Simulation and Implementation of Speed Control of Single Phase Induction Motor Using Microcontroller

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Abstract

This project is about controlling of speed of single-phase induction motor by using Arduino Uno. By using this method of speed control we can control the speed smoothly along with energy saving. The induction motors are widely used in the industrial applications due to its advantages like low cost and versatile speed control. But by using the stator control we can control speed of short range only. This problem can be solved by using power electronics devices. The objective is controlling of speed by using stator control. This hardware gives input signal to microcontroller, which in turns controls the input of power electronic devices. By controlling the firing angle of semiconductor power devices with the help of Arduino Uno, the terminal voltage across the stator winding of the motor can be varied to achieve the speed control of single phase induction motor.

Keywords: Single phase induction motor, Microcontroller, Power electronic device

I. INTRODUCTION

Induction motor speed control is a process of manipulating currents in an induction motor to regulate speed. While often used in fixed frequency applications, induction motors are popular for variable frequency applications such as industrial drives and electrical vehicles[1]. There are a variety of motor speed controllers available. Induction motors do not run at synchronous speed, they are generally fixed speed motors. In industries mechanical loads should not only be driven but should also be driven at desired speed[2]. Here by using an inverter circuit speed control of single phase induction motor achieved[3]. An inverter is a power electronic device which

converts electrical energy of DC form into AC and its various industrial applications are uninterruptible power supply (UPS), adjustable speed AC motor drives and Induction Heating etc. The DC-AC inverters operate on Pulse Width Modulation (PWM technique)[4]. In PWM technique width of the Gate pulses are controlled or varied using different methods like by changing the ON time or OFF time of the pulses[5]. The source voltage to an inverter maybe a battery, fuel cell, solar cell or other DC source but in most of the applications, it is fed from a rectifier[6]. There are two types of inverters as (1) voltage source inverters (VSI) (2) current source inverters (CSI). When an inverter has input DC source as a stiff DC voltage source at its input terminal with small or negligible impedance then it is called a VSI or voltage fed inverter (VFI)[7]. When the input DC source is an stiff DC current source with high impedance then the inverter is called a CSI or current fed inverter (CFI)[8].

II. LITERATURE SURVEY
An IDE, or Integrated Development Environment, enables programmers to consolidate the different aspects of writing a computer program. IDEs increase programmer productivity by combining common activities of writing software into a single application: editing source code, building executables, and debugging. The Arduino IDE supports the languages C and C++ using special rules of code structuring[9]. The Arduino IDE supplies a software library from the Wiring project, which provides many common input and output procedures[10]. Variable Frequency Control is a method that is used to control the speed of an induction motor[11]. The synchronous speed and therefore, the speed of the motor can be controlled by varying the supply frequency. The variable-frequency supply is obtained by Voltage Source Inverter. An inverter converts a fixed voltage DC to a fixed or variable voltage AC with variable frequency. The variable frequency control allows good running and transient performance to be obtained from a cage induction motor[12]. A variable frequency drive controls the motor speed by using PWM (Pulse Width Modulation) to alter the power supply frequency that's fed to the motor. In simulation circuit voltage sensor block represent an ideal voltage sensor, that is, a device that convert voltage measured between any electrical connections into a physical signal proportional to the voltage. Connections + and − are conserving ports through which the sensor is con nected to the circuit[13]. Connection V is a physical signal port that outputs voltage value[14]. Current sensor represents an ideal current sensor, that is, a device that convert current measured in any electrical branch into a physical signal proportional to the current. Connections + and − are conserving electrical ports through which the sensor is connected to the circuit. Connection I is a physical signal port that outputs current value[15].

III. SYSTEM DESIGN
3.1   Inverter circuit
The main inverter circuit completes the inverter programme by using a semiconductor switching device. The output circuit primarily compensates and corrects the frequency, phase, voltage, and current amplitude of the main inverter circuit's output AC power to

It reaches a certain standard. The control circuit provides pulse signals for the main inverter circuit to control the opening and closing of the semiconductor switching device.
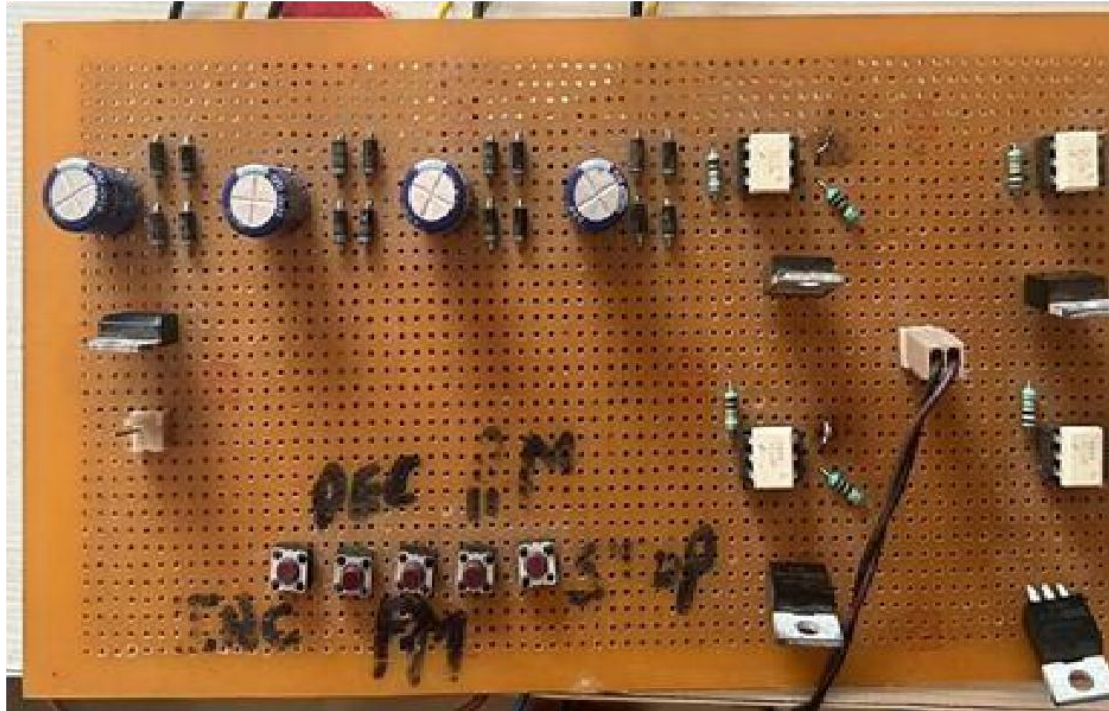

Figure 1: Inverter board

3.2   Working

A switching power supply's operating principle is similar to that of an inverter. The output of the oscillating signal, which is amplified to force the FET to flip continuously, is controlled by an oscillating chip or specialised circuit. After some tweaking, the AC properties can generate an AC sine wave that resembles the power grid.

For standalone solar systems that employ AC loads, an inverter is a power measurement equipment that is necessary. When selecting an inverter, the size of the established DC voltage is important to take into account. The output of the A inverter can be divided into two categories: DC output and AC output. Because it transforms DC voltage to DC voltage to be able to supply the voltage needed for the operation of DC loads of different voltages, the inverter is known as a converter for DC output. For AC output, waveform and frequency should be taken into consideration in addition to output power and voltage. Pay close attention to the DC voltage needs of the inverter and the range of surge voltage variations that it can withstand at the input end.
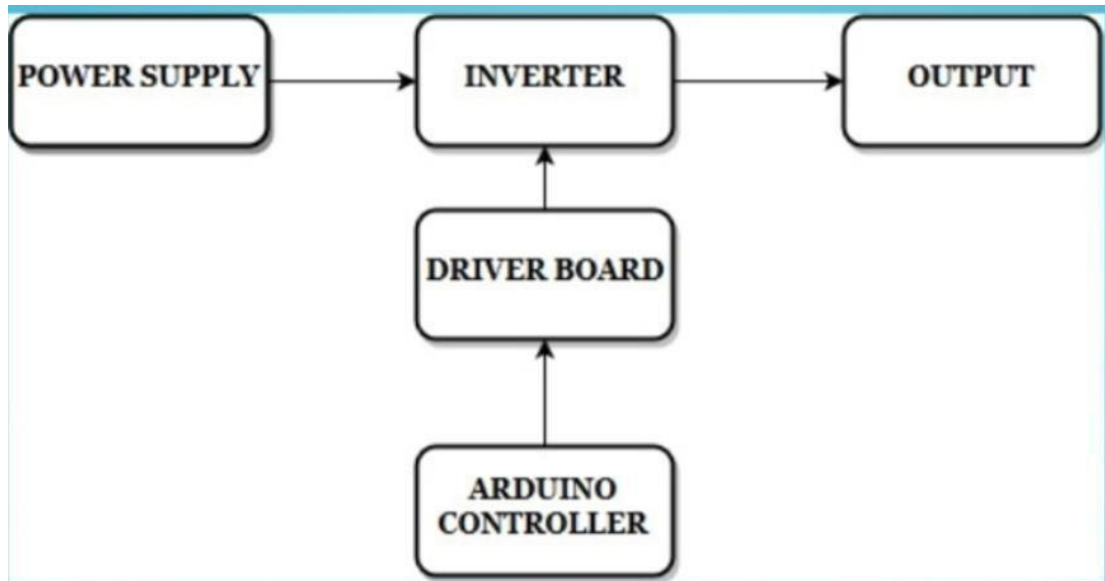
Figure 2: Block diagram

A general-purpose single-chip microprocessor, a DSP chip, a logic circuit, a dedicated control chip, etc. can all be used to manage the power switch tube's gate drive circuit. The inverter output has the capacity to regulate voltage. The rated voltage of the AC bus output by the bridge inverter, for instance, should be 10%−20% lower than the rated voltage of the DC bus (the goal is to ensure it has certain stability).

PWM is then used to operate the inverter and offer a margin whose amplitude may be adjusted from 10% to 20%. The modification range from low to high is unlimited; just lower the PWM on-duty ratio. The inverter's input DC voltage fluctuation range is therefore 15% to 20%. As long as the withstand voltage of the gadget permits it, there is no restriction. Only the small output pulse width (similar to chopping) needs to be changed.

The inverter needs to be equipped with a booster in cases where the battery or solar cell output voltage is low. The circuit booster or the DC charge pump method can both be used to boost voltage in the switching power supply mode. The inverter outputs a lower AC voltage that is then increased by the power frequency transformer and fed into the distribution line. The inverter boosts the voltage using the output transformer so the inverter voltage matches the voltage of the battery or solar cell array.

It should be kept in mind that some energy will be lost regardless of whether the electronic circuit or the transformer is amplified. When the DC input voltage is the same as the transmission line voltage and the DC power only passes through one layer of inverter links to minimise conversion link loss, the inverter is operating at its best. The inverter's efficiency is generally more than 90%. Energy lost in the inverter link is turned into thermal energy for the power tube and transformer..

The inverter's performance suffers from this heat, which also jeopardises the device's security. A radiator, a fan, or some other method must be utilised to dissipate the heat

from the apparatus. Typically, inversion loss consists of two components: switching loss and conduction loss.

The amount of voltage applied to the MOSFET's gate terminal is used to control conductivity, or how much electricity can flow between its source and drain terminals, and the inverter it uses to convert DC power to AC power. In contrast, the IGBT has a small conduction voltage drop, a moderate switching loss, and a switching frequency. The average frequency is less than ten kilohertz, with a range of several thousand to tens of kilohertz.

It's not exactly a terrific switch. During the turn-on process, the current increases as the voltage at the tube terminals decreases. When the voltage and current cross, the turn-on loss happens, and when they do so in the other way, the turn-off loss occurs. The decrease of switching loss is the main objective of inverter loss reduction. The innovative resonant switching inverter minimises switching loss by activating or deactivating at the voltage or current's zero-crossing point. The fundamental working principle of the inverter circuit (a) will be demonstrated using the single-phase bridge inverter circuit, as shown in Figure 1-2. The four arms of the bridge circuit hold the switches S1 through S4, which are constructed of power electronic components and auxiliary circuits.
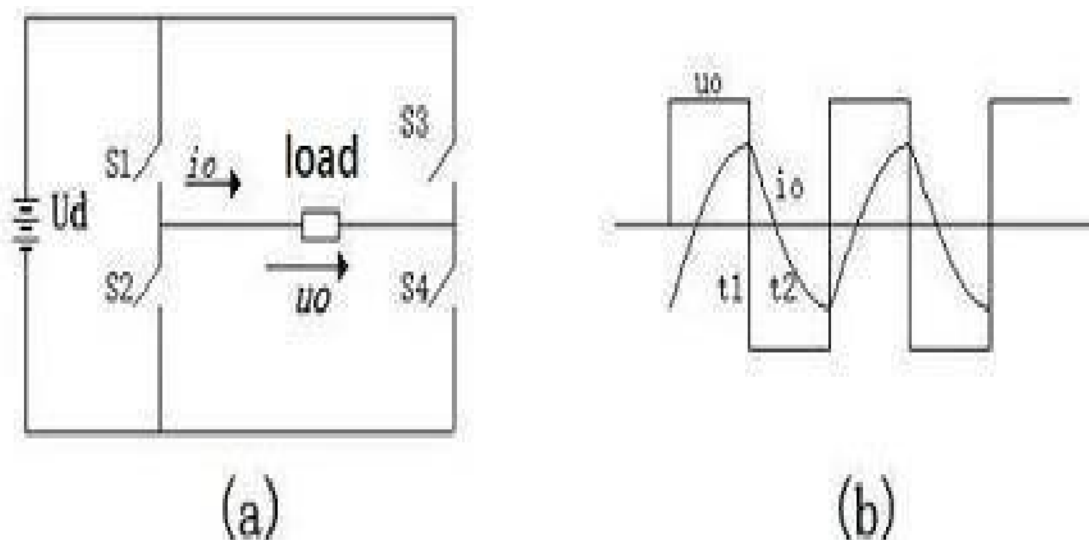

Figure 3: Single phase inverter circuit and waveform

When S1 and S4 are closed and S2 and S3 are disconnected, the left positive and right negative-positive voltage U0 is obtained on the load, and its waveform is shown in Figure 1-2. (b). By converting the DC power to AC power and changing the switching frequency, the output AC power's frequency is also changed.

When a resistive load is used, the load current io and voltage uo have the same waveforms and phases. However, when an inductive and resistive load is used, the fundamental wave of the current io has a phase that is later than the shock wave of the

uo, and the two also have different waveforms, as shown in Figure 1- 2(b). The polarity of uo changes instantly to negative if S1 and S4 are both closed before time ti, uo and io are both positive, they are disconnected at time t1, and S2 and S3 are also closed at the same moment.

The Due to the inductance in the load, the current direction cannot be changed instantly; rather, it keeps the initial direction. S2 and S3 carry the current from the power supply load to the power supply's positive pole. As energy stored in the load is transferred back to the DC power source, the load current gradually decreases. It is small and gradually increases in the opposite direction before zeroing out at time t2. The situation is the same when S1 and S4 are closed and S2 and S3 are open. The analysis above is for the ideal switches S1–S4, however the workings of the circuit are more intricate..

IV. RESULTS

By adjusting the duty cycle of the pulses the Arduino generates, the single phase induction motor's speed is achieved in this section of the project. Pulse width modulation is used in simulation to control the speed of the single phase induction motor.
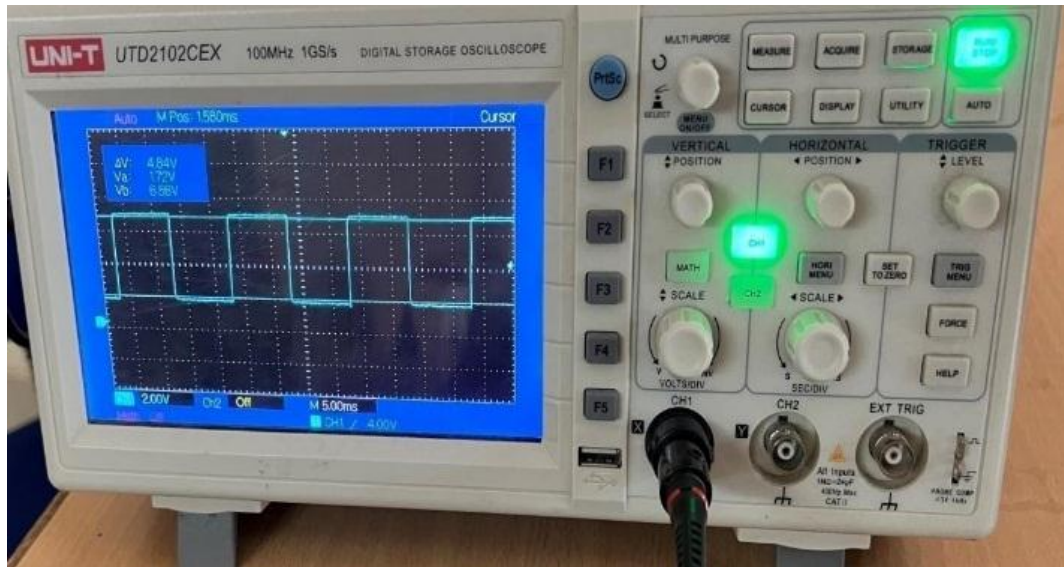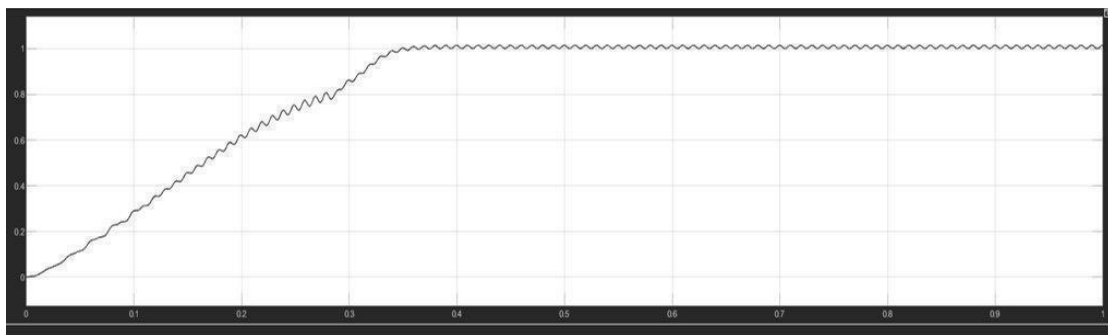

Figure 4: Hardware setup

Figure 5: Output waveform

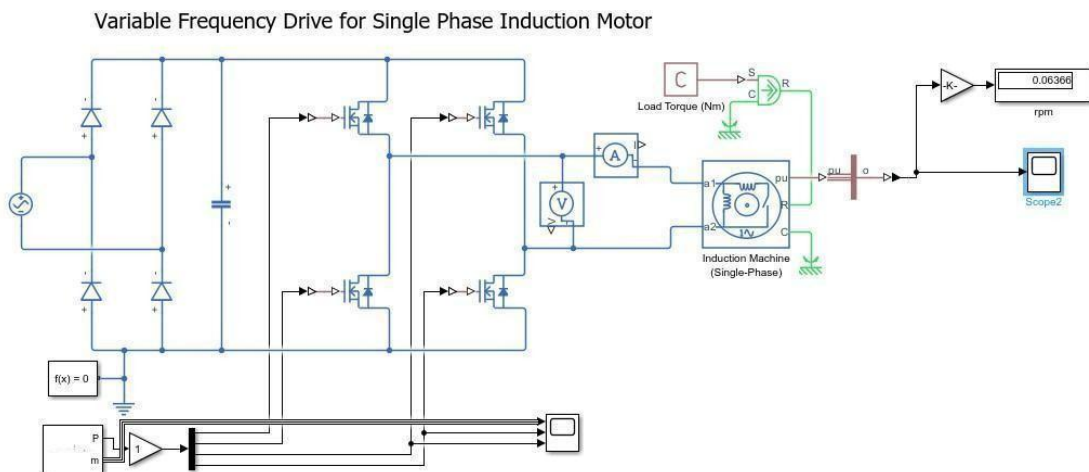**Figure 6:** Speed waveform of single phase induction motor

Figure: Simulation circuit

V. CONCLUSION:
the use of a microcontroller to regulate the speed of a single phase induction motor. This project uses an Arduino to construct a single phase inverter driving an induction motor. By altering the duty cycle of the pulses the Arduino generates, the single phase induction motor's speed may be increased or decreased. Pulse width modulation (PWM) is used in simulation to regulate the speed of the single phase induction motor. An induction motor's speed is controlled by the generated pulses. As a result, in this case, an induction motor's speed is regulated by adjusting the frequency; specifically, the frequency of the reference wave. This is a control of an open loop of an

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