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Speed Control of Split phase induction motor with Temperature using Arduino

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Abstract: *Automation plays an ever-increasing part in a human manner of life. This Paper presents a speed control unit of a permanent split capacitor external-rotor single-phase induction motor for Air conditioner Applications.HeretheroomtemperatureissensebytheLM35sensorgivesittotheArduinowhich generate PWM signal. A pulse width modulated (PWM) from Arduino give to the motor through opt isolator that changes the effective value of the supply voltage applied to the motor that changes with surrounding Temperature. There are various techniques are available for speed control of induction motor but out ofthem here we have use the PWM technique. This paper elucidates that how the automatic speed of the split phase induction motor of air conditioner changes with temperature.ThemainobjectiveofthisworkisConservation of energy and reduces the bill ofconsumer.*

Keywords*- Arduino UNO, Inductionmotor,LM35 (Temperature Sensor), Opt isolator, Proteus, TRIAC*

I. Introduction

Electricity has always endured a prime need of life without electricity it is impossible to image our life. But the only problem, as far as electricity is concerned, is the cost at which it is generated – that is crossing all limits by every passing day, thus putting undue burden on the buyers in the form of high bills of electricity. However, there is a solution to manage energy efficient lightning at home. This article talks about such a powerful solution for energy efficient lighting to save energy by optimizing home appliances. Such as split phase induction motor, Air Conditioner, etc.

Generally Split phase induction motor used in the compressor of A.C where power consumption of the ACis very high as compared to the other appliances. [1]Presently, the demand for right temperature control hasbeen important fortoomanyofindustrialareassuchasprocessheat,automotive,industrialplacesor office buildings where the air is cooled in order to maintain a relaxed environment for its residents. One of the most important concerns involved in heat area consist in the desired temperature achievement and consumption optimization.to conserve the energy and increase the comfort of the consumers speed of the split phase induction motor in A.C should change with temperature.[2]With the progression in technology, intelligent systems arepre- sented every day. Everything is getting more sophisticated and intelligible .There is an increase in the demand of cutting edge technology and smart electronic systems. Arduino play a very important role in the development of thesmartsystemsasbrainisgiventothesystem.Arduinohavebecometheheartofthenewtechnologiesthatare being introduced daily. An Arduino is mainly it consist of microcontroller suited for control and automation of machines and processes.Today, Arduino are used in many disciplines of life for carrying out automated tasks in a moreaccuratemanner.[8]Almost present day device include in gair conditioners, toys, power tool office machines employ.This paper presents the design and simulation of the split phase induction motor speed control system using PWM technique based on the surrounding temperature.ALM35temperature sensor has been used to measure the temperature of the surroundings and the speed of the split phase induction motor is varied according to the surroundings temperature usingPWM technique.[5]The duty cycle is varied from0 to100 to control the split phase induction motor speed depending upon the room temperature, which is displayed on Liquid Crystal Display

II. Literature survey

Split phase induction motor is one of the types of single phase induction motor that is used in wide house hold and industrial applications.it can be used to cover the electrical energy to mechanical energy.it is available invarious ratings depending upon there quirements.[4]These types of motors are widely used in the compressors of refrigerat or, air conditioners. In the compressors there is auto cut facility is provided that means when [6] the temperature of outer medium is reaches to particular set low level then it will cut the supply through relay and when temperature changes from reference level then it will directly start the motor with full speed. Due to this motor operates at its full speed for large duration of time hence power consumption also increases of the motor hence electricity bill also increases [7].

To increase the efficiency of the operation and reduce the power consumption by the motor we have to change speedofinductionmotorwithtemperaturesothatwithchangingtemperaturespeedofthemotorchangesinsteps and power consumption of motor also reduces for this operation we have to control the input voltage given tothe motorhereweusePWMtechniqueinwhichforparticularrangeoftemperaturedutycyclewillsetwhichchange the amplitude of applied voltage to themotor.

III. Pulse Widthmodulation

Pulse Width Modulation (PWM) is a technique where the width of the period icorder pulses is varied in accord with the base band signals. PWM is also known as Pulse Duration Modulation. [9]The leading edge of the pulse is held constant and the variation in pulse width with signal is measured according to leading edge. In PWM, the pulse width is related to the amplitude of the signal. [1]By changing the duty cycle of the pulse, the speed of the split phase induction motor can be controlled. Duty cycle may be defined as the amount of time in a specific period during which the pulse is active or high. The speed is made slow (25%), medium (50%), fast (75%), very fast (100%) and zero by having different duty cycles. Figure 1 shows the pulses with varying dutycycles

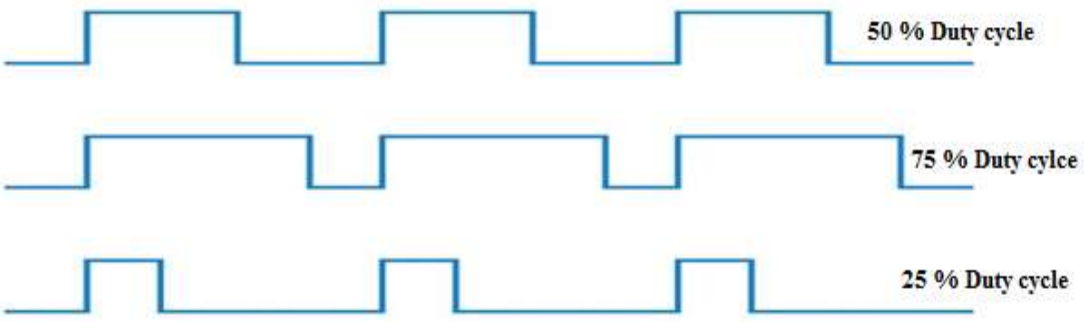

Fig.1: Different Duty Cycles

Formula = Ton/(Ton+Toff)

IV. System Design

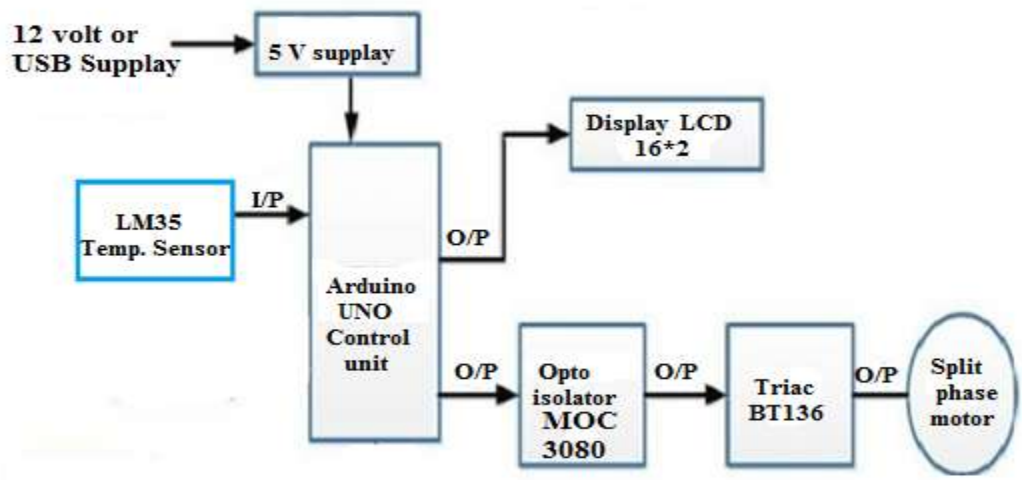

Fig.2: Block Diagram

The block diagram of the system has been shown in Fig 2 .It consists of:

4.1 LM35(Temperature Sensor):-

LM35 is a temperature sensor IC with its output proportional to the temperature (in oC). The LM35 can measure accurate temperature as compare to the rmist or with high accuracy and widerang.Theself-heatingofthe LM35temperature sensor is less and having 0.1degree in normal still air.The operating temperature range is from -55˚C to 150˚C. The output voltage changes by 10mV with respect to every oC variation in ambient temperature, i.e., its scale factor are 0.01V/ oC.

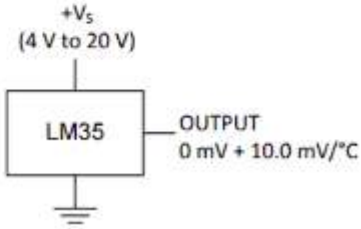

Fig.3: LM35 Temperature sensor

4.2 Arduino UNO:-

Arduino is an open-source electronics stand based on use hardware and software. Adriano boards can read inputs - bright on a sensor, a finger on button, switched on a motor, switching on an LED. You can tell your board what to do by sending a set of directions to the microcontroller on the board. For that we use the Arduino programming language, and the Arduino Software, it is based on Processing. Over the years Arduino has been themindofthousandsofprojects,fromeverydayobjectstocomplexscientifictools.Auniversalcommunityof producersStudents, hobbyists, entertainers, programmers, and specialists - has collected around this open-source

plat- form, their contributions have added up to an unbelievable amount of accessible information that can helpful to beginners and experts. Arduino was made first time at the Ire Interaction Design Institute as a user friendly tool for fast prototyping; the objective is students without a background in electronics andprogramming. As soon as it grabbed a broader community, the Arduino board started varying to familiarize to new suppliesandchallenges,differentiatingitsofferfromsimple8-bitboardstoproductsforapplications,wearable,3D printing, and embedded environments. All the Arduino boards are fully open-source, authorizing users to build them independently and eventually adapt them to their specific needs. The software is also open-source, and it is growing through the contributions of usersworldwide.

4.2.1 Features of the Arduino UNO:

Microcontroller: ATmega328 Operating Voltage: 5V
Input Voltage (recommended): 7-12V Input Voltage (limits): 6-20V
Digital I/O Pins: 14 (of which 6 provide PWM output) Analog Input Pins: 6
DC Current per I/O Pin: 40 Ma DC Current for 3.3V Pin: 50 mA
Flash Memory: 32 KB of which 0.5 KB used by boot loader SRAM: 2 KB (ATmega328)
EEPROM: 1 KB (ATmega328)
Clock Speed: 16 MHz

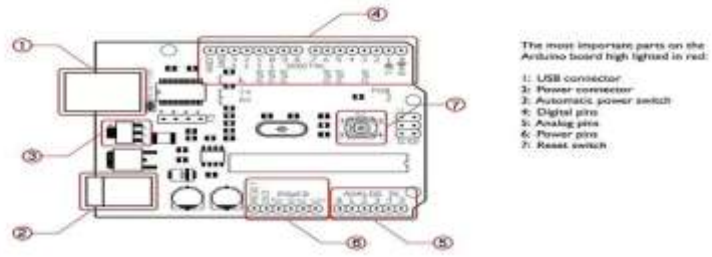

Fig.4: ArduinoUNO

4.3 L.C.D (Liquid Crystal Display):-

It is a flat-panel display or other electronically modulated optical device that uses the light modulating propertiesofliquidcrystals.Liquidcrystalsdonotemitlightdirectly,insteadusingabacklightorreflectortoproduce images in color in monochrome. LCDs are accessible to display arbitrary images or fixed images with low information content, which can be displayed , such as words, digits, and seven segment displays, as in digital block the same basic technology, except that arbitrary images made up of a large number of small pixels, while other display have largeelements

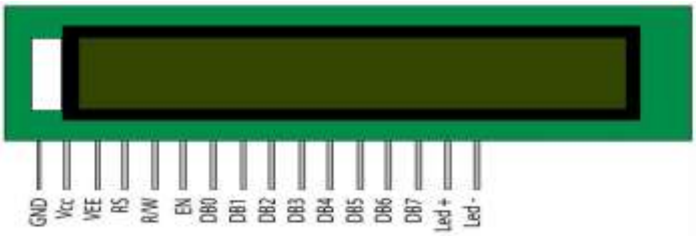

Fig.5: LCD 16*2 Display

4.4 Opto-isolator:-

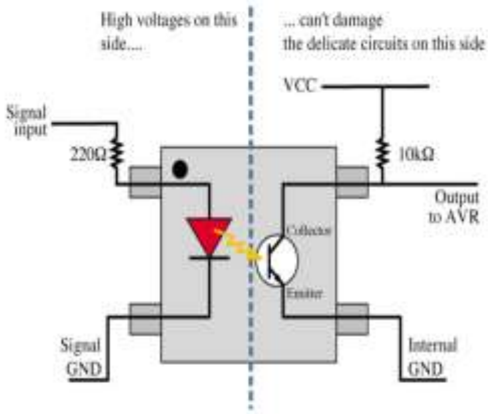

Fig. 6: MOC 3080 Opto-Isolator

Opto- coupler is IC which having 6 pins. It’s a combination of a LED and one transistor.6 number Pin of transistor is not usually used. When light is incident on the Base-Emitter junction then it will switch and pin5 goes to low. If input at diode is low and other end is GND then the output goes to high. When zero is given as input then the light wouldn’t fall on transistor hence it doesn’t conduct which gives zero as output. If logic one is given as input thenlightfallsontransistorsothatitwill start to conduct anditoperates as a shortcircuitdue to which the output logic zero as collector of transistor is connected toground.

4.5 TRIAC:

It is a component that is based on the two antiparallel thyristor. It offers AC switching for electrical systems. Same like the thyristor, the TRIAC sare basically use dinmany electrical switching applications. They find specific use for circuits in light dimmers,etc.,where they permit both halves of the ACcycletobeused. By using this we can efficiently use the available power. While it is possible to use two thyristors back to back, this is not always cost effective for low cost and comparatively low powerapplications.

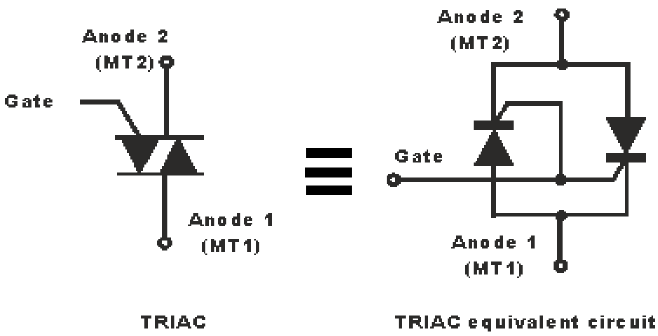

Fig.7: TRIAC equivalent as two thyristor

V. Circuit simulation

The simulation of the system has been completed on Proteus Professional Software v8.0. Arduino based on Modified Harvard architectureis used in the system.Coding of the system has been done in C++ language.16X2LCD display has been used which is connected to Arduino. The simulation is shown inFigure below

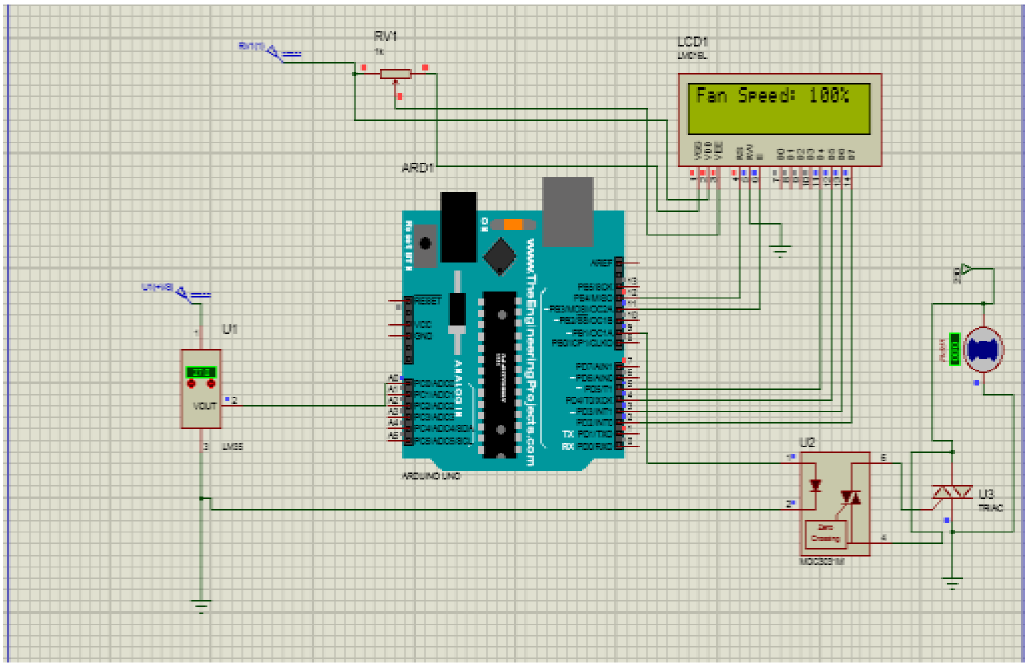

Fig.8: Circuit diagram using proteus

The temperature sensor will sense the room temperature and displayed on the LCD. The speed of the split phaseinductionmotoriscontrolledbyusingPWMtechniqueaccordingtotheroomtemperature.Thetemperature sensor LM35 interfaced to the analog port A0 of the Arduino acquires the room temperature and converts it into digital voltage signal. Fig shows the relationship between digital voltage and temperature. Then according tothe output voltage Arduino generate the signal on the output port 9 hence operation of the opto-isolator start and activate the triac where using PWM signal from Arduino duty cycle varies hence speed of split phase induction motor varies from 0 tomaximum

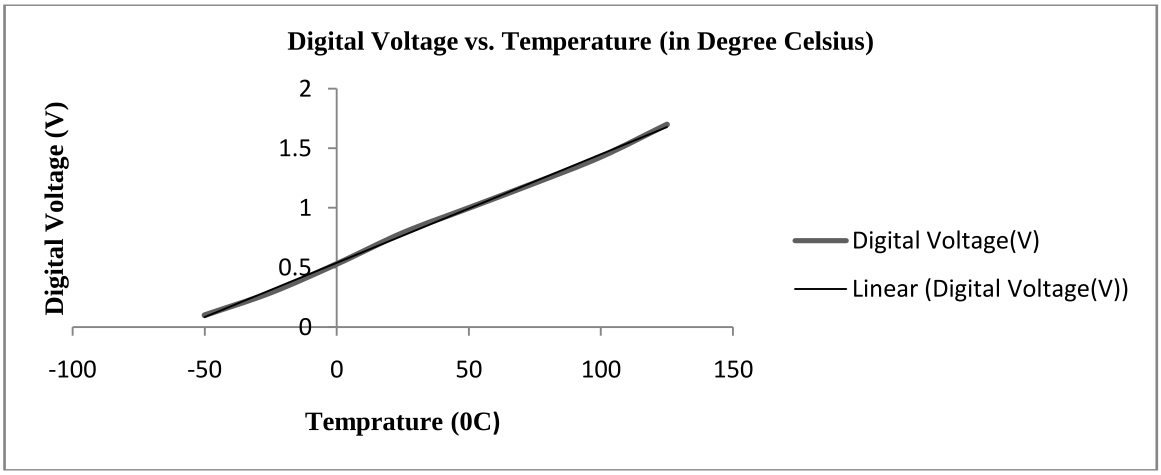

Fig.9: Digital Voltage vs. Temperature (in Degree Celsius)

The Arduino is used in this system has inbuilt PWM module which is used to control speed of the splitphase induction motor by varying the duty cycle. According to the readings from the temperature sensor duty cycle is varied automatically thus controlling speed of split phase motor. The below Table shows the duty cycles varying with thetemperature

Table 1: Duty cycle and Temperature

SR NO	TEMPRATURE (oC)	PWM	Duty cycle	SPEED (%)
01	T<20	0	0%	0%
02	T=20	64	25%	25%
03	T=25	85	33.33%	50%
04	T=30	128	50%	75%
05	T>30	255	100 %	100%

The 75 % speed corresponds to 50 percent duty cycle and 100 % corresponds to 100 percent duty cycle. The change of the duty cycle with temperature (in Celsius) is shown in the Fig9. The split phase induction motor is in full swing when the duty cycle is made 100 percent

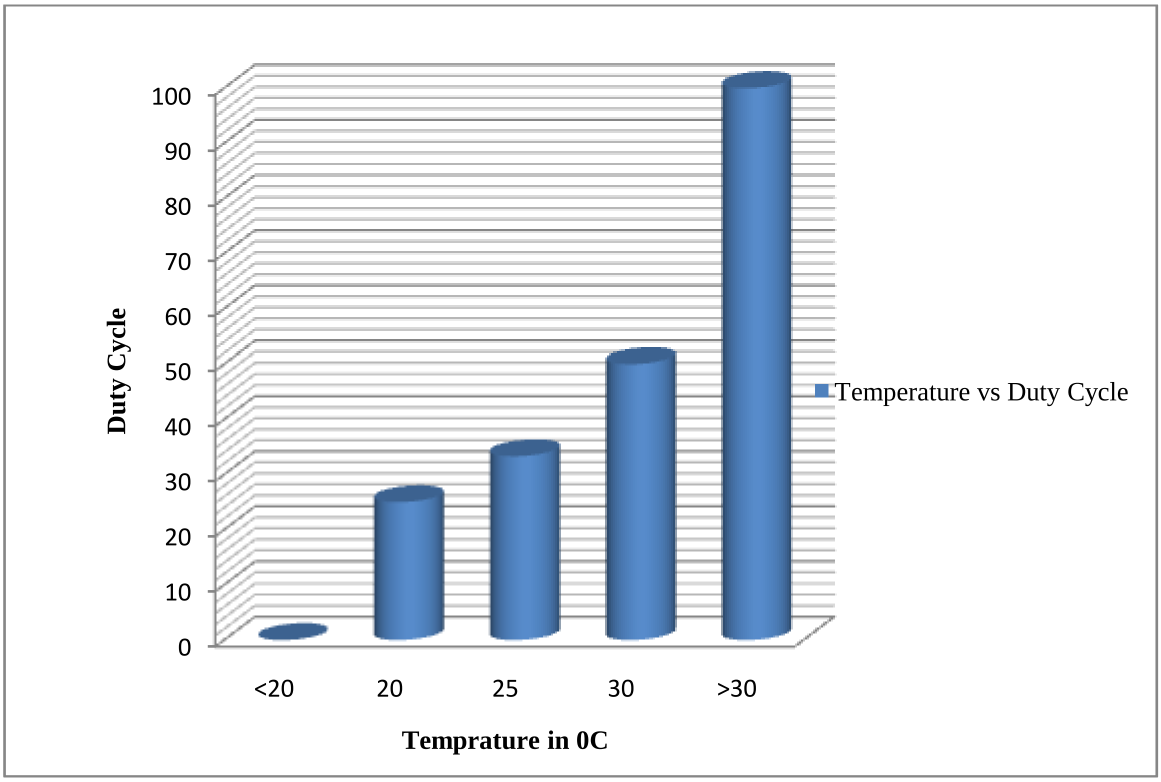

Fig. 10: Temperature (in oC) vs Duty Cycle

Variation of duty cycle with temperature (in Degree Celsius) has also been shown in Fig. The duty cycle will change according to the temperature of room and speed is controlled accordingly

VI. Flowchart Of The System

The logical illustration of the Arduino software code has been presented in the flow chart form.Figshows the flow chart of the logic executed in the modeled system.The temperature issense from the temperature sensor and the condition is checked and the following processes are done:

1. When temperature is less than 20 degree Celsius, then split phase induction motor isoff..
2. Whentemperatureisequaltothe20degreeCelsius,thesplitphaseinductionmotorspeedis25%.
3. Whentemperatureisequaltothe25degreeCelsius,thesplitphaseinductionmotorspeedis50%.
4. Whentemperatureisequaltothe30degreeCelsius,thesplitphaseinductionmotorspeedis75%.
5. When temperature is greater than 30 degree Celsius, the split phase induction motor speed is 100%.

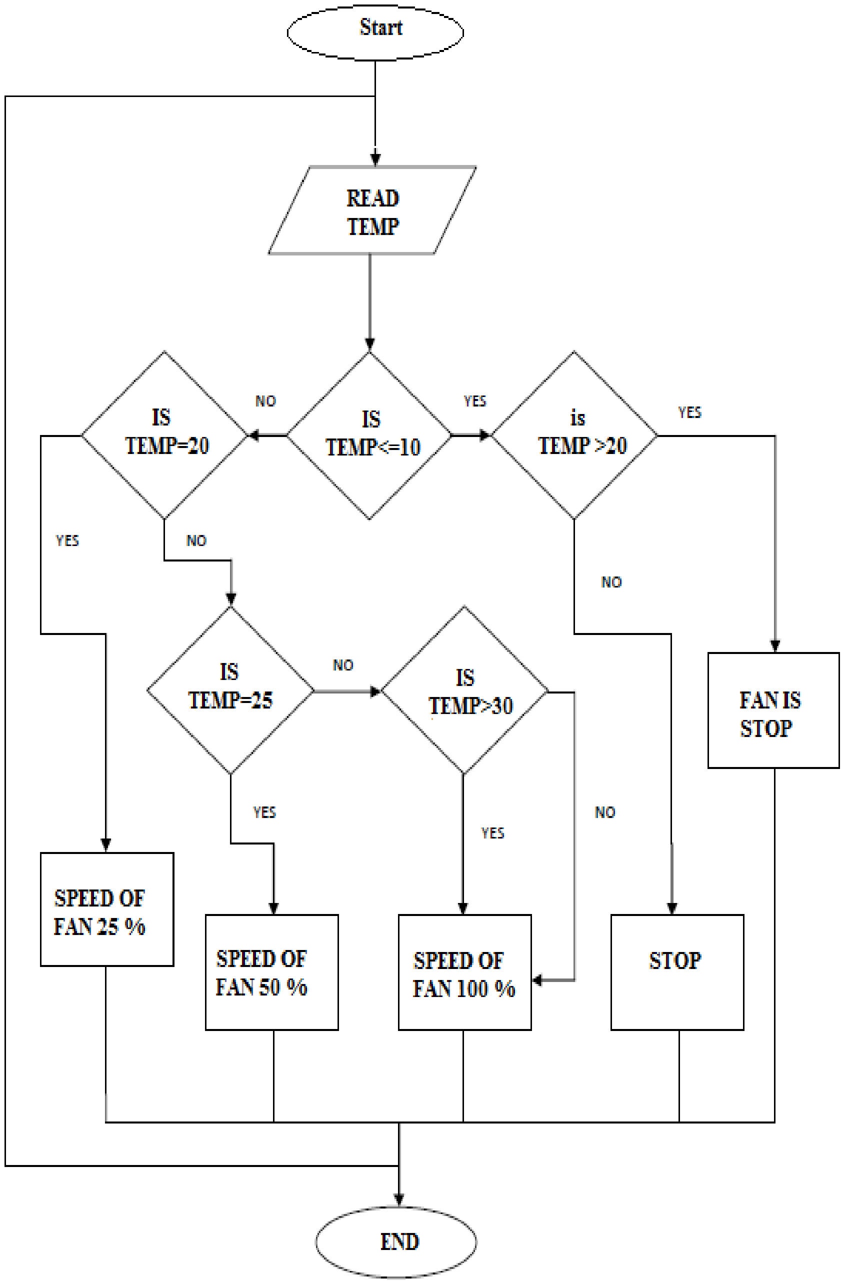

Fig. 11: Flowchart of the system

VII. Advantages & Disadvantages

7.1 Advantages:

- High efficacy.
- Reliable & Accurate.
- High Power conservation As compared to direct method.
- Running cost is reduces.

7.2 Disadvantages:

- Initial cost is increases.
- Due to use of voltage control method for small change in speed large change in voltage is required

VIII. Result And Preformance Analysis

Table 2: Resultand performance analysis

SR NO	TEMPRATURE (oC)	PWM	SPEED (%)	Power consumption	Power consumption without change
01	T<20	0	0%	0	0
02	T=20	64	25%	6.25%	100%
03	T=25	85	50%	12.5%	100%
04	T=30	128	75%	50%	100%
05	T>30	255	100%	100%	100%
Average				42.1875	100
Saving of energy				**100-42.1875= 57.8125 %**	

IX. Conclusion

This paper elaborates the design and construction of speed control of the split phase induction motor with changing temperature. Temperature sensor measure temperature and accordingly PWM changes hence speed of the motor gets change. Room temperature and speed can be seen on the L.C.D. A centrifugal pump or split phase induction motor running at half speed consumes only one-eighth of the energy compared to one running at full speed. This is because the torque needed to run a pump or split phase induction motor is the square of the volume. A novel design of speed control of split phase induction motor based on room temperature using PWM technique is proposed in this paper. The simulation model of the system in protius is working properly and the design is appropriate according to the modern needs and technology. The speed of split phase induction motor depends on the room temperature and there is no need for regulating the speed manually. Various graphs are plotted to show the changing relationships between different parameters. The PWM technique is found tobe suitable for controlling split phase induction motor speed according to room temperature. This design can be further stretched in terms of area, ratting, and power at layout and characteristic level by using Advanced VLSI applications, MSP430,Rasbaerry pieetc.

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