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DESIGN AND CONSTRUCTION OF VARIABLE SPEED DC FAN USING TEMPERATURE SENSOR

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ABSTRACT

This paper presents the construction of a Variable Direct Current (DC) Fan Speed Control System utilizing a Temperature Sensor. The objective of this system is to create an efficient and responsive method for regulating the speed of a DC Fan based on real-time temperature conditions. The project employs a temperature sensor to detect environmental changes, and a microcontroller to process the sensor data and adjust the fan speed accordingly. The system's flexibility in responding to varying temperature levels enhances its applicability in numerous scenarios, such as climate control in rooms, electronics cooling, and energy conservation. The circuit was simulated, constructed and tested by varying the temperature of the surrounding and the corresponding fan speed was noted, the result showed a linear relationship. Results shows that the constructed device performed according to the design specifications, with an automatic increase in fan speed due to temperature increase and decreasing fan speed as the temperature falls with a smooth switching action. The recording output of the temperature sensor against the tachometer yielded a linear relationship which indicates the sensitivity of the device. The speed control can provide comfort to both domestic and industrial users especially when the temperature is considerably high and at night when the user is asleep. The inclusion of time and date monitoring to the circuit made it unique and different from the works of previous researchers.

Keywords: Variable Direct Current, Speed control, Fan, Temperature Sensor, Automatic

1.0 INTRODUCTION

A temperature-controlled DC fan tends to address this issue as it automatically switches on and off with respect to change in temperature as observed by its sensors. It also saves electricity and power consumption as billions of kw-hrs of energy is used by fans per year. And this constitutes to 15% of power consumption (White, 2017). An electric fan is a device used to produce flow of air the purpose of providing comfortable ventilation. They are designed to create breeze and circulate the air in a region so as to provide the necessary cooling, especially during hot weather condition. While an electric fan circulates the around

its environment, the air-conditioning system changes the temperature of the air in its environment (Turner, 2021). The modern DC FANS works on a principle which does not include any means to relate with the environmental temperature that is to say they are manually controlled by the user and at such poses a lot of demerits and unwanted situations (Oleg, 2019; Zhao et al, 2022). This fan works on a predetermined speed at a constant time irrespective of the temperature causing mechanical and body part wears to the materials used to construct them and higher consumption of electricity (Smith, 2018, Edeh et al, 2020). With the advancement in technology, intelligent systems are introduced every day. Everything is getting more sophisticated and intelligible (Oshkosh, 2017). There is an increase in the demand of cutting-edge technology and smart electronic systems and this can be applied to a more modern smart fan that can relate with the environmental temperature in its speed control and usage. Such smart fan can be of great importance as it tends to cut cost and electricity usage (Patel, 2020). Older DC fans used mechanical brushes, which can cause increased electromagnetic interference (EMI) along with dust particles due to mechanical wear throughout the system. Over time, the fan would wear and eventually fail. Brushless fans have replaced these mechanical brushes with electronic sensors and switches that now perform the necessary commutation and increase the lifetime and the reliability of these fans (Lin, 2018). Brushless DC fans are called "brushless" because the electric motor within the fan is commutated electronically which makes them highly reliable with ease to use (Kim, 2019,; Edeh et al, 2021). With the improvement in machinery, smart systems are being introduced every day. In the present time microcontrollers play a vital role in the development of the smart systems (Chen and Li, 2019). A temperature controller is a closed loop control system which senses the temperature of the environment and compares it with a user-fed threshold temperature value and changes the speed of the fan so as to increase or reduce accordingly between the minimum and maximum speed values (Jones, 2019). In an automatic temperature-controlled system, the independent variable (temperature) is measured by a suitable sensor such as a thermocouple, thermistor or thermostat and converts it to a signal accepted by the controller (Lander, 2021, Ruby et al, 2022). The controller compares the signal to the desired temperature (set point) and activates the final control device. The final control device alters the dependent variable (fan speed) to change the quantity of heat being taken or added to the process (Kim, 2018). Turning ON and OFF fans in some homes or buildings is often a serious problem as these fans are mostly left ON even when the user leaves the room, thereby consuming unnecessary power.

2.0 METHODOLOGY

2.1. MATERIALS

The materials used for this research include: fan, power supply, resistor, capacitor, diode, microcontroller, switch, LCD.

2.2. METHOD

The temperature Controlled Variable DC fan was designed and implemented through the process of electronic design and work bench. The various electronic components required were tested to ensure good functionality before implementing.

The block diagram for the automatic speed controller using a temperature sensor is shown in Figure 1.

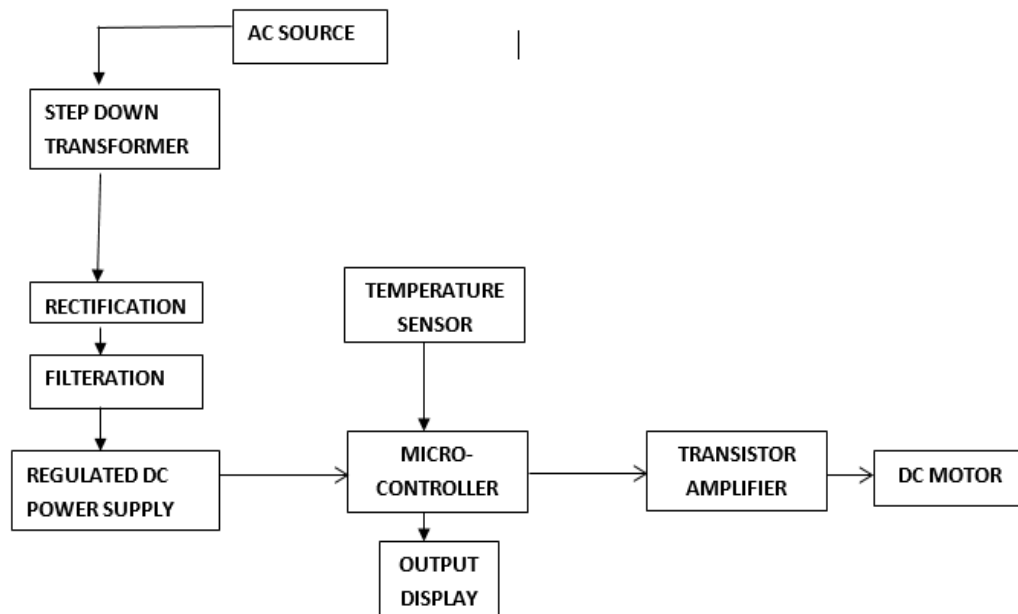


Figure 1: Block Diagram for the Automatic Speed Controller

a. AC source

The alternating current which is predominantly the major source of current for electrical appliances plays a major role in powering the far project. The direct current (DC) serves as the main working current is obtained through the rectification of the AC input and the alternating current from external source which may include power grid of 240V or less and Generators of equivalent voltage rating serves as an input voltage to a centre transformer.

b. Step-down transformer

The main function of a step-down transformer is in stepping a high voltage down to a required rating. The AC power source of the project is feed to this transformer which gives an output power of 12/24v to the system.

c. Rectification

Rectification can be defined as a process of converting an AC to a DC output source. The project

d. Filtration

The DC output of the rectifier undergoes some filtration in order to obtain a ripple free DC as well as a perfect direct current free of any AC component. This was actualized by the use of capacitor.

e. Regulated power supply

This provides and ensures that the output voltage will always stay at the rated value of power supply. The type of regulated power supply used for this project is a linear switch.

f. Temperature sensor

Temperature sensor senses the room temperature. This electronic device converts the data that sensed in the surrounding into the electronic data for recording purpose. But for the purpose of this project LM35 temperature sensor is used.

g. Micro-controller

A Micro Controller is a compact integrated circuit designed to govern a specific operation in an embedded system. A typical microcontroller includes a processor, memory and input/output (I/O) peripheral, on a single chip.

h. Output display

This is the most common form of output device which represents output visually. The system has a display unit which shows the operating condition of the fan. The display enables the user to know the value of the output speed of rotation of the fan blade and also to know the current temperature (C) of the immediate environment. The display is an LMDIOL screen which has the best functionality for the specified purpose.

i. Transistor amplifier

The output signal from the micro controller feeds the input of the transistor amplifier. This is to amplify the signal to a suitable range in order to power the DC motor.

j. DC Motor

A motor is an electrical machine converts electrical energy into mechanical energy and when such an electrical machine uses direct current source. It is termed DC motor. In a DC motor, the input electrical energy (Direct current) is transformed into mechanical rotation and then further into a rotational fine.

2.3 Circuit Simulation

The simulation of the system was done on proteus professional software v8.0. ATmega 328P microcontroller is used in the system. Coding of the system has been done in embedded C language. 16 x 2LCD display has been used which is connected to port B of the microcontroller. The simulation of the circuit is shown in Figure 2.

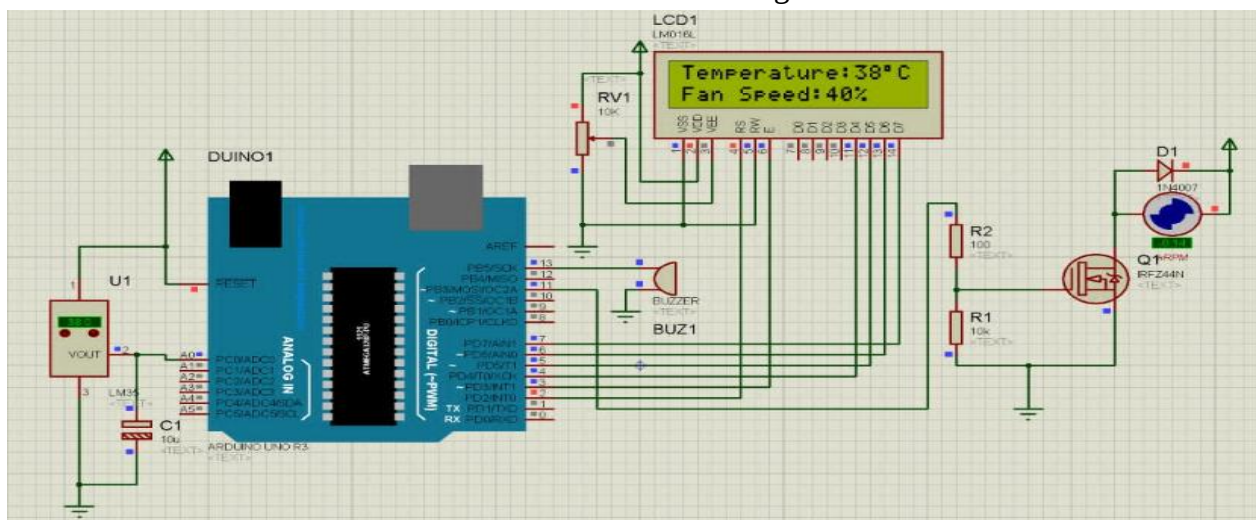


Figure 2: Simulation Diagram of the System

3.0 RESULTS AND DISCUSSION

The circuit mainly consists of ATMEGA microcontroller, temperature sensor, DC motor, Rectifier circuit, driver IC temperature sensor is connected to the input of the ADE pin i.e ADC0 pin of the micro controller. The supply mainly from ratification of AC and hence supply is connected to AC power outlet during which the inbuilt battery charges and stores power in care of emergency usage. Temperature sensor has three inputs, VCC, ground, middle one is having three input and the other two plus are ground and VCC. VREF and AVCC for the ADC are applied externally to the microcontroller connected to the microcontroller is connected to the motors through a motor driver IC. input plus of the motor driver are connected to the microcontroller. PBO and PBI are connected to the input 3 and input 4 of the motor driver IC output pins reconnected to the motor. As the motor has two pins, these are connected to the output pins of the motor driver are connected to the microcontroller. PBO and PBI are connected to the input 3 and input 4 of the motor driver ICPB2 and PB2 pins are connected to the motor. as the motor has two pins; these are connected to the output pins of the driver IC. Figures 3, 4, 5, 6, are the results of Pulse for temperature 29⁰, Pulse for temperature 32⁰, Pulse for temperature 35⁰ and Pulse for temperature 37⁰ and above respectively.

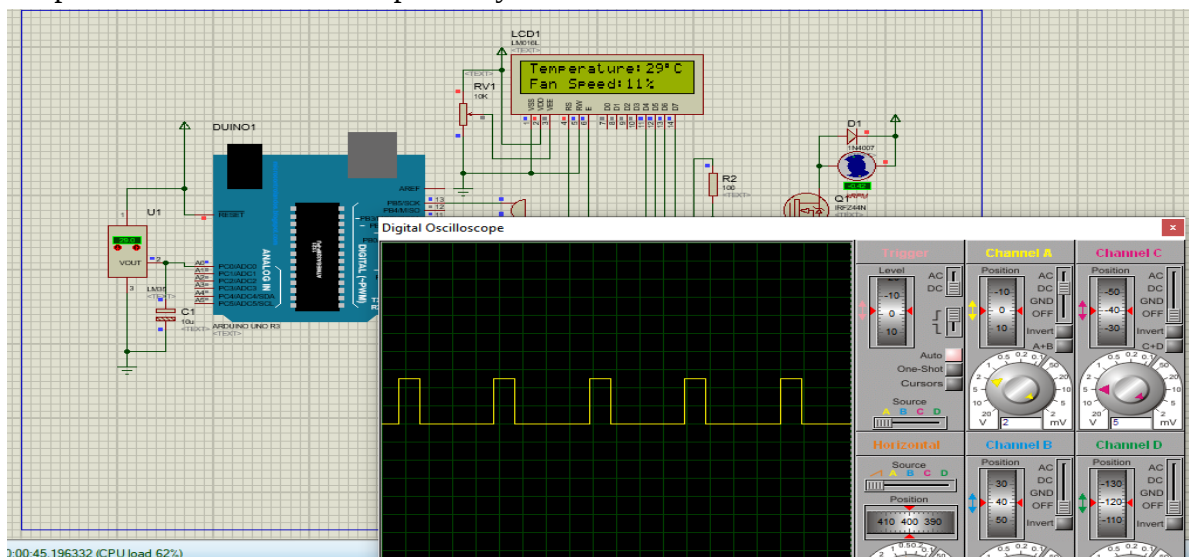


Figure 3: Pulse for temperature 29^0

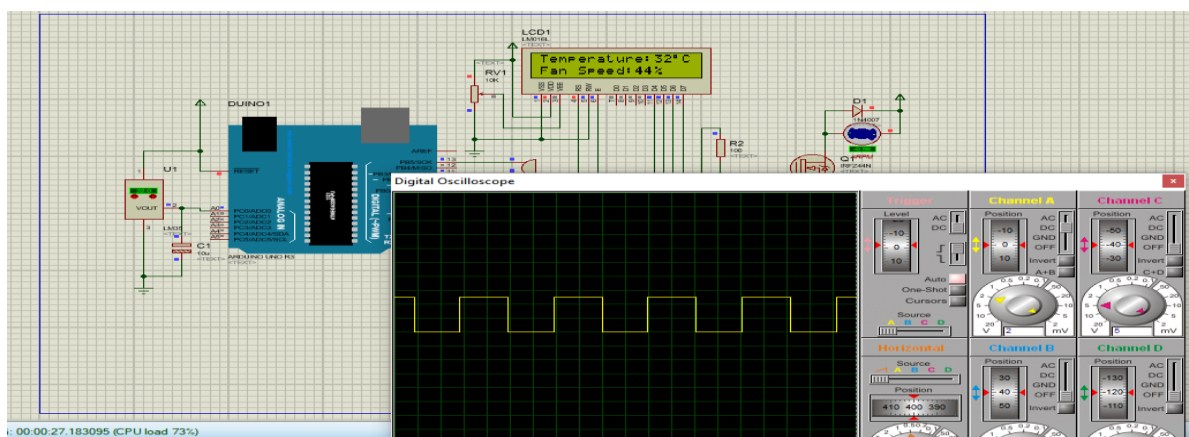


Figure 4: Pulse for temperature 32^0

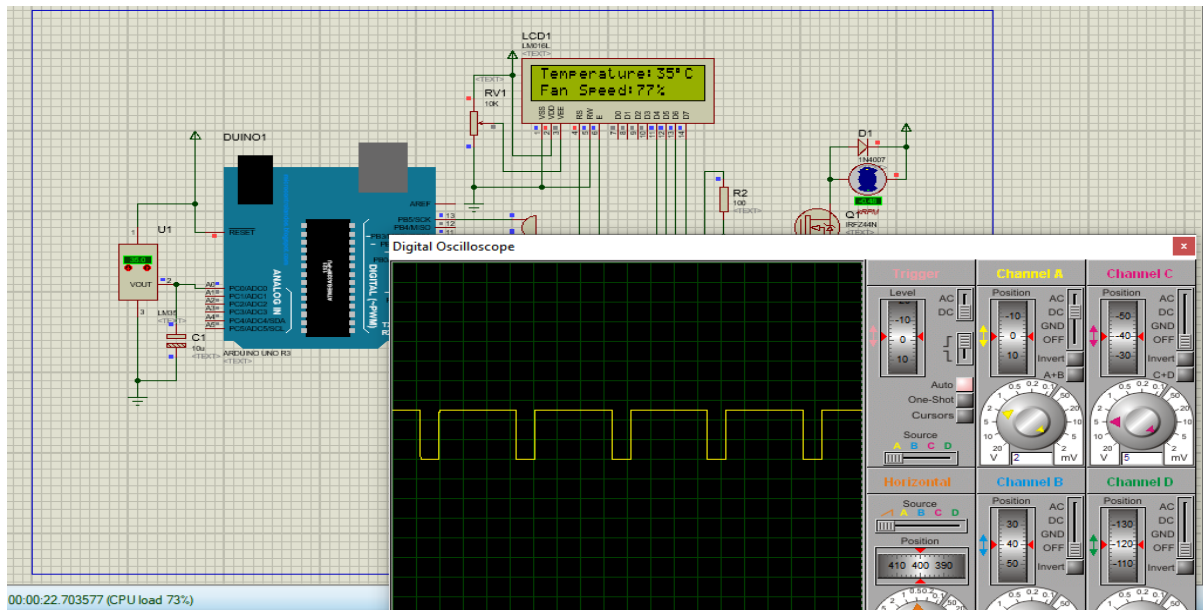


Figure 5: Pulse for temperature 35⁰

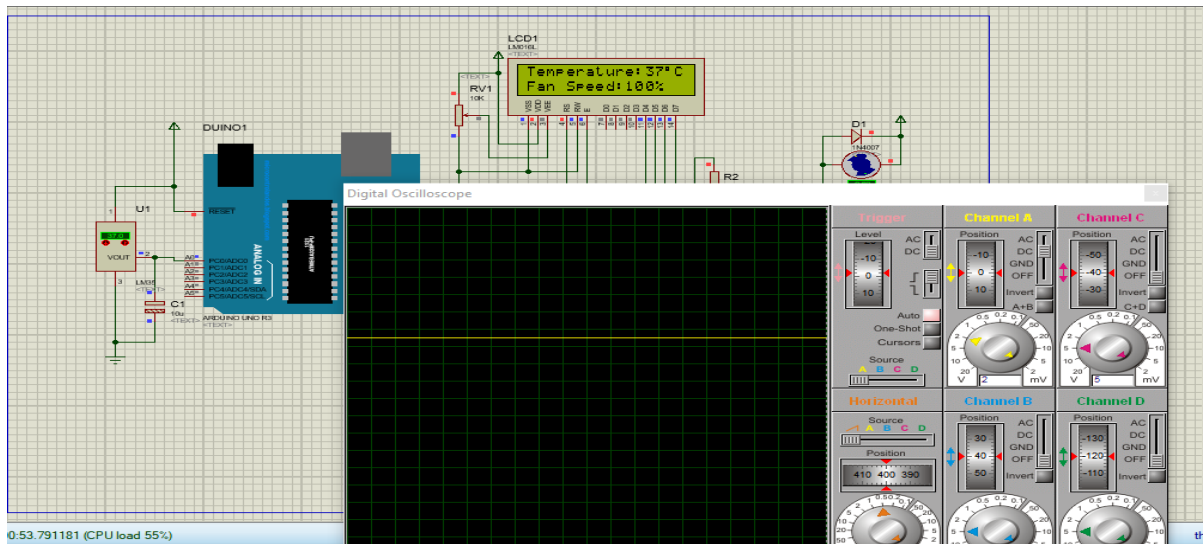


Figure 6: Pulse for temperature 37⁰ and above

Table 1 is the Results of Duty cycle and speed with temperature and output voltage (v)

Table 1: Results of Duty cycle and speed with temperature and output voltage (v)

Temperature	Duty cycle	Speed	Equivalent output voltage (v)	rpm
0 – 27	0	Zero	0	0
28 – 31	25	Slow	6v	477
31 – 34	50	Medium	8v	668
34-37	75	Fast	10v	859
37 above	100	Very fast	12v	1050

Figure 7 is the plot of voltage against rpm from table 1

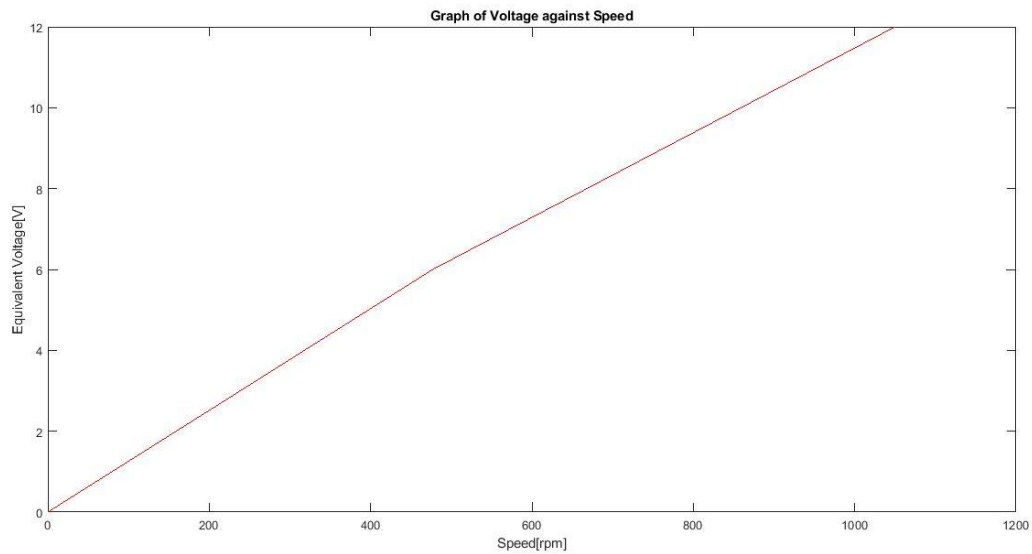


Figure 7: Graph of Voltage against Speed

From Figure 7, it was seen that the relationship between the voltage and the rpm of the fan is increasing linearly respectively.

Figure 8 is the plot of voltage against temperature from table 1

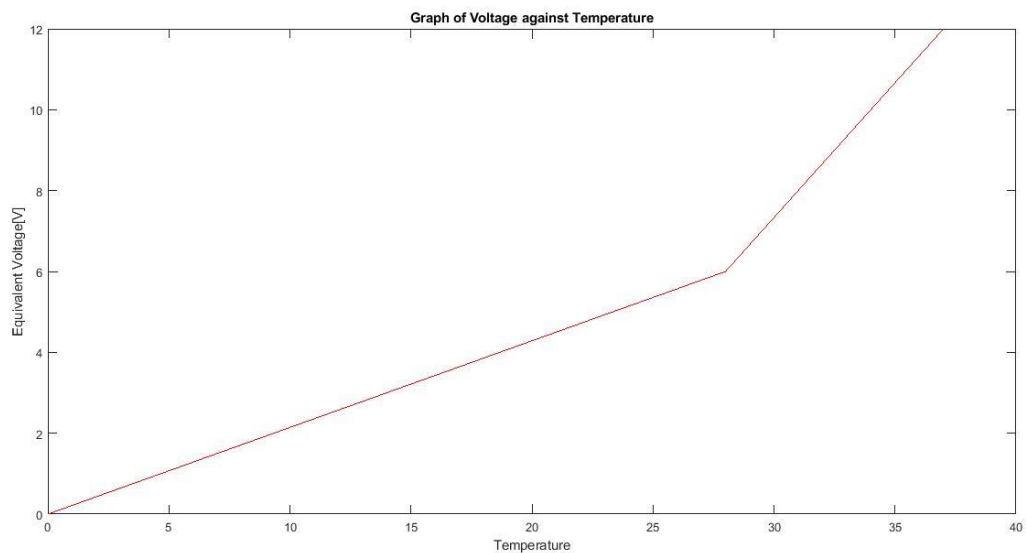


Figure 8: Graph of Voltage against Temperature

From the graph of voltage against speed (rpm) which is a linear graph showing that the voltage is directly proportional to the speed and as well as the temperature of the environment. As the temperature increases, the output D.C voltage increases in equal proportion which affects the spread of rotation of the fan.

4.0 CONCLUSION

The goal of this work was to construct a circuit that will automatically control the speed of a fan according to changes in the temperature of the surrounding. The digital temperature sensor LM35 is used which integrates the A/D conversion circuit, which makes the circuit structure simpler and reduces the loss of precision in the temperature measurement conversion. The circuit was simulated, constructed and tested by varying the temperature of the surrounding and the corresponding fan speed was noted, the result showed a linear relationship. The inclusion of time and date monitoring to the circuit made it unique and different from the works of previous researchers. With automated fan control, you no longer need to disrupt your work-flow to adjust the speed and direction of your fans. The device can be used in the tropical areas where the temperature is very hot and especially for the old aged and disabled people homes and in the hospitals for the sick who cannot stand up to regulate their fan. The device can also be used to improve comfort in our various homes and offices.

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