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IMPLEMENTATION OF IoT ON SINGLE PHASE PWM INVERTER FOR SPEED CONTROL OF INDUCTION MOTOR BY V/F METHOD

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Abstract – *Single-phase induction motors are widely used in home appliances and Industrial control because of their cost and useful application. Many industrial processes require Variable speed drives for various applications. This paper investigates the speed control of single-phase induction motor using microcontroller ATmega328P. PWM technique has been Employed in this Power inverter to supply the motor with variable frequency. The MOSFET driver serves the purpose of amplify between the microcontroller circuit and the inverter and supplies the required gate voltage for the conduction of the power MOSFET (IRF540) in the inverter. The microcontroller senses the speed signal and consequently provides the pulse width variation signal that sets the frequency, which intern provides the different switching Frequency for the desired speed. The complete system is modelled and tested using hardware implementation to control the speed of a single phase induction motor.*

Key Words**: Pulse width modulation, Internet of Things, Speed control, Three keypad module, MOSFET (IRF540).**

1. INTRODUCTION

Motors are broadly utilized in most industrial processes because of their reliability, low maintenance, rough nature, robustness and less cost. Although, induction motors are nonlinear and complex control systems due to their characteristics which require complex control, hardware and inverter over estimating size. Motion is required in any mechanical application be it household or modern. Induction motor use is in numerous mechanical applications requiring variable speed because of significant expenses brought about in techniques for speed control and inefficiency of the methods utilized. A variable frequency referred to as a variable speed drive is a sort of system through which speed of an induction motor can be changed.

In the earlier days, the variable speed drives had different constraints, for example, larger space, poor efficiencies, lower speed and so on. Be that as it may, the innovation of power electronics devices change the circumstance so now, variable speed drive are built in smaller size, high productivity and high dependability.

Two significant functions of the variable frequency are:

- Provide power transformation starting with one frequency to another.
- Output frequency can be controlled.

This Paper includes fabrication of the speed control of induction motor utilizing ATmega328P Microcontroller. The microcontroller gives the pulse width variation signal. This pulse width variation signal is given to the inverter, which thus provides the necessary frequency to the desired speed. PWM method has been utilized in this inverter to supply the motor with variable frequency. Pulse Width Modulation (PWM) is a typical method for speed control which can conquer the issue of the poor starting performance of a motor. It combines the strategy of PWM technique and the control of speed of motor by variable frequency technique utilizing microcontroller.

2. SPEED CONTROL OF INDUCTION MOTOR

2.1 Speed control by variation of supply frequency:

The induced EMF in induction motor is similar to transformer. And it is given by,

$E1 = 4.44\ Kw\ T\ f\ \emptyset$

Where, T = number of turns per phase.

f = supply frequency

$\emptyset$ = Magnetic flux

Kw = Stator winding factor $E1 \sim V$

By neglecting stator voltage drops, above equation can be rewritten as, $\emptyset = V\ /4.44\ Kw\ T\ f$

$$V/\ f\ \alpha\ \emptyset$$

Form above equation, if frequency decreases accordingly flux increases, thus heavy no load current flows which damages the motor. Similarly if frequency increase, flux decreases this reduces the torque capabilities. With change in the frequency there will be a change in the flux per pole unless induced EMF has to be changed in the same ratio. Any imbalance in the ratio V/f will cause the excessive flux and magnetic saturation.

2.2. Variable speed drives.

VFD sands for variable frequency drives and further more known as AC drives or variable speed drives, because it controls the rotational speed of an AC motors.

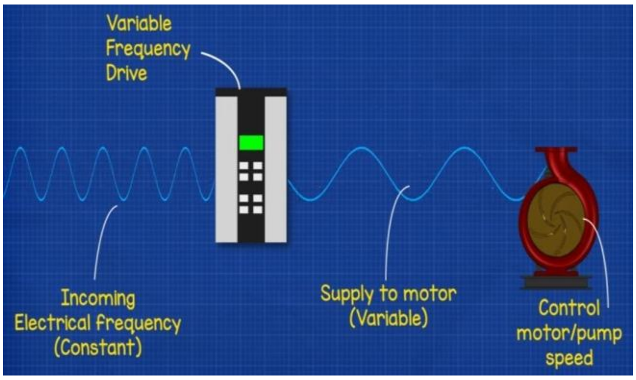

Figure-1: Variable frequency drive

2.3. Pulse Width Modulation.

Inverter segment consisting number of electronic switches i.e., MOSFET, IGBT's, by closing and opening of these switches, we can control the flow of power. Accordingly we can create AC power from the DC power. Controller quickly opens and shuts the switches on different times per cycle in a pulsating pattern, each pulse changing in width. This is known as “PULSE WIDTH MODULATION”.

The Pulse width modulation technique is utilized to control the simple analogue devices and principally the power which is controlled to the analogue devices which is constrained by utilizing this method. Presently as a result of this high efficiency, low power loss, and its capacity to precise the controls the power. This technique is utilized in numerous applications.

3. BLOCK DIAGRAM AND WORKING OF PROPOSED SYSTEM

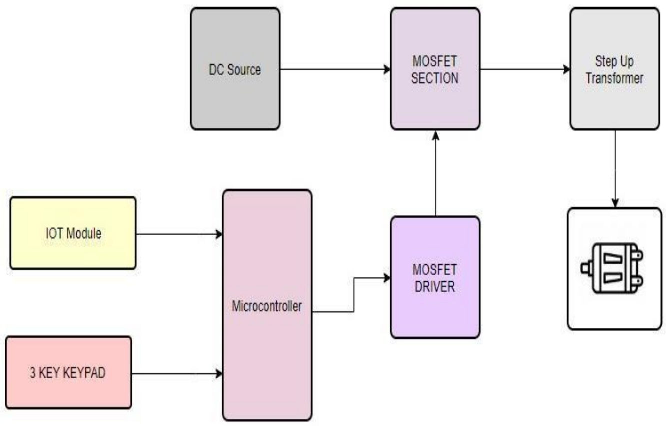

Figure-2: Block diagram

3.1. MOSFET Section

The proposed work will examine an essential inverter circuit with just two switches, for this case two N channel MOSFET’s, so the output will not be an ideal sinusoidal AC voltage as the home outlet will give you yet increasingly like a square wave. Thus, do not utilize this inverter with high Tech electronics that would require an ideal sine wave. This circuit is valuable for mobile and laptops chargers, low power lights, etc. both because it is low power but in addition for not having an ideal sinusoidal output. In this way, we have a 12V DC on one side and we need oscillating 220 volts and also 60 hertz at the output. For that we will utilize a transformer like the one above with one coil on the output side and another at the input side, but the loop at the input is divided half so that the center pin will be the main input and afterward we have two outputs. We all know the output voltage of the transformer will be given by this below formula, where N is the amount of turns of each coil.

$$Vp/Vs = Np/Ns$$

Utilizing the formula above, It can be noted that the amount of turns for each coil. We realize that the input will be 12V from a battery and let’s make the essential coil 100 turns. In the event that we need 220 at the output we will require a secondary of 1833 turns.

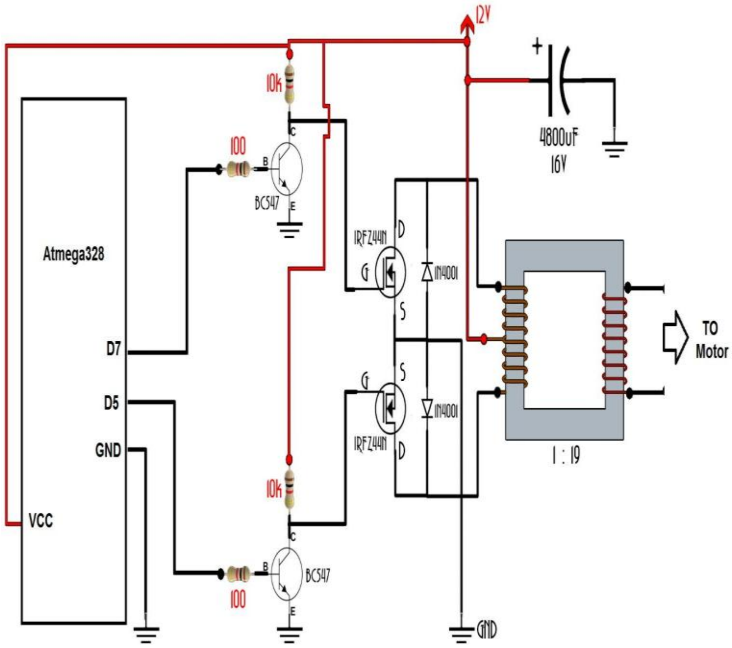

Figure-3: Connection diagram of MOSFET section

We know that, MOSFET’s will work at 12 volts however the Arduino works at with 5V. So if we want to apply 12V at the MOSFET gate we should utilize a MOSFET driver. The most essential MOSFET driver will be for this case is a BJT NPN transistor at the gate of each MOSFET. The pull up resistor is associated with 12V. So when the NPN (BC547) transistor is off the voltage at the gate will be 12V. But when we activate the NPN transistor the voltage will drop to ground. So we could get a square wave with values from 0 to 12 volts and apply it to the MOSFET gate.

4. HARDWARE IMPLEMENTATION

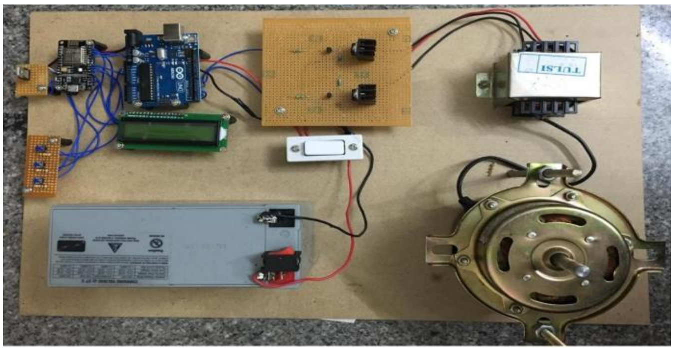

Figure-4: Hardware connection

This project is dependent on the frequency. So output motor speed will change as indicated by frequency. So for control the speed of motor we will change the frequency. This system utilizes two MOSFET's. These MOSFET's are connected to MOSFET driver. And this MOSFET driver is connected with Arduino Uno microcontroller. This microcontroller generates the PWM cycles to trigger the MOSFET's. One MOSFET works at positive cycle and other in negative cycle.

Thus PWM cycle time and frequency we are controlling through the IoT and from manual switch. In this work, ESP8266 Wi-Fi module is used. This gives the commands to the microcontroller and microcontroller takes the actions accordingly whatever it receives the commands from Wi-Fi module. Where Wi-Fi module is connected to our mobile using Wi-Fi connection anywhere in the world location we can give the command.

4.1. Comparison study of different existing control methods with proposed existing method.

[1] Blue tooth Low Energy (BTLE) method.
The disadvantages of BTLE are Covers low area and wide range control is not possible.

[2] Using PIC Microcontroller.
The microcontroller compares the monitored and set speed to regulate the speed. Here we used the keypad to give the set value to Microcontroller.

[3] Using manual control.
This method can be applied when the control person is available near induction motor. Due to this we need operating person located near to motor every time. This was the main disadvantage of this method.

By comparing all the methods, proposed method of speed control has wide range of advantages. Comparing to all the methods the system has found more disadvantages i.e. less speed, controller with complex PWM generation, area restriction of control, control near to motor with operator and so on. As the progress in science and technology is a nonstop process. New things and new technology are being invented. The proposed system based on Arduino Uno is found to be more compact, user friendly and less complex, which can readily be used in order to perform several tedious and repetitive task. Though it is designed keeping in mind about the need for industry, it can extended for other purposes such as commercial and research applications. And also system can be controlled anywhere in any remote location.

5. RESULTS AND ITS DISCUSSIONS

Here there are two ways to control the speed.

1. Manual control (by using 3 keypad):
This control consists of three keypad device where it has increment control, decrement control and motor ON/OFF control. This control can be made nearer to the setup by monitoring manually in hand with the help of skilled person.

2. IoT control (by using android app):
In IoT control, we can control the speed from any remote locations. Here android application is used for those three controls using Wi-Fi module connected to mobile.

From the above discussion, Speed can be varied either by using one of control, if we press incremental button, LCD will display the speed increment by 10% (i.e. percent of rated speed). Similarly we press decrement button, speed will gradually reduce by 10%.

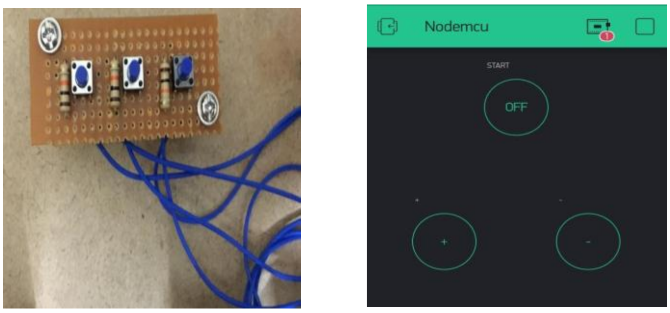

Figure-5: Three keypad control and control on mobile

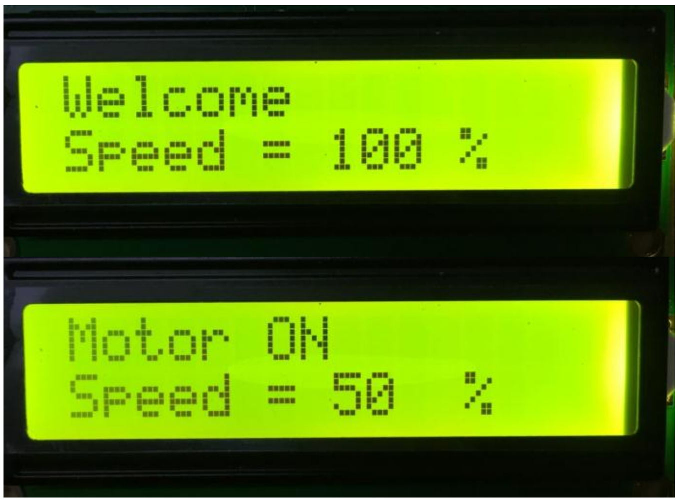

Figure-6: Speed display in LCD

6. CONCLUSIONS

The new topology of speed control of single phase induction motor utilizing frequency control and microcontroller programming is effectively executed in this work. This is the one of the strategy for controlling the speed, which is utilized for AC motor drives. The speed control of AC motor is performed utilizing this innovation by the ATmega328P microcontroller. It has high dependability or reliability and long life requiring low cost.

The experimental results are analyzed and it is discovered that the speed of the single phase induction motor is controlled successfully. Here the proposed work uses two ways of controls one is by manual control(by using three keypad) and another one is by IoT control, where the system can able to controlled speed in any remote locations. Finally by using any one of the above controls can able to increase and decrease speed of the motor. And also motor can be turned ON or OFF by both the controls stated.

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