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Electrical Method in Automated On-Off and Speed-Selection Switching of 220V AC Electric Fan

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Abstract

This paper is concerned with the 220V AC *electric fan*. Most electric fans sold in the market today are still *manually operated*, except for a few automated ones. Mostly, the ON-OFF and SPEED-SELECTION switching is still manually done by the user. The purpose of this paper is to present an innovation on the said manually-operated ON-OFF and SPEED-SELECTION switching of the common household 220V AC electric fan. Here, the switching is to be automated by means of ambient temperature; but no microcontroller, with its program, no internet would be used. Generally, this innovation is an automated ON-OFF and SPEED-SELECTION switching using electrical method. As temperature rises, the electric fan itself automatically switches ON and selects to the higher SPEED. As temperature lowers, the electric fan also automatically selects to the lower SPEED, corresponding to a pre-set temperature, and, switches OFF as temperature lowers even more. This study utilizes the *applied technological research design*. It applies scientific knowledge to solve a problem or to develop a new method. The findings of this study show that the innovation is feasible, technically doable, and implementable. In conclusion, the innovation is manufacturable, integrable, and adoptable in the current designs of the 220V AC electric fans commonly sold in the market today.

Keywords: electric fan, manual control, temperature relay module, temperature sensor

Introduction

The 21st century is in the 4th industrial revolution. In the 1st industrial revolution, railroads and steam engine began to occur about 1784. In the 2nd industrial revolution, electricity and assembly line production began to occur about 1870. In the 3rd industrial revolution, automated production, electronics, and computers began to occur about 1969. In the 4th industrial revolution, AI, big data, robotics began to occur about the year 2000 ("The Four Stages of Industrial Revolution," in https://www.researchgate.net/figure/The-Four-Stages-of-the-Industrial-Revolution-Industry-40_fig1_323187931).

Electricity is common in the 2nd, 3rd, and 4th industrial revolutions. It plays an indispensable role in the industry (e.g., assembly line, automated production, computers, robotics, AI, etc.)

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and in the residence (e.g., lightings, cooking, washing, air-conditioning, etc.).

Today, electricity makes man's work easier. Ironing clothes is easier now with electric iron. Washing of clothes is easier with washing machine. Air-conditioner makes bedroom or offices, etc. comfortable.

Air-conditioner removes heat (which is better than) electric fan which circulates air ("Air-con vs Electric Fan: Which One is Cheaper to Use?," in https://teko.ph/tips/aircon-vs-electric-fan-which-is-cheaper-to-own-and-use/). However, in third world countries, not all can afford to use air-conditioners. It is expensive and consumes more electricity. The cheaper option is electric fan for comfort in the household especially in hot season. Moreover, electric fan is better than-air-conditioner in terms of *acquisition cost*, *electric energy consumption*, and *easy periodic maintenance*.

Today, the ON-OFF and SPEED-SELECTION switching of most electric fans are still manually done, a sort of "manual interface" between man and the device. Fig. 1 shows a manually operated electric fan.

Fig. 1: Manually Operated Electric Fan

(https://www.tradeindia.com/products/ap-oretta-fan-c11925541.html (accessed 3-4-26))

The common household *electric fans* are still widely used in many average households today. They are of different *designs* and *sizes*. But most of them are *still designed to be operated manually*. Specifically, the ON-OFF and SPEED-SELECTION switching remains *manually* done.

The manual switching ON-OFF and SPEED-SELECTION of the electric fan may not be a problem for young people. But it could be a *problem for the old ones*, especially the sick ones who have difficulty in movement. This reality could warrant for the automation of the ON-OFF and SPEED-SELECTION switching of the electric fan, but one that involves only electrical method.

In his article, *Is Technological Progress Slowing Down?*, Vidhyashankar observes the decline in technological progress in both discovery and innovation. Thus, he proposes that governments should create more scientists and technologists (see "Is Technological Progress

Slowing Down," 2024, June 29). This solution implies that something could still be discovered or innovated. This shows that there is still room for innovation.

In this paper, I propose an innovation of the switching method for the ON-OFF and SPEED-SELECTION of electric fans using temperature-controlled relay module and temperature sensors as the main components.

Gap

There is still a *gap* in the different methods employed as presented in survey of the related literature. The said device can still be innovated, improving it into an automatic ON-OFF and SPEED-SELECTION switching by means of temperature sensor together with temperature-controlled module.

In the works of Verma et. al. (2016), Rizman et al (2013), Junizan et al (2019), Alon and Susa (2020), Jesusimo L. Dioses, Jr. (2020), Kristine Joy A. Biagtan et. al. (2019), Bagali and Navalyal (2016), Adeloye, M.Y. et. al. (2017), Warlito M. Galita and Wenceslao M. Valerio (2022), the popular Arduino Uno microcontroller was used. The studies of Kanchanasatian (2018) and Yammen et. al. (2019) involved the internet. And the work of N.R. Bhasme and Pranit Durge (2015) compared the electric motors used in electric fans.

Purpose of the Paper

The purpose of this research work, then, is an innovation on the *ON-OFF and SPEED-SELECTION switching of 220V AC electric fan.* In this innovation, the mechanical switch is replaced with temperature sensors plus temperature-controlled relay module.

The claim of this innovation is that, in controlling the *ON-OFF* and *SPEED-SELECTION* switching of electric fan, no programming or internet method is used. This kind of research design intended to innovatively automate the ON-OFF and SPEED-SELECTION switching of the 220V AC electric fan is an additional innovation in the area of electrical technology.

Literature Review

This section presents some related research studies done by researchers from around the globe on this subject.

In their research study, Verma et. al. (2016) automated the speed control of the electric fan using temperature sensor, or a NTC (negative resistance coefficient) thermistor. In this design, the electric fan increases its speed *gradually* as the ambient temperature increases.

In the work of Rizman et. al. (2013), the electric fan was controlled using *microcontroller*, with its *program*. It has a double feature design: using 2 fans, 2 LEDs, and 2 sensors, intended to make the cooling system efficient.

In their study, Junizan et. al. (2019) intended to make an automatic change of the speed of the electric fan, with a DC motor, based on room temperature, using *arduino uno microcontroller* and temperature sensor LM35.

Alon and Susa (2020) proposed to automatically control the switching of electric fan by means of *hand gesture*, using Bluetooth technology, with a *microcontroller*.

The research work of Jesusimo L. Dioses, Jr. (2020) is designed to control the electric fan using voice command, utilizing (1) Bluetooth technology, (2) Arduino Uno microcontroller, and (3) smartphone. Moreover, it uses Filipino language for voice commands.

Kristine Joy A. Biagtan et. al. (2019) used temperature to control the electric fan. They determined: a) the number of hours that a temperature-controlled electric fan can function continuously; b) how high or low is the temperature needed to rotate the fan blade fast or slow; and c) how usable, workmanshipable, and durable is a temperature-controlled electric fan.

The research work of Bagali and Navalyal (2016) was concerned with efficient electric power consumption. It used a *visitor counter* to *automatically control the electric fan* in an Auditorium for example. The visitor counter determines the number of visitors inside an auditorium.

Adeloye, M.Y. et. al. (2017) involved the control of electric fan by the change of ambient temperature using *microcontroller* and *programming*, temperature sensor, relay, resistor, and crystal oscillator.

The research work of Warlito M. Galita and Wenceslao M. Valerio (2022) involved the control of the electric fan by means of motion and temperature. Motion was used to activate the electric fan and temperature was used to change its speed.

In the study by Kanchanasatian (2018), the ON-OFF and SPEED-SELECTION switching of electric fan was automatically controlled *through the internet*, using *microcontroller*, with its program, and DHT22 temperature sensor.

Yammen et. al. (2019) proposed an efficient method of *remote* speed control of electric fan using *Android* or *IOS phone* with *Wi-Fi* connection, primarily intended for senior citizens. However, the disadvantage of this method was in the case of the absence of the *internet*.

The article by N.R. Bhasme and Pranit Durge (2015) compared various motors used in ceiling fans particularly between AC induction motor and DC motor, to show that induction motor could provide up to about 30% efficiency.

Methodology

The method used in this research paper is applied technological research design. "This type of research involves seeking new applications of scientific knowledge to the solution of a problem, such as the development of a new system or procedure, new device, or new method in order to solve a problem" (Calmorin and Calmorin, 2007). This research design applies scientific knowledge to develop a "new method" in the ON-OFF and SPEED-SELECTION switching of the 220V AC electric fan.

Results and Discussion

This section presents the innovated method of the ON-OFF and SPEED-SELECTION switching of the common household 220V AC electric fan. First, it presents the design of the innovation. Secondly, it describes the manufacturability, integrability, and adoptability of the innovated method.

[A] Design

This subsection presents the five (5) aspects of the electric fan: 1) bill of materials or component parts, 2) electrical circuit diagram, and 3) principle of operation.

***Bill of Materials*:** The materials used in the construction of the prototype as an output of this study are shown in the following Table 1 below.

Table 1: Bill of Materials

Description
➢ Electric fan 220V AC ➢ Relay 220VAC ➢ Relay socket ➢ Temperature-controlled relay module ➢ Temperature sensor ➢ Tachometer display ➢ Hall-effect sensor ➢ Ribbon cable ➢ Neodymium magnet ➢ Adapter (220V AC – 12V DC) ➢ Power indicator light (220V AC) ➢ Fuse cartridge/holder ➢ Tube type fuse ➢ Terminal block (10A, 12-points) ➢ Mono-gang convenience outlet ➢ Electrical wire (AWG #18)

[B] Electrical Circuit Diagram

In this subsection, the principle of operation of the developed innovated method is discussed, based on the electrical circuit diagram in Figure 2.

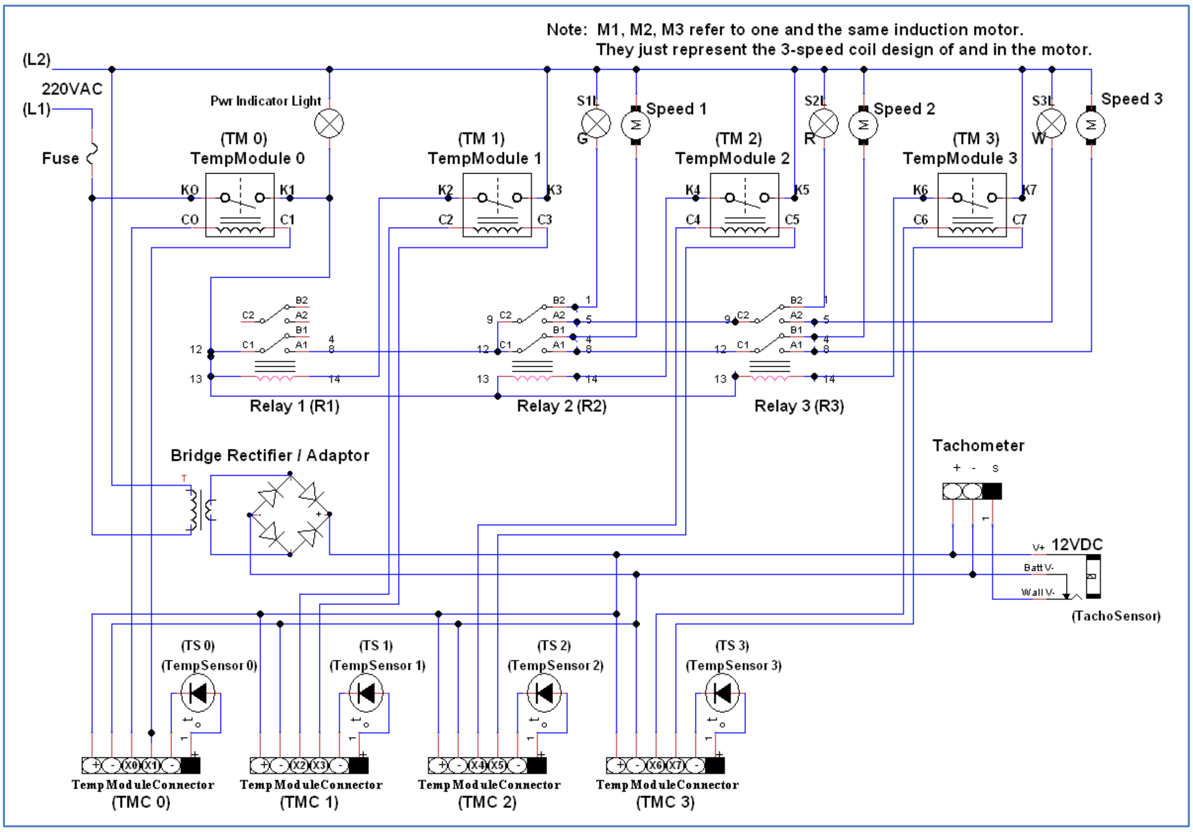

Fig. 2: Electrical Circuit Diagram

Plug and Fuse: In the upper left side of the diagram, the *plug* for connecting the circuit to the 220V AC power from the grid is located. Next to it is the *fuse* that blows off when there is a short circuit or overload.

TempModules: *TempModule0* is next to the fuse; the *power light indicator* is connected to it. *TempModule1* is located further to the right; the speed 1 light indicator (G) is next to it, followed by *Speed 1 coil* (represented with letter M inside a circle) of the induction motor. *TempModule2* is next, where close next to it is speed 2 light indicator (R), followed by *Speed 2 coil* (M) of the motor. *TempModule3* is at the rightmost part, where close next to it is speed 3 indicator light (W), followed by *Speed 3 coil* (M) of the motor.

Relays: Three 220V AC relays, designated: R1, R2, and R3, are located next below the *TempModules*.

Adapter: The adapter is located next below the 220V AC relays, at the left side of the diagram, represented by the *bridge rectifier* symbol. The *TachoSensor* and the *Tachometer* are located in the right side of the diagram.

TempSensor Connector: The temperature sensors, TSensor1, TSensor2, TSensor3, and TSensor4 are located at the lower portion of the diagram.

[C] Principle of Operation

First, the use of the temperatures, 30^0C, 35^0C, 40^0C and 45^0C is arbitrary. They are chosen for illustration purposes. The appropriate temperature values shall be used in the actual operation of the electric fan, by resetting the temperature-controlled module.

When temperature reaches 30^0C, TempModule0 is activated, and its own relay is switched ON, closing the contacts K0-K1. The current flows to the power indicator light. Also, the current flows to points 12 and 13 of Relay 1, and to points 13 of Relay 2 and Relay 3.

When temperature reaches 35^0C, TempModule1 is activated, and its own relay is switched ON, closing the contacts K2-K3 and activating the coil of R1, which, in turn closes the contacts C1-A1 of R1. The current flows from A1 (of R1) to C1 to B1 (of R2), then to Speed 1 coil (M) of the motor. And the fan blade of the electric fan rotates at LOW speed.

When temperature reaches 40^0C, TempModule2 is activated, and its own relay is switched ON, closing the contacts K4-K5 and activating the coil of R2, which, in turn opens the contacts C1-B1 of R2, disconnecting the power from Speed 1 coil, and, simultaneously closes the contacts C1-A1 of R2. The current flows from A1 (of R2) to C1 to B1 (of R3), then to Speed 2 coil (M) of the motor. And the fan blade of the electric fan rotates at MEDIUM speed.

When temperature reaches 45^0C, TempModule3 is activated, and its own relay is switched ON, closing the contacts K6-K7 and activating coil of R3, which, in turn opens the contacts C1-B1 of R3, disconnecting the power from Speed 2 coil, and, simultaneously closes the contacts C1-A1 of R3. The current flows from A1 (of R3) to Speed 3 coil (M) of the motor and the fan blade of the electric fan rotates at MAXIMUM speed.

When temperature goes down, the speed of the electric fan motor would inversely change, from Speed 3 down to Speed 1. When temperature falls below 45^0C but above 40^0C, TempModule3 relay is de-energized, causing Speed 3 to be switched OFF, and causing Speed 2 to be automatically switched back ON.

When temperature falls below 40^0C but above 35^0C, TempModule2 relay is de-energized, causing Speed 2 to be switched OFF, and causing Speed 1 to be automatically switched back ON.

When temperature falls below 35^0C but above 30^0C, TempModule1 relay is de-energized, causing Speed 1 to be switched OFF, but TempModule0 remains ON. And when temperature falls below 30^0C, TempModule0 relay is de-energized, causing the power supplied to the electric fan to be switched OFF. The tachometer sensor simply indicates the different speeds of the RPM of the fan blade of the electric fan.

[D] Manufacturability and Integrability

The developed innovated method in this research study is shown in Fig. 3. It is the hard wiring circuit of the said innovation. Basically, the innovation is composed with three main components, namely, 1) temperature-controlled relay module, 2) 220V AC relay, and 3) temperature sensor. Secondary components are a) adaptor (220V AC-12V DC), b) mono-gang convenience outlet, c) pilot lights, d) wires, e) tachometer, and e) terminal block.

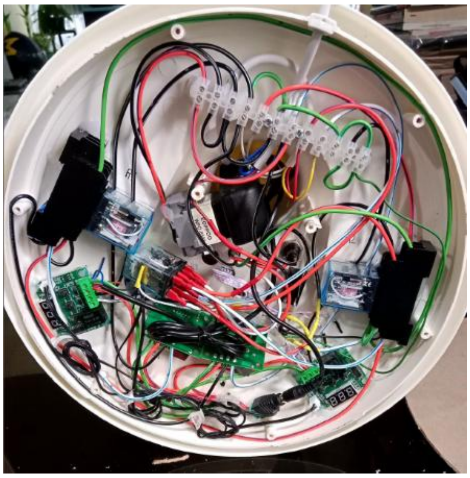

Fig. 3: Hard Wiring Circuit of the Developed Innovation

By ***manufacturable***, it means that it can be scaled down or minuturized. The component parts can be placed in smaller circuit board, such as shown in Fig. 4.

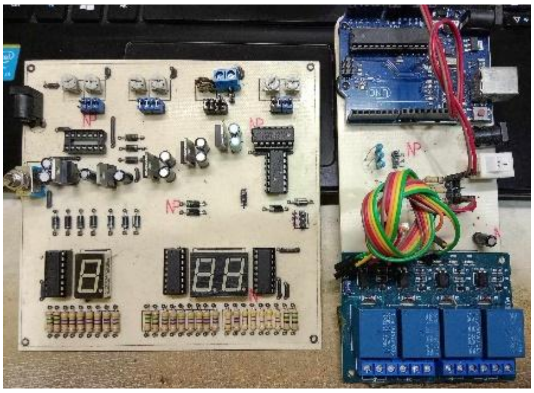

Fig. 4: Homemade Circuit Board

The 220V AC relay can be replaced with smaller relay modules, and the 4 temperature-controlled relays with its display can also be made into one (1) small circuit board. The adaptor can also be integrated into a circuit board using electronic method. And the hard wires can be replaced with "traces" in the circuit board, as shown in Fig. 5.

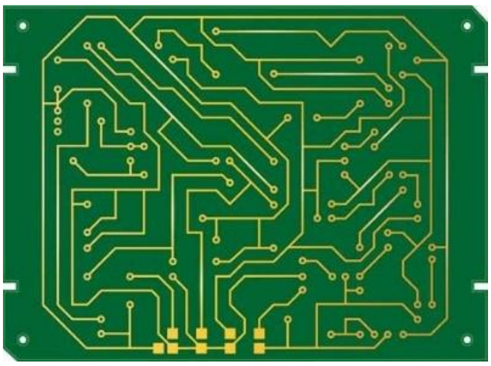

Fig. 5: Traces of Circuit Board

(https://www.linkedin.com/pulse/pcb-trace-the-importance-traces-pcbs-ourpcb-tech-ltd / accessed 3-10-26)

In Figure 5, the "traces" are the lines etched from copper in the raw PCB, replacing the hard wires shown in Fig. 3. This innovation can be manufactured into one small control printed circuit board (PCB), which can easily be fitted into the housing of the electric fan.

The *integrability* of the innovated method could mean two things. First, those component parts in this innovation can be *integrated* into one small *printed circuit board*, instead of all those separate component parts connected together by hard wires.

Secondly, the small circuit board can easily be *integrated* into the *housing* of the electric fan. It is up to the design engineer how to integrate the control circuit board into the housing of the electric fan. It can be applied to any common household electric fans sold in the market today. It could be integrated into a *Ceiling Fan*, *Wall Fan*, *Stand Fan*, *Desk Fan*.

Conclusion

First, as shown in the gap, the *manual* ON-OFF and SPEED-SELECTION switching of the common household 220V AC electric fan can be *automated* using *electrical method only*, without using microcontroller such as Arduino. Secondly, the innovation is found to be feasible, technically doable, implementable, and manufacturable.

The component parts of the developed innovation can be integrated into (1) a single circuit board, and, (2) the circuit board itself can be integrated into the housing of electric fan designs. Thus, the developed innovation is significant in that it is possible to be adapted and manufactured and be integrated in the current designs of the 220V AC electric fans commonly and widely sold in the market today.

This work could still be advanced by conducting a study and construction of a prototype of a miniaturized circuit board that can be incorporated in a small housing of an electric fan.

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