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Application of Microcontrollers in Speed Control of Motors: An Adaptive Approach

Arundhati Dogra[1], S. G Desai[2]
[1]*Department of Electrical Engineering, Bharati Vidyapeeth Deemed to be University College Engineering Pune.*
[2]Assistant Professor, *Department of Electrical Engineering, Bharati Vidyapeeth Deemed to be University College Engineering Pune.*

Abstract: The electric drive systems that are used in industrial applications increasingly work to meet higher performance and reliability requirements. Microcontrollers provide a suitable means of meeting with these needs. Certainty, part of the recent activity on microcontrollers can be ascribed to their newness and challenge. This paper reports the usage of microcontroller based systems in the development of high performance DC, Induction and various special purpose motors using microcontroller interfacing.

I. INTRODUCTION

The use of power electronic devices for the control of Electric Machines not only improves the efficiency of the machine due to precise control and fast response but maintenance requirement are also reduced along with an increase in ease of implementation.[1] This is due to the fact that the implementation of microcontroller in Electric Machines increases the flexibility and versatility.[2]
Permanent-magnet excited brushless DC motors have become highly attractive in a number of applications because of performance advantages such as reduced size and cost, reduced torque ripples, increased torque-current ratio, low noises, high efficiency, reduced maintenance and good control characteristics over a wide range in torque–speed plane.
It is known that an industrial drive system consists of a mechanical working equipment ie. load, which is kept in motion to produce output of mechanical work with the help of a prime mover. A combination of prime mover, transmission equipment, and mechanical working load is called a DRIVE. We can define an electric drive as a drive, which uses an electric motor as a prime mover. The electric motors that are used also require some control equipment to realise speed control and torque control in case of a three phase induction motor.[3]. DC motor can be a good choice whenever controlled movement is needed due to the fact that it is simple, has a low cost, high reliability, high torque at lesser speeds, and high accuracy of motion in applications where control of rotation angle, speed, position and synchronism is needed. Speed control of a DC motor can be achieved by mechanical as well as electric techniques.
The driving circuit can control DC motors in both clock/anti-clock wise directions.
At this stage it is of importance to discuss a technique that we will be observing the use of extensively throughout this paper. The technique is known as Pulse Width Modulation(PWM)
PWM is a technique that focuses on utilizing switching of devices to produce the effect of a continuously varying analog signal. This PWM conversion has very high electrical efficiency and can be used in controlling a three-phase synchronous motor or a three phase induction motor. With technological advancements under way, microcontroller has become a more suitable chip to control different electro-mechanical devices. Microcontrollers reduce the size and cost making digital control more efficient.
This paper will aim at discussing the use of microcontroller based application in better utilisation and optimisation of various types of motors and their optimisation process.[4]

II. USE OF MICROCONTROLLERS IN SPEED CONTROL OF DC MOTOR.

Armature voltage and field current are usually varied to obtain variable speed of DC motor.However a better range is obtained if armature voltage is varied. To obtain a variable DC voltage, a chopper or PWM circuit is usually used. PWM is commonly used to control the speed of DC motors. However the design and implementation is extremely difficult.This paper puts forth a microcontroller based control system to change the speed and direction of rotation of DC motor
By using the microcontroller that sends the signals at the microcontroller's PWM terminal armature voltage is varied by pulse width modulation (PWM) of DC input voltage . Hence the speed of the DC motor is varied. By switching the signals at armature terminals of the DC motor by initiating an interrupt signal to the microcontroller direction of rotation of DC motor is changed. In the referred paper[1] Hardware implementation was done using an 8 bit ATmega16 microcontroller and its software was written in C language using the AVR Butterfly that makes the hex file to be sent to the microcontroller by the Ponyprog software through the ISP port.[5]

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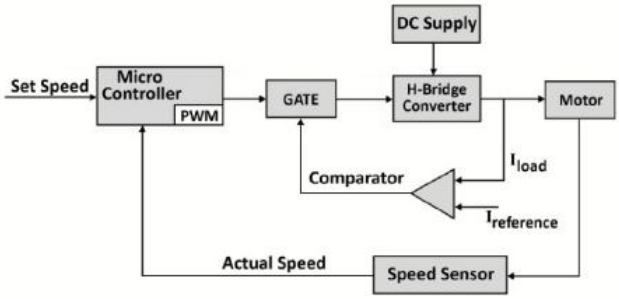
A block diagram of of microcontroller based speed control system that was designed has been shown below;



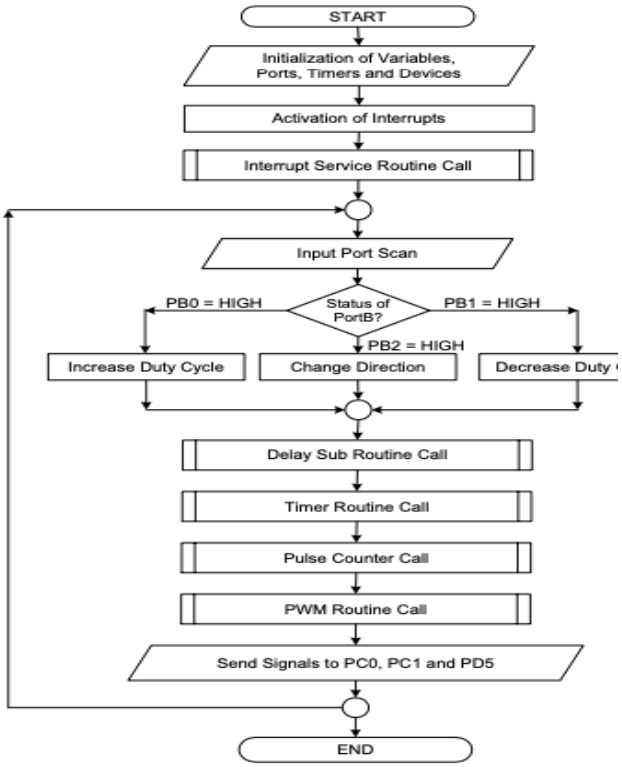
Finally, in the referred paper[1] by controlling the DC motor the circuit was tested and for various speeds results were recorded. The hardware aspects included various parameters.It was notable that the measured data showed agreement with the expected output taking into consideration that the device is suitable for use in switching applications at frequencies up to 5 kHz.Also, each of the current channels posses is current capability of about 600mA. The design of the power supply unit is done with the use of step down transformer, bridge rectifier, capacitors and regulated power supply ICs of 7805 and 7812 to obtain the the DC voltages of 5 V and 12 V respectively.

The software development on the other hand had the following aspects.

C language is a general-purpose programming language which works on any microprocessor that includes a C compiler that is written for it. C extracts the concepts of what a computer executes and gives a text based logical output.

In C programming WinAVR is a set of tools. The AVR microcontroller family is a set microcontroller which are executable, open source software development tools for the ATMEL AVR series of RISC microprocessors. Ponyprog o the other hand works as burner software for the microcontroller. The program has been developed for the microcontroller using the software WinAVR Butterfly [1] in C programming language, it is then debugged and later edited as required and lastly the hex codes are obtained using a microcomputer. The hex codes of the developed program were sent to the of the microcomputer by the Ponyprog software.[7]

Flow chart of a part of the algorithm is as follows[8];



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Basically two techniques are available for controlling BLDC motor. They are sensor control and sensor less control. Motor also can be controlled through controlling the DC bus rail voltage or through PWM method. In case of BLDC motors the commutation is carried out with the aid of using electronic switches which need the rotor position. In control techniques the usage of sensors, mechanical position sensors, such as a hall sensor, shaft encoder or resolver have been applied in order to offer rotor position information. This paper proposes a speed control of brushless drive using PWM technique. This paper deals with control approach to lessen speed oscillations and to runs the motor at specific entered speed. This is achieved through the usage of the microcontroller programming.[14]

III. BLDC MOTOR CONTROL METHOD

Pulse-width modulation (PWM) is a usually used technique for controlling power to an electrical device, made practical via way of means of modern electronic power switches. The average value of voltage (and current) fed to the load is managed via way of means of turning the transfer among supply and load on and off at a quick pace. The longer the switch is on compared to the off periods, the higher the power provided to the load is. The PWM switching frequency must be much faster than what could have an effect on the load, that's to mention the device that makes use of the power.

The main advantage of PWM is that power loss in the switching devices is very low. When a switch is off there is practically no current, and when it is on, there is almost no voltage drop across the switch. Power loss, being the product of voltage and current, is thus in both cases close to zero. PWM works also well with digital controls, which, because of their on/off nature, can easily set the needed duty cycle. The duty cycle is of utmost importance as it decides the speed of the motor. The PWM in a is usually microcontroller is used to control the duty cycle of DC motor. Average Voltage=D * Vin [16]

IV. SIMULATION RESULTS FOR VARIOUS PWM PULSES(AS CONCLUDED BY THE REFERRED RESEARCH).

The average voltage obtained for various duty cycles is likewise cited and because the duty cycle per cent decreases average voltage additionally decreases from the supply voltage. Duty cycle is described as the percentage of time the motor is ON. Therefore, the duty cycle is given as

Duty Cycle = 100% x Pulse Width/Period

Where Duty Cycle in (%)

Pulse Width = Time the signal is withinside the ON or high state (sec) Period = Time of 1 cycle (sec). The program for the closed-loop manipulate of BLDC motor operation is written in embedded C and performed in Keil software.

The hardware is designed and the operation has been finished primarily based totally upon the program written withinside the microcontroller for the Closed-loop control of the BLDC motor and the speed is likewise controlled via way of means of the use of PWM technique.[17]

V. OPERATION PROCEDURE(ACCORDING TO THE REFERENCE RESEARCH)

1) Press '#' one time display reveals the store Max RPM.
2) 2. Press '#' once more to save Max.RPM.
3) 3. Press '*' to get the required RPM. Display shows % of Req_RPM:
4) 4. Enter the required percentage using Keypad.
5) 5. Press '#' to save the required RPM. [18]

The paper concluded saying that the hardware for closed-loop control of BLDC motor using microcontroller is designed. By the use of the PWM approach speed of the BLDC motor was controlled and it becomes made to run at precisely entered speed. In destiny, this hardware could be carried out in dSPACE and the speed control could be observed.[19-20]

The program for a microcontroller is commonly saved on a memory integrated circuit (IC) referred to as an EPROM or at the microcontroller chip itself. Once you've evolved software program for a microcontroller, it is typically programmed into an EPROM chip and that chip is finally physically inserted into the circuitry of your hardware. The microcontroller accesses the program saved withinside the EPROM and executes it. With the technological improvements instead of having a circuit that consists of both a microcontroller and an external EPROM chip, it is now absolutely feasible to have microcontroller which stores the program code internally. Power line modem which is useful to send and receive serial data over present AC mains power lines of the building. The modem is in the shape of a ready to use circuit module. Due to its small size, it is able to be incorporated into and turn out to be a part of the user's power line data communication system.[23]

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VI. HARDWARE IMPLEMENTATION OF THE REFERRED MODEL

Microcontroller primarily based totally speed control of induction motor the usage of power line communication Technology system is done and the developed hardware is tested with variable load. The proposed hardware system is implemented via way of means of AT89S52 microcontroller. The developed hardware system is examined in the power electronics laboratory. The test is performed on an inductive-resistive load.

It is recognised that the voltage and frequency values increase as the speed of the motor is increased. The corresponding output voltage waveforms are taken which display the pulse pattern for specific speeds. The curve nature is similar to the linear curve which suggests that frequency is increased as the voltage increases. By this approach, multiple motors may be controlled at the same time.[24]

VII. APPLICATIONS AND CONCLUSION

Proposed system can be applied in

A. Rolling mill.
B. Printing press
C. Bottle filling.
D. Cotton mill
E. Mine winders
F. excavators and cranes[25]

The new topology of speed control of induction motor using PLCC technology is successfully implemented on this work. This is one of the techniques for controlling the speed, that is employed for AC motor drives. The speed manipulate of AC motor is performed the usage of PLC technology through the AT 89S52 microcontroller. It has high reliability and long existence at low price and compact.

The experimental outcomes are analyzed and it is found that the rate of the induction motor is controlled in Normal. And step up, step down speed requirement is done easily the usage of PLC technology. The proposed system is well suitable for 90% of industrial applications.[26-29]

VIII. CONCLUSION

In this paper we saw the efficient use of different microcontrollers used for the speed control of DC motor, Induction Motor and a special function motor known as the BLDC or Brushless DC motor. It was unanimously observed in the scope of all three types of motors that the use of microcontrollers by using the Pulse Width Modulation Techniques makes the system more efficient as well as cost effective. In some cases it has also proved to reduce the maintenance frequency of the machines. This paper has also explored the future exploration possibilities of amalgamated research in microcontrollers and different types of motors.

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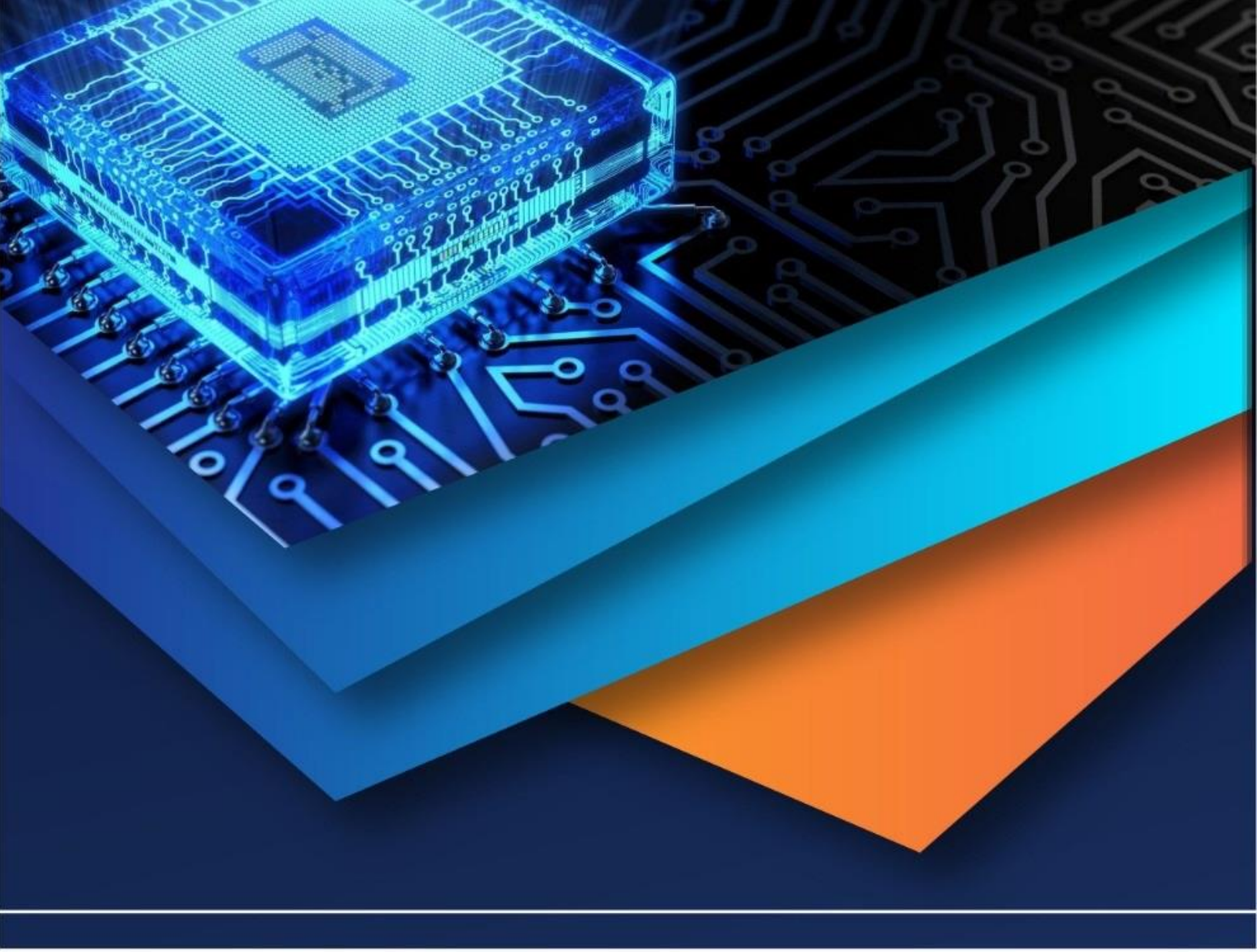

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