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Design and Development of a Remote-Control Device for Bladeless Fan

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Abstract

This work designs and develops a remote control for a bladeless fan. The bladeless fan used is designed to use continuous variable speed control. However, a three-speed remote was developed to limit the speed to three selections: low speed, medium speed and high speed. The speed selector unit was built using infrared technology where a selected speed level is sent by an infrared transmitter to the receiver whose output is interfaced to a microcontroller unit. The control unit built around the PIC16F876A microcontroller receives the output and selects the speed according to the algorithm used to program the microcontroller. An LCD display displays the chosen speed. The developed remote satisfactorily worked selecting the appropriate speed according to the key press on the remote control.

1.0 Introduction

A "bladeless" fan blows air from a ring with no external blades. Its blades are hidden in its base [1]. A bladeless fan works like a jet engine, sucking air into a cyclone accelerator that amplifies it 15 to 18 times before blowing it out over an airfoil-shaped ramp. Up to 5.28 gallons of air per second is drawn in by an energy-efficient, brushless motor. A combination of the technologies used in turbochargers and jet engines generates powerful airflow[2]. The breeze generated by the Air Multiplier is more consistent and steady than one from a standard fan with blades. Since there are no rotating blades, the breeze from the fan does not buffet with short gusts of air [3].

The “bladeless” fan actually has blades concealed in the base of the unit and is driven by a 40-watt electric motor-driven impeller fan that sucks air through vent holes in the base and pushes it into the hollow hoop[4,5]. The back of the hoop has a 1.3 mm-wide slot running completely around the hoop and facing forward. Air is blown through the thin slot toward a Coanda adhesion airfoil that channels the air into a straight forward-moving annular jet stream[4].Air behind the Air Multiplier™ fan is drawn into the airflow, through a process known as inducement.Air around the machine is also drawn into the airflow, through a process known as entrainment, amplifying it 15 times [2].The bladeless fan dramatically increases air circulationas air forced from relatively fat hoop through thin slot speeds up and its pressure drops[4,5]. The high-velocity, low-pressure annular air stream sucks room air in from behind and alongside the hoop. This has the effect of multiplying the circulation of air, as it puts out 15 units of air for every unit of air drawn into the fan's base. The basic 10-inch table fan moves up to 5.28 gallons of air per second, equal to 40 cubic feet of air per minute.Fig.1 shows a typical bladeless table fan.

Fig. 1: Bladeless fan

However, the bladeless fan comes without a remote control and the speed selection is achieved by manually turning a knob which can select speed within the range of continuous rotation. This works thus aims to develop a remote control to provide the convenience of regulating the bladeless fan speed from a distance.

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Remote control facilitates the operation of fan regulators around the home or office from a distance. It provides a system that is simple to understand and also to operate, a system that would be cheap and affordable, a reliable durable and easy to maintain system. It adds more comfort to everyday living by removing the inconvenience of having to move around to operate a controlled device. Basically, a remote control button is pressed, specific connection is made and this a Morse code line signal specific to that button. The transistor amplifies the signal and sends it to the LED which translates the signal into infrared light. The sensor on the appliance detects the infrared light and reacts appropriately.
The remote control's function is to wait for the user to press a key and then translate that into infrared light signals that are received by the receiving appliance. The carrier frequency of such infrared signals is typically around 36 kHz [6]. Usually, the transmitter part is constructed so that the transmitter oscillator which drives the infrared transmitter LED can be turned on/off by applying a TTL (transistor-transistor logic) voltage on the modulation controlled input. On the receiver side, a photo transistor or photodiode takes up the signals.
This works develops a remote control for use with a bladeless fan the regulator of which is not calibrated.

2.0 Methodology

The block for the control system is shown in Fig.2.

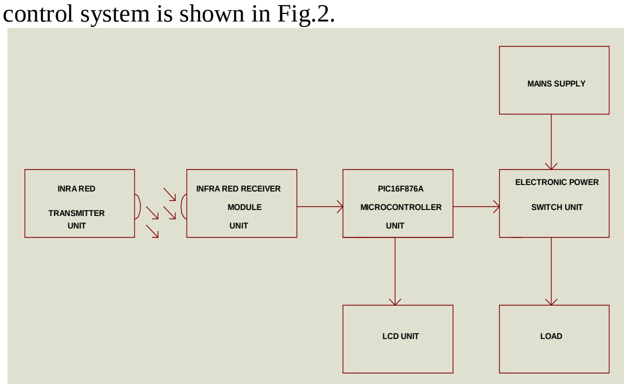

Fig.2: The remote controlled fan regulator block diagram.

2.1 The Design Of The Transmitter

The remote control device has the task of sending the infra-red signal, which is received by the infra-red sensor. The block diagram is as shown in Fig.3

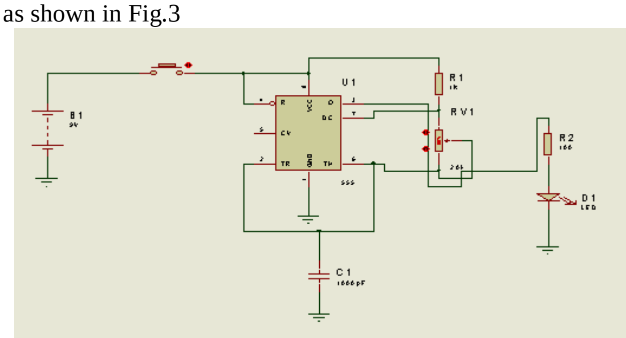

Fig.3: The IR Transmitter Circuit Diagram

The 555 timer oscillator produces a stream of pulses at a frequency determined by the RC of resistors R1, VR1 and capacitor C1. The frequency of oscillation is given by eqn (1):[7,8,9]

$$f_1 = 1.\frac{44}{(R_1 + 2\,VR_2)C_2} ------ -(1)$$

At the application of voltage from the 9V battery or when the single switch is closed, the 555 timer oscillator U1 generates an output signal which oscillates at a frequency of 36kHz. The output from the oscillator is used to drive an IR diode which converts the 36 kHz signal to its corresponding IR light signal.

2.2 The Design of the IR Receiver

The IR light signal from the infra-red transmitter is received by an infra-red sensor. The sensor converts the infra-red energy into corresponding electric voltage. The sensor employed is an IR receiver module which detects IR signal at 36 kHz. Fig.4 shows the circuit diagram of the IR receiver.

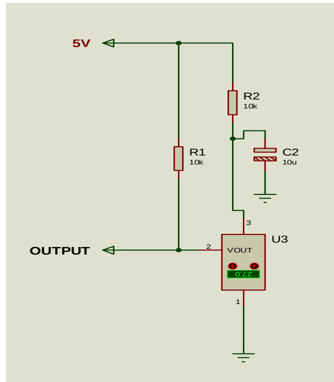

Fig.4: The Circuit Diagram of the IR Receiver.

The IR module used in implementing this design is the TSOP1736 IR receiver module. The TSOP17 series are miniaturized receivers for infrared remote control systems. PIN diode and preamplifier are assembled on lead frame, the epoxy package is designed as IR filter[10]. The demodulated output signal can directly be decoded by a microprocessor. The main benefit is the reliable function even in disturbed ambient and the protection against uncontrolled output pulses[10].

2.3 The Design of the Control/Display Circuit

The microcontroller unit receives command signal from the IR receiver module and then decodes the received command. After decoding the command, it sends signal to the electronic power switch, according to the programmed algorithm, to switch to the appropriate output that switches the fan to the appropriate speed. The microcontroller unit is also used to drive an LCD unit which displays the speed number of the fan. Fig.5 shows the microcontroller control/display circuit.

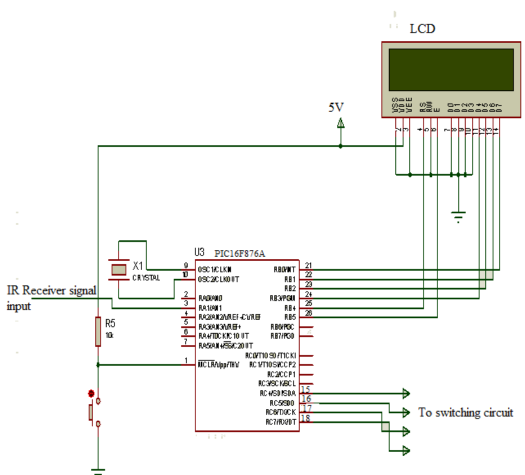

Fig.5: Microcontroller Control/display unit

From the circuit diagram, the microcontroller unit is implemented with a pic16f876a. The PIC16F877A features 256 bytes of EEPROM data memory, self-programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, the Synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI™) or the 2-wire Inter-Integrated Circuit (I²C™) bus and a Universal Asynchronous Receiver Transmitter (USART)[11]. It has three i/o ports(i.e. portA , portB and portC). portA is configured as input port while portB and PortC are configured as output. portA is used to receive command signal from the IR receiver module. Port is used to drive the 16X2 Lcd unit while portC is used to drive the electronic power switch unit. Shown below is the source code for the microcontroller unit written in Mikrobasic.

2.4 Programming of the Micro Controller Unit

The program for the control/display unit was written according to the flowchart of Fig.6.

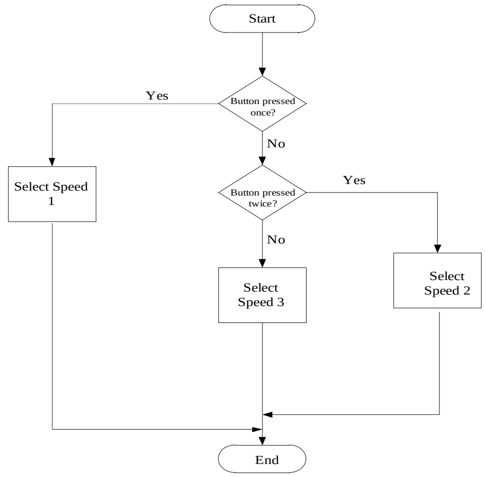

Fig. 6: Flowchart for the control unit

2.5 The Design Of The Electronic Power Switch

The electronic power switch is used to switch voltage from the mains source to the fan. It receives control signal from the microcontroller control unit. It is made up of opto-couplers which are used to drive triacs. Shown in Fig.6 is the circuit diagram of the electronic power switch.

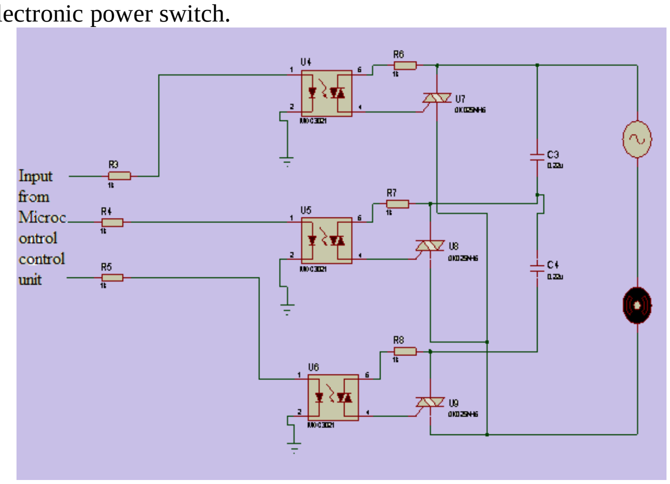

Fig.7: The Electronic Power Switch Circuit Diagram.

From Fig.7, the current flowing through the LED in each opto coupler is obtained from eqn. (2): [12,13]

$$I = \frac{V_{cc} - V_d}{R_3} \text{ ------------ } (2)$$

Where Vd = forward bias voltage across the LED
Since Vcc = 5V and with I = 3.2mA,

$$R_3 = \frac{V_{cc} - V_d}{I} = \frac{5 - 1.8}{3.2\ mA} = 1000\Omega = 1K$$

Current flowing from the mains to the gate of each triac is obtained from Eqn (3):

$$I_m = \frac{V_{ac} - V_{gt}}{R_6} \text{ ----------------------- } (3)$$

Where Im = mains current=15mA, Vac = Mains supply = 220Vac and Vgt = gate trigger voltage of the triac= 5V.

$$R_6 = \frac{V_{ac} - V_{gt}}{I_m} \text{ ---------- } \quad (4)$$

$$R_6 = \frac{220 - 5}{15\ mA} = 1000\Omega = 1K$$

Assembling Figures 3, 4, 5 and 6 gives the complete circuit diagram for the remote controller as shown in Figure 8 while Figure 9 is the Button-controlled speed selector circuit (remote speed controller).

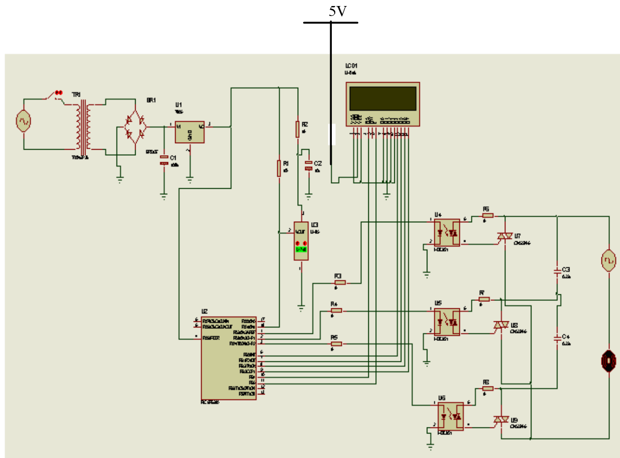

Fig.8: Complete Schematic Diagram of Circuit

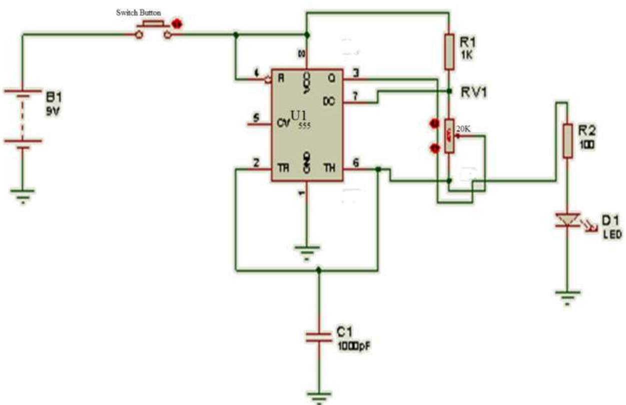

Fig. 9: Button-controlled Speed Selector

3.0 Discussion

From Fig.8, selecting speed1 associated with turning on the triac connected to opto-coupler U4 by passing current through U4 supplies maximum power to the fan and produces maximum fan speed while second high speed is achieved by passing current through U5 and lower speed is produced by passing current through U6. Thus, this control circuit limits speed to three different speed values. Selection of a particular speed is achieved by pressing the remote, Fig. 9, according to the desired speed- once for first and highest speed, double for second high speed and triple for the third speed- to which the control unit responds according to the program algorithm based on Fig. 6 and causes the appropriate triac to be turned on. More calibration can be achieved by modifying the program code appropriately and then adding more triac circuits in the mains triac-control circuit.

4.0 Conclusion

This work designed and developed a remote control for bladeless table fan with a non-calibrated regulator. Instead of using a potentiometer for speed control, a microcontroller controlled-triac gate-trigger circuit was used to limit the fan to three different fan speeds.

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