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TEMPERATURE DEPENDENT FAN SPEED CONTROLLER UTILISING INFRARED SENSING

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Abstract—**This study introduces a novel approach to develop a low budget and easy to use temperature based fan speed controller for induction fans. An infrared based temperature sensor(MLX90614ES) has been used to monitor the temperature of the room and an ATMega8A microcontroller has been used to monitor and processes the temperature data to generate a corresponding PWM signal. This PWM signal is feed into a Triac (BTA12) to control fan speed by limiting power. A Zero Cross Detection (ZCD) method has been used to provide flexibility. An Optocoupler based driver has been used to drive the Triac and also used to isolate high voltage side from low voltage side. A LCD display has been used to display real time temperature value.**

Keywords: —*IR temperature sensing, PWM signal, Triac, Zero Cross Detection, Optocoupler.*

I. INTRODUCTION

Nowadays, everyone is looking towards the newtechnologies by replacing the manual operations toautomatic controlled devices. One of the basicrequirements of the people during summer is a cooling fan. But, the speed of the fan can becontrolled manually using a manualswitch i.e. fan regulator or dimmer. By turning thedimmer, the fan speed can be altered. It can beobserved that during daylight temperature usuallyrises and during night the temperature falls. The usersdo not understand the difference in temperature. Soto overcome the speed of the fan, the solution is tovary the speed according to temperature. This concept isparticularly applicable for the areas like wheretemperature changes rapidly during day and nighttime. In 2016 it was observed in Gobi-desert where the temperature increases and decreases very frequently [1]. This work will convert the induction fan intoautomatic smart fan. The automatic fan will change itsspeed according to the temperature in the room. Automated-systems that have less manual operationare flexible, reliable and accurate.Microcontroller plays a vital role in the smart system of the electronic world. A microcontroller is a control system on a single chip that makes possible for the automation of the designed system and control process and produces precise results [2,3].

Various kind of smart fan, speed controllers and room temperature monitoring system are available but most of them are not user-friendly and cost effective and some of the speed controllers are not made for home applications and are not supported by all kind of fans.

Shwetha S Baligar et al. have made a model using LM35 temperature sensor IC and UNO R3. The model can be operated only for 12V supply and also can drive up to 12V DC fan. The precision of LM35 IC is less since it is a three pin analog based IC. Overall, the setup is less flexible [4].Gurmu M. Debele,Xiao Qian et al. have designed a system utilising DHT11 temperature and humidity sensor [5].The DHT11 sensor, while affordable and easy to use, has limited accuracy and has relatively slow response time. Its temperature accuracy is ±2°C, which might not be sufficient for precise temperature control, leading to suboptimal comfort levels [6].Patryk Modrzejewski et al. have made great project for automatic temperature controlling system but the main disadvantage of this project is that it is applicable only for temperature below 0°C, also the cooling system relies on a combination of a laboratory thermostat filled with methanol and a chiller filled with a dry ice and acetone mixture. This setup can be complex to operate and maintain, requiring careful handling and replenishment of cooling agents and replicating coolant is not so easy [7].Mashud, M. A. A et al. have developed a full analog based circuit using operational amplifier and have used PT100 fluid temperature sensor. Since it has not used any kind of microcontroller, it's precision level is less than others and also PT100 is not a suitable sensor for this project [8].

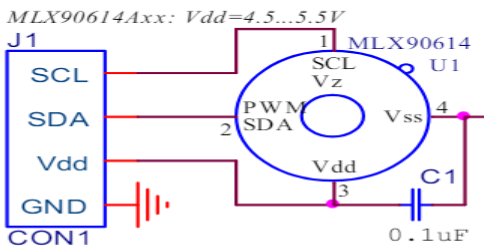
In this present work we have developed MLX90614ES IR temperature sensor based fan speed controller which can drive in both AC and DC load. Here we have used BTA12 Triac which can handle up-to 600V and 12A current and heat dissipation factor is also less. An optocoupler based inverting driver has been used to drive the Triac and also it can provide isolation from high voltage to low voltage. A full wave rectifier (without filter) has been used as zero cross detector (ZCD) to generate PWM signal in a synchronise way with AC phase angle. As zero cross detector has been used, the flexibility of the setup is good and can be operated on any frequencies. A LCD display has been used to display real time temperature and current fan speed.

II. METHODOLOGY

A. Apparatus used

In our present work, the whole setup has been classified into four major blocks-

1) Sensory and feedback unit – In this part MLX90614ES infrared temperature sensor has been used to monitor real time temperature value.



Figure

Figure 1: MLX90614ES pin diagram

It has a good range of sensitivity from -40°C to 85°C. It has very low power consumption and can be operated on 4.5V to 12V [9].

2) MCU unit – An ATMega8A has been used as a microcontroller unit in this project. ATMega8A is a 28 pin microcontroller with 16MHz clock speed, 8kB flash memory and 23GPIO pins [10].

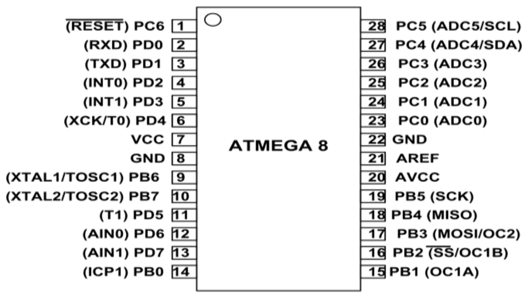


Figure 2: ATMEGA 8 pin diagram

Here we have used it to read the upcoming sensor data and to generate corresponding PWM signal to drive the triac.

3) Driver and output unit– In this project, optocoupler based inverting driver has been used to drive the triac. A push pull amplifier consisting of 2N3906 pnp transistor and 2N3904 npn transistor to convert 5V logic to 12V logic. A BTA12 triac has been used in this project. This triac can handle 12A current in 600V. Moreover, the heat dissipation is significantly less [11].

4) Zero Cross Detector (ZCD) – To drive the triac in a synchronous manner with main power socket (AC) a zero cross detector is needed. Here a step down transformer of 5V and a full wave rectifier have been used as zero cross detector.

B. WORKING PRINCIPLE

In this present work, infrared temperature sensing method has been used to monitor the real time temperature of the room. The principle of infrared temperature sensing is based on the Law of Planck's distribution. The law shows that the radiation energy of blackbody is distributed according to the wavelength at different temperatures[12].

The mathematical formula is -

$$E_{b\lambda} = \frac{\lambda^{-5} c_1}{e^{c_2/\lambda T} - 1} \quad \text{.............(1)}$$

$E_{b\lambda}$ is the blackbody spectral radiation flux density, Wcm^{-2} μm^{-1}; c1 is called the first radiation constant, c1 =3.7415×10 Wcm^{2}; c2 is called the second radiation constant, c2=1.438cmK, λ is the wavelength of the spectral radiation, μm; T is the absolute temperature of the blackbody, K.

MLX90614ES has four pins Vcc, Ground, SCL, SDA. Vcc and Ground pin are used for power connection. SCL and SDA are the data-bus to communicate with microcontroller. Then the upcoming sensor data has been fed into microcontroller which then process the data and generate a PWM (Pulse Width Modulation) signal corresponding to temperature level. Higher the temperature, more will be the duty cycle of the PWM signal.

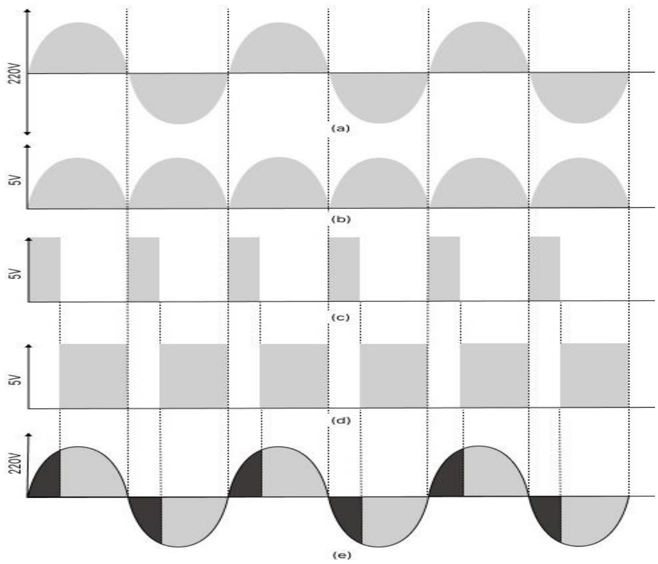


Figure 3: (a) AC signal, (b) ZCD, (c) PWM, (d) Gate pulse, (e) Triac output

As mentioned earlier, to generate PWM signal in a synchronous manner a zero cross detector consisting of a step down transformer of 5V and a full wave rectifier have been used. By using this set up it converts the AC signal into pulsed DC signal of 5V peak to peak and by analysing the signal it can easily detect the 0V positions.

The output PWM signal then come into the driver unit which converts the 5V signal into 12V PWM signal and also invert the signal to generate appropriate gate pulse to drive the triac. Depending on the duty cycle of the gate signal the triac allows the power flowing through output side. Less the duty cycle of gate signal, less it will allow the power to flow through.

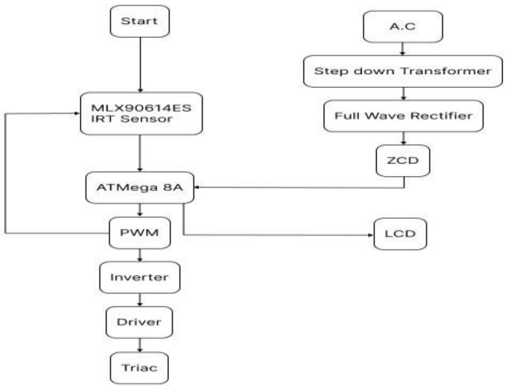


Figure 4 : Flow diagram of the setup

Also in the setup a LCD display has been incorporated to monitor the real time temperature value of the room and also current speed of the fan.

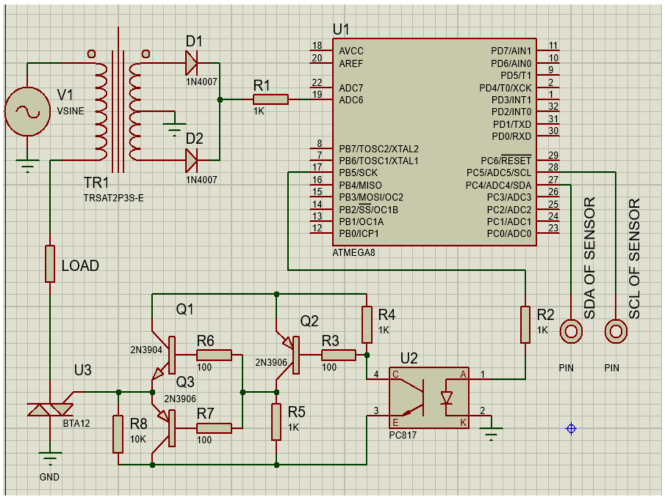


Figure 5: Circuit diagram of the setup

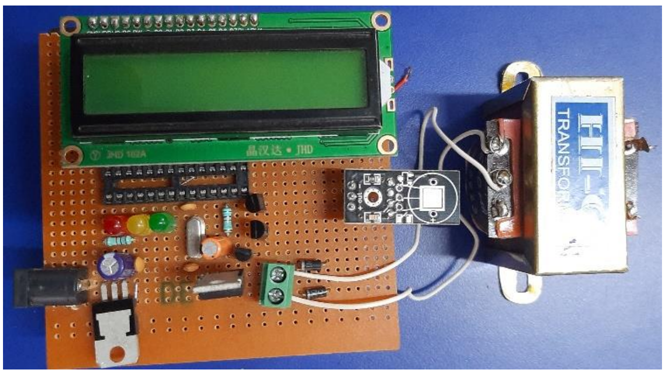
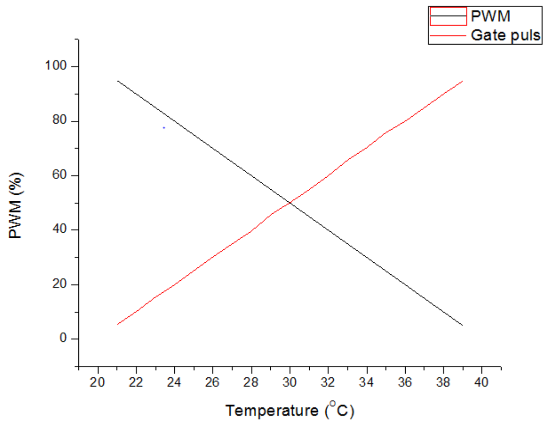


Figure 6: Experimental setup

III. RESULT AND ANALYSIS

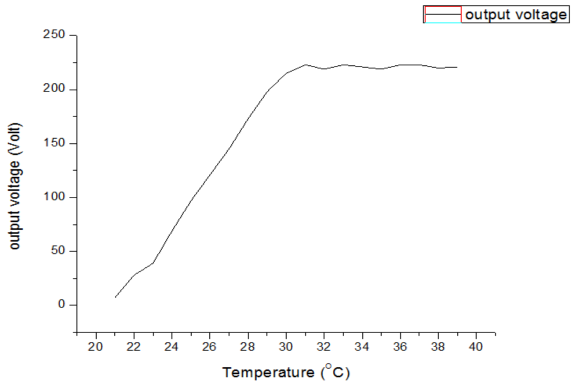
The fabricated device has been tested precisely inside an air-conditioned room to ensure that the initial temperature is less than 21 °C. Further to increase the temperature inside the chamber a hair dryer was used. A 40W table fan acted as the load for the controller, and the controller was powered directly from a 220V main power supply.

We have tested the circuit by varying the temperature from 21°C to 40°C and measuring the parameters: PWM, gate pulse, output voltage, output current, and output power.



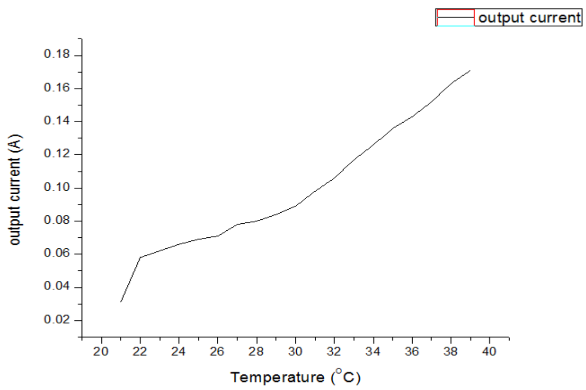
Graph 1: Temperature vs PWM & Gate pulse

In graph 1, a linear relationship between temperature, PWM, and gate pulse has been established. An optocoupler-based inverting triac driver has been used, so that the PWM signal and gate pulse are complementary to each other.



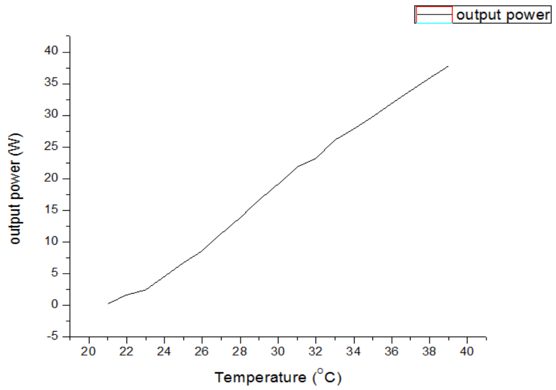
Graph 2: Temperature vs output voltage

In Graph 2 Temperature vs Output Voltage, two parts of the graph have been observed. It has noted that the output voltage increases linearly between 20°C to 30°C, and stabilises after 30°C. It concludes that 30°C temperature is equivalent to 50% pulse width.



Graph 3: Temperature vs output current

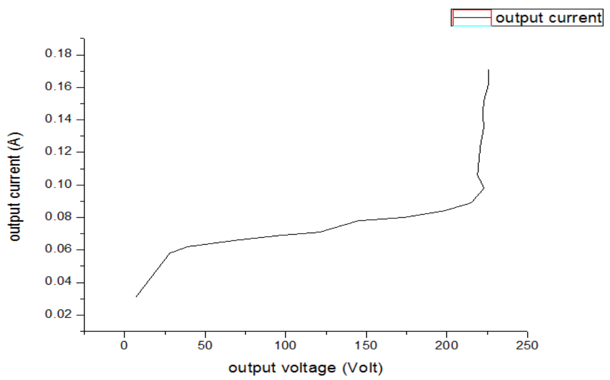
From graph 3, it has been shown that the output current is showing an increasing nature with respect to temperature. Because increasing gate pulse width allows more current to flow through the triac.



Graph 4: Temperature vs Output Power

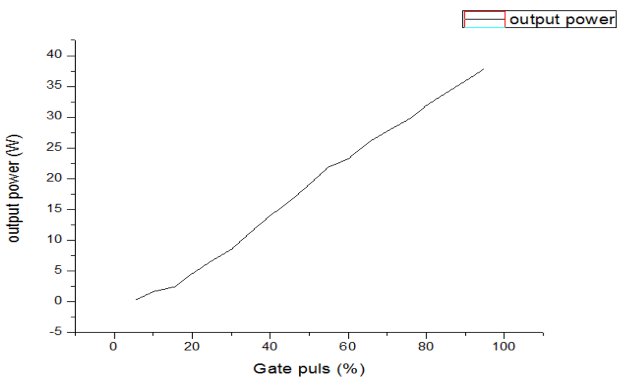
From graph 4, it can be concluded that output power is linearly related with an increase in temperature.

We have analysed the V-I characteristics of the triac and also establish the relation between gate pulse and output power.



Graph 5: V-I characteristics of triac

From the above graph 5, it has been observed that a very small blocking state is present in triac's V-I characteristics. This blocking state depends on the amount of gate current (I_g). As an optocoupler based driver has been to drive the triac, it drives the triac efficiently by providing enough gate current to avoid massive blocking state.



Graph 6: Gate pulse vs Output Power

From the graph 6, it can be concluded that with the increase in gate pulse (on-time) the output power flow, also increases linearly. It concludes that the higher pulse width allows more power to flow through the connected load.

IV. CONCLUSION

The project effectively demonstrates a smart fan speed control system using an infrared temperature sensor. The system accurately adjusts the fan speed based on real-time temperature data, enhancing energy efficiency and user comfort. The non-contact temperature sensing ensures precise measurement, while the TRIAC provides reliable and cost-effective speed modulation. This innovative approach not only conserves energy by adapting to environmental conditions but also offers a scalable solution for various applications, highlighting the potential for integrating advanced sensing technologies in everyday devices.

V. REFERENCES

[1] Mugume, I., et al. "Analysis of temperature variability over desert and urban areas of Northern China." *J. Clim. Weather Forecast* 4.2 (2016)

[2] DilrubaYamin, Automatic Room Temperature Controlled Fan Speed Controller Using PT100, International Journal of Scientific and Engineering Research, Volume 6, Issue 8, August 2015.

[3] M. Kumaran, I. Vikram, S. Kishore Kumar, R. Rajesh Kumar, S. Lokesh, Design of An Automatic Fan Speed Controlling System Using Arduino UNO. International Journal of Intellectual Advancements and Research in Engineering Computations, Volume-6 Issue-2, 2018 [2039-2042].

[4]Shwetha S Baligar et al. "Temperature Based Speed Control of Fan Using Arduino"March 2019 | IJIRT | Volume 5 Issue 10 | ISSN: 2349-6002

[5] G. M. Debele and X. Qian, "Automatic Room Temperature Control System Using Arduino UNO R3 and DHT11 Sensor," *2020 17th International Computer Conference on Wavelet Active Media Technology and Information Processing (ICCWAMTIP)*, Chengdu, China, 2020, pp. 428-432, doi 10.1109/ICCWAMTIP51612.2020.9317307.

[6] Srivastava et al. "Measurement of Temperature and Humidity by using Arduino Tool and DHT11." *International Research Journal of Engineering and Technology (IRJET)* 5.12 (2018): 876-878.

[7] Patryk Modrzejewski et al."Komoraniskotemperaturowa do badaniawytrzymałościmateriałówwysokoenergetycznych w warunkachtestuHopkinsona" XXII MIĘDZYNARODOWA KONFERENCJA NAUKOWO–TECHNICZNA UZBROJENIE 2019Problemyrozwoju,

produkcjiieksploatacjitechnikiuzbrojenia, doi10.13140/RG.2.2.29868.72329.

[8] Mashud, M. A. A., et al. "Automatic room temperature controlled fan speed controller using PT-100." *International Journal of Scientific & Engineering Research* 6.8 (2015): 1780-1783.

[9] https://www.melexis.com/-/media/files/documents/datasheets/mlx90614-datasheet-melexis.pdf

[10]https://ww1.microchip.com/downloads/en/DeviceDoc/Atmel-2486-8-bit-AVR-microcontroller-ATmega8_L_datasheet.pdf

[11] https://www.st.com/resource/en/datasheet/bta12.pdf

[12] Zheng Zhaoping, Zeng Hansheng, Ding Cuijiao, et al. Summary on the infrared thermal Imaging temperature measurement technology and its application. Infrared Technology, 2003; (01):96-98.