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Designing and Controlling the Speed of Single Phase Induction Motor using Raspberry pi System

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Abstract

The induction motors are widely used in industrial drives since of their low cost and flexibility. The control facet is very essential for any drive. This paper proposes an economical method of INDUCTION MOTOR speed control with efficient performance. The induction motor speed variation can be easily attained for a short range by stator voltage control. The terminal voltage across the stator winding of the motor can be varied to achieve the preferred speed control by controlling the firing angle of the semiconductor power devices (TRIAC in this paper). RASPBERRY PI 2(model B) plays an important in our project. Raspberry Pi is very small in size and it is a low cost device. Raspberry Pi has a Quadcore-broadcom BCM2836 900 MHz processor and 1GB RAM. It can perform all the work similar to a computer and can be referred as minicomputer. Python language must be used for this. It uses Raspbian operating system based on Debian distribution of LINUX.

Keywords*: Induction motor, raspberry Pi, stator voltage control, TRIAC, python*

INTRODUCTION

Introduction of microcontroller in playing the speed management of the induction motor makes it a lot of versatile compared with different ancient strategies. Single-phase induction motors are wide utilized in home appliances and industrial application. The multispeed operation and utile operation are provided by dominant the speed of the motors. Current advances in semi-conductor experience and realization of micro-controller have created it easier to use AC Motors in speed management application [1, 2]. Generally, Ac part management switch is employed for the speed control of single-phase induction motors, however, it introduces giant higher order harmonics. An integral-cycle management methodology is

additionally out there but it sets up sub-harmonics within the line and, therefore, the output voltage is adjustable in steps. Automatic speed management of single part Induction motor with variation of close temperature. This circuitry of the systems contains of temperature detector, management and loading circuit. The system has undergone an undefeated take a look at approach and its behavior is discovered by analyzing its temperature versus load curve [3, 4]. The variable changeable speed drives of induction motor for constant torsion victimization V/F quantitative relation technique. On top of system is planned with control system wherever the particular speed of motor is compared with the reference speed. The distinction within the speed is adjusted by fixing firing angles of change devices and there by achieving variable speed. This technique is tested for its performance and is additionally recorded. A variable speed drive of induction motor victimization frequency management mechanism is mentioned.

For mitigating these things, a discontinuous phase-controlled shift technique is given. The voltage management is completed by a mixture of the section management and also the integral-cycle shift. Voltage and step voltage area unit controlled by the previous and also the latter ways severally. Just in case of constant torque loads, voltage management together with ac regulators provide a really restricted speed control vary. For inductive loads, once this system is applied to regulate the most winding voltage, the planned controller provides superior performance [5, 6].

EXISTING SYSTEM

There are different methods for control, Variable Voltage Variable Frequency or V/F is the most common method of speed control in open loop. Scalar control presents a simple structure characterized by low steady-state error. The constant voltage–frequency scalar control system is considered due to its wide application in industrial fields. The block diagram of the proposed fuzzy control system is shown in Figure 1. The system are chargeable for measurement the TIM shaft angular speed, achieving the fuzzy management algorithmic program and generating the curving modulated PWM signal so as to show on three part PWM electrical converter [7, 8]. The motor speed signal of Induction motor is compared with the reference speed provides the inputs of formal logic controller with the speed error and speed error variation.

The variable frequency drive controller could be a solid state power electronics

conversion system consisting of three distinct sub-systems: a rectifier bridge device, a direct current (DC) link and an electrical converter. Three part input supply is common electrical system that is utilized in commercial and industrial installations. Rectifier is a device or circuit that converts AC (ac) to direct current (dc), which permits current in one direction solely. An electrical device is solely a right away current (dc) to AC (ac) converter. Electrical converter driven with PWM pulses through gate driver circuit, it uses solid state relay (SSR). Summary of Variable Frequency Drive management [9]. The embedded fuzzy system planned here are designed to cut back memory-space necessities and machine effort for time period applications hardware application, which needs least prices, a attainable answer is to store a matrix of relation in memory house as a search table cluster would then be no got to do any computation in a very fuzzy illation system, since it may be achieved means that of easy table indexing. However, this technique would insist an outsized memory house that would increase project prices.

On the other hand, in an application where a minimal memory requirement is desired, the whole fuzzy inference process can be calculated online, avoiding storing membership functions in memory. As a result, in many applications, it is optional that memory requirements and computational effort be traded off, in order to achieve the best structure-satisfying requisites, project costs and real-time performance for a particular application [10].

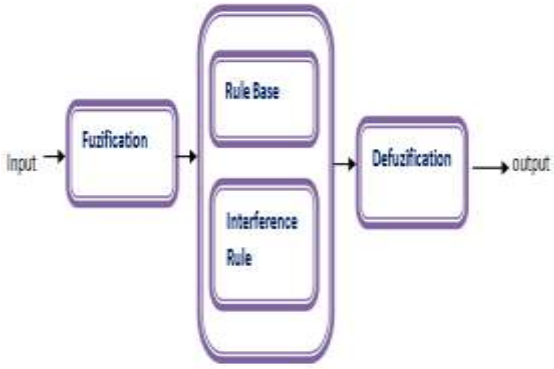

Fig. 1: *Existing System Model.*

PROPOSED SYSTEM

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. 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 bit quicker to program with, and user get a few side benefits. In Python user do not

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 individual commands. Command line program to execute standalone script. Integrated development environment (IDE) bundled with Python and the Raspberry Pi is called IDLE [11].

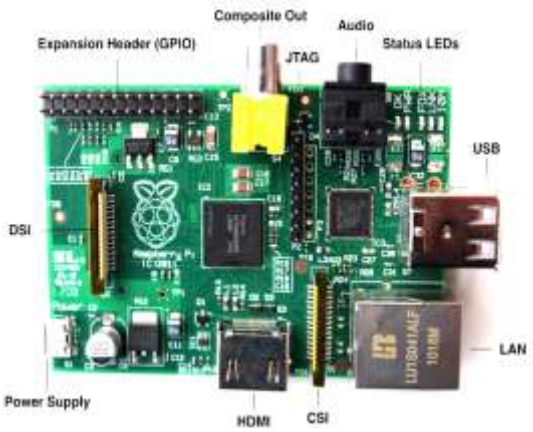

Fig. 2: *Raspberry Pi Model 3Control.*

BLOCK DIAGRAM OF A PROPOSED SYSTEM

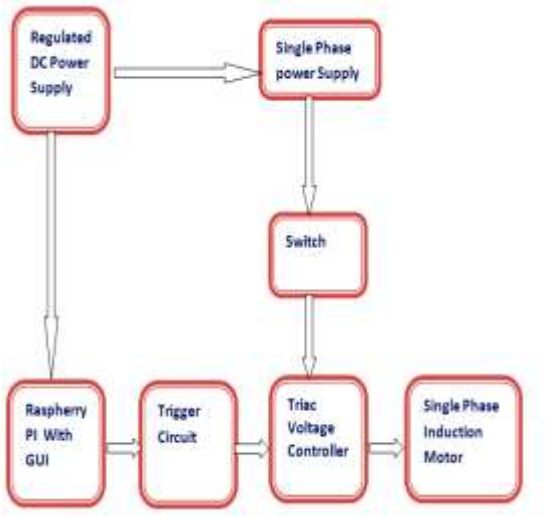

Fig. 3: *Raspberry Pi Model 3Control.*

TRIGGERING CIRCUIT

The light is proportional to the signal, therefore, this signal is so transferred to the photo-transistors. Opto-couplers may comes in few module like the SCR or photodiodes or TRIAC of alternative semiconductor switch A Triac contains a complicated multiple-junction structure and it is an integration of a combine of phase-controlled thyristors connected in inverse-parallel on constant chip. During this figure the triac image and its power unit characteristics has been shown. The three-terminal device is often triggered into conductivity in each positive and negative half-cycles of provide voltage by applying gate trigger pulses. In I+ mode, the terminal T2 is positive and, therefore, the device is switched on by positive gate current pulse.

SINGLE PHASE INDUCTION MOTOR

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. 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. In the single-phase induction motors the rotor is the squirrel cage type.

POWER SUPPLY

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

RASPBERRY PI

Raspberry PI Controller plays an important role in scheming 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.

CPU CORE

- ARM 1176JZF-S (armv6k) 700MHz
- RISC Architecture and low power draw
- Not compatible with traditional PC software

Graphics Processing Unit

- Broadcom Video IV
- Specialized graphical instruction sets

RAM

- 512MB (Model B rev.2)
- 256 MB (Model A, Model B rev 1)

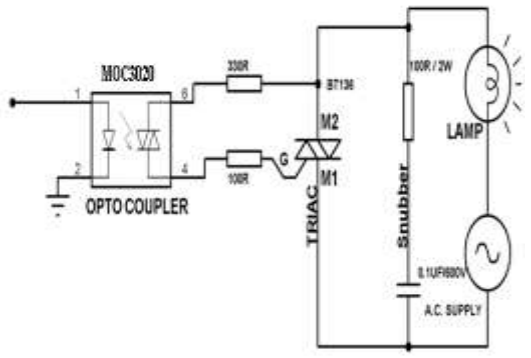

Fig. 4: *Triac Circuit.*

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).

RASPBERRY PI PROGRAMMING

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.

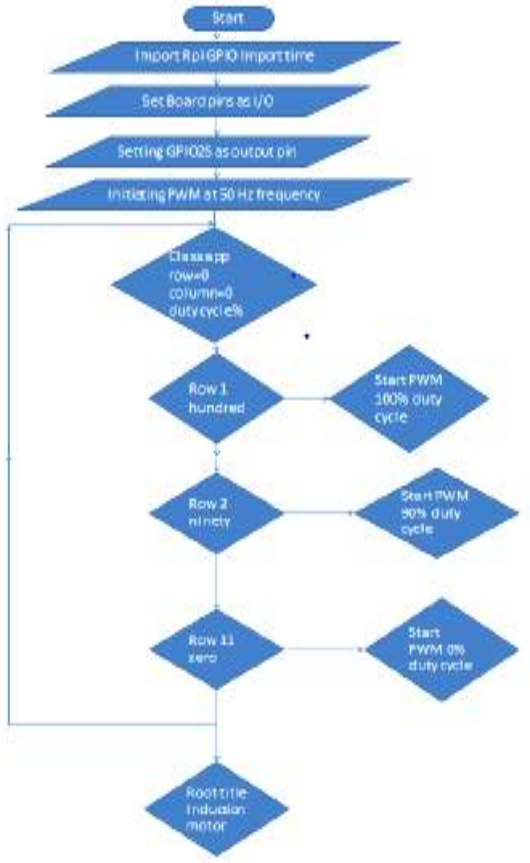

Fig. 5: *Flow Chart Representation.*

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.

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.

OUTPUT WAVEFORMS

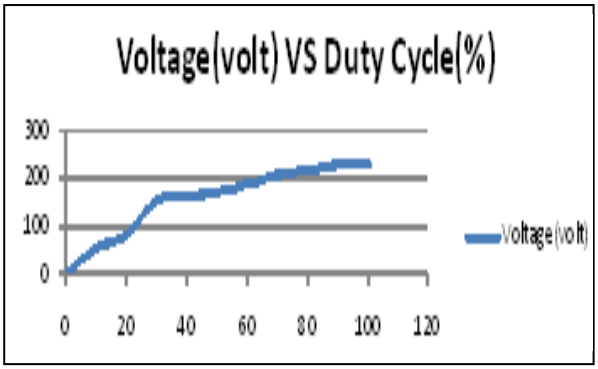

Fig. 6: *Graph of Votlage (vs.) Duty Cycle.*

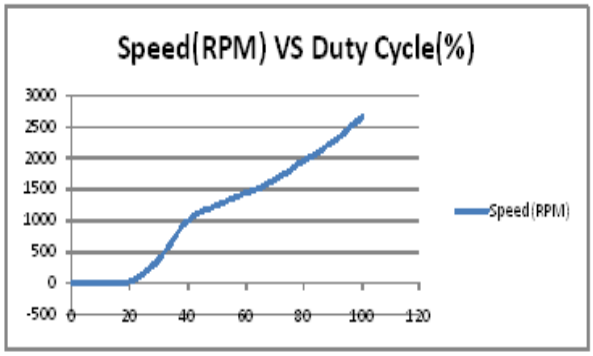

Fig. 7: *Graph of Speed (vs.) Duty Cycle.*

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

Table 1: *Comparison between Parameters.*

S. No.	Duty Cycle (%)	Voltage (Volt)	Speed (RPM)
1.	100	229.3	2659
2.	95	228.9	2365
3.	90	227.3	2136
4.	85	220.4	2057
5.	80	216	1975
6.	75	210	1753
7.	70	204	1650
8.	65	195	1385
9.	60	183	1441
10.	55	180	1397

It is evident from Figure 6 and 7 that the speed of the motor can be varied by

varying either the voltage or duty cycle. In order to maintain V/F ration, varying both the voltage and duty cycle at a time is essential. From the Table, it is seen that a 55% variation in duty cycle provides almost 42% variations in the speed. Approximately a speed of 1300 r.p.m is achieved from a synchronous speed of 3000 r.p.m. With a wide range of voltage and duty cycle variation, a wider range of speed variation is possible.

HARDWARE DIAGRAM

Fig. 8: *Hardware Diagram.*

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. The analysis with control platforms such as Direct Torque Control direct self control Indirect Vector Control Stator Flux Control and Scalar control clears that, the proposed embedded fuzzy system for three phase induction motor scalar speed control is having a simplified architecture which reduces memory-space requirements. Results show promising speed variation when Raspberry Pi controller is employed as a main controller for V/F speed control.

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