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Automatic Indoor Temperature Controlled Electric Fan

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Abstract: In this study, we *report the development of an automatic indoor temperature-controlled electric fan, enabling the automation of the regulation of the ambient temperature. The manual physical control of the indoor electric ceiling fans can be challenging and inconvenient, especially in facilities for the infants, the disabled, or handicapped people. It is also crucial for the indoor fans deployed in farm houses for livestock to be automated, such that the fan speed can be automatically regulated by the ambient temperature. That way, the operation of the indoor electric fans dependent on manual control will be eliminated making the device more effective and efficient without relying on human cognitive ability. The developed prototype device utilizes an LM35 temperature sensor, an LM339 comparator, and a relay switch to actuate and automatically control the speed of the rotation of the ceiling fan, generating a cooling breeze that enhances the transfer of heat via convection. In this setup, the indoor electric fan rotation speed changes automatically through a five-speed range in ascending order levels. Another unique improvement of this device is in the design of the shape of the fan blades, width, length, and total number of three in a star arrangement that enhanced the velocity of the air distribution within its circulation field. The trial tests using the developed prototype automatic indoor temperature-controlled electric fan showed improved room ventilation up to 20% and a more efficient fan aerodynamics rotating with reduced noise and with a uniform air distribution pattern in the room.*

Keywords: *Automatic fan, Air ventilation, Indoor fan, Fan speed regulator, Temperature control sensor.*

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1.0 Introduction

Indoor electric cooling fan is one of the most frequently used electric home appliances in tropical locations needing convective heat transfer owing to its comparatively low cost, relatively lower electric power consumption, and effectiveness in room ventilation (Akangbe *et al*, 2024). Usually, the conventional electric ceiling fans used in cooling rooms consist of a manual speed regulator unit calibrated into five different speed ranges in ascending order, manually switched to the desired speed as reported by (Das *et al*, 2024). The operation of the manual speed control fan requires that the user will be available to switch ON the fan regulator to the desired speed level. This is not possible if the user is asleep or assuming a room for infants who cannot operate the manual fan regulator. Also, patients in a hospital who are disabled and incapacitated might not be able to reach the manual fan regulator to operate the device, forcing the users to rely on an operator who might not be available when the need arises, according to Irakoze *et al*, 2025). In an agricultural livestock farm, the homeothermic animals will need to maintain their body temperature within a specific narrow range, independent of the ambient temperature. This means that the ambient temperature needs to be monitored and maintained at a certain optimal temperature range for the well-being of the livestock. Excessive cold or excessive heat to the livestock farm has a severe negative impact on their daily production and health as reported by (Rizman *et al*, 2024). In the poultry farm, excess heat above 24 $^{\circ}$C will reduce the growth rate of the broilers, while the hens' egg production rate will decline with excess heat according to (Wilcox *et al*, 2023).

The operation of the manually controlled ceiling fan regulator poses a challenge in the effective control of the fan's speed when the operator is not conscious or not available to promptly adjust the fan speed during a sudden change in weather, leading to a transition of cold to hot weather and vice versa. There is a pressing need for the automation of the cooling fan to make it independent of an operator and more effective in the regulation of the fan speed and the ventilation of the environment, as reported by (Khaing *et al*, 2020).

The impacts of climate change have worsened the fluctuations in the weather conditions, causing extreme temperatures and incessant transitioning of the climatic conditions. The adaptation to the current weather trend demands more timely temperature monitoring and quick response to excess heat or cold in our environment, according to (Kumar *et al* (2023).

A previous report by Buco *et al*, (2025) developed a remotely controlled electric fan which has the additional ability to control the fan regulator remotely using a wireless infrared transmitter and receiver technology. A remote control handset that generates the infrared pulses at line of sight to the receiver installed on the fan regulator enables the user to select any fan speed from the range of the regulator fan five fixed speeds. This solves the problem for patients in a hospital or at home who cannot reach the fixed electric fan regulator box but can now operate the fan using a remote control. There is still a need to automate the indoor fan so that it can be more effective for the purpose of livestock farms, infants, and be made independent of human cognitive ability. This will also create an opportunity for a deep sleep without thinking of waking up to regulate the fan speed during a sudden change in weather conditions, according to (Junizan *et al*, 2019).

The problem this research focuses on solving is summarized as follows. Most of the existing technologies of regulating the ambient temperature using electric fans are manually operated, limiting its operation to human cognitive ability and obviously not suitable for the current situation of frequent abrupt changes in weather conditions attributed to climate change. The dimensions of the shape and the blade arrangements of the electric fans can be improved further to enhance its breeze control and reduce the noise generated during operations.

This research aims to develop an automatic indoor temperature-controlled fan for the regulation of the ambient temperature at homes, offices, hospitals, and livestock farms. The objectives of this research are: to automate the switching of the electric fan regulator speed using the ambient temperature conditions as a determinant; to deploy a temperature sensor in the automatic control of indoor fan speed regulator in a manner that makes the operation of the device independent of an operator; to design fan blades that will efficiently deliver breeze and cooling, eliminating noise.

Furthermore, this research is very important and timely, as Future Market Insights forecasts revealed that there is a huge demand for efficient thermal management solutions across various industries. According to Future Market Insight, the market size is projected to reach USD 10,746 million at the end of 2025, and expand to USD 29,967 million by 2035 (Pandita *et al*, 2025). The development of an indoor automatic temperature-controlled fan forms part of the efficient thermal management solutions contributing to the global adaptations of climate change.

2.0 Materials and Methods

This section covers the conceptualisation, design, and development of the indoor automatic temperature-controlled electric fan. The basic components deployed in the development of the prototype indoor automatic temperature-controlled electric fan are the transformer, temperature sensor (LM35), comparator (LM339), 555 timer, bipolar junction n-p-n transistor, power diode, relay switches, and resistors and capacitors for the biasing of the transistors. The block diagram of the developed indoor automatic temperature-controlled electric fan is presented in Figure 1.

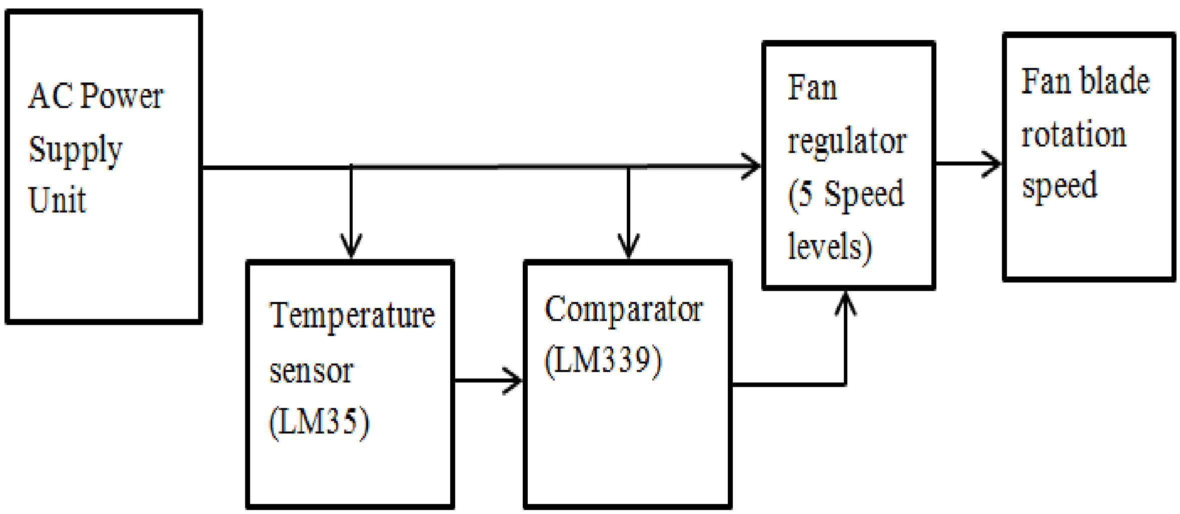

Fig 1. Block Diagram for the Fan Blade Spinning Speed Control

2.1 The conceptualization and design

The sensing of variations in temperature using LM35 produces a digital output which can be fed to a comparator and used to switch the electric fan regulator. The ambient temperature is partitioned into five ranges, with each range controlling one of the levels of the fan regulator speed. So, temperatures within each range switch the corresponding regulator speed level thereby automating the control of the fan regulator speed. The mode of operation of the fan can be changed to manual by using the regulator knob. In that scenario, the automatic mode is switched OFF. The arrangement of the electric fan blades is adjusted in a manner that produces the maximum breeze using the star positioning style. Also, the blade pitch, length and width of the fan blades are modified to gather maximum breeze at minimal noise.

2.2 The development of the prototype indoor temperature-controlled electric fan

The development of the prototype indoor temperature-controlled electric fan is as shown in the block diagram in Figure 1. The power supply source is an alternating current (AC), usually 220 to 240 volts, used for household electric appliances. The voltage is stepped down to 12 volts using a transformer coil and then rectified to convert to direct current (DC). The LM35 temperature sensor detects the temperature and sends a digital output to the comparator. The LM339 comparator outputs a high or low based on the difference in the input voltages from the temperature sensor. A 555 timer integrated circuit (IC) is implemented as a monostable multivibrator to trigger the switching of the fan regulator. The selection of each level of fan speed depends on the output of the 555 timer IC via the relay switch. The details of the operation of the basic electronic components used in the development of the indoor temperature-controlled electric fan are discussed in the following section.

2.3 The Power Supply Unit

The rated building electric wiring voltages is between 220 V to 240 V, but the prototype indoor automatic temperature-controlled electric fan requires 12 V DC for operation. The device circuitry therefore, includes a step-down transformer and a rectifier circuit to deliver 12 V DC. A pair of diodes arranged in a full-wave bridge rectifier is used to rectify from AC to DC. A pi filter circuit consisting of two capacitors and a resistor are used to filter out the AC ripples from the input voltage. The power supply circuitry is presented in the circuit design of the automatic indoor temperature-controlled electric fan in Figure 5. The power rectifier part of the circuit will only be required if the device is plugged to AC power supply. Alternatively, a 12 V DC battery can be deployed as a power source.

2.4 Temperature sensor

The LM35 temperature sensor was implemented in the development of the prototype indoor automatic temperature-controlled electric fan because of its desirable temperature range of -55^{o}C to 150^{o}C, small size, and pin connections that fit the circuitry. It delivers 10 mV/C during operation. The Pin 1, is the input that is connected to the source voltage, +vcc, normally, ranging between 4 V and 30 V. In this prototype, a voltage supply of 12 V was used. Pin 2 is coupled to a resistor. Voltage output (V_{out}) is the voltage divider of pin 2 and the coupled resistor. In this configuration, an output voltage which is proportional in magnitude to the Celsius scale temperature is obtained according to (Mithal, 1992).

$$\text{Temperature } (^{o}\text{C}) = V_{out} \times 100^{o}\text{C/V} \quad (1)$$

The Pin 3 is normally grounded. The LM35 temperature sensor does not require to be calibration or any trimming. During operation, the LM35 maintains an accuracy range of ± 0.4 ^{o}C at room temperature to ± 0.8 ^{o}C. The LM35 temperature sensor draws only 60micro amps from its supply voltage source and has a low self-heat capability during operation, as reported by Narwade *et al*, (2025). Usually, the observed sensor self-heating is less than 0.1degree Celsius temperature rise in still air. Figure 2 shows the circuitry for the LM35 temperature sensor.

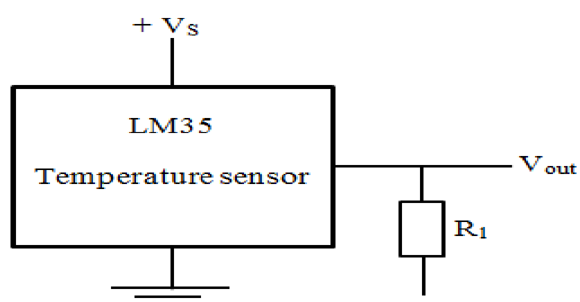

Fig 2. LM35 temperature sensor circuit

2.5 The comparator (LM339)

The function of the comparator is to evaluate two or more binary strings, usually bit by bit and then outputs a '1' 'High' if they are exactly equal or '0' 'Low' if they are unequal. (Bagal, 2021). So, it compares the input strings' magnitude or words to check if they are equal in value. To achieve this logic, an exclusive NOR gate is deployed to compare the input values for equality by evaluating the bits. Assuming both input bits are equal, for example (0-0 or 1-1), the exclusive NOR outputs a 1. The LM339 comparator is described in Figure 3. The LM339 comparator operates by inputting two analogue signals in the system and comparing their values to generate the logical output ‘high’ “1” or ‘low’ “0”. At the input, ‘+’ input refers to “non-inverting” while ‘–‘ input refers to “inverting”, the LM339 comparator will evaluate and compare the magnitude of the two analogue signals accordingly. The differential input between the inverting and the non-inverting terminals determines the output. Assuming the analogue input on the non-inverting input is greater than the value of the analogue input on the inverting –input, then the output will be logical ‘1’ ‘High’, and this will switch ON the open collector n-p-n transistor Q_8 in Figure 3. If the input on the non-inverting terminal +input is less than that on the inverting terminal –input, the comparator will output logical ‘0’ ‘Low’ and the transistor Q8 will be switched OFF.

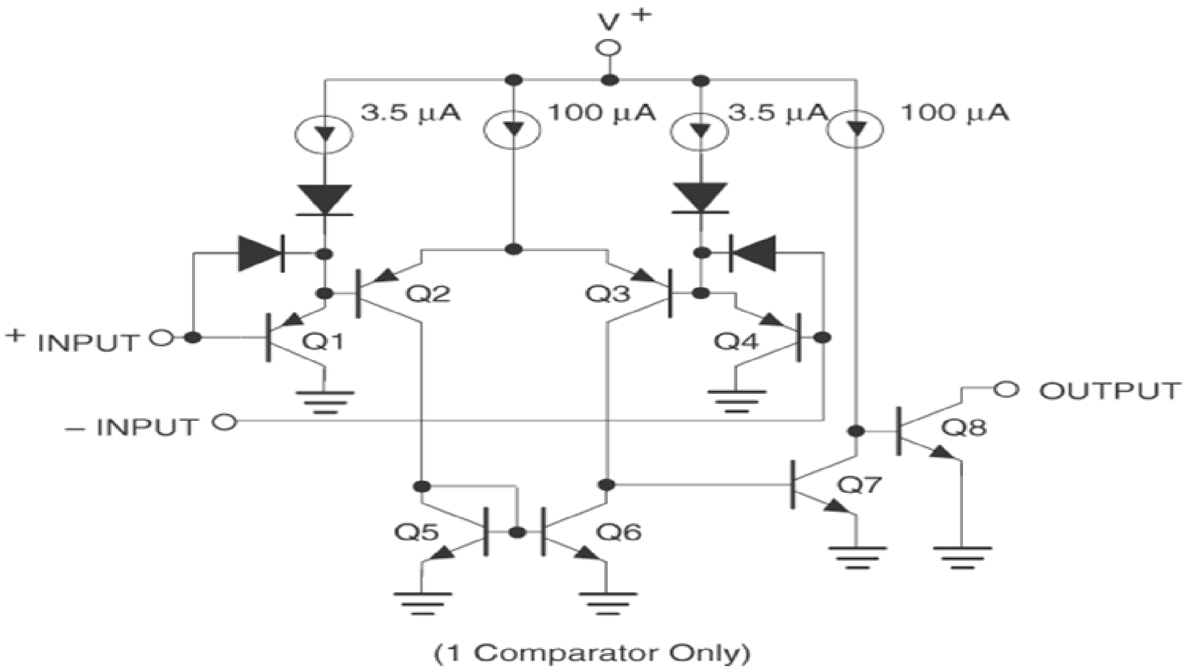

Fig 3. LM339 Comparator circuitry

2.6 The 555 timer integrated circuit

The 555 timer integrated circuit is a monostable vibrator in which the charging time constant is determined by the coupling resistor and capacitor in the circuit. The device is a triggering mono-shot pulse generator described in Figure 4.

In the development of the prototype indoor automatic temperature-controlled electric fan, the resistor R_t (100kΩ) and the Capacitor C_t (47µF) were charged at 5.2 seconds (T) timing duration applying the formula as reported by (Mashud *et al*, 2015):

$$T = 1.1R_t * C_t \quad (2)$$

The PIN connections are as shown in Figure 4. The Pin7, termed ‘discharge pin’ is a transistor signal output fed into capacitor C_t, which then discharges when the Pin 7 is switched ON. The Pin 2, termed the ‘trigger pin’ is triggered by a signal below 1/3Vcc. This pulse is responsible for the switching transition of the flip-flop device from the set mode to reset mode. The Pin3 is connected to deliver the output signal. The Pin4, termed the 'reset pin' is coupled to +Vcc terminal to prevent any false triggering of the flip-flop. The Pin 6, is termed 'threshold pin'. Usually, the amplitude of voltage that is applied to this terminal determines the set state of the flip-flop according to (Malvino & Bates, 2006). If the applied voltage is greater than 2/3Vcc, then the upper comparator will switch to $+V_{sat}$ and force the output to switch to set. The Pin8, termed 'supply pin' is responsible for the supply of voltage of +5V that is applied to the input terminal with respect to the Pin1 being at the ground

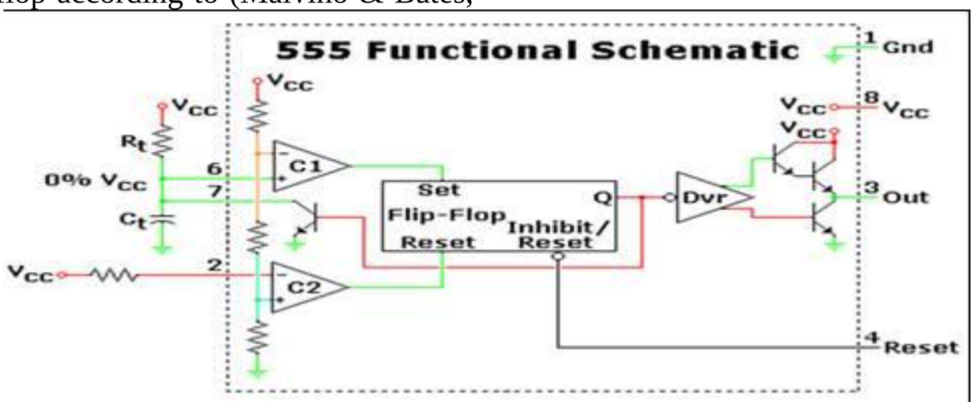

Fig 4. The circuitry of the 555timer integrated circuit

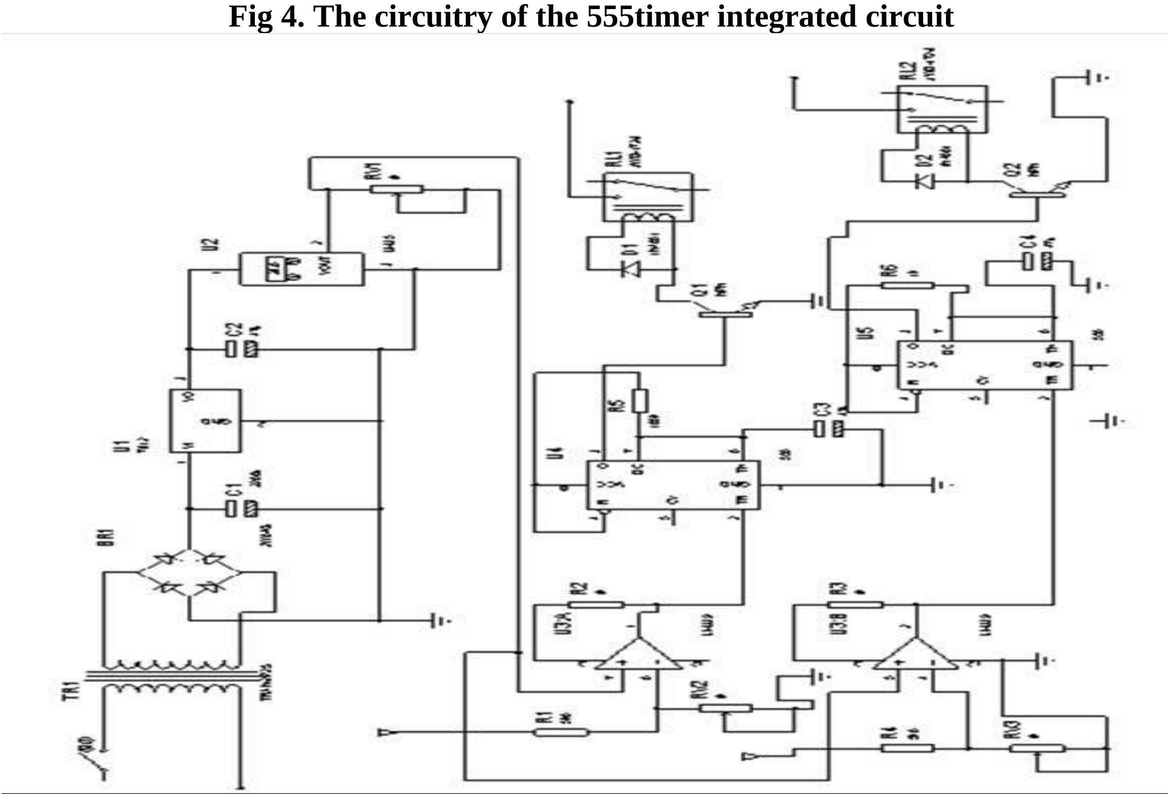

Fig 5. The circuit diagram of the indoor automatic temperature controlled electric fan

2.7. Packaging of the prototype indoor automatic temperature-controlled electric fan

The electronic components were first arranged on a breadboard following the circuit diagram in Figure 5. A 12-volt DC battery was connected to the power rails of the breadboard to supply the required voltage at the terminals. Five light-emitting diodes (LED) were connected to each speed level of the fan regulator such that upon the selection of each speed level, the corresponding LED switches ON while the others are OFF. The device was tested at various room temperatures, and it activated the fan regulator, selecting the corresponding speed as the temperature increased. A heater for a hair dryer was used to cause an increase in the ambient temperature.

The electronic components were then coupled on a circuit board following the same connections on the breadboard. The LM35 sensor was placed in a position by the side of the box. The side housing the temperature sensor was perforated with multiple holes to allow direct contact with the ambient temperature. The diagrams of the developed prototype indoor automatic temperature-controlled electric fan are presented in Figure 5 and Figure 6. The knob for the manual control of the fan regulator was positioned at the top of the box. Using the knob will force the regulator to switch to any selected mode and momentarily disable the automation. The scaling of the fan speed with the temperatures is presented in Table 1. The costing of the device is as shown in Table 2. The costing does not include the cost of the constructed fan blades since an existing fan blade was modified in dimensions for the device. The device operation was validated through five different trial tests presented in Table 3. The construction of the fan blades is discussed in section 2.9.

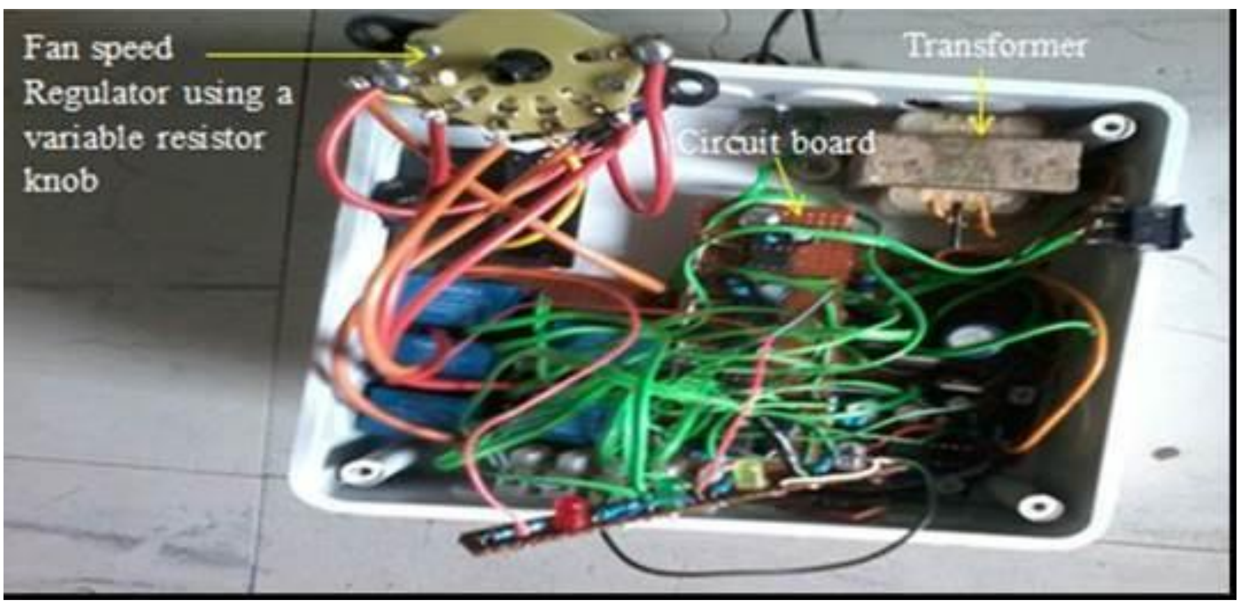

Fig 6. The prototype indoor automatic temperature-controlled electric fan showing the packaging of the electronic components

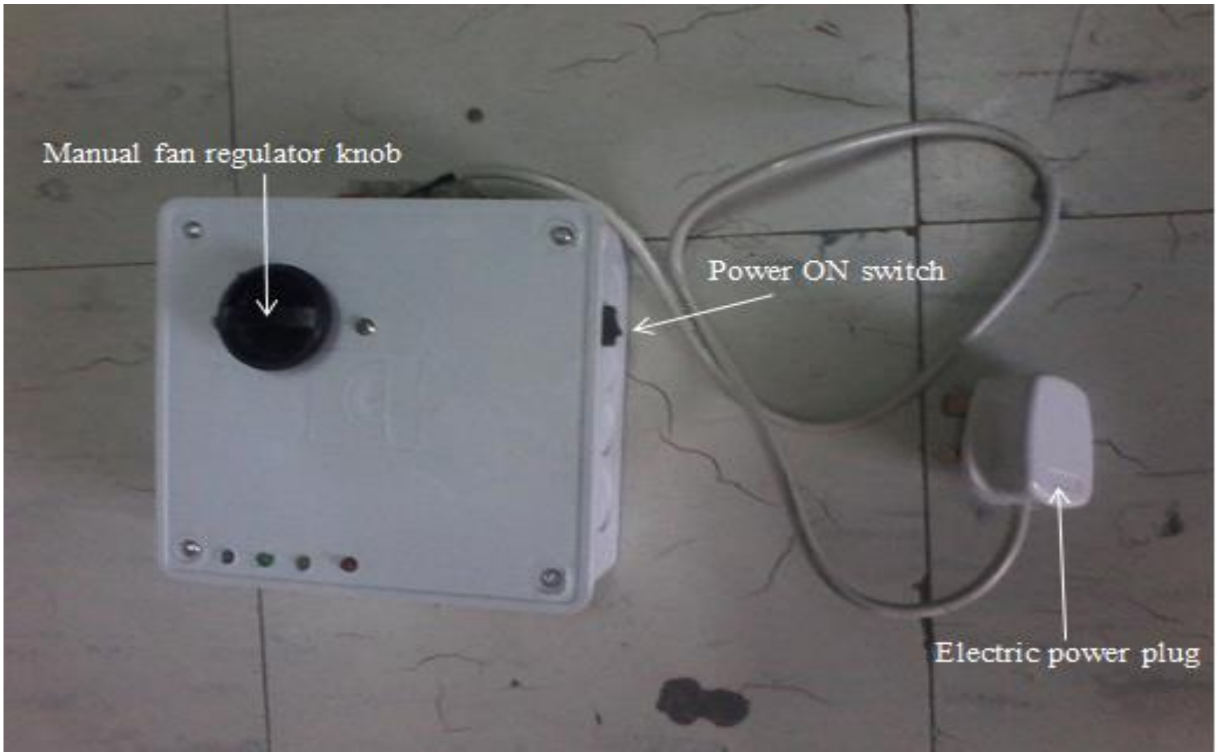

Fig 7. The developed automatic indoor temperature controlled electric fan

2.8 Scaling of the operating temperature range of the developed prototype automatic indoor temperature-controlled electric fan

The temperature range within the regular ambient temperatures is between 15 to in the tropical climatic weather. But the standard room temperature is 25 ^{o}C while the human normal temperature is 37 ^{o}C. So, the ambient temperature is best maintained at 36^{o} and 37 ^{o}C to suit the normal human temperature. This is a bit different when dealing with a livestock farm for example. poultry. So, the calibration of the temperature range for the fan speed depends on the application of the developed device. Here, for the validation of the prototype indoor automatic temperature-controlled electric fan, the application is for human specifically in a room 4 m by 3 m. The temperature range was set for a range of 15 ^{o}C to 38 ^{o}C and matched with the input voltages. Table 1, shows the linking of the five regulator speeds with their corresponding temperatures in ascending fan speed levels; 1, 2, 3, 4 and 5.

Table 1: Scaling of the automatic regulator fan speed with temperature

FAN REGULATOR SPEED LEVEL	FIXED TEMPERATURE RANGE(^{O}C)	NON-INVERTING PIN +V	INVERTING PIN -V
1	15	0.15	0.05
2	30	0.30	0.2
3	35	0.35	0.3
4	36	0.36	0.35

5	38	0.38	0.38

2.8.1 Costing of the automatic indoor temperature controlled electric fan regulator

The electronic components were procured in Lagos, Nigeria.

The total cost of the developed prototype automatic indoor temperature controlled fan regulator is relatively cheap at N8,465.00 (Eight thousand four hundred and sixty five Naira) compared to the market price of a manual fan regulator in Nigeria which is N10,000 (Ten thousand Naira) and above.

Table 2: Costing of the developed automated fan regulator

Implemented Components	Unit cost in (Naira)	Quantity	Total cost in (Naira)
Temperature sensor LM35	1,445	1	1,445.00
Transformer	550	1	550.00
Resistors/Potentiometer	50	25	1,250.00
Capacitors	60	8	480.00
N-P-N Bipolar Junction Transistors	250	5	1,250.00
Integrated Circuit 555 timer	1,255.00	1	1,255.00
Comparator LM339	1,235	1	1,235.00
Packaging			1,000.00
Total cost			N8,465.00

2.9 The construction of the fan blades

The aerodynamic blade design of the automatic indoor temperature controlled electric fan was focused on the sweep angle of the blades, the length and width of the blades, and the arrangement of the three blades in a star position. The axial fan with the shape of the conventional blade inboard, outboard, fan hub and tip chord was implemented in the design. The parameters that were adjusted on the construction of the fan blades are the sweep angle, also termed blade pitch, the length and the width of the blades. Usually, the dimensions of the ceiling fan are determined by the size of room, number of fan blades, and the blade pitch according to (Adeeb *et al*, 2018).

The Computational Fluid Dynamics (CFD) software was used to determine the optimal fan blade pitch for a room size of 4 m by 3 m deploying three fan blades. The CFD software is used for the simulation analysis of the fan blades. The input variables include the room size for the mounting of the fan. The software implements numerical methods in the simulation of the fluid flows to obtain optimal dimensions for the fan blades. The obtained optimal blade pitch value was 15^{o}. The blade pitch refers to the angle at which the blades are mounted to the fan hub. The length of the blade is 35 cm and the width is 8 cm. The automatic indoor temperature controlled electric fan blades are presented in Figure 8.

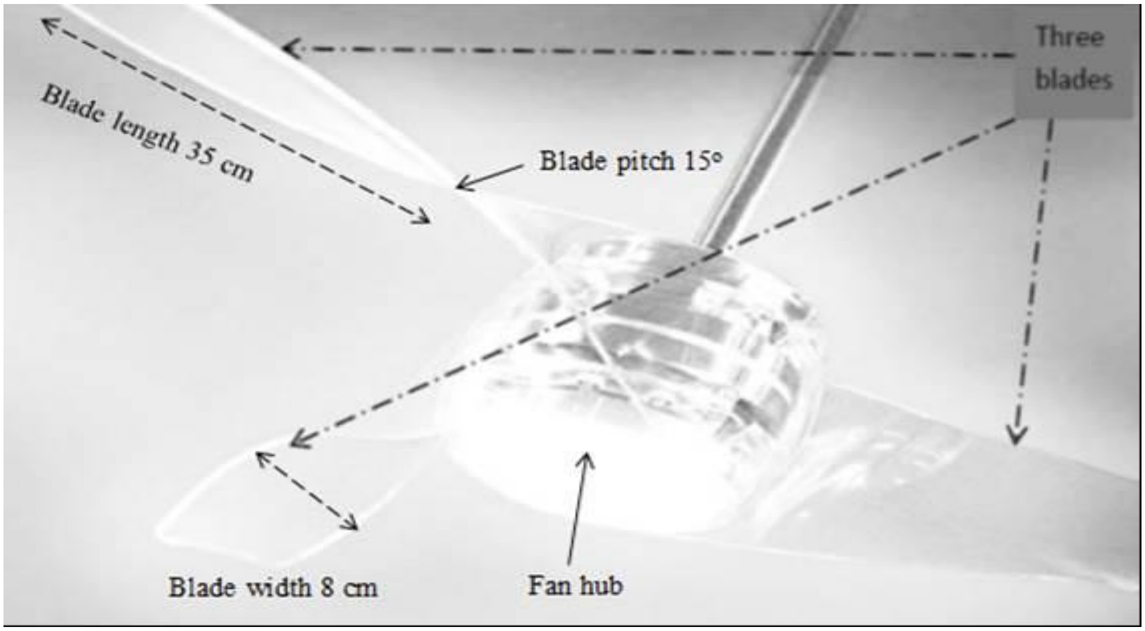

Fig 8. The dimensions of the fan blades

3.0 Results and Discussion

The validation of the operations of the developed prototype automatic indoor temperature controlled electric fan is presented in Table 3. The ceiling fan was mounted in a room measuring 4 m by 3 m, and the ambient temperature was varied using the heater of hair dryer to blow in hot air. The trial test was repeated five times and the records of the automatically selected fan speed were taken for each trial. It was observed that the selection of the first three speeds was more accurate, while the last two speeds were sometimes overlapping due to the closeness of the temperature ranges.

The circulation and conduction of heat by convection current is sometimes delayed due to the variations in flow rate, which affects the heat transfer. So, the detection of the increase in ambient temperature is sometimes delayed, affecting the response time of the automatic fan speed regulator.

Table 3: The test trial of the prototype automatic indoor temperature controlled electric fan

Temperature (°C)	1st trial	2nd trial	3rd trial	4th trial	5th trial
25	Speed 1	Speed 1	Speed 1	Speed 1	Speed 1
31	Speed 2	Speed 2	Speed 2	Speed 2	Speed 2
33	Speed 2	Speed 2	Speed 2	Speed 2	Speed 2
36	Speed 3	Speed 3	Speed 3	Speed 3	Speed 3
37	Speed 4	Speed 3	Speed 4	Speed 4	Speed 3
39	Speed 5	Speed 5	Speed 5	Speed 5	Speed 5

The developed prototype automatic indoor temperature controlled electric fan performed well as shown in Table 3, selecting the corresponding fan speed within the ambient temperature range. The installation of the device to an existing ceiling fan is very easy. During the installation, the power input cables of the fixed manual fan regulator is disconnected and connected to the input terminals of the prototype automatic indoor temperature controlled electric fan regulator. The output terminals of the automatic indoor temperature controlled electric fan regulator will be connected to the cables leading to the ceiling fan. The connection can also be done using a socket. The existing fixed manual fan regulator is first disconnected and the input terminals are connected to an electric socket of 220 V. The output cables of the manual fan regulator are now transferred to the output terminal of the automatic indoor temperature controlled electric fan regulator. So, the plug is just inserted in the socket to operate the device.

It is preferable to use the electric socket approach so that a power stabilizer can be connected along the supply voltage line. That way, the device will be protected from power surge.

3.1 The novelty in the developed automatic indoor temperature controlled electric fan

The novelty of the automatic indoor temperature controlled electric fan is in its ability to automate the switching of the regulator fan using the fluctuations in temperature, making it independent of human cognitive ability. The developed device can be used in an agriculture farm to monitor and control the ambient temperature for the livestock as reported by (Gržinić *et al*, 2023). Also, it is very suitable for the pediatrics and infant wards at hospitals.

The developed effective and efficient fan blades will form the basis for more scientific research towards the improvement of the performance of fan blades in different aerodynamic applications.

It is comparatively cheap at NGN8,465.00 (Eight thousand, four hundred and sixty five Naira). The implemented electronic components are readily available making the product attractive for commercialization. The adopted design and technology is very reliable, durable, and demonstrate excellent response time for the regulation of the electric fan speed. The device is applicable in smart cities, hospitals, agriculture farms, and industries where ambient temperature monitoring and control is required.

3.2 The limitations of this research

The scope of this work does not cover the fluid mechanics and the analysis of fluid flows. It also discusses the application of the relevant solid-state electronic components without being indebt to the fabrication process of the components.

The study is limited to the development of a prototype automatic indoor temperature-controlled electric fan without the consideration of the application of fans in the automobile industry.

3.4 The applications in the industry

Thermal management solutions are needed in most industries to monitor temperature and control the associated effects on various manufacturing activities. The developed automatic indoor temperature controlled electric fan is a key product for thermal management. Regulating the ambient temperature in an indoor environment is a vital aspect of safety driving optimal performance. Although, the manually fixed regulator fan controls the ambient temperature, it is inefficient, ineffective, and resource wasteful since an individual needs to physically operate the device. The various industry processes and practices are adopting automation to maximize yields. The developed automatic indoor temperature controlled electric fan is a major leap in the automation processes in the industry.

Agriculture sector is gradually taking the lead in the overall contributions to national economy after oil sector. The developed automatic indoor temperature controlled electric fan is applicable in livestock farm with the potential to increase the productivity of the livestock with huge impacts on gross domestic product (GDP).

The developed automatic indoor temperature-controlled electric fan is also applicable in the health sector for the hospital wards for the people with severe disability and other conditions that cannot operate the fixed manual fan regulator. Maintaining a stable body temperature is one of the pointers to a healthy human. The implementation of the developed automatic indoor temperature-controlled electric fan in hospitals will contribute to the general well-being of patients and translate to better management of health.

3.5 Contributions to knowledge

The automation of the thermal management technique deployed in the regulation of the ambient temperature achieved using the developed prototype automatic indoor temperature controlled electric fan is an important contribution to knowledge. The construction of the fan blades with the geometric dimensions that deliver maximum breeze in an efficient manner is a contribution to the fluid flow dynamics.

The approach of this research is to reduce complexity while sustaining efficiency. According to previous reports by Robson *et al*, (2021), methods that implemented artificial intelligence in training and regulating the speed of the fan to adapt to the ambient temperature introduced more electronic components, like microcontrollers and programmable logic controllers. The additional components not only increased the cost but also increased the overall power consumption of the device. It also made diagnosing of faults and repairing the device more challenging compared to the developed automatic indoor temperature-controlled electric fan.

4.0 Conclusion

This research developed a prototype automatic indoor temperature-controlled electric fan that can be deployed at homes, offices, hospitals and livestock farms. The validation trial test result shows that the developed prototype is efficient and functions effectively in regulating the ambient temperature.

The product is comparatively cheap and reliable. The process of conceptualization of the product, the construction of the proof-of-concept, and the development of the prototype has been concisely described in this paper. The developed fan blades and its features that enhanced the performance efficiency have been described. The implemented fan blade geometry provides resources for further scientific research on the aerodynamics of fan blades.

The available variants of the electric fan regulator units in the African landscape are expensive and are not conditioned to function independently of an operator. There is a rapidly growing market for thermal management solutions as research reveals its tremendous benefits to the economy in providing a more stable and reliable heat transfer as reported by Future Market Insights (2025). Investing in the commercialization of the developed innovative product will create excellent return on investment for all the stakeholders, considering the enormous market in Africa and the comparatively low cost of the developed device.

The short-term impact of this developed prototype automatic indoor temperature controlled electric fan is that it will pave the way for a more stable, reliable, and cost effective thermal management solutions, thereby catalyzing manufacturing businesses and livestock agricultural farm investments, especially in Africa. The long-term impact will mean that the wellbeing of human and livestock will be deliberately and intentionally improved following the establishment of a regulated and properly controlled ambient temperature.

The developed prototype automatic indoor temperature-controlled electric fan is a welcome advancement in the technology industry today and is expected to replace the conventional manually fixed-operated regulator electric fans once it is commercially produced. Although there exists hybrid electric fan regulator which uses both manual control and remote control technologies, the developed prototype automatic indoor temperature-controlled electric fan described in this paper demonstrates superiority because of its added comfort, health safety, excellent unique operation, lower cost, reliability, installation simplicity and fan blades design.

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