

VOLTAGE AND FREQUENCY BASED CONTROL OF INDUCTION MOTOR USING ADVANCE VOICE AND COMMAND SYSTEM

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Abstract - In the era of artificial intelligence development, the communication plays a very important role in our lifestyle, so using communication as a codify/response tool the speed can be controlled of the motor. In speculative and hazardous environment industries it is difficult for a human being to work with high efficiency. There are too many factors that affect the performance like temperature, pressure, etc. Working on this kind of platform not only affects the performance as well as its menaces to human health. To overcome this situation which developed a system on voltage and frequency control of induction motor on voice command using AI-based Alexa Echo Device. The project aims to design and implement a system using the Alexa AI device to control the speed of the motor to adjust itself to commanded parameters. The system has a feature of voice-command-based control of 3 Phase IM for industrial purposes via the method of voltage & frequency variation using VFD. Also, it has basic features of drive protection based on thermal and over current protection of drives. The device is having a closed feedback loop system based on a tachometer speed sensor to adjust speed accurately and maintain it even if the load varies. The voice recognition device used is Alexa by Amazon and it communicates to custom-designed drive control via WI-FI using Node MCU.

Key Words: AC Motor, Alexa Echo Device, Voice reorganization and command system, variable frequency and variable voltage drive VFD.

1. INTRODUCTION

There were too many losses of life in many industries in a year. Now innovation has achieved drastic development in technology. To overcome some major issues there was an alternative to work in a speculative and hazardous environment for which the voice control was helpful. But communication through wireless technology was limited to the field of communication. By combining Alexa Device with the embedded system in order to form a Voice-based speed control system. Through Alexa, one could communicate with the hardware and sending voice commands. Voice control is used mainly to reduce manual

operation. Voice communication can be used to control various fields. In this, the voice technique is going to control the speed of IM using Voltage Frequency Drive. Speed control of AC/DC motor is used for various applications. Controlling the AC motor using voice was a tedious process. There were numerous issues in voice control, Alexa AI Device was preferred to process voice. The microcontroller is being used in this process where it is directly connected to the voice-controlled device. Depending upon the application sensors can be used.

In the traditional system, there are various ways of speed control of an Induction Motor, AC motor speed is controlled in two ways mainly – either by controlling the voltage or frequency. Frequency controlling gives better control due to constant flux density than voltage control. This is where the working of VFD comes to play the main role. It is the power control device that converts the fixed voltage, fixed frequency of input power to variable voltage, the variable frequency output AC induction motors. If the voltage is controlled manually by a person and he slight adjust the speed of the motor with respect to tachometer reading in particular steps, this method is time-consuming and contains human errors also whenever load on drive increases the motor loses its set speed hence the speed has to be reset and calibrated manually. The protection system for induction motor is completely different based on various parameters.

In this project, our aim is to control the speed of the induction motor via voltage and frequency variation control method using voice command. The designed system utilizes a device named Alexa Echo Dot by Company AMAZON in AI Devices Section this device will be used to recognize voice command and send the signal wirelessly to the main unit. The main unit is a NODE MCU which receives the digital data from Alexa via WI-FI communication. Now it will convert the digital data which is in the form of voice command to signal the servo motor which will actuate the VFD. The system is designed to control the speed of induction motors in various steps as well as it provides thermal and over current protection to IM. A tachometer feedback system will be attached to Drive for accurate and automatic speed control.

2. Implementation Details

There are certain parts of our project which are dependent on each other. Functioning or command will be transferred to each part after in terms of electrical and mechanical signals. The dependency or working functions of the main parts are as follows:

1. Alexa Echo Dot.
2. Node MCU.
3. Servo motor.
4. Variable Voltage Frequency Drive.
5. 3Phase Induction Motor.
6. Tachometer feedback.

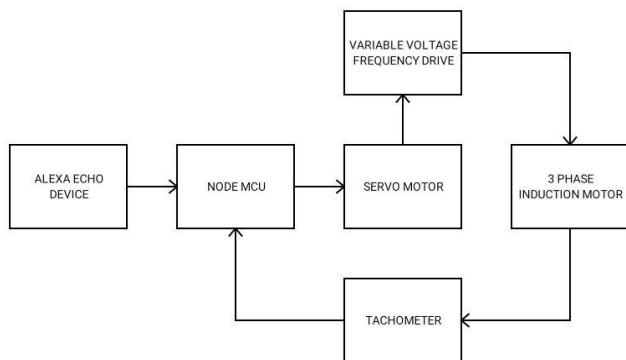


Fig -1: The basic block diagram structure.

Fig. 1 shows the parts of the 3Phase Induction Motor speed control system with basic functionality. There is two main part which is Alexa Echo Device and Node MCU. The Alexa Echo device will recognize the voice command and will be sent to Node MCU the signal will recognize and this electrical signal will be encoded, to signal the servo motor to adjust the Variable frequency drive VFD, the VFD will further proceed by varying the supply frequency and supply voltage this is how the result of speed variation is obtained, now the tachometer will give feedback to Node MCU to determine the actual speed is equal to command speed or not, then again it will follow the same loop Node MCU to the servo motor and then to VFD after that to the 3phase motor and last to the tachometer.

3. METHODOLOGY

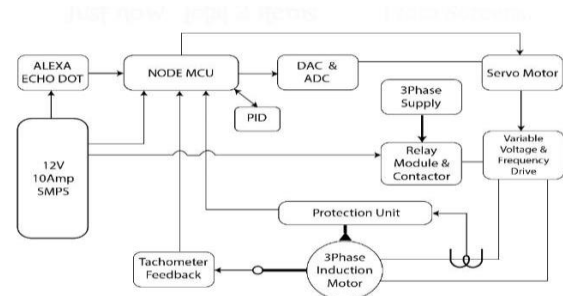


Fig -2: Name of the figure

The main process of our project is classified into 4 stages. The beginning is the voice command which will act as an input signal and it will recognize by our AI-based Alexa Echo Device which is our first stage of operation. Amazon Alexa, also known simply as Alexa, is a virtual assistant AI technology developed by Amazon, first used in the Amazon Echo smart speakers developed by Amazon Lab126. Alexa will get the command and it will define the commanded RPM value which will signal the Node MCU as an input. The Node MCU ESP8266MOD Wi-Fi module is used. Node MCU is a Node MicroController unit is an open-source software and hardware development environment built around an inexpensive system-on-a-chip (SoC).

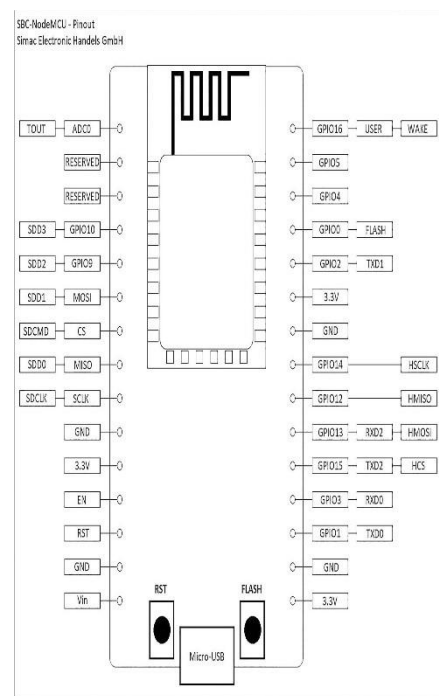


Fig -3: Pin diagram of Node MCU.

Design based on the architecture of 30 pin layout. It has 4 power pins: VIN Pin and three 3.3V Pins, GND: Ground Pin, ADC channel: Embedded with 10-bit precision SAR

ADC, UART Pins, SPI Pins, SDIO Pins, PWM Pins, CONTROL Pins: EN, RST, WAKE. This Chip contains crucial elements of the computer that are CPU Ram Networking (Wi-Fi) and even modern operating system and SDK. Now it will proceed with command and it will define the operation of the servo motor with the help of DAC and ADC setup. The MG995 Metal Gear Servo Motor is used which has a high-speed standard servo that can rotate approximately 180 degrees (60 in each direction) it provides stall torque of 10kg/cm at 4.8V, and 12kgcm at 6V. It is a Digital Servo Motor that receives and processes PWM signal faster and better. It equips sophisticated internal circuitry that provides good torque, holding power, and faster updates in response to external forces. This servo motor will get to know the operating parameters in terms of degree rotation for the operation of the potentiometer which is directly attached to the virtual frequency drive VFD. In this MS300 VFD is used.

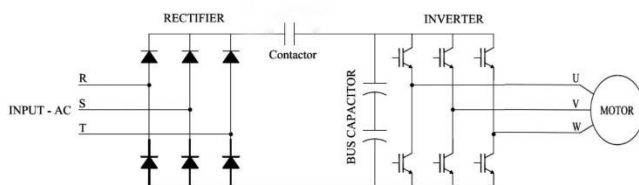


Fig -4: Basic working of VFD.

VFD is a power conversion device that converts the fixed voltage and fixed frequency of the input power to the variable voltage and variable frequency output to control AC Induction Motor. It consists of power electronic devices like IGBT, MOSFET, and high-speed Central controlling unit such as Microprocessor, DSP, and the option sensing device depending on the application used. VFD maintains the speed of the motor at a constant level even in case of Input and load disturbance. It is an impactful and powerful controller for AC motor control where it consists of mainly four sections those are a rectifier, intermediate dc-link, inverter, and controlling circuit. VFD converts a single-phase to three-phase so by varying voltage and frequency using the help of VFD by which the speed of the motor is Controllable. A Single HP Squirrel Cage Induction Motor is used which is a delta driven, 415V. Which has a class B insulation, which means that it can withstand 80° Celsius of temperature, squirrel cage induction motor has good speed regulation and they are able to maintain a constant speed. It has high efficiency in converting electrical energy to mechanical energy while running, as the speed of the motor is now varying by the VFD so to check the actual speed of the motor is running on commanded parameters or not, so by using IR sensor module which is named as IR sensor HW - 201. It has 3 feet range it will work as a tachometer. Which will act as a feedback system. The IR sensor module will report the actual running speed of the motor to the Node MCU after that Proportional - Integral - Derivative - Controller (PID) which is a loop mechanism employing for feedback that is widely used in industrial control system and a variety of other applications. Here it

plays the main role, it will calculate the percentage error and it will report to the Node MCU after that Node MCU will further give the signal to the Servo Motor which will signal the VFD to adjust the speed of the motor according to the percentage error of RPM. In between this system the relay module and contactor are used to protect, it has 6 channel relay modules with a 5-volt operating coil and on-board optocoupler for di / dt and dv / dt protection for DAC and ADC which can be used in a NO and NC, SPDT configuration. So, this system features an AI-based Alexa Device to control 3 Phase Induction Motor for industrial purposes with a method of voltage and frequency variation using VFD. This system is designed to reduce the risk of human life as well as more accurate and automatic to adjust itself to commanded parameters.

4. CONCLUSIONS

To make the world a better place it is essential to reduce the suffering of living human beings. This paper represents our assistive system for the industrial purpose which offers speed control of induction motor through the voice command using Alexa Echo device. It brings something new for better surveillance.

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