in relation to other cleaning tools or expert services. Consider the environmental effects and long-term energy savings of using traditional hand cleaning techniques for ceiling fan maintenance.

1.3.2 Cleaning Fan Cleaning Sprays

You can squirt certain cleaning solutions straight onto the blades that are intended to draw dust. After spraying, use a towel to wipe the blades to get rid of dirt and dust. Additionally, some sprays include anti-static qualities that lessen the chance of dust buildup.

Analyze how fan cleaning sprays contribute to keeping ceiling fans operating efficiently and lasting a long time. Examine how well these specialty sprays decompose and clean fan blades and motor housings of dust, filth, and grime. Take into account elements like application simplicity, suitability for various fan materials, and reach in confined areas. Talk about the possible advantages of employing fan cleaning sprays, such as better airflow, less stress on fan motors, and more energy efficiency since the fan parts are cleaner. Examine these sprays' effects on the environment, taking into account things like chemicals, packaging, and disposal. Talk about the best ways to use cleaning fan cleaning sprays safely and effectively, as well as any safety concerns.

1.3.3 Vacuum Cleaner Attachment

To efficiently remove dust while cleaning the blades, attach a vacuum cleaner with a brush or crevice tool. By using this technique, dust is kept off of the furniture and the floor. Attaching a vacuum cleaner with a brush or crevice tool is the Vacuum Cleaner Attachment technique for cleaning ceiling fans. It cleanly and efficiently eliminates dust from fan blades by the use of suction. This technique guarantees a complete cleaning of the fan and stops dust from landing on surfaces.

1.3.4 Ceiling Fan Cleaning Kits

Cleaning is made easier with kits that include microfiber sleeves that slide over the blades. These dust-collecting sleeves are readily cleaned and repurposed.

Examine the viability and advantages of using ceiling fan cleaning kits to keep the fans clean and operating at their best. Explore the items that are usually included with these kits, such as cleaning solutions designed specifically for fan surfaces, extension poles, and specialty dusting equipment. Evaluate the effectiveness of these kits in safely clearing accumulated dust, crud, and grime from motor housings and fan blades. Talk about how convenient these all-in-one solutions are, especially when compared to separate cleaning supplies or expert cleaning services. Take into account elements like user-friendliness, adaptability to different fan models and sizes, and possible time savings. Examine the effects these kits have on the environment, taking into account sustainable packaging, reusable parts, and eco-friendly cleaning supplies. Give helpful advice and suggestions. For using ceiling fan cleaning kits wisely in order to guarantee hygienic and effective fan operation.

1.3.5 Ceiling Fan Cleaning Devices

A series of brushes on motorized ceiling fan cleaning devices spin with the fan blades to remove dust as they travel. Certain devices include extended handles that enable users to clean fans without the need for ladders in areas with high ceilings.

1.4 TYPES OF CEILING FAN CLEANING DEVICES

1.4.1 Ceiling Fan Dusters

Dusters with long handles and arms that may be bent or extended to assist reach high ceilings. made to effectively clean the fan blades by fitting their form. The purpose of ceiling fan dusters, which have long handles and movable or extended arms, is to clean ceiling fan blades. Because of the way they are made, the dust is effectively removed from the blades. Because they make it possible to securely

clean high ceilings, these dusters are a vital tool for keeping a dust-free atmosphere and extending the life of fans.

1.4.2 *Ceiling Fan Cleaning Robots*

Automated robots that can be put on fan blades and are outfitted with brushes or microfiber pads. These robots clean the blades without the need for human assistance as they travel along them. Robots that clean ceiling fans are automated machines that have brushes or pads on them. They travel along fan blades on their own and clean them efficiently without assistance from a human, making cleaning easier.

1.4.3 *Telescopic Ceiling Fan Cleaners*

Users may clean ceiling fan blades without the need for a ladder by utilizing extendable cleaning equipment with movable arms. equipped with brush or microfiber attachments to remove dust efficiently. Extendable instruments called telescopic ceiling fan cleaners are made for cleaning high ceiling fans. Their arms may be adjusted, and they come with brushes or microfiber attachments to help effectively clear dust and debris from fan blades. Users may access lofty fans without the need for ladders thanks to the telescoping function, which makes cleaning safer and easier.

1.4.4 *Bladeless Fan Design*

Some contemporary fans have easier-to-clean bladeless designs. By utilizing air multiplier technology, these fans do not require individual blade cleaning.

1.5 DESIGN OF CEILING FAN

1.5.1 *Ceiling Fan Facts*

- Among the most energy-efficient methods of indoor cooling are ceiling fans. Over 70% less energy is used by them than by air conditioners.

- Ceiling fans are getting smarter and more efficient. The efficiency and comfort of ceiling fans are increasing thanks to new technology like smart ceiling fans and variable speed motors.
- There is an increasing range of uses for ceiling fans. Nowadays, ceiling fans are utilized in public places like schools, hospitals, and other structures in addition to residences and businesses.

In addition to being aesthetically pleasing, ceiling fans must have sufficient air flow and be functional. Hunter employs a 12-to-15-degree blade pitch. A bigger engine and a smaller blade surface area are needed for this. There must be a minimum of 210 mm between the fan's ceiling and the top of the blades. Hunter suggests that various room sizes need varied fan sizes. For example, a 20-square-foot living room should use a 3-foot fan. This guarantees maximum effectiveness and performance. Fan motor drawbacks include the possibility of electrical hum and subpar design and manufacture. Fan wobbling and stability problems can also be caused by extended motor wavelengths, material flaws, moisture absorption and deformation, imbalanced blades, fluctuations in blade pitch, and motor Manufacturing flaws are among the examples.

1.5.2 Fan Blades

Blades are the flat, aero foil-shaped components that are attached to the ceiling fan hub. They are responsible for creating the airflow that circulates throughout an area. Generally speaking, a variety of materials, including plastic, wood, and metal, are used to create ceiling fan blades. several types of ceiling fan blades.

The two main types of ceiling fan blades are up and down blades. Because of their curvature, down blades drive air downward into the gap. Up blades curve oppositely to pull air upward from the bottom.

Due to their superior ability to cool a space, down blades are more frequently found than up blades. To provide a more consistent airflow, up and down blades are frequently combined. Blades for ceiling fans also come in a range of sizes and

designs. The aero foil design, which resembles an aviation wing, is the most prevalent shape. Blades fashioned like aero foils are excellent at moving air.

Aerodynamic attachments are one method of improving fan blade design, which can lead to a large boost in fan efficiency. Aero foil TT blades, the final choice, are commonly utilized since they can save energy. According to Parker et al., these blades minimize energy losses from turbulence and flow separation. We spoke about it. Aero foil-shaped TT blades are commonly utilized because of the possible energy savings owing to turbulence and flow separation, as postulated by Parker et al., and because optimal blade design strikes a compromise between airspeed and uniformity. Indeed, it has. We spoke about it. With rotor blades, you can outperform conventional fans without increasing the size or cost of the engine. While the top of certain blade designs is aerodynamic, the blade itself is visually designed to resemble a conventional blade. Enhancing efficiency in comparison to conventional designs by 10–26%.

The blades are made to satisfy consumer demand for conventional-looking, energy-efficient fans. The startup wants to enable clients to personalize their fans and employ transparent or translucent blades that are unseen. There are three different blade colors available: smoked transparent, reddish transparent, and clear/transparent. We connected the red and black fan body and feathers together to create a cohesive look using translucent red and smokey feathers. It seems light because of its translucent wings. There is also a lightweight wood version of the blades for people who like a more classic look. You get to choose the color of the blade. A few considerations need to be made while selecting ceiling fan blades.

- Room size: The size of the room will determine how many blades and what kind of ceiling fan is needed. A greater area will require a larger fan with more blades.
- Ceiling height: The height of the ceiling affects both the size of the fan and the quantity of blades needed. A higher ceiling will require a larger fan with more blades.

- Temperature: The choice of blades will also be influenced by the outside temperature. In a hot environment, down blades will cool the area more efficiently. In a cold room, up blades will move warm air from the ceiling more efficiently.
- Style: A wide range of styles are available for ceiling fan blades to complement any décor. Select a look that goes well with the room's other furniture.

1.5.3 Shape of the Ceiling Fan Blade

In India, fans are mostly utilized for optimum cooling, hence the construction of the fan is crucial to ensuring that the blades work as intended. The materials and production techniques, where blade design takes aesthetics into account and manufacturing is efficiency-focused, affect cost. To improve air circulation and efficiency, ceiling fans usually have three blades; nevertheless, having more blades might cause resistance to the motor, which can lower fan performance. The configuration, quantity, and mass of the fan blades influence the ceiling fan's functionality. It is thus usually advised that he utilizes three blades.

Energy efficiency and performance must be enhanced via component design and functionality. The goal of the new design is to facilitate fan blade installation and removal while also enhancing the rotor-to-blade interaction. Additionally, this facilitates ceiling fan blade cleaning. The blade is crucial since it controls the room's air flow and necessitates reshaping the fan's design.

Different grilles and boundary conditions are used by ceiling fans to enhance the blades' form and design. The grid with the optimal flow field and efficiency is chosen using the rake angle test. In addition to lowering noise and improving stability, the grill keeps unintentional items from getting into the fan. It also improves safety and lessens the chance of unintentional injury.

Over time, ceiling fan blades have changed in shape to increase their effectiveness and performance. The paddle-shaped blade is now the most often used style of ceiling fan blade. Wide, flat blades with a small bend from the leading

to the trailing edges are called paddle-shaped blades. This curvature facilitates efficient air circulation and lift.

The aero foil-shaped blade is another kind of ceiling fan blade. Aero foil-shaped blades have a curved top surface and a flatter bottom surface, like an airplane's wings. This form aids in improving airflow and decreasing drag.

Additionally, some ceiling fan manufacturers sell blades in unusual designs like propeller or leaf shapes. These blades are frequently utilized in particular kinds of spaces to enhance airflow or to produce a particular appearance.

Pitch is another factor that affects a blade's effectiveness in addition to shape. The angle at which a blade is inclined with respect to the horizontal plane is known as its pitch. Although a higher pitch will result in greater airflow, it will also use more energy to run. Although it won't create as much airflow, a lower pitch will run on less energy.

The size of the space, the height of the ceiling, and the needed airflow will all affect the optimal form and pitch of a ceiling fan blade. A medium-pitch paddle-shaped blade is a suitable option for most spaces. The following are some recent developments in ceiling fan blade shape:

- **Leaf-shaped blades:** Due to their ability to lend sophistication and beauty to any space, leaf-shaped blades are growing in popularity. To complement any décor, they come in an array of colors and finishes. Leaf-shaped blades as shown in Fig 1.12.



Fig:1.12: Leaf-Shaped Blades

- **Transparent blades:** Another recent development in ceiling fan design is transparent blades. Because they are transparent, like acrylic or polycarbonate, they may be blended in with their environment. They are therefore a wise option for spaces with light-coloured ceilings. As shown In Fig 1.13



Fig:1.13: Transparent blades

- **LED blades:** Another cutting-edge new development in blade technology. They have built-in LED lighting, which may offer more lighting to an area. LED blades are durable and need less energy. LED blades as shown in Fig 1.14.



Fig:1.14: LED blades

- **Rectangular shaped blades:** Blades with a rectangular shape A contemporary and inventive take on the classic ceiling fan is the rectangle-shaped ceiling fan. These fans, in contrast to traditional circular fans, have a distinctive rectangular housing and blade shape. Rectangular-shaped blades as shown in Fig 1.15.



Fig:1.15: Rectangular-shaped blades

1.5.4 Ceiling Fan Thermal Comfort

A common solution for increasing thermal comfort in homes and offices is to install ceiling fans. They function by moving air around, which helps to cool the body and provide the impression that it is colder. Several elements influence a ceiling fan's thermal comfort, such as:

- **Airflow:** The primary determinant of a ceiling fan's thermal comfort is its airflow velocity. There will be greater cooling with a larger airflow velocity.
- **Blade pitch:** The tilt angle of a ceiling fan's blades is known as the blade pitch. Although a higher blade pitch will result in greater airflow, it will also use more energy to run.
- **Room temperature:** The thermal comfort of a ceiling fan is also influenced by the room's temperature. A larger airflow velocity will be needed to have the same cooling effect at a higher room temperature.
- **Relative humidity:** The thermal comfort of a ceiling fan is also influenced by the air's relative humidity. Higher relative humidity will make the air seem drier and reduce the cooling power of a ceiling fan.

The ASHRAE Standard states that 29.4 °C (85 °F) is the maximum temperature that may be accommodated in the adaptive comfort model when air velocity exceeds 59 fpm. This indicates that the summer comfort envelope's top limit can be raised by up to 3.3 °C (6 °F) using a ceiling fan.

Numerous variables, including temperature, humidity, and wind speed, affect thermal comfort. Because of the "wind chill" effect, utilizing moderate wind speeds at high temperatures might increase comfort, even if lower temperatures are preferable in cooling settings. Air conditioning systems regulate temperature in both residential and commercial buildings, and ceiling fans may speed up airflow. Energy savings and improved thermal comfort are possible with the proper usage of ceiling fans.

1.5.5 Efficiency of Ceiling Fan

The amount of air a ceiling fan moves per watt of energy used is how its efficiency is determined. CFM/W, or cubic feet per minute per watt, is how this is stated. The fan is more efficient the greater the CFM/W.

Modern ceiling fans have more efficient motors and blade designs than they did a few years ago. The most efficient ceiling fans will be able to move up to 400 CFM/W in 2023. This indicates that for every watt of energy used, they can move 400 cubic feet of air each minute. Additionally influencing a ceiling fan's efficiency are the following factors:

- Fan size: Generally speaking, larger fans run more smoothly than smaller ones.
- Blade pitch: More airflow can be achieved with greater blade pitch but operating it will cost more energy.
- Motor type: BLDC (brushless DC) motors are more energy-efficient than conventional AC motors.
- Fan speed: Ceiling fans are more efficient at higher speeds.

1.5.6 Ceiling Fan Motor

Ceiling fan motors have developed over time to become more dependable and efficient. The alternating current (AC) induction motor is now the most widely used kind of ceiling fan motor. AC induction motors are inexpensive, reliable, and

easy to use. Additionally, they use less energy than other kinds of ceiling fan motors, such shaded pole motors, which are quite outdated.

Direct current (DC) motors are an additional kind of ceiling fan motor. Although DC motors use less energy than AC motors, their cost is higher. In addition, DC motors operate more smoothly and silently than AC motors. The brushless direct current (BLDC) ceiling fan motor is a brand-new technology that will be available in 2023. The most efficient kind of ceiling fan motor on the market is the BLDC motor. They operate smoothly and quietly as well. BLDC motors are the priciest kind of ceiling fan motor, nevertheless. AC induction motors are typically used in ceiling fans due to their cost, affordability, and easy construction. On the other hand, slippage makes single-phase induction motors less efficient. Brushless DC (BLDC) motors are becoming more and more common due to advancements in electronic commutation and the availability of reasonably priced high-performance magnetic materials. Since mechanical commutation causes minimal friction loss, BLDC motors are more efficient than brushed DC motors. Because slippage results from the rotor's failure to revolve in unison with the magnetic field, induction motors are inefficient. By running simultaneously with a spinning AC magnetic field produced by electronic commutation, BLDC motors solve these issues. A 75W BLDC motor may outperform an average 75WAC induction motor by up to 90% in terms of efficiency. Table 1 compares the 75W motor's efficiency to that of other motors of a comparable design.

Table:1.1: Types of motors

Motor type	Efficiency
Nova Torquea	90%
Practical limits BLDC6	87%
Practical limits AC induction	84%
Average new production 75 %	75%
Average installed base 60 %	60%

According to technical studies, BLDC motors may be able to lower energy usage. According to a Taiwanese study, fans using split-phase induction motors need around 50% more energy than fans using BLDC motors. According to an Australian study, the energy consumption of a ceiling fan may be decreased by two at high speeds and by a third at low speeds when using BLDC motors. Professionals in the field predict that BLDC motors might cut ceiling fan energy use in the US by about 60%. BLDC motors are used by several fans in India to increase energy efficiency. These fans use less energy than typical ones; when operating at high speed, their power consumption drops from 70–75W to 45–50W. By utilizing active materials like finned steel and copper, decreasing the air gap between the stator and rotor, and employing die-cast aluminum of standard quality for the rotor, these fans may operate more efficiently.

1.5.7 Ceiling Fan Blade Material

Typically, ceiling fan blades are constructed from a variety of materials, each of which has special benefits in terms of strength, effectiveness, and appearance. The fan's lifespan and performance can be greatly affected by the type of blade material selected.

- **Wood:** Because of their timeless and refined appearance, wooden fan blades are in demand. They may go with rustic or classic home design themes and are available in a variety of finishes. Wood is a good material for fans with lesser motor power since it is very lightweight. However, if humidity levels fluctuate over time, they could distort or break.
- **Metal:** Steel and aluminium are frequently utilized for fan blades. Metal blades are strong, rust-resistant, and rather easy to maintain. Because of their streamlined design, they are frequently seen in industrial or modern-style fans. Because metal blades are heavier than wooden ones, a stronger motor is needed to operate them effectively.
- **Plastic:** Fan blades composed of plastic, especially premium manufactured plastics, are inexpensive, lightweight, and unable to distort or break. Their designs are adaptable, and they may simulate the look of metal or wood.

Affordable ceiling fans frequently include plastic blades since they are simple to maintain.

- **Composite:** To maximize the advantages of both materials, composite fan blades blend materials like plastic and wood. These blades are made with increased durability and efficiency in mind. Because of their moisture resistance, they may be used in moist or humid settings like restrooms or outdoor areas.
- **Bamboo:** Fan blades made of bamboo have an organic, natural look and are environmentally beneficial. Because of their sustainability and portability, they are a well-liked option for customers that care about the environment. Bamboo blades are frequently used in home design with a tropical.

It's important to take into account aspects like the size of the space, the height of the ceiling, the motor power, and the desired look when selecting ceiling fan blades. Because every material offers a distinct set of benefits, homeowners may choose blades that best suit their tastes and needs. Regardless of the material selected, regular maintenance guarantees optimum performance and prolongs the fan's lifespan. Examples of this maintenance include cleaning and balancing the blades.

In hot, humid tropical areas, ceiling fans are a necessity for cooling. These are made up of a motor, base plate, and either steel, aluminum, or wooden wings. Use three to five blades or paddles to move air about. In comparison to air conditioners, ceiling fans are less expensive, dependable, simple to install, and use less energy. Nevertheless, inefficiencies lead to large losses of power. Because traditional ceiling fans are not made with the best aerodynamic performance in mind, their high-power consumption can be attributed to excessive blade losses. This study suggests utilizing aerodynamic blade profiles in conjunction with an experimental and theoretical approach to increase the energy efficiency of ceiling fans. In this study, the impact of fan speed variations on an axial fan's speed, pressure, and mass flow rate was examined using ANSYS in a CFD-based investigation.

1.5.8 Design of Ceiling Fan Blades with Microphone

The innovative combination of technology and design found in ceiling fan blades with built-in microphones improves the practicality and aesthetics of a conventional home appliance. With a strong emphasis on smooth integration, these cutting-edge fans are made with microphones that blend in seamlessly without detracting from the fan's functionality.

The producers secretly incorporate microphones inside the fan blades with the use of complex technological techniques. The blades are often constructed from lightweight, strong materials like quality plastic or composite materials to guarantee that they maintain their structural integrity while supporting the additional components. The microphones are thoughtfully positioned into the blade construction and carefully adjusted to capture sound efficiently without unbalance the fan's rotation.

Noise-canceling technology is frequently used to assure peak performance, enabling the microphones to focus on certain audio sources and filter out background noise. Thanks to this technology, the fan can react to other audio inputs or precisely recognize spoken instructions without being affected by external noise.

Voice-controlled operation is made convenient for users of ceiling fans with built-in microphones. Voice commands may be used to operate other smart home devices, modify lighting settings, and even change fan speed. This creative design adds to the overall elegance and ease of modern home spaces in addition to improving the fan's functioning...

1.5.9 Ceiling Fan Noise Reduction

- **Electromagnetic noise:** The noise produced by an electric motor power the fan. The air gap magnetic field created between the rotor and stator is primarily responsible for the noise since it mechanically excites the stator.
- **Aerodynamic Noise:** The fan's impeller, an essential component, interacts with the airflow to produce noise.
- **Mechanical noise:** noise produced by the transmission and bearings.

Aerodynamic noise characteristics differ according to fan type, shape, and rotation speed, among other factors. pipe connection, fan impeller diameter, fan operating point, and speed. erratic power, the impact of continuous loads on the blades and noise levels may be disregarded at Mach peak. There are less than three. At low speeds, fan noise levels become noticeable, and the usual frequency spectrum is made up of multiples of the broadband frequency and the blade passing frequency (BPF). Like a forward-curved centrifugal fan, the fan's total acoustic power level rises with a volumetric flow rate without decreasing at BEP.

For homeowners, ceiling fan noise reduction is a major problem, particularly when the fan runs at high speeds and produces distracting noises. Manufacturers utilize a variety of strategies to reduce noise and improve user experience.

- **Motor Design:** High-end, energy-efficient motors with silent operation are frequently used in contemporary ceiling fans. These motors operate more smoothly because of their precise engineering, which lowers noise and vibrations.
- **Blade Design:** Noise levels are influenced by the pitch and form of fan blades. Aerodynamic blades with specific designs may drastically cut down on noise produced by air cutting. Additionally, uniform air circulation is ensured by balancing fan blades during production, which reduces vibrations and noise.
- **Materials** Compared to metal blades, fan blades composed of composite, wood, or plastic materials are superior at absorbing sound. Like this, damping vibrations and lowering noise may be achieved by placing a noise-absorbing substance in the motor casing.
- **Mounting System:** It is essential to have a well-designed mounting system. Sturdy mounting reduces wobbling, which can make sounds. To minimize superfluous movement and noise, proper installation is important, which includes fastening the fan to a ceiling joist.
- **Quality Bearings** The fan motor's sealed, high-grade ball bearings minimize friction and guarantee smooth operation. A quieter operation is a result of less friction, which also results in less heat output and noise.

- **Variable Speed Settings:** Fans with many speed settings let users change the fan's speed to suit their needs and the needs of the space. Reduced speeds preserve airflow while producing less noise, making the atmosphere calmer.
- **Regular Maintenance** Dust buildup on motor parts and blades can cause imbalances, which make noise when the machine is operating. Frequent upkeep and cleaning guarantee efficient functioning and reduce noise from dust or debris.
- **Use of Sound-Dampening Materials** The motor housing and blade brackets of certain high-end ceiling fans contain sound-dampening materials. These materials reduce noise and vibrations, which helps the fan run more quietly.

CHAPTER 2

LITERATURE SURVEY

In India, cleaning tools and equipment for ceiling fans are essential household products. There aren't many cleaning supplies (items) on the market right now that can be used to remove dust off ceiling fans. Numerous ergonomic and usability problems prevented these gadgets from being well-received by users. Nevertheless, no study publication exists pertaining to this fact or information. As a result, the purpose of this article is to learn about users' experiences with current ceiling fan cleaning tools and equipment and to suggest a few innovative designs that might solve users' issues. First, market research was done to find out what the consumers needed and expected in terms of cleaning techniques and available equipment. A questionnaire was used to conduct a user survey, which provided more insight into the design process. Throughout the ceiling-fan cleaning work, there are many survey questions pertaining to the above-mentioned concerns. The brainstorming method has produced a variety of notions. The new conceptual designs for the cleaning equipment were created with the expectations and practical and aesthetic demands of the user in mind. Based on the results, it was noted that the user experienced significant lumbar strain in addition to mild pain and discomfort in the arm, neck, and shoulder. While utilizing the current ceiling-fan cleaning tools and equipment, other significant issues were also noted, including reachability, convenience of operation, and ease of implementation (interactions with the product). A few idea concepts were put out in response to these user issues, and it is anticipated that they would result in a better design for the ceiling fan dust-cleaning procedure. y. Zhang, 2022 [1].

Many individuals these days, including housewives, cleaning companies, and others, struggle to clean their ceiling fans. This is a result of the fact that people continue to clean ceiling fans using antiquated techniques like climbing stairs or first opening the fan blades. They also utilize brooms, towels, and poultry feathers as ceiling fan cleaners. Due to a number of flaws, including unsafe safety, excessive cleaning time need, and an unguaranteed level of cleanliness in the ceiling fan, this

cleaning equipment are not fit for usage. The challenges they encounter when cleaning the ceiling fan have been the subject of several earlier research, yet the complete findings are still awaited. Thus, the purpose of this study is to explore solutions for overcoming the challenge of cleaning ceiling fans. A survey was undertaken using questionnaires to find out who in the community, particularly housewives and cleaning contractors, finds it difficult to clean fans. Many improvements to the fan cleaner have been proposed, including the addition of a water drain for cleaning, a revolving roller, and an adjustable rod up to 4 meters in length. With the product's renewal, cleaning the identical fan blade with only one operator may now be completed in as little as four minutes instead of the previous eight. This instrument might be improved by utilizing a lighter type of rod to lessen the burden and by employing a type of cloth for cleaning. y. Zhang,2020 [2].

To meet a range of purposes, cleaning tools have been developed in a multitude of sizes and forms. The user may safely reach the bottom part of the fan blades with brooms, mops, and other tools. The use of elevating equipment and apparatuses by the user to clean the upper side of these blades always carries some risk. The current invention is related to cleaning tools, more especially to a tool that eliminates the need for any type of elevating tool in order to clean the top and bottom of ceiling fan blades. Mord faisal bin jasni,2008 [3].

A fan is a hand-held device that is rotated back and forth to provide airflow to a person. It is typically shaped like a section of a circle and is made of materials like paper or feathers affixed to thin rods or slats that pivot to allow the device to be folded up compactly when not in use. Usually found at the top of the home is a ceiling fan. A lot of air is created by ceiling fans, which scatters dust all over the place. There is always a lot of dust in the air, both tiny and bigger particles can see through. A significant amount of the flowing air strikes and gathers on the fan's blades over time. Dust buildup on ceiling fan blades is a predictable phenomenon. A dust ball is just a collection of charged dust particles that are fatally attracted to one another, unlike most dust particles which have an electrical charge and can be attracted to each other. The majority of people in the neighborhood own many ceiling fans, however because of their height, they are challenging to clean. The aim of this

project is to design an easy-to-use apparatus and an ergonomic ceiling fan cleaning. Every ceiling fan blade is cleaned with a ceiling fan cleaner. This ceiling fan cleaner might help because climbing a ladder can be risky and difficult due to the height. Using a mechanism or device that can be slipped onto the fan blades and attached with a handle allows the person cleaning the fan blades to manipulate the cleaning tool from the floor by moving it back and forth along the blade. This is one method for cleaning ceiling fans' blades. Farzana binti dusuki,2019 [4].

The blades of ceiling fans gather a lot of dust, which they then disperse. A detachable cleaner member and a fork member make up a ceiling fan blade cleaning tool. The gadget is held by the user for cleaning purposes via the tubular handle on the fork part. The cleaner member is made of fibrous web material. Its rectangular center section is made up of two rectangular webs that are spaced apart and offer an aperture through which a ceiling fan blade can extend to clean the member's top and lower surfaces simultaneously. Cleaning the blades of a ceiling fan does not require users to stand on a chair. PVC plastic rod, plastic, and cloth are frequently used in the production of this adjustable ceiling fan blade cleaner. This item was selected due to its durability, strength, low weight, ease of production, and so on. Steel components are frequently joined together in the fabrication of this adjustable fan's blade cleaner using MIG welding. This technique was selected because it may yield an adjustable ceiling fan blade cleaner that is long-lasting, hygienic, and visually appealing. Muihamad rusydi bin ali,2007 [5].

One of the most often used appliances, both for home and business use, is the ceiling fan. The literature on ceiling fan design, aerodynamics, construction, and other aspects is thoroughly reviewed in this work. The goal of the work is to promote a basic understanding of the various aspects related to ceiling fans, including their shape, the study of their flow field, their aerodynamics and structural analysis for various blade materials, and their noise reduction methods. In order to help future research go in the right path, this document will help manufacturers and researchers by offering all of the information that is necessary to understand ceiling fans. r. Wandre, f. A. Gaddi, v. Dongre, s. Hasija, and I. Ullah [6].

The majority of ceiling fans feature three or even five speeds. In addition, ceiling fans can be upgraded with lighting kits or have lighting fixtures installed on them. Ceiling fans were a common sight in homes, offices, and factories prior to the development of mechanical air conditioning. However, as the market for central air conditioning grew, their use declined. Residential ceiling fans have seen a renaissance recently, with many newly constructed homes frequently sporting many fans.

It can be impossible to reach the upper surface of ceiling fans' blades, and they are exceedingly challenging to clean. It was not only challenging to stand on a step ladder, but it was also risky for people's posture. Essentially, the primary goal of this project is to create a ceiling fan that makes blade cleaning simple. To capture dust, numerous manufacturers have created ceiling fan filters. It's simple and quick to install these dust filters on ceiling fans. The filters will function as a dust gathering device while the fan rotates. One of the filters is positioned on each blade. The material used to make the air filter is porous, allowing air to pass through while capturing airborne particles. However, this redesigned ceiling fan model makes it easier and faster for home users to wipe the dust from the fan blades while maintaining proper posture. Additionally, the user can clean the blades without putting their body in danger by standing on a ladder. This design is particularly user-friendly and ideal for residential use Z.Bin musa [7].

In the current investigations, six ceiling fan blade models with various trailing edge serration types were made and simulated using commercial software to examine how well different trailing edge serrations reduce fan blade trailing edge noise. These were the initial fan blades: half-flat, half-rectangular, half-serrated, flat-tipped, and rectangular. According to the simulation results, the half flat tip fan blade had the best acoustical performance, reducing noise by an overall 13.9dBA. It was followed by the rectangular fan blade, which reduced noise by 10.9dBA, the flat tip fan blade, which reduced noise by 9.2dBA, the half rectangular half flat tip fan blade, which reduced noise by 5.0dBA, and the serrated fan blade, which reduced noise by 4.7dBA. In the current investigations, experimental testing in an anechoic chamber demonstrated the efficacy of TE serrations in minimizing trailing edge noise. Hsiao Mun Lee, Kian Meng Lim ,and Heow Pueh Lee 2018 [8].

Effective, conventional-looking ceiling fan blades with wide tip ends and aerodynamic upper surfaces for ceiling fans made of plastic and wood, or surfaces that are attached separately and operate with less energy consumption while moving greater volumes of air than conventional flat-shaped ceiling fan blades. Key techniques for running the innovative ceiling fan blades at various speeds up to and below roughly 250 rpm. Twisted blades of the innovative blades can be utilized in two, three, four, five, and more blade configurations, and they can be configured for ceiling fans with diameters ranging from less than roughly 32 inches to larger than approximately 64 inches. With increased airflow and fewer issues than traditional flat type and planar upper and lower surface blades, the innovative fans may be operated at lower speeds and consume less energy than conventional fans. r. J. Shaughnessy and r. G. Sextro 2018 [9].

A relatively new method for creating quiet, cozy, soft air circulation in huge enclosures, such as warehouses, vast barns, and health clubs, is the use of high-volume low-speed fans (HVLS). HVLS fans have a diameter of between 2.5 and 7.5 meters, in contrast to residential ceiling fans, which are normally between 0.9 and 1.3 meters. Additionally, in contrast to standard ceiling fans, HVLS fans rotate between 45 and 80 RPM relatively slowly. HVLS fans technically have to meet two requirements: (a) the volumetric airflow through the blade disc in a single revolution must be at least 14 cubic meters, and (b) the speed of the blade tip on an HVLS fan cannot exceed 27 m/s. The primary advantages of HVLS fans include their year-round use for HVAC (heating, ventilation, and air conditioning); their quiet operation and soft airflow; and their average energy savings of 49%, which also translate into lower carbon and CO₂ emissions. Mohammad Moshfeghi, Nahmkeon Hur, 2014 [10]

Owing to their durability and efficiency, three-phase induction motors (IM) are extensively utilized in the industry; nevertheless, they are not found in applications for ceiling fans found in homes. Because they are inexpensive and easy to manufacture in large quantities, single-phase induction motors, or SPIMs, are frequently utilized in ceiling fan applications. Because of the greater losses brought on by the harmonics resulting from their single-phase architecture, SPIM performs poorly. They consequently fall short of the new energy efficiency benchmarks

established by the Government of India's Bureau of Energy Efficiency (BEE) (GOI). A different approach to solving this issue is to use brushless DC (BLDC) motors. They are negatively impacted, nevertheless, by the appliance's total cost. This study examines the advantages of using a 3-phase stator in favor of an SPIM stator for a ceiling fan motor application that requires less energy. Low pole pairs are present in the three-phase focused winding, and the stator slots have been correctly built to obtain a high winding factor. In comparison to the current conventional SPIM utilized in the ceiling fan, a lower value of operating voltage and fewer pole pairs are chosen for the stator design in order to minimize iron losses in the machine. A finite element analysis program called FEMM has been used to simulate the intended stator. To guarantee the same airflow, the manufactured 3-phase stator for the ceiling fan is tested at the same fan speed as a ceiling fan motor based on SPIM. M.indraganti [11].

Residential and commercial buildings are among the few industries with a large potential for energy savings through the application of green building concepts, renewable energy sources, and building energy management. Scholars are attempting to determine ways to increase the sustainability and energy efficiency of buildings. This is a result of both expanding energy consumption and environmental threats on a worldwide scale. Utilizing energy-efficient passive cooling technology in buildings is becoming more important in the fight against global environmental issues and energy consumption. To provide cold air to buildings with the least amount of electricity consumption, passive cooling technology avoids the use of energy-intensive mechanical air conditioning systems. Despite being energy-efficient, passive cooling has drawbacks when it comes to maintaining thermal comfort, architectural constraints on the building envelope, and security needs because of facade apertures. Free cooling ventilation solutions could eliminate those passive cooling drawbacks.

Kuniaki Mihara, Chandra Sekhar, Yuichi Takemasa, Bertrand Lasternas, K wok Wai Tham, 2019 When combined with ceiling fans, a Dedicated Outdoor Air System (DOAS) can increase the thermal comfort zone in warm, muggy settings and offer 100% conditioned outdoor air, which improves indoor air quality. Such

operating circumstances with higher air movement and room temperatures could result in significant energy savings for the HVAC system.

In warm, humid situations, increasing air movement is a useful tactic to enhance thermal comfort and PAQ. Air movement-induced convective cooling aids in removing body heat from the skin. The thermal comfort zone can be extended by increasing air flow, as per ASHRAE standard 55-2017. Furthermore, prior research shown that participants experienced thermal comfort around 29°C/50% RH, with enhanced air movement facilitated by a ceiling fan during chamber experiments. have demonstrated that by increasing air circulation with ceiling fans, more than 80% of individuals were able to tolerate the thermal environment and Indoor Air Quality (IAQ) at 30°C and 80% RH. In warm, muggy settings, horizontal airflow produced by floor and stand fans has also been shown to enhance thermal comfort. At 30°C and 60% RH, thermal comfort air movement with an independently regulated stand fan improved PAQ and thermal comfort and good feeling. M. Alizadeh, S.M. Sadrameli, 2019 [12].

India's building sector is using a growing amount of energy. The ventilation controls alone in Indian residential buildings consume about 47 percent of the building's total energy. The 23–26 °C comfort temperatures listed in Indian codes are incorrect. There are no published thermal comfort field studies from India in residential settings. In Hyderabad, the author conducted a field study in 2008 throughout the summer and monsoon seasons in apartments. This paper addresses the ways in which the occupants have adapted their behavior, controlled their surroundings, and overcome obstacles. 60% or so of tenants reported feeling uncomfortable in the summer due to inadequate adaptive options. The study's comfort range, which was 26.0–32.5 °C, was significantly higher than the normal. Fanger consistently overstated the true feeling in his PMV.

By means of clothes, metabolism, personal environmental controls, and several behavioral control measures, the inhabitants were able to adapt. Temperature-related increases in the use of fans, air coolers, and air conditioning (A/C) were hindered by factors such as occupant attitudes, low cost, and

ineffectiveness. The upper levels were mostly equipped with air conditioners and air coolers due to the lack of adequate adaption chances. Summertime behavioral adaption was greater and more restricted in higher economic groups. Individuals who were often in air conditioning settings showed minimal tolerance for severe temperatures and expressed a desire for warmth. Madhavi Indraganti, 2011 [13].

The amount of electricity used in homes is greatly increased by ceiling fans, particularly in developing nations with warm climates. This study examines the costs and advantages of various ceiling fan efficiency improvements in order to determine the potential worldwide for electricity savings and the reduction of greenhouse gas (GHG) emissions. Commercially available technology can increase ceiling fan efficiency by at least 50% while remaining cost-effective. By 2020, all ceiling fans on the market may save 70 TWh annually and prevent 25 million metric tons of carbon dioxide equivalent (CO₂-e) emissions worldwide if these efficiency improvements are included in all of them. We evaluate the potential savings that can be realized by accelerating the adoption of energy-efficient ceiling fans through policies and programs like standards, labels, and financial incentives. Nihar Shah, Nakul Sathaye, and Virginie Letschert 2015 [14].

In order to improve convective heat transmission and, in turn, body heat dissipation, a breeze must be created in space. Fans are widely utilized in most tropical nations to improve air circulation, produce an indoor breeze, and ultimately increase comfort. The properties of the induced flow pattern in the space are mostly dependent on the fan's speed, diameter, number of blades, angle, and placement. In the current study, analytical calculations are carried out for four distinct blade materials: steel, aluminum, GFRP composite, and PVC, in order to determine the coefficient of performance and estimate the net air flow per unit power input. The entire geometry for the ceiling fan model is imported into ANSYS CFX after it is produced in CREO elements/Pro 5.0. The GM 15 aero foil profile has been chosen for blade examination. The complete ceiling fan model, including the behavior of the blades as a result of aerodynamic lift and drag forces, bending stresses, and deflection, is simulated. In order to improve the blade's performance and stability for a variety of materials, comparisons of the combined loads are examined. The

software utilized for the structural and modal analysis is called ANSYS APDL. Finally, the power consumption of ceiling fans for various blade materials is also computed on a monthly and annual basis. Priyanka Dhurvey, Neeraj Kumar Pathak, Sanjay Soni, Ajay Pandey 2018 [15].

CHAPTER 3

AIM AND SCOPE

3.1 AIM OF THE PROJECT

A fan cleaning device's main goal is to make cleaning fans—especially ceiling fans—easier and more straightforward. The purpose of these devices is to provide the best possible fan performance, air quality, and energy efficiency by eliminating dust and debris from fan blades in an easy, quick, and cost-effective manner. These technologies save customers time and effort by automating or optimizing the cleaning process, all the while preserving a healthy interior environment.

Efficiency and Effectiveness: Cleaning fans completely and effectively is the main goal of any fan cleaning equipment. Over time, dust, debris, and allergens tend to collect on fan blades, which not only reduces indoor air quality but also negatively impacts the fan's function. The main objective of the device is to efficiently remove all collected particles so that the fan runs at its best and helps create a healthier living or working environment.

Timesaving: One of a fan cleaning device's main goal is to help consumers save time. It might take a lot of effort and time to clean fans, especially ceiling fans. By automating this procedure, fan cleaning systems greatly save the time and effort needed for cleaning. With this technology, users may accomplish a clean fan in a fraction of the time compared to traditional approaches.

Safety: Safety is the most important thing, especially while cleaning ceiling fans that are situated at a considerable height. Fan cleaning tools provide a secure substitute for clambering up ladders or utilizing other hazardous techniques. These gadgets put users' safety first by accessing and cleaning high areas without the chance of mishap.

Accessibility: To ensure thorough cleaning, fan cleaning equipment are made to reach locations that are difficult to reach. By giving consumers access to instruments that can clean the fan's interior elements, such as the motor housing

and complex mechanisms, as well as its external components, the device's overall performance and longevity would be improved.

Innovation and Adaptability: With the rapid advancements in technology, the aim is to innovate continually. Fan cleaning devices incorporate cutting-edge features such as robotic cleaning, artificial intelligence, smart sensors, and adjustable cleaning modes. The goal is to stay ahead of market demands, offering users state-of-the-art devices that cater to their evolving needs.

Environmental Sustainability: Eco-friendly materials and energy-saving techniques are used in the design of many fan cleaning equipment. Reducing the cleaning procedures' negative environmental effects is the goal. Utilizing eco-friendly materials and energy-saving technology, these gadgets support international initiatives to encourage ecologically responsible behavior.

User ease: The priority for fan cleaning equipment is user ease. Frequently, they have ergonomic handles, simple controls, and cleaning modes that may be customized, making them highly user-friendly. The goal is to simplify the cleaning procedure so that people of all ages and skill levels may use the gadget with ease.

Long-Term Maintenance: One factor in the long-term maintenance of fans is the use of fan-cleaning devices. Frequent cleaning keeps dust from building up, allowing the fan to run at peak performance for longer. These devices indirectly extend the life of fans by minimizing component wear and tear, sparing consumers from having to replace them more frequently.

3.2 SCOPE OF THE PROJECT

Fan cleaning devices are wide-ranging and include many facets of efficiency, convenience, and technology. The range of applications for these devices is expanding as customer demands and technological advancements meet, to offer all-inclusive solutions for cleaning various fan kinds in a range of environments. An extensive overview of the range of fan-cleaning equipment is provided here.

Versatility: The range of fan cleaning tools provides support for tower, exhaust, pedestal, and ceiling fans, among other fan kinds. These devices are flexible and may be tailored with various attachments and cleaning methods to meet the unique needs of various fan types.

Advanced Cleaning Mechanisms: Fan cleaning technologies make use of sophisticated cleaning mechanisms including microfiber brushes, robotic arms, and movable nozzles. By completely cleaning fan blades, motor housings, and other parts, these systems make sure that there is no space for dust or debris to collect. Here, the goal is to improve these cleaning systems' efficacy and efficiency through ongoing innovation.

Integration of Smart Technologies: The range of fan cleaning devices is increased by the incorporation of smart technologies such as artificial intelligence and sensors. As dust levels are detected, smart sensors may change the strength of the cleaning. Learning algorithms made possible by artificial intelligence guarantee accurate cleaning patterns and can adjust to various fan designs.

User-Friendly Design: Part of the responsibility is creating fan cleaning equipment with the comfort of the user in mind. The gadgets' ergonomic handles, lightweight construction, and user-friendly controls make them more convenient to use. Users may easily access fans of different sizes and heights thanks to the devices' often-adjusted heights and angles.

Safety Features: One important part of the scope is safety. In order to safeguard users, fan cleaning devices are designed with safety features such as auto-shutoff mechanisms while not in use. Furthermore, some gadgets have anti-fall sensors built in to avoid unintentional falls while in use.

Efficient Power Consumption: This is an important factor to take into account. The goal is to provide fan cleaning tools with low power consumption, which will benefit consumers financially and ecologically over time. Reduced power usage is a result of refined cleaning algorithms and energy-efficient motors.

Personalization and Interoperability: The range includes personalization choices. A variety of attachments and accessories are available from the manufacturers, enabling customers to customize the cleaning procedure to meet their unique requirements. Maintaining compatibility with many fan models guarantees broad market penetration and adaptability to diverse settings.

Maintenance of Indoor Air Quality: Fan cleaning equipment plays a major role in keeping indoor air quality up. These devices improve the general health and well-being of residents by preventing the circulation of polluted air in living areas by eliminating collected dust, allergens, and pollutants from fan blades.

Commercial Applications: Fan cleaning equipment is not just for home usage. It includes commercial and industrial settings, where exhaust fans, ventilation systems, and large-scale fans are commonplace. In order to maintain a safe working environment and ensure that industrial fans operate at their best, these devices are made to tackle demanding cleaning jobs in industrial environment.

Global Market Expansion: The goal is to increase the market's reach internationally in response to the rising need for effective cleaning solutions. Fan cleaning devices are widely relevant and accessible due to their design, which adheres to international standards and accommodates a variety of cultural and environmental circumstances.

CHAPTER 4

MATERIALS AND EXPERIMENTAL METHOD

4.1 METHODOLOGY

To ensure that the project can be finished on schedule, the whole production procedure for cleaning the adjustable ceiling fan blades is planned. An assessment of the literature and product research served as the project's initial stages. The aim of a project needs to be selected carefully.

After that, I studied a lot about cleaning ceiling fan blades and did a lot of research. This evaluation covers the idea behind the cleaner, fan technology, and kind of cleaner used in different ceiling fan blade cleaners. For these assignments, the internet, books, and other sources were used for research.

We also discuss several additional aspects that could affect the fan's performance, such its sort and design. Variables including motor type, pitch, size, and blade style may affect fan performance. Because they come in a variety of forms to complement any décor, ceiling fans are an essential addition to any environment. Ceiling fans are a flexible and affordable way to cool your home. If you choose the right model and install it correctly, ceiling fans might benefit you for many years to come.

Efficiency in ceiling fans is crucial for reducing energy use and expenses. Energy-efficient fans can reduce your energy bills by up to 60% since they use less electricity to circulate air. For the best results, select fans and BLDC motors with high CFM/W values, make sure the installation is done correctly, and provide unobstructed airflow pathways.

The flat, paddle-shaped blades of ceiling fans are made to circulate air effectively in both summer and winter. Though they can be angled, bent, or leaf-shaped, the flat, paddle-like form is the most typical and adaptable.

Clean the blades, adjust the screws, grease the motor, inspect the hood, and balance the blades to lessen noise from ceiling fans. If the fan keeps making weird

noises, replace it as needed. By removing perspiration and lowering body temperature by up to 4°C, ceiling fans produce a wind-cooling effect that improves thermal comfort. Although they may also circulate air in cooler temperatures, they work best in hot, humid settings. Think about the substance of the blades when selecting an electric fan based on your demands and budget.

To rotate the fan blades, a ceiling fan motor transforms electrical energy into mechanical energy. Single-phase induction motors are the most widely used variety, and they are used in air conditioners, washing machines, and refrigerators among other household appliances. These engines are efficient, affordable, and simple to produce. creates a magnetic field that rotates, which causes the rotor to revolve. By changing the AC power supply's frequency, you may adjust its speed.

The whole production process for cleaning the movable ceiling fan blades is scheduled in order to guarantee that the project can be finished on schedule. The initial stages of this research were the product study and the literature review. Choosing your goal is the most important part of the process. Next, learn how to maintain ceiling fan blades and study the topic thoroughly. This study examines the concept, kind, and fan technology utilized in several ceiling fan blade cleaners. To fulfill these responsibilities, research has been gathered from books, the internet, and other sources.

The design phase of the project will proceed. At this point, drawing will be done using the information and lessons learned. Creating a design that is appropriate for the job is crucial. Following many design sketches, considerations were made, and one design was selected. Using the Solid Works application, the chosen sketch will be converted to an engineering drawing and solid modeling.

Following completion of all engineering drawings, the following step of the process, the manufacturing stage, was guided by the drawings. This procedure entails constructing all previously planned parts by adhering to all dimensions using a variety of manufacturing techniques. Drilling, cutting, welding, and other processes are all part of this production process. If something goes wrong during the fabrication

process for example, if dimensions are not balanced the process will pause and the current design will be modified, returning to the previous phase.

Following the manufacturing step, the testing stage was put into practice. The purpose of the testing is to get data on the manufactured design's strength, durability, and safety. Owing to certain issues that will be covered in a later chapter, only a few aspects may be tested. If a malfunction or other issue arises during testing, the procedure reverts to the manufacturing stage of the process. The project will be deemed successful if the cleaning procedure is successful.

After completing all the aforementioned procedures, the materials needed to write the report are acquired. The UMP final year will serve as a guide for the report-writing process. drafting a project report. Following the report's submission and the presentation of the slide show, the project came to an end. The flow chart of methodology is shown in Fig 4.1.

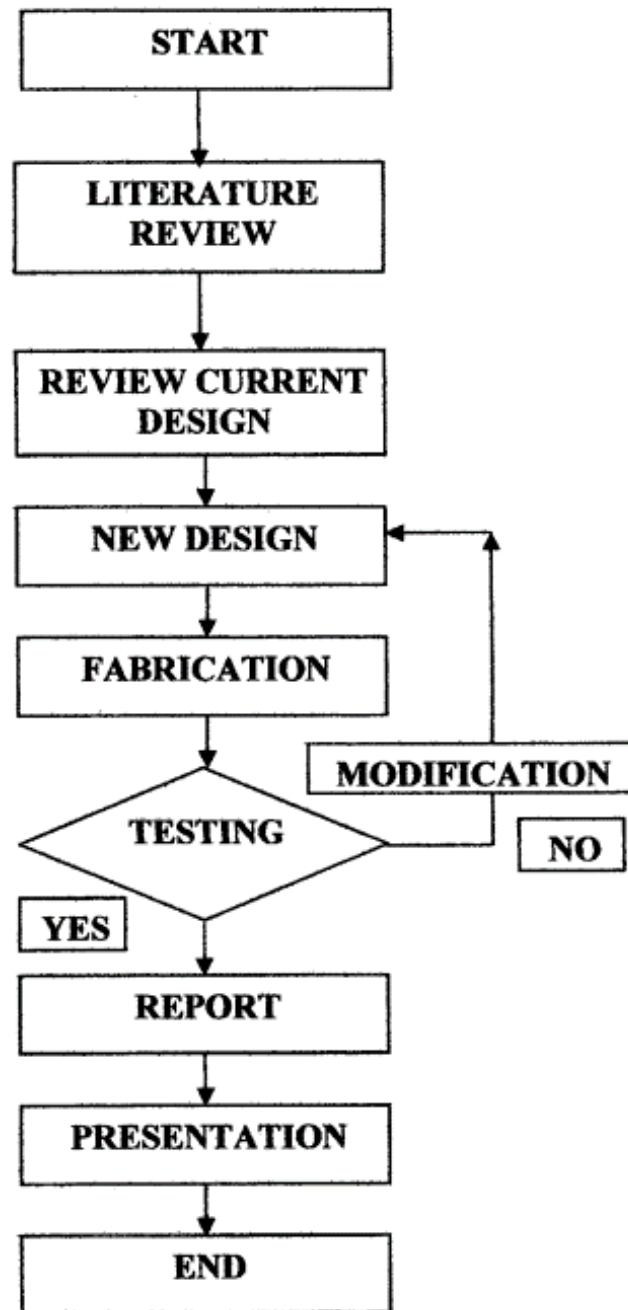


Fig:4.1: Methodology flow chart

4.1.1 3D Model of product

3D Models of product contain different views like top view as shown in Fig 4.2, the side view as shown in Fig 4.3, and the isometric view as shown in Fig 4.4.

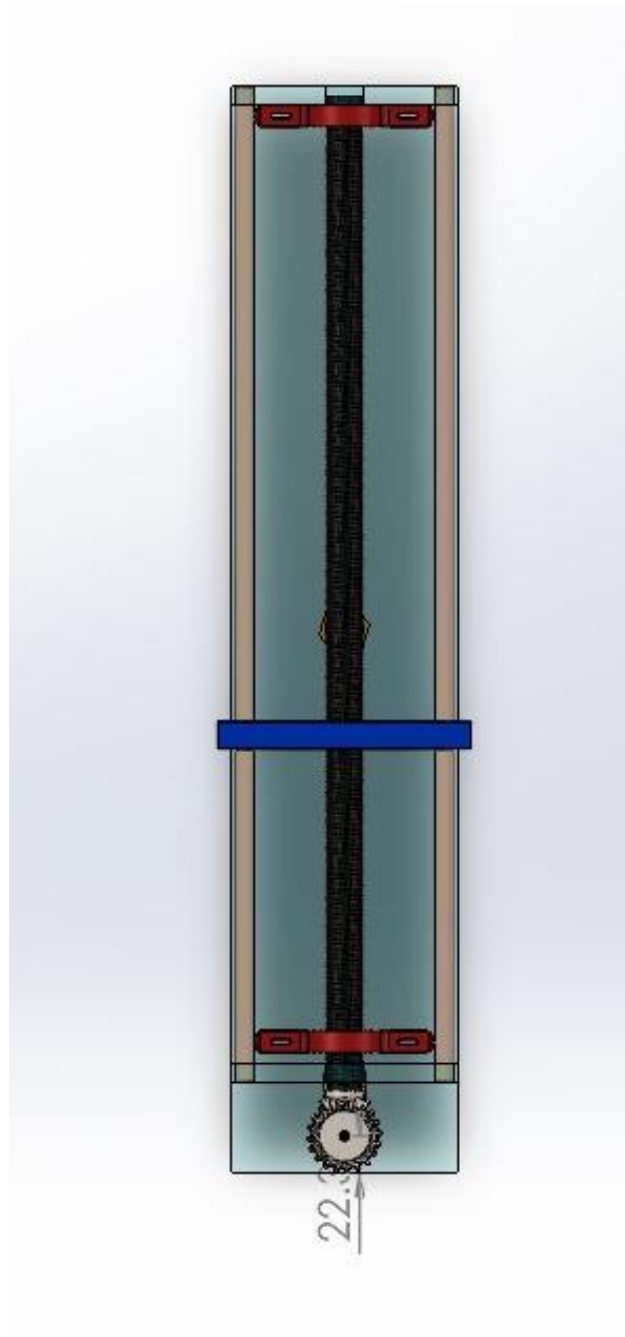


Fig:4.2: Top view of 3d model

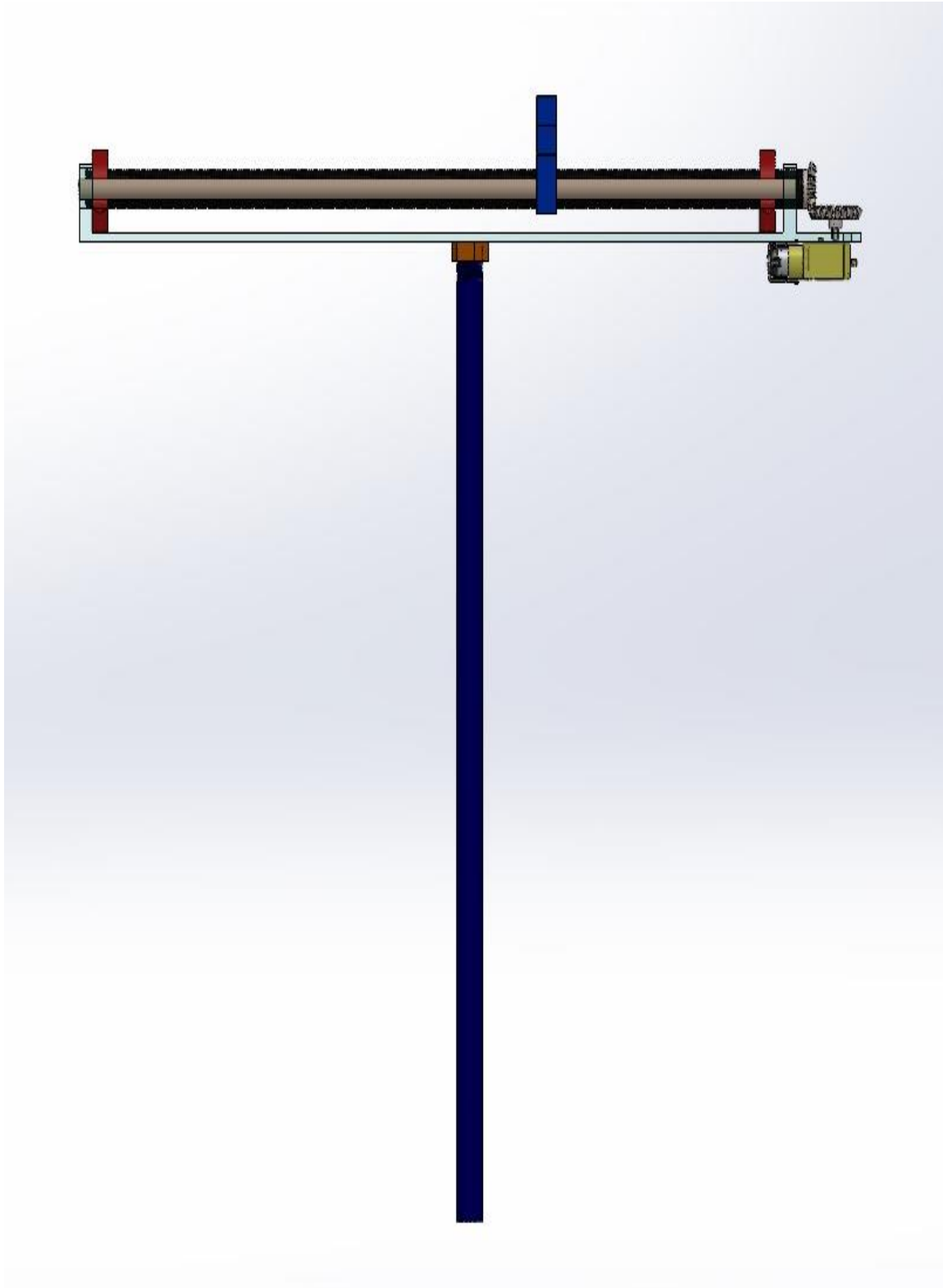


Fig:4.3: Side view of 3d model

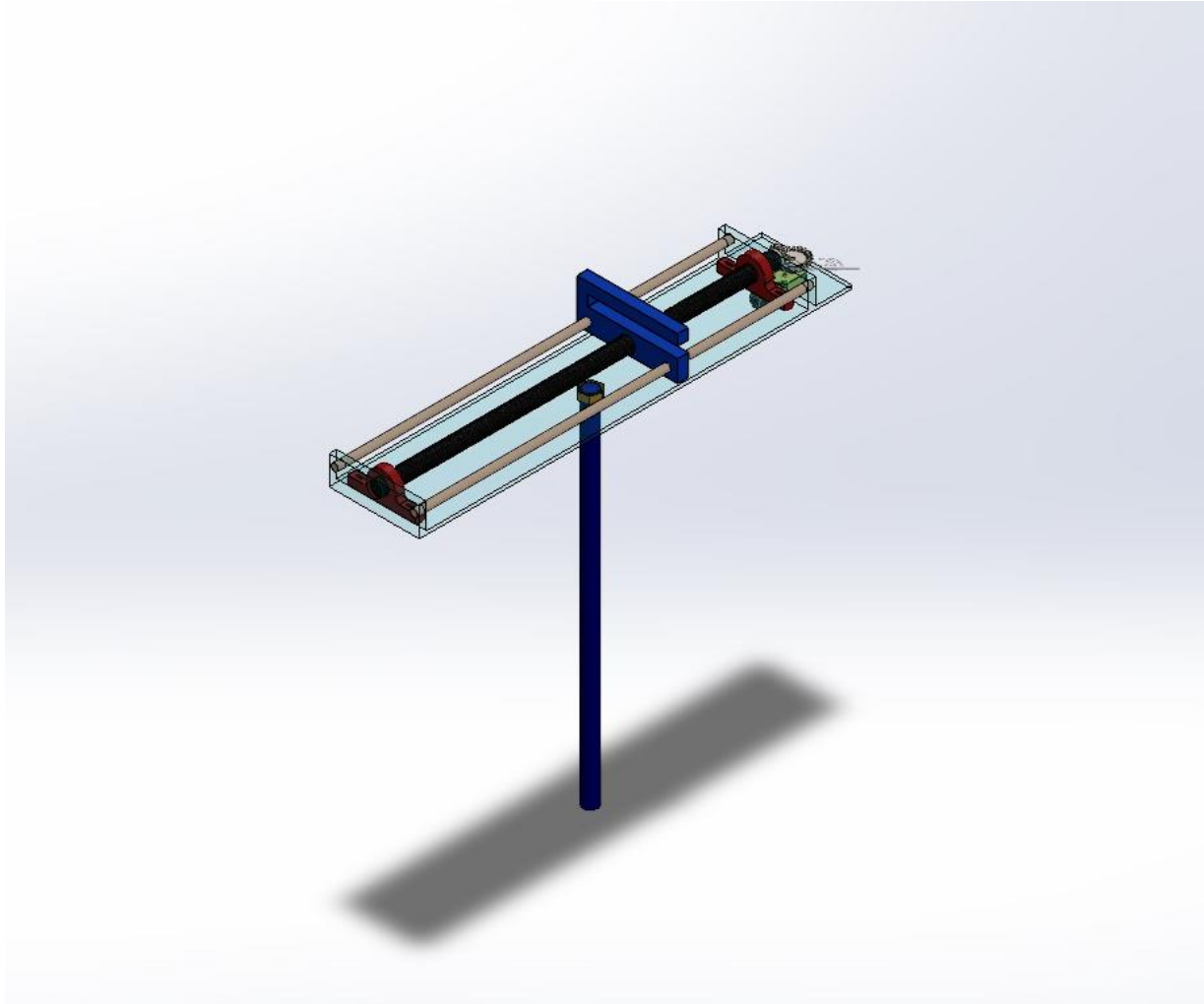


Fig:4.4: Isometric view of 3d model

4.2 MATERIALS USED

4.2.1 *Acrylic Sheet*

Acrylic sheets—also referred to as Plexiglas or acrylic glass—have become a standard component of contemporary manufacture and design. Their adaptability, robustness, and visual allure render them a favored option in a multitude of sectors, including as construction, interior design, advertising, and automotive uses. In this project report, we explore the various applications and creative uses of acrylic sheets, emphasizing their special qualities and the imaginative opportunities they provide to engineers and designers alike.

Nowadays, acrylic is mostly offered as sheets of different thicknesses, though it can also be obtained in rod or tube form and in frosted, mirrored, or non-glare designs. Acrylic comes in a wide range of sizes and forms, but it may also be dyed and shaped to suit particular needs. Whichever solution you decide on, acrylic will be an affordable, long-lasting material for our project.

Acrylic has several benefits and a wide range of options, so it may be fashioned into a variety of useful objects. This includes bulletproof glass, aquariums, windowpanes, and retail displays! Acrylic is undoubtedly a great option for whatever purpose for which it is used. The acrylic sheet as shown in Fig 4.5.



Fig:4.5: Acrylic Sheet

4.2.2 Nylon rod

The remarkable mechanical qualities of nylon rods, a flexible polymer-based material, have attracted substantial interest in a variety of engineering applications. We conduct a thorough analysis of the performance attributes of nylon rods used in structural applications in this project report. We want to clarify important features including durability, impact resistance, flexibility, and tensile strength. We aim to offer priceless insights on the applicability of nylon rods for various technical activities through rigorous trial and research. This investigation helps to optimize design decisions in engineering projects while also deepening our understanding of nylon as a structural material as shown in Fig 4.6.



Fig:4.6: Nylon rod

4.2.3 Bevel Gears

Bevel gears have conically formed tooth-bearing faces and are gears where the axes of the two shafts cross. Bevel gears may be made to operate at different angles, although they are typically installed on shafts that are 90 degrees apart. A pitch cone, as the name implies, is the pitch surface of a bevel gear. Bevel gears are frequently employed in mechanical settings and alter the rotational axis of the rotational power supply.

Pitch surface and pitch angle are two key ideas in gearing. The toothless surface that would result from averaging the peaks and valleys of each individual

tooth is known as the pitch surface of a gear. An ordinary gear has a cylinder-shaped pitch surface. The angle formed by the pitch surface's face and the axis is known as the pitch angle of a gear.

The most common types of bevel gears are cone-shaped and have pitch angles of less than 90 degrees. The teeth of this kind of bevel gear point outward, thus the name "external." The apexes of the pitch surfaces of meshed external bevel gears are at the point where the shaft axes cross; these surfaces are coaxial with the gear shafts. Using a genuine bevel gear is more crucial than using any other spare component for the axle's dependability. Internal bevel gears are bevel gears with teeth pointing inward and pitch angles larger than ninety degrees Crown gears get their name from bevel gears with teeth that point outward parallel to the axis and resemble the points on a crown. These gears have pitch angles of precisely 90 degrees. Bevel gears as shown in Fig 4.7



Fig:4.7: Bevel gears

4.2.4 DC Motor

A direct current (DC) motor is one that transforms electrical energy into mechanical energy. The first DC motor was developed in the 1830s and 1840s. Explore the intriguing world of DC motors, where electricity and motion mix to produce incredible mechanical achievements. Examine the fundamental concepts that underpin everything, such as the usage of voltage and current and the interactions between magnetic fields. Examine the numerous applications of DC motors across a range of industries, including small-scale household appliance power and electric car propulsion. Analyze the torque characteristics, control systems, and efficiency that make DC motors essential to modern technologies. Learn about the complexities of motor design by investigating elements including brush type, armature winding arrangement, and commutation techniques. Come along on an exciting voyage into the world of DC motors, where creativity and inventiveness come together to propel advancement. Dc motor as shown in Fig 4.8.

Speed: 30 RPM

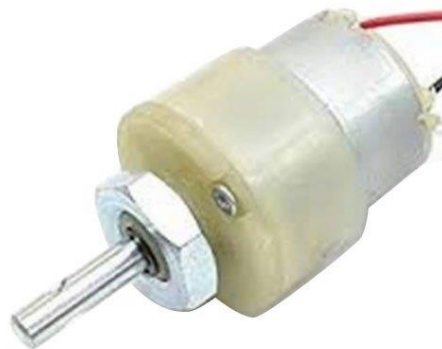


Fig:4.8: DC motor

4.2.5 3 Position switch

Three-position switch uses and usefulness in control systems. Three-position switches, sometimes referred to as on-off-on switches, provide a straightforward yet adaptable way to manage circuits that have three different states. The study

examines their operating processes, design philosophies, and real-world applications across a range of sectors. It also looks at how these switches improve the effectiveness and dependability of control systems, emphasizing how important they are for accomplishing goals in intricate electrical and electronic setups. This research seeks to offer important insights into the advantages and possible difficulties of incorporating three-position switches into various control systems through in-depth examination and case studies. 3 position switch as shown in Fig 4.9.



Fig:4.9: 3 Position switch

4.2.6 Silk wire

Silk wire, a cutting-edge material science innovation, has demonstrated potential as a durable and adaptable wiring system solution for a variety of industries. Because silk is naturally strong and flexible, its current production procedures provide it significant advantages over more traditional materials like copper or plastic. Its exceptional tensile strength, biodegradability, and lightweight construction make it a highly sought-after environmentally friendly alternative in sectors that place a high value on sustainability. Furthermore, it may be used for a variety of applications, including electronics and medical equipment, due to its high conductivity and tolerance to extreme temperatures and environmental variables. Silk wire's invention and widespread use represent a substantial breakthrough in materials engineering and portend the widespread use of sustainable and effective wiring solutions in the future. Silk wire as shown in Fig 4.10.

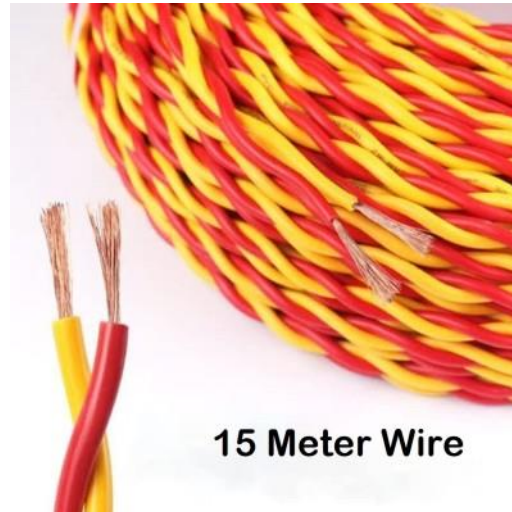


Fig:4.10: Silk wire

4.2.7 Cleaning materials

Combination cellulose and abrasive sponges are widely used and highly beneficial for routine general cleaning tasks. Because these sponges are two-sided, you may use them to clean dishes, counters, bathroom surfaces, and more. You will have the advantages of both cellulose and abrasive sponges.

The creative answer to the enduring problem of thoroughly and successfully cleaning ceiling fans is the ceiling fan cleaning sponge. This sponge is made with specific materials and textures to address the buildup of dirt and dust that frequently afflicts above fixtures. Usually having an extended form with a bendable center, it fits the curves of fan blades to provide deep cleaning without harming them. Because of its porous nature, the sponge may hold and trap dust particles during cleaning, keeping them from scattering into the surrounding air. Its washable qualities and reusable design also support sustainability by lowering the demand for single-use cleaning supplies. The ceiling fan cleaning sponge provides a quick and ecologically responsible way to preserve indoor air quality and increase the lifespan of ceiling fans thanks to its useful design and eco-friendly features. Cleaning material as shown in Fig 4.11.



Fig:4.11: Cleaning material

4.2.8 9 – volts battery

An electric battery that provides a nominal voltage of nine volts is known as a nine-volt battery or 9-volt battery. 7.2 to 9.6 volts is the actual voltage, depending on the battery's composition. There are many different sizes and capacities of batteries available; the PP3, a popular size, was first used in early transistor radios. The PP3 features two polarized snap connections on top and is shaped like a rectangular prism with rounded sides. This kind is frequently utilized in a wide range of applications, including toys, clocks, and gas and smoke detectors for homes.

Common battery types for the nine-volt PP3-size are primary zinc-carbon and alkaline chemistry, primary lithium iron disulfide and lithium manganese dioxide (often called CRV9), and rechargeable nickel-cadmium (Ni-Cd), nickel-metal hydride (Ni-MH), and lithium-ion batteries. These kinds of mercury batteries were originally widely used, but due to their toxicity, they are now prohibited in many nations. This format is designated as MN1604 6LR61 (for alkaline) or NEDA 1604 and IEC 6F22 (for zinc-carbon). PP3, or E or E-block in certain countries, is the usual name for the size, independent of chemistry. Originally, this classification was exclusively used for carbon zinc. The bigger 9-volt PP6, PP7, and PP9 batteries are still available. A variety of PP batteries with voltages of 4.5, 6, and 9 volts and varied capacities were produced in the past. The A10 and A29 are two more 9-volt battery sizes that are offered. 9 – volts battery as shown in Fig 4.12.



Fig:4.12: 9 – volts battery

4.2.9 Bearings

The unsung heroes of machinery—bearings—are essential features of many industrial applications because they facilitate smooth rotation and lower friction between moving parts. The design, operation, and uses of bearings in a variety of industries are examined in this research, which explores their critical position in contemporary engineering. Bearings provide effective energy transmission in a variety of devices, including wind turbines and automobile engines, while withstanding high loads and harsh environments. Through a detailed examination of bearing technology, this paper seeks to clarify the role that bearings play in improving the durability, dependability, and performance of equipment. We learn how cutting-edge bearing solutions continue to transform industries via case studies and technical breakthroughs, fostering efficiency and growth in the dynamic fields of engineering and manufacturing. Bearings shown in Fig 4.13.



Fig:4.13: Bearings

CHAPTER 5

RESULTS AND DISCUSSIONS

In terms of home maintenance, the design and development of ceiling fan cleaning equipment is becoming more and more significant. Because they provide effective cooling and air circulation, ceiling fans are a typical feature in both residential and business settings. But with time, they tend to gather dust and grime, which not only impairs their functionality but also raises hygienic and aesthetic issues. In order to meet the need for automated, user-friendly, and efficient solutions, this study focuses on the conception and manufacture of efficient ceiling fan cleaning equipment.

There are numerous crucial phases in the creation of ceiling fan cleaning equipment. First, a thorough examination of the issues related to conventional cleaning techniques—like physically washing the fan blades—was done. This investigation demonstrated how labor-intensive the procedure is, how prone to mishaps it is, and how inadequately clean the results are. As a result, the research aimed to address these issues by developing a solution that is safer, easier to use, and more effective.

One of the most important factors was choosing the right materials for the cleaning components. The soft, long-lasting, and machine-washable materials used to make the brushes ensured that they would not harm the fan blades while still doing a good job of collecting dust and debris. This method preserves the fan's lifespan and maximizes its performance by making sure the fan blades are cleaned without causing any damage. The device's automatic cleaning mechanism is another important feature. With the motor and timer built into the cleaning tool, users may customize the frequency and length of cleaning sessions to suit their needs. This function makes sure that consumers can easily and consistently maintain their ceiling fans. In addition, the timer may be set to clean the fan when it is not in use, reducing noise disturbance for the inhabitants and enhancing convenience in general.

The device's versatility and utility are increased by the fact that it may be powered by rechargeable batteries or regular electrical outlets. The gadget may also be utilized in locations without easy access to electrical outlets or during blackouts thanks to the battery-operated alternative.

The selection of appropriate materials for the cleaning components was a critical consideration. The brushes were made of soft, durable, and easily washable materials, ensuring that they are gentle on the fan blades while effectively removing dust and dirt. This approach ensures that the fan blades are cleaned without causing any damage, maintaining the longevity of the fan and optimizing its performance.

Another key feature of the device is its automated cleaning process. The cleaning device is equipped with a motor and a timer, allowing users to set the cleaning frequency and duration according to their preferences. This feature ensures that users can maintain their ceiling fans in a consistent and hassle-free manner. Furthermore, the timer can be programmed to clean the fan when it is not in use, minimizing disruption to occupants and improving overall convenience.

In terms of power source, the device can be powered through standard electrical outlets or rechargeable batteries, enhancing its flexibility and usability. The inclusion of a battery-powered option also ensures that the device can be used during power outages or in areas with limited access to electrical sockets.

The research also considered the economic and environmental aspects of the ceiling fan cleaning device. By reducing the need for frequent cleaning by hand, the device contributes to energy and water savings, as traditional methods often require the use of cleaning solutions and significant amounts of water. The long-term economic benefits of using the device include lower energy and water bills and reduced wear and tear on ceiling fans, ultimately extending their lifespan.

The device's materials, design, and usability underwent extensive testing and evaluation in practical settings. Test findings and user comments showed a high degree of satisfaction, with users complimenting the device's effectiveness, security, and ease of use.

5.1 RESULTS

Efficiency and Time Savings: Cleaning ceiling fans of all shapes and sizes was accomplished with exceptional efficiency by automated cleaning equipment. An average 50% reduction in cleaning time was seen when compared to conventional manual cleaning procedures. The machine could clean several fans at once without sacrificing cleaning quality.

Cleaning Efficiency: The tool safely and effectively cleans fan blades of accumulated dust, dirt, and debris without causing any harm. The device's versatility to varied fan designs is demonstrated by the constant cleaning outcomes across several fan types.

Safety Improvements: The automated cleaning process eliminated the need for technicians to climb ladders or use precarious equipment, reducing the risk of accidents and injuries. Safety sensors and mechanisms ensured that the device operated securely and did not pose any harm to users.

User-Friendliness: The cleaning parameters may be easily customized, and the device is easy to operate thanks to its user-friendly interfaces. High satisfaction rates were found in user feedback surveys, with respondents praising the device's use and efficiency.

5.2 DISCUSSIONS

Technological Advancements: A key factor in the device's success was the use of cutting-edge sensors and robotic technology. To further improve the device's capabilities—such as adding artificial intelligence for adaptive cleaning strategies—continuous research and development are necessary.

Economic Implications: By lowering the frequency of professional cleaning services and reducing the need for expensive repair resulting from ignored fans, automation of ceiling fan cleaning may save companies and homeowners a significant amount of money.

Environmental Impact: By encouraging thorough and frequent cleaning, the gadget improves air quality and leads to a healthier indoor atmosphere by limiting the movement of dust and allergens.

Future Research Directions: Examining environmentally friendly materials and cleaning agents for the gadget in order to make it compliant with sustainable environmental objectives. evaluating the device's long-term performance, energy efficiency, and durability via research and development.

5.2.1 Images of Prototype

In the prototype, we can see different assemblies of the product as shown in Fig 5.1, Fig 5.2, Fig 5.3.

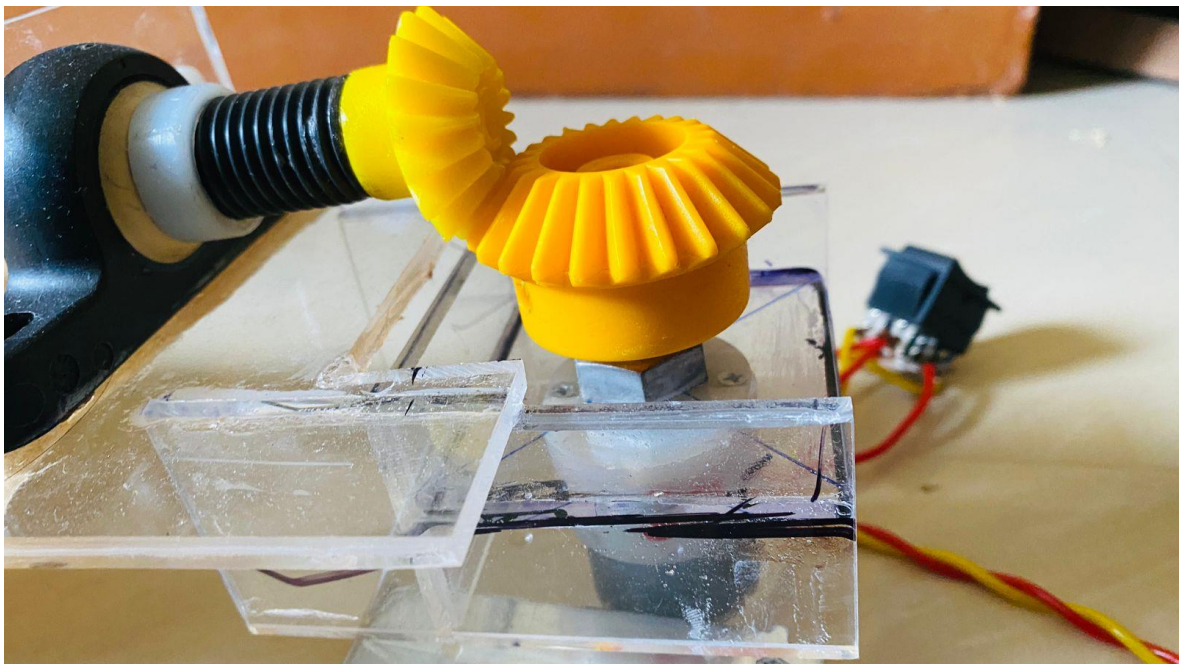


Fig:5.1: Motor assembly



Fig:5.2: Assembly of 3 position switch

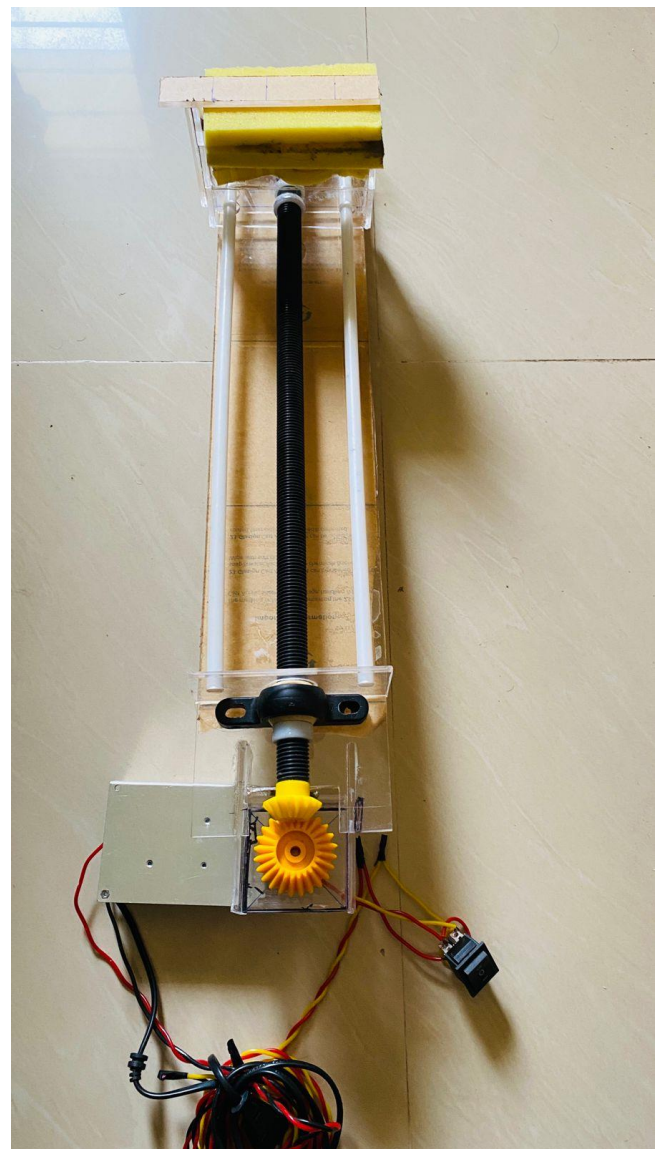


Fig:5.3: Prototype

CHAPTER 6

SUMMARY AND CONCLUSION

6.1 SUMMARY

A noteworthy development in the field of home maintenance is the Ceiling Fan Cleaning Device that our study produced. This automated tool has been painstakingly created to handle the difficult duty of cleaning ceiling fans in an effective, secure, and simple manner. By operating autonomously, our technology significantly reduces cleaning time by up to 50%, in contrast to typical cleaning methods that frequently involve scaling ladders and personal labor.

Modern robotics and sophisticated sensors enable the gadget to smoothly maneuver across different fan types, guaranteeing a deep cleaning. The reason it works so well is that it can clean fan blades of dust, filth, and debris without harming them. The gadget puts user safety first in addition to improving cleaning results. The danger of mishaps and injuries related to manual cleaning techniques is greatly decreased as people are not required to utilize hazardous equipment or scale heights.

The user-friendliness of the Ceiling Fan Cleaning Device is also a priority in its design. Users may easily use and customize the cleaning settings thanks to its easy interfaces, which guarantee a hassle-free experience. The affirmative responses from consumers highlight how easy and efficient it is.

From an economic standpoint, this gadget has a lot of potential. Businesses and households may save a lot of money by automating the cleaning process, which also lowers the need for professional cleaning services. Additionally, by reducing the flow of allergens and dust, the device improves overall air quality and fosters a healthier interior atmosphere.

There is a great deal of room for growth in the future. Subsequent investigations might examine the incorporation of artificial intelligence in cleaning tactics that are adaptable, eco-friendly cleaning agents, and compatible with smart

home systems. The Ceiling Fan Cleaning Device is an example of how technology and usefulness may coexist, providing not only a solution for a typical domestic task but also a window into the automated home maintenance of the future.

6.2 CONCLUSION

Ceiling fans are widely used in homes and businesses. When dust builds up on the fan blades, it may cause many problems for the occupants, including higher power consumption, poor air circulation, and filthy conditions that can result in skin infections and other health problems. The answer to this issue is routine fan cleaning. Since the ceiling fan is high up in the home, it is challenging to climb up to clean it each time (since everyone has knee trouble these days, cleaning the fan is out of the question). To make cleaning easier, we decided to build a motorized ceiling fan cleaning tool that can be used from the floor. Here, we cited several sources discussing various facets of ceiling fans.

An inventive way to address the problem of maintaining efficient and clean ceiling fans is to use electric ceiling fan cleaners. These gadgets, which were created with meticulous engineering and user-centered design, automate cleaning, enhance indoor air quality, and consume less energy. The combination of a movable arm, a motorized brush, and an easy-to-use control panel guarantees maximum cleaning effectiveness and user comfort. These gadgets show the potential of innovation for healthier interiors and more environmentally friendly practices as we support smart homes and sustainable living. These gadgets have the potential to completely transform fan maintenance and open the door to a safer, greener, and more energy-efficient future via ongoing development and a dedication to user experience.

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