

Speed Control of an Induction Motor using Raspberry PI

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ABSTRACT: The main objective of this project is to control the speed of INDUCTION MOTOR at lower cost and efficient performance. The induction motor speed variation can be easily achieved for a short range by stator voltage control. The terminal voltage across the stator winding of the motor can be varied for obtaining the desired speed control by controlling the firing angle of the semiconductor power devices (TRIAC in our project). RASPBERRY PI 2 (model B) plays an important in our project. Raspberry Pi has very small size and it is a low cost device. Raspberry Pi has a Quadcore broadcom BCM2836 900 MHz processor and 1GB RAM. It can perform the work like that of computer thus it can be referred as minicomputer. Python language must be used for this. And it uses Raspbian operating system based on Debian distribution of LINUX.

KEYWORDS: Induction motor, Raspberry Pi, Stator voltage control, TRIAC, Python

I. INTRODUCTION

Ac phase controlled switching is used for the speed control of single-phase induction motors but it introduces large higher order harmonics. An integral-cycle control method is also available but it introduces sub-harmonics in the line and the output voltage is adjustable in steps. For mitigating this situations, a discontinuous phase- controlled switching technique is given. The voltage control is done by a combination of the phase control and the integral-cycle switching. Voltage and step voltage are controlled by the former and the latter methods respectively. For fan type of loads, performance of the proposed controller improves when this technique is applied to control the main winding voltage only. In case of constant torque loads, voltage controllers including ac regulators offer a very limited speed control range. [1]

Recent advances in semi-conductor technology and implementation of micro-controller have made it easier to use AC Motors in speed control applications. This paper, deals with variable speed drives of induction motor for constant torque using V/F ratio method. Above system is designed with closed loop where the actual speed of motor is compared with the reference of speed. The difference in the speed is adjusted by changing firing angles of switching devices and there by obtaining variable speed. This system is tested for its performance and is also recorded under condition. Introduction of microcontroller in performing the speed control of the induction motor makes it more flexible when compared with other traditional methods. [2]

Single-phase induction motors are widely used in home appliances and industrial application. The multispeed operation and multipurpose operation are provided by controlling the speed of the motors. These research paper is variable speed drive of induction motor using frequency control mechanism. It is to develop the solid state control system to be reliable and economically feasible to use with fractional horse power motors. Proposed variable speed drive includes power conversion section, used the switching element of IRF 840 N-channel MOSFET. Four IRF 840 MOSFETS are used as H-bridge inverter to provide the alternating current to the motor. In case of this drive, C124 transistors and MJE 13002 transistors are used as driver circuit to drive the H-bridge inverter. Moreover, the experimental tests of this drive when driving a fractional horse power single-phase induction motor are described. [3]

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 8, August 2015

Induction motor is the most used in industry because of its high robustness, high efficiency and good self starting. In this paper rule-based Mamdani type fuzzy logic controller applied to closed loop Induction Motor model. Motor model is designed and membership functions are chosen according to the parameters of the motor model. Such results are obtained in Simulation. These results obtained in the simulation are interesting, considering the presence of strong nonlinearities in the IM Model. Conventional PI controller is compared practically to fuzzy logic controller using Simulink. [4]

When connected with the main power supply, this induction motors run at their rated speed and there are many applications where variable speed operations is required. System consists of the control, driver and the power circuits. This circuit includes the power supply circuit and the microcontroller. Power circuit includes the full-bridge single-phase Pulse Width Modulated type of inverter. Simulation was done using MATLAB Simulink software. This system was implemented, tested and the experimental results are examined and discussed. [5]

The relation between rotor speeds of the Travelling wave ultrasonic motor and current drawn by TWUSM is not linear for the TWUSM under different loading condition. In order to solve this nonlinearities and variation problems of TWUSM, PI controller, frequency controller and phase difference controller are proposed and are implemented. Proposed system evaluates the steady-state performance of TWUSM drive system by using PI controller and current controller. Experimenting results of the proposed technique are analyzed and presented. [6]

This paper is based on Automatic Speed Control of Single Phase Induction motor with variation of ambient temperature. These circuitry of the systems comprises of temperature detector, control and loading circuit. The system has undergone a successful test approach and its behavior is observed by analyzing its temperature versus load curve. Various equation of the curve using Newton's Interpolation method is incorporated. Simulation approach is incorporated. [7]

II. RELATED WORK

Raspberry Pi

Raspberry Pi has very small size and low cost. Raspberry Pi has Quadcore broadcom BCM2836 900 MHz processor and 1GB RAM. It performs the work like that of computer thus it can be referred as minicomputer. It has to be work on Python language. And it uses Raspbian operating system based on Debian distribution of LINUX.

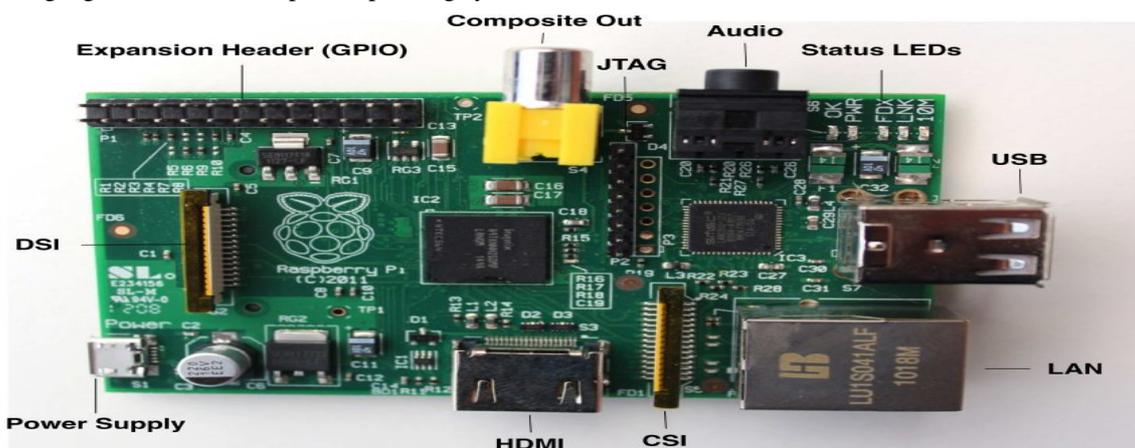


Fig.1 The Board configuration

Python

Python is an interpreted language that user can write a program or script and execute it directly rather than compiling it into machine code. Interpreted language is a bit quicker to program with, and user get a few side benefits. In Python user don't have to explicitly tell the computer whether a variable is a number or a list, or a string; the interpreter figures out the data types when execute the script. Python interpreter can be run in two ways: as an interactive shell to execute

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individual commands. Command line program to execute standalone script. Integrated development environment (IDE) bundled with Python and the Raspberry Pi is called IDLE.

Triggering Circuit

The light is proportional to the signal, so this signal is thus transferred to the photo-transistors. Opto couplers may also comes in few module such as the SCR or photodiodes or TRIAC of other semiconductor switch.



Fig. 2 MOC 3020

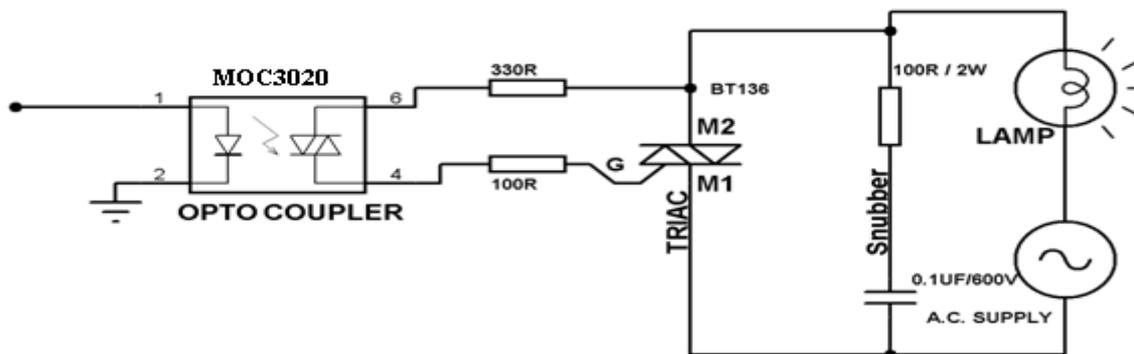


Fig 3 Triggering circuit

Triac

A triac has a complex multiple-junction structure and it is an integration of a pair of phase-controlled thyristors connected in inverse-parallel on the same chip. In this figure the triac symbol and its volt-ampere characteristics has been shown. The three-terminal device can be triggered into conduction in both positive and negative half-cycles of supply voltage by applying gate trigger pulses. In I+ mode, the terminal T2 is positive and the device is switched on by positive gate current pulse.

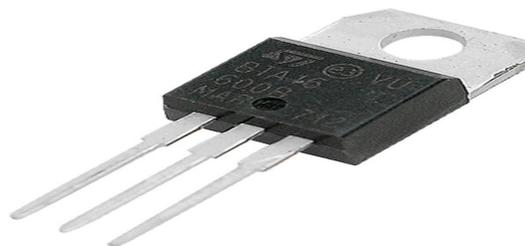


Fig 4 Triac symbol

Single Phase Induction Motor

There are probably more single-phase AC induction motors in use today than the total of all the other type. It is logical that the least expensive but lowest maintenance type motor should be used. The single-phase AC induction motor best fits for this description. As name suggests, this type of motor has only one stator winding and operates with a single-phase power supply. In the single-phase induction motors the rotor is the squirrel cage type.

International Journal of Innovative Research in Science, Engineering and Technology

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III. HARDWARE DESIGN

Hardware consists of several prime sections which are as follows:

- DC power supply

A 5 V DC power supply is supplied to the Raspberry Pi to turn ON the Raspberry Pi circuit.

- Raspberry PI

This device plays an important role in controlling the whole system.

It acts as a heart of the system which is then interfaced with triggering circuit. This interfacing between both circuits shares or transmit the data in the form of PWM signals to the triggering circuit.

- Triggering Circuit (MOC 3020)

The input of the opto- coupler which also known as a triggering circuit (moc 3020) is connected with the output signals supplied through the raspberry pi circuit. This output signals make this triggering circuit

In conduction mode, it turned on and its output is then given to the triac section for further operation.

- Triac as voltage controller

This is the voltage controlling section and plays a prime role in the hardware. This triac is out of conduction mode until the output of triggering circuit is given to the triac (i,e to the gate terminal).

A separate single phase ac supply is also given to the triac .

- Single Phase AC supply

A separate Single phase 230ac, 50Hz supply is requirement of the triac section and to operate the single phase induction motor (the load to be varied).

- Single Phase Induction Motor

The motor is used as a load in the hardware. The ac supply is given to the motor through the triac section .the output terminals of the triac is given to the motor for controlling the speed of motor through the snubber circuit.

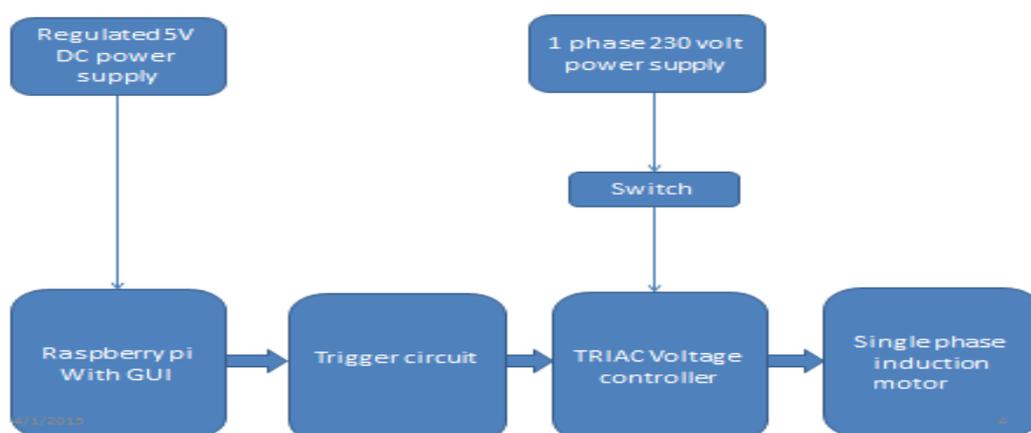


Fig. 5 Block Diagram of Hardware

IV. PROGRAMING OF RASPBERRY PI

The flowchart of the program of Raspberry Pi to create GUI for end user is as follows. It starts with the importing the Raspberry Pi and loop goes on for various duty cycles and getting various speeds for Induction motor.

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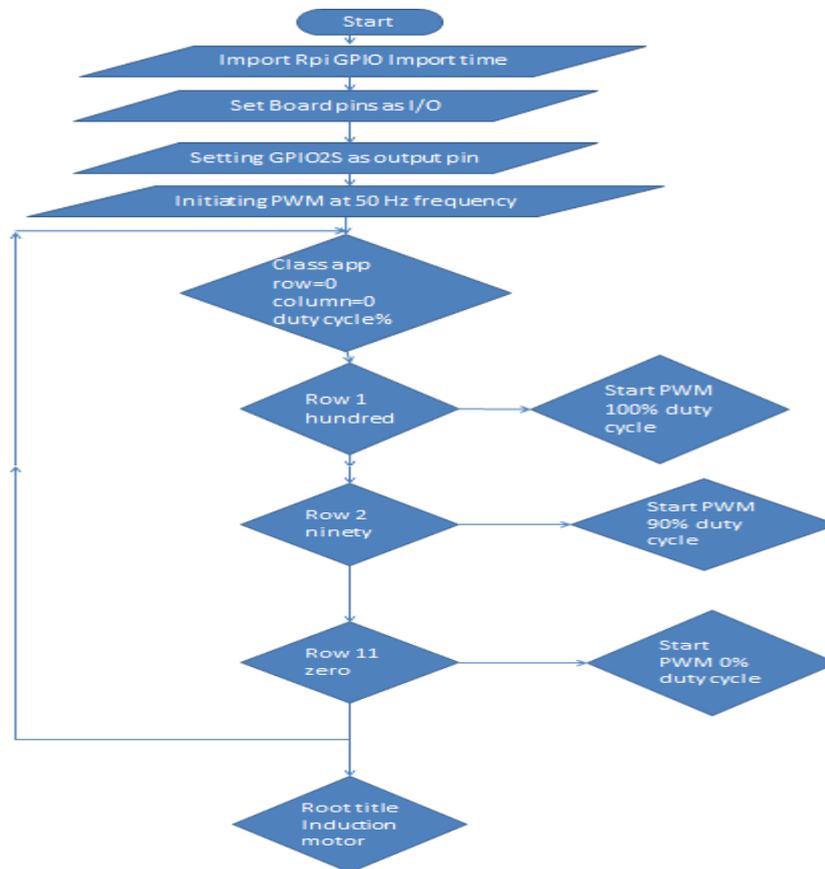


Fig. 6 Flowchart

V. EXPERIMENTAL RESULTS

We select the percentage of duty cycle from the GUI of Raspberry Pi, according to that gate current and thus firing angle of Triac changes which further gives the variation in stator voltage of single phase Induction motor. Due to the change in stator voltage to the single phase IM, speed of the motor changes accordingly which is required

Output Table and graphs

Table No. 1

Sr. No	Duty Cycle (%)	Voltage (volt)	Speed (RPM)
1	100	229.1	2660
2	90	228.5	2252
3	80	217	1968
4	70	207	1638
5	60	188	1436
6	50	171	1240
Sr. No	Duty Cycle (%)	Voltage (volt)	Speed (RPM)

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7	40	162	1000
8	30	154	377
9	20	81	22
10	10	54	15
11	0	2.72	0

We can draw a graph between

- 1) The voltage applied and the duty cycle.
 - 2) The speed of IM and duty cycle.
 - 3) The speed of IM and voltage applied.
- The following plot shows the variations of stator voltage of motor with respect to the variation of duty cycle applied

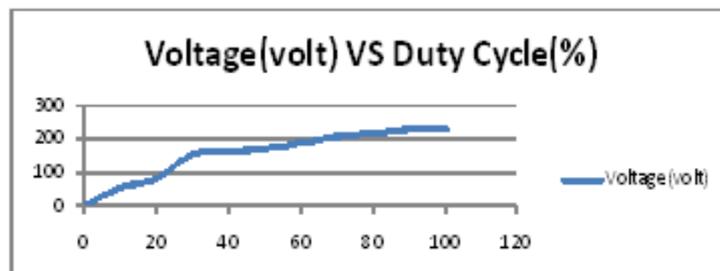


Fig.7 Plot of voltage Vs Duty cycle

Above plot shows the variation in speed of motor with respect to the variation of duty cycle

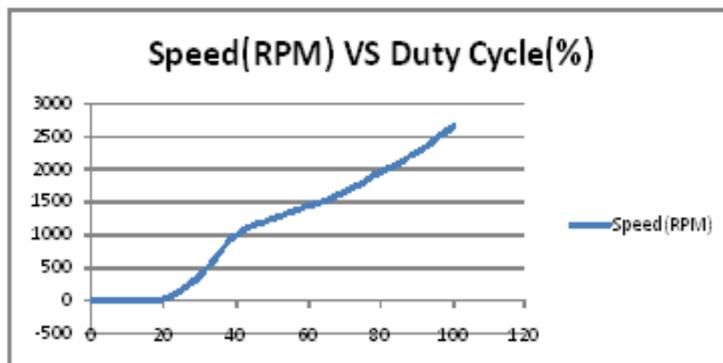


Fig.8 Speed Vs Duty cycle

Above plot shows the variation in speed of motor with respect to the variation of duty cycle

VI. CONCLUSION

The triac output is same as the output of the AC voltage controller. The percentage value of duty cycle from the GPIO of Raspberry Pi and the firing angle to the triac's gate is controlled. The output of the triac is in the form of chopped wave that is reduced in value. The reduced voltage is applied to the induction motor and speed control is achieved

International Journal of Innovative Research in Science, Engineering and Technology

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