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Remote administration of speed of an induction motor

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Abstract- Induction motors are widely used in many industries and domestic applications. They are used commonly in many open-loop control applications due to their cost, size, efficiency, less maintenance, simplicity and easy manufacture. In the past traditional speed control methods were used to control the speed of the DC motors, But DC motors have commutator and brushes which require more maintenance and hazardous. So, induction motors are more preferred in these fields. Since most of the industries use Induction motors, controlling of it plays a major role. This project deals with controlling the speed of Induction Motor using Android phone remotely through Bluetooth Technology. We are using android application which uses Bluetooth to connect to the Bluetooth modem of the control circuit. Bluetooth modem is interfaced with the AVR Microcontroller. The Bluetooth slave receives the commands from the Android phone, then The Bluetooth module sends the signal to the Microcontroller. It decodes the signal and generates the pulse width signals which activates its circuit and gives the change in speed of induction motor with respect to the change in firing angle of TRIAC. This way speed can be easily varied and maintained as per the required values. We are not only controlling the speed of the induction motor; we can also detect the temperature and voltage of it which can be displayed on the android phone. Therefore, this project will be helpful in households, commercial use, industries etc.

Keywords: IoT, Induction Motor, Speed Control

1. INTRODUCTION

The characteristics of single-phase induction motors are identical to 3-phase induction motors except that single phase induction motor has no inherent starting torque and some special arrangements have to be made for making it self-starting. Though single-phase induction motor is not self-starting we are using it because the 3-phase supply is not

present at everywhere especially in domestic purposes single phase induction motors are widely used. In many electrical appliances namely ceiling fan, refrigerator, washing machines etc. we are using this type of motor. The main reason behind using it is the availability of single-phase supply and one more is economical i.e., less costly in price. So, speed control of induction motor is important. The complete control circuitry depends on only one parameter i.e., Voltage. We know that torque developed is proportional to square of the voltage. Thus, the applied voltage to induction motor stator terminals is controlled by TRIAC and its gate pulses. When pulses to the gate are delayed then reduced voltage is applied to the induction motor stator terminals and thus as voltage and torques are proportional to each other, torque decrease and simultaneously speed of the motor gets reduced. The power supply circuit will provide DC supply 5v and 12v (after rectification) to the electronic devices which require the biasing voltage. The triggering circuit will generate the pulses and are given to TRIAC as gate pulses for triggering purpose. And finally, TRIAC circuit acts as intermediate part between supply and induction motor. Therefore, applied voltage from the supply to induction motor and thereby speeds are controlled. An induction or asynchronous motor is a type of AC motor where power is supplied to the rotor by means of electromagnetic induction, rather than a commutator or slip rings as in other types of motor. These motors are widely used in industrial drives, particularly polyphase induction motors, because they are rugged and have no brushes. Single-phase versions are used in small appliances. Their speed is determined by the frequency of the supply current, so they are most widely used in constant-speed applications, although variable speed versions, using variable frequency drives are becoming more common.

Be it domestic application or industry, motion control is required everywhere. The systems that are employed for this

purpose are called drives. Such a system, if makes use of electric motors is known as an electrical drive. In electrical drives, use of various sensors and control algorithms is done to control the speed of the motor using suitable speed control methods. Earlier only dc motors were employed for drives requiring variable speeds due to ease of their speed control methods. The conventional methods of speed control of an induction motor were either too expensive or too inefficient thus restricting their application to only constant speed drives. However, modern trends and development of speed control methods of an induction motor have increased the use of induction motors in electrical drives extensively. The purpose of this project is to control the speed and direction of AC Motor using Microcontroller and Bluetooth with android phone. (Here Voltage control technique is applied to control the speed of AC motor) Android provides access to a wide range of useful libraries and tools that can be used to build such applications. In addition, Android includes a full set of tools that have been built from the ground up alongside the platform providing developers with high productivity and deep insight into their applications. The objectives of this project are to control the speed of the single-phase AC motor using wireless Bluetooth technology, to control the speed of the single-phase AC motor using limited power supply, to facilitate the flexible control of the speed of single-phase AC induction motor used in industries, along with speed control, it also gives feedback for temperature rise and to detect the over voltage and low voltage indicating in mobile phone.

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2. LITERATURE SURVEY

In order to improve the quality product many industrial applications demand for constant speed and adjustable speed. Due to the rapid advancement in automation and process, controlling the Field of adjustable speed drives has become a necessity. In the recent technology, for the selection of speed of the drive system various alternate Techniques are available. The most preferred choice for variable speed drive application were Dc motor up to the 1980's. In most of the applications such as automotive control, Industrial drives control, etc. Induction motors are being used. In the past few years, there has been an increasing demand in industries for compressors, Fan pumps, paper machines, domestic applications, adjustable speed drives etc. Due to the many disadvantages of DC motors, there has been a lot of research and development done towards the control of ac drive.

Whenever, there is no availability of three phase supply for domestic and commercial application, Single phase induction motors are being used, which is one of the most widely used low power motor in the world. An induction motor is a type of AC motor, in which power to the rotor is supplied by means of EMI(electromagnetic induction). Several methods have been developed in the past few years for the speed control of ac motor one of which is to vary the voltage and frequency of the motor. For a single-phase motor Speed modulation can be usually achieved either by switching windings of the motor to change the number of poles for the different operating

condition as required or by some electrical means, that is reducing supply voltage (through auto-transformer).

Motor To Control the speed of Single-Phase Induction Motor by Using AC Chopper through Asymmetrical PWM Method (In IJAREE)

In this paper, several PWM strategies by using an AC chopper is described to control the speed of Single-phase motor. Here, Asymmetrical PWM technique is used to operate the power electronics switches (such as IGBT) of an AC chopper. The main objective is to maintain, a constant speed of the single-phase IM(induction motor) at different load conditions by applying Asymmetrical PWM technique, which can reduce the harmonic contents that are present in the motor current and therefore increasing the motor efficiency. The simulation is carried out in MATLAB/SIMULINK using a Split Phase IM, where in the motor is operated in normal PWM strategy, Hysteresis PWM strategy.

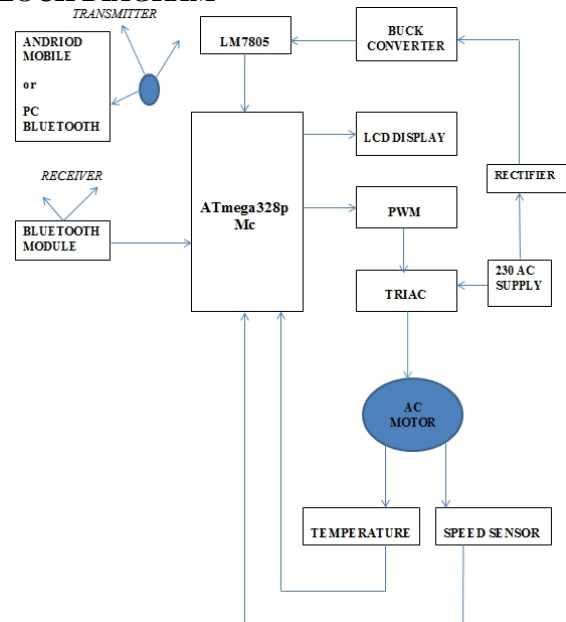
To Monitor and Control the Speed of a Fan based on its Temperature by Using Arduino (IJCTEE)Vol2,Issue5

In this paper, A low-frequency, PWM signal (pulse-width modulated signal) usually in the range of about 30Hz, is used whose duty cycle is varied in order to adjust the fan's speed. A single small pass transistor (which is inexpensive) was used here as it is efficient because the pass transistor is used as a switch. One disadvantage in this approach was that, due to the pulsed nature of the signal it makes the fan noisy. It was observed that the PWM waveform's sharp edges was causing the fan's mechanical structure to move, which can easily be audible and therefore was making it noisy.

To Control the Speed of IM (induction motor) by Using a VFD Technique(Variable Frequency Drive)

In this paper, the concept of Variable Frequency Drive(VFD) was used. To a motor driven system, a Variable Frequency Drive(VFD) was added so that potential energy saving can be done in a System in which the load varies with time. The main advantage of opting for VFD in applications are that it can provide energy saving and also a speed reduction by 20% can save energy of up to 50%. By changing the frequency of the motor supply voltage, the operating speed of the motor that is connected to a VFD is varied. Therefore, this method allows continuous process speed control.

3. BLOCK DIAGRAM



4 CIRCUIT COMPONENTS

4.1 Hardware

1. ATmega328p Microcontroller
2. HC05 Bluetooth Module
3. IC7805 - Voltage Regulator
4. LM35 - Temperature sensor
5. LM393 - Speed sensor
6. LCD Display
7. TRIAC
8. Buck Converter
9. Opto-Coupler
10. ARDUINO Board
11. Single Phase Induction Motor

4.2 Software

1. Arduino IDE
2. S2 Terminal for Bluetooth

4.1.1 ATmega328p Microcontroller: Arduino Uno is a microcontroller board which contains mainly Microcontroller. Atmel's ATmega328P is 8-bit microprocessor in 28 pin which is of DIP package. It is based on enhanced RISC architecture. It is a 8 bit CMOS microcontroller. It has a special feature of executing heavy instructions that is huge number of codes written on it in a clock cycle.

This special feature of ATmega328P is due to that it achieves outputs around 1Million Instructions per Second (MIPS) per MHz for this the designer is empowered to optimize the device processing speed vs Power Consumption.

4.1.2 Bluetooth Module (HC05): Fig 4.2: Bluetooth module (hc05) Bluetooth module HC-05 module is a wireless communication setup which is easy to use. Bluetooth SPP (Serial Port Protocol) module. It is mainly designed for transparent wireless communication. This device can be operated in two states that is Master or Slave configuration. It is a qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. AS we know this device can be configured into two different modes that is Master or Slave, the default value of factory setting is SLAVE. The slave module is designed such a way that it cannot initiate a connection to another Bluetooth device, but can accept any number of connections from the neighboring devices which are 30m radius circle. Whereas master configuration can start a Bluetooth connection to any other devices. This module can be used to establish connection between MCU and GPS, PC and to the projects which are embedded. It works from 3.3 to 5 V I/O. This module has an integrated antenna which has transmit power up to +4dBm RF. It communicates with UART protocol. The data bits are of 8-bit size. It initiates the connection to the latest device which was powered.

4.1.3 Voltage Regulator – IC7805: Fig 4.3: IC7805 (voltage regulator) IC's that can be used for the regulation of voltage are called voltage regulator ICs. IC7805 is a member of 78xx series of regulator ICs. It's a fixed linear voltage regulator. It also has a provision for heat sink. The input voltage given to this voltage regulator is 12V and this IC gives a constant 5V as output. In IC7805 the first two digits "78" represents the positive series voltage regulators and last two digits "05" represents the value of fixed(+5V) DC regulated output voltage.

4.1.4 Temperature Sensor (LM35): Fig 4.5 temperature sensor (lm35) Temperature sensor LM35 is a commonly used temperature sensor. This sensor is used to measure temperature

of an electrical o/p comparative to the temperature (in °C).It is advantageous and reliable than the conventional thermistor since this LM35 measures correctly the accurate value of temperature. The sensor working principle is that it generates an output voltage in proportion to the rise or dip in Celsius temperature. The scale in which the output voltage is sensed is that .01V/°C. The LM35 is more advantageous since it does not require any exterior calibration and maintenance. The sensor maintains an exactness of +/-0.4°C at room temperature and +/-0.8°C over a range of 0°C to +100°C.The main characteristic of this sensor is that it operates by drawing a minimum current of 60 micro amps from its supply. This device is more eco- friendly and does not self-heat fast. These LM35temperature sensors are used world-wide and available at different packages since it is most commonly used for sensing temperature of any devices and the output of the device is most accurate.LM35 has 3 pins. VCC the power supply of the device is usually 5v.The second pin is the Analog output pin in which there will be increase in 10mV for raise of every 1°C .Pin3 is the ground pin connected to the ground of the circuit.

4.1.5 LCD Display: LCD (liquid crystal display) modules are most commonly used electronic display system. The 16x2 LCD display is very simple and most reliable one which is commonly used in DIYs and circuits. The display has 2 rows and 16 columns, that is it can display 16 characters in each of the lines. These LCD modules are used for embedded projects because they are cheap, easily available and programmer friendly.

4.1.6 TRIAC Control Circuit

TRIAC or Triode for AC: It is a power electronic component which can conduct in both directions ,when it is triggered through a gate. It is widely used in switching and power control applications. It also finds applications in phase control, switching, chopper designs, speed control in fans, brightness control in lamps, induction motors etc. They can be used in both AC and DC circuits. It is an equivalent circuit of two SCRs that are connected in inverse parallel with its gates connected together. Due to which the TRIAC acts as a Bidirectional switch (i.e., to pass the current in both directions) once the gate is triggered. It is a three-terminal device(with a Main terminal1 (MT1), Main terminal 2(MT2) and a Gate.)
MT1 and MT2- used to connect Phase and Neutral lines.
Gate- to feed the triggering pulse(can be triggered by a positive voltage or negative voltage)

When the terminal MT2 gets a positive voltage w.r.t. the terminal MT1 and the Gate gets a positive trigger, then only the left SCR of the TRIAC triggers and circuit completes. When the polarity of the terminals MT2 and MT1 are reversed and the Gate gets a negative trigger, then the right SCR of the TRIAC triggers and circuit conducts. When the Gate current is removed the TRIAC switches off. Therefore, to keep the TRIAC conducting, a minimum holding current is

4.1.7 Buck converter: Buck converter is a step-down converter. It is also known as the DC-to-DC power converter. It is used to step down the voltage .Buck converter comes under switched mode power supply class. Buck converter circuit includes diode, capacitor, and inductor. Usually, the capacitors are included to reduce the ripple. Buck converter is highly efficient when compared to others

4.1.8 Optocoupler (MOC3021): It is an opto-triac, used for isolation between power and driving circuitry. When the

applied voltage is greater than 0.7V, opto-triac will be triggered. As the opto-triac is triggered now, the positive or negative voltage (whichever is applied) will pass through the gate of the TRIAC BT136 and hence triggers it. By using this arrangement, the RMS voltage in both directions can be controlled. Provided that the triggering time or firing angle is taken care of.

For the firing angle to be 90° for 220V 50Hz AC signal, a delay of 2.5ms ($t_1=2.5\text{ms}$) is needed right after each zero crossing. Here the microcontroller Atmega328 drives the opto-coupler MOC3021 in order to give the firing pulse based on the interrupts that is generated by the zero-crossing detector.

4.10 Arduino BOARD

Features

- High Performance, Low Power Atmel®AVR® 8-Bit Microcontroller Family
- Advanced RISC Architecture
 - 131 Powerful Instructions
 - Most Single Clock Cycle Execution
 - 32 x 8 General Purpose Working Registers
 - Fully Static Operation
 - Up to 20 MIPS Throughput at 20MHz
 - On-chip 2-cycle Multiplier
- High Endurance Non-volatile Memory Segments
 - 32KBytes of In-System Self-Programmable Flash program

4.11 Single Phase Induction Motor

Single phase induction motor is an **AC motor** where electrical energy is converted to mechanical energy to perform some physical task. This induction motor requires only one power phase for their proper operation. They are commonly used in low power applications, in domestic and industrial use. Simple construction, cheap cost, better reliability, ease to repair and better maintenance are some of its markable advantages.

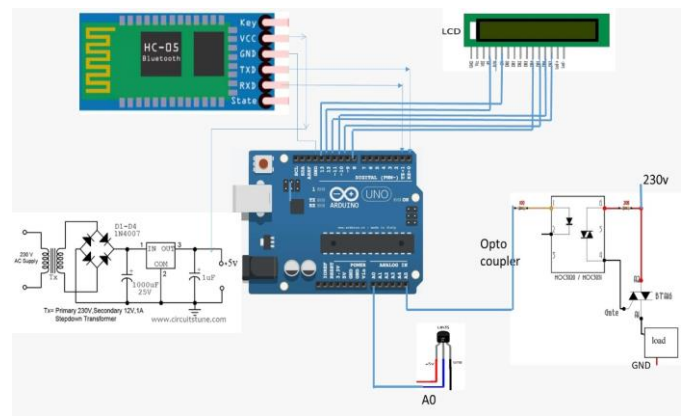
4.2.1 Arduino Software

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing. It runs on Mac, Windows, and Linux. Teachers and students use it to build low cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics. Designers and architects build interactive prototypes, musicians and artists use it for installations and to experiment with new musical instruments.

4.2.2 S2 Terminal for Bluetooth

S2 Terminal for Bluetooth Free is a free app for Android published in the Telephony list of apps, part of Communications. The company that develops S2 Terminal for Bluetooth Free is S2(Futaba). The latest version released by its developer is 4.0.3. This app was rated by 1 users of our site and has an average rating of 4.0.

5. CIRCUIT DIAGRAM



5.1 Methodology

The supply obtained from the mains is single phase 230V which has to be stepped down to 12V DC. Firstly the 230V AC supply is rectified into 230V DC using rectifier (inbuilt). Then 230V DC is stepped down to 12V DC using Buck Converter (step-down converter). LM7805; a 3 terminal voltage regulator is used for voltage regulation and it gives 5V DC constant supply. This 5v DC is given to Atmega328 microcontroller for its working. Parallel Communication is done by connecting 16 pins of microcontroller to the 16*2 LCD display. A Potentiometer is used to adjust the contrast of the display. The required code is written in Arduino software which is uploaded to the microcontroller board. The code is written in such a way that PWM signal is generated and also can be controlled from Atmega microcontroller and this signal is given to the gate of TRIAC for its triggering. Input to the TRIAC is given from the 230V, Single phase supply. By applying a trigger pulse at a controlled phase angle in an AC cycle (via PWM) allows us to control the voltage and thereby controls the speed of the motor. “MIT AI2 COMPANION” is the android application that is installed in the phone which uses Bluetooth device of the android phone. We can also use the “S2 Terminal for Bluetooth” App instead. On the other side control circuitry of motor also contains a Bluetooth module (HC05) which is used to connect with the phone. The RX and TX of microcontroller is connected to TX and RX of Bluetooth module (HC05), which is used to decode the command sent by phone. Once the Bluetooth is paired, by increasing or decreasing the buttons on display of phone, the speed of the motor can be controlled and also these variations can be observed in the 16*2 display. Speed Sensor (LM393) is placed on the shaft of the motor to measure the speed of the motor and also a temperature sensor (LM35) is used to measure the temperature of the motor.

5.2 Programs

```
#include <LiquidCrystal.h>
#include <stdio.h>
#include <SoftwareSerial.h>
SoftwareSerial mySerial(A4, A5);
LiquidCrystal lcd(8, 9, 10, 11, 12, 13);
unsigned char rcv,count,robo='s';
int countc=0;
float tempc=0;
char pastnumber[11];
char lt[12],ln[13];
char igns='0',alcs='0';
char password[5];
int countm=0;
int sti=0;
String inputString = "";
```

```
// a string to hold incoming data
boolean stringComplete = false; // whether the string is
complete
int motor = 5;
int swi = A1;
int swe = A2;
int swd = A3;
char gchr,gchr1;
void motor_speed(int x,int y)
{
digitalWrite(motor,HIGH);
delay(x);
digitalWrite(motor, LOW);
delay(y);
}
void setup()
{
Serial.begin(9600);serialEvent();
// mySerial.begin(9600);
pinMode(motor, OUTPUT);
pinMode(swi, INPUT);
pinMode(swe, INPUT);
pinMode(swd, INPUT);
// initialize serial:
digitalWrite(motor,HIGH);
digitalWrite(swi,HIGH);
digitalWrite(swe,HIGH);
digitalWrite(swd,HIGH);
//serialEvent();
// set up the LCD's number of columns and rows:
lcd.begin(16, 2);lcd.cursor();
// Print a message to the LCD.
lcd.print(" Welcome ");
delay(2000);
lcd.clear();
lcd.setCursor(0,0);lcd.print("Motor:");
lcd.setCursor(0,1);lcd.print("Temp:");
serialEvent();
}
void loop()
{
tempc = analogRead(A0);
tempc = (tempc*0.48828125);
lcd.setCursor(5,1);convertI(tempc);
if(gchr1 == '*')
{gchr1='x';
Serial.print("Temp:");Serial.println(tempc);
}
if(gchr == '0')
{
digitalWrite(motor, HIGH);
}

if(gchr == 'a')
{digitalWrite(motor, LOW);}
if(gchr == '5')
{motor_speed(2,90);}
if(gchr == '4')
{motor_speed(10,80);}
if(gchr == '3')
{motor_speed(20,30);}
if(gchr == '2')
{motor_speed(30,20);}
if(gchr == '1')
{motor_speed(40,10);}
}
```

```
void serialEvent()
{
while (Serial.available() > 0)
{
char inChar = (char)Serial.read();
gchr = inChar;
gchr1 = gchr;
if(gchr != '0')
{
lcd.setCursor(6,0);lcd.write(gchr);lcd.print(" ");
}
}
else
{
lcd.setCursor(6,0);lcd.print("Stop ");
}
}
}
```

6. OBSERVATION AND RESULTS



As described in the above chapters, the motor can be controlled using the mobile phone using the S2 Application. Five speeds are configured and each speed can administered by sending the respective character from 1 to 5 via the application. We can also monitor the temperature by sending the asterisk * character

7. ADVANTAGES AND DISADVANTAGES

7.1 Advantages

- Energy is conserved.
- It is efficient.
- Design cost is less.
- Operation is convenient.
- By using resistance control the response is very fast.
- Power consumed is very low.
- Smart phone with Android OS can be used for controlling the operation(as a remote).
- For controlling the entire operation expert is not required.
- Android app is very useful as it can develop any programming code because it is a
- Open-source system.
- For changing input parameters at different instances, programming code is not required.
- Less power is consumed by Bluetooth, hence it is more preferred.
- For disabled people it is very convenient, as they can operate it from the same place, movement is not required.

7.2 Disadvantages

- The transmitter that we use here is Bluetooth, hence it can be used only for short range distances. This can be overcome by using Wi-Fi or GSM technology (the distance can be large as it uses sms technology).
- As we are using android app, it consumes more battery of phone (charging does not last for long time).
- Complexity is more because of the devices that we have used.
- It is more sensitive as we are interfacing resistance and relays to microcontroller.
- It is not applicable for high voltage distances.

8. APPLICATIONS

It can be used for domestic applications (eg: for controlling the speed of the fan).

- In industries for improving the product quality, it requires varying the speed as well as constant speed.
- Using android application intensity of light can be controlled.
- It can be used to operate the small conveyors, large blowers, pumps etc.,
- Wood working machinery air compressors, water pumps, high processors and it is also used for high torque application.
- It can be used to control various devices at home.
- It does not require any controlling unit or remote.
- It can be used in shopping malls.

9. CONCLUSION

The objective of this project has been achieved which was developing an interface between hardware and software for controlling speed of single-phase induction motor using android application. The demand for wirelessly operating device has been increasing, so it is more preferable over wired devices. Here we are controlling speed of induction motor using Bluetooth and android application wirelessly. So, this device is very simple to use and because it contains only a control unit and a Bluetooth receiver, android app and few supporting elements in it which makes the device economic and user friendly. Therefore, the device is practical and successful.

10. FUTURE SCOPE

The main purpose of our project is to control the speed of single-phase induction motor by android application. In this project TRIAC control unit, opto-coupler, Bluetooth module components are interfaced with AVR microcontroller (Atmega328p). They receive command signals from Bluetooth module and decodes it first and then sends signals to the circuit. The main disadvantage of system is the Bluetooth module support only for short distances. This can be eliminated using GSM, WI-FI, and also dual tone multi frequency signal so that we can increase the distance.

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