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A Review Paper on Speed Control of DC Motor & Virtual Instrumentation

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ABSTRACT: This paper gives a review on the speed control of Direct Current (DC) motor and application of virtual instrumentation. DC motor plays an important role in many areas such as research, laboratory experiments, industries etc and their speed control become mandatory in order to achieve the desired output. Speed control can be achieved either manually or by using automatic controlling devices. Control mechanisms like Proportional- Integral-Derivative (PID) controller and Fuzzy Logic Controller (FLC) are discussed here along with the application of Virtual Instrumentation which allows the access of motor parameters over the web.

KEYWORDS: DC motors, PID controller, Fuzzy Logic Controller (FLC), Virtual Instrumentation.

I. INTRODUCTION

The DC Motors are rotary electrical machines which converts direct current electrical energy to mechanical energy. A permanent magnet (PM) DC motor works like a shunt DC motor. It plays an important role in many areas because of its simple structure, low cost and high efficiency. Industry also needs variable and fixed DC drives and speed control becomes mandatory in-order to achieve the expected output depending upon the applications. Speed control can be achieved by using various techniques either manually or by automatic control devices.PID controller is a control loop feedback mechanism widely used in industrial control systems. Derivative mode gives fast reaction on change of the controller input; the integral mode eliminates the offset error and the proportional mode increase the system stability and is often used in combinations to achieve better results. The performance of the PID controller depends on the precise tuning of gain parameters i.e. its implementation relies on the exact mathematical model of the plant. The FLC unlike the PID controller is able to model inaccurate or imprecise models. The main advantage of fuzzy logic controllers over PID controllers is that no precise mathematical model is required.

Virtual Instrumentation is a technique used to create user defined systems called virtual instruments and is used for modeling and simulation of virtual real time systems. The motor parameters are remotely accessed over the web with the help of virtual instrumentation tool available in the LabVIEW software. In LabVIEW there is a provision for creating a web server and this can be used to publish the front panel of our project over the internet which helps to monitor and control the system parameters remotely over the internet.

II. RELATED WORK

In the paper Application of Virtual Instrumentation LabVIEW for Power Electronics System Analysis [1], a virtual instrument for studying the boost type DC/DC converter in the continuous and discontinuous conduction mode was presented. Virtual Instrumentation which is a combination of measurement and control hardware and application software is used to create user –defined instrumentation systems. The main purpose of the system was regenerative braking of DC motors. The system was recommended for self studying purposes and in e-learning education. Virtual Instrumentation is used for creating user defined virtual instruments that are used for modeling

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and simulating real time systems. Virtual Instrumentation tool available in LabVIEW can be used for creating web server and an URL is generated during the server creation. The URL helps to publish the front panel of LabVIEW anywhere in the world and can monitor and control the device parameters remotely over the web. Block diagram of Virtual Instrumentation is shown in Fig.1.

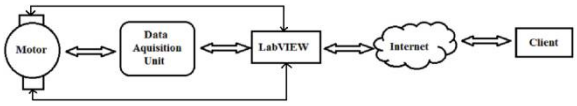

Fig.1: Block Diagram of Virtual Instrumentation

In paper [2], the authors describe a web-based control and monitoring system of a DC motor which is implemented using the Virtual Instrumentation tool available in the LabVIEW (Laboratory of Virtual Instrumentation Environment Workbench) software. The web services feature of LabVIEW along with the National Instruments (NI) Hardware makes the monitoring and control of system parameters through web easily. LabVIEW is used to design a Graphical User Interface (GUI) and hence can be published anywhere by using the web service feature. The NI DAQ system acts as an interface between the real time signal and the digital signal available to the LabVIEW. Here by using a thyristor based full wave converter the speed of the DC motor is controlled by varying the firing angle of pulse given to the thyristor.

The paper An Embedded Web Server based Remote Motor Control System using Virtual Panel [3], presents monitoring and controlling of motor speed through the TCP/IP connection using Virtual Instrumentation tool. PIC 18F458 Microcontroller along with Ethernet controller is used here for hardware implementation of the system and parameters like temperature, voltage, current etc are monitored. The virtual instrumentation tool available in the LabVIEW helps the user to monitor and control the system from remote locations thereby automating the system and avoiding human interventions. It was also recommended that in the future the proposed system can be upgraded to its portable form by replacing PC with a PIC based mobile computer.

In paper [4], speed estimation and equivalent circuit parameter determination of induction motor is presented based on LabVIEW. Here Virtual Instrumentation is used for no-load and blocked motor tests of induction motor and a real time controller cRIO (compact Reconfigurable Input/output), NI9025 has been used for this purpose. The data acquisition modules NI9225 and NI9227 are used for measuring analog voltage and current respectively. They also verified the result obtained using virtual instrumentation technique, by comparing it with result obtained using actual instruments and was found to be satisfactory.

Amit Dhondiram Magdum and A. A. Agashe in their paper [5] makes use of the Virtual Instrumentation tool in the LabVIEW software in order to remotely access the motor parameters over the internet. In this paper different types of motor parameters are monitored and controlled using LabVIEW based design techniques.

Gabriel Găşpăresc in his paper [6] describes a low-cost Proportional-Integral-Derivative (PID) control system of DC motor based on an Arduino Uno board. The system was developed as an educational tool, based on the Arduino platform and LINX Package, a soft-ware that allows communication with Arduino Uno board to develop projects using LabVIEW. The sampling rate for Arduino Uno is very limited, due to limited amount of RAM memory and slow serial communication. To achieve higher sampling rate a dedicated acquisition board should be used.

In paper [7], the speed control of Permanent Magnet DC (PMDC) motor is done using LabVIEW interfaced with Arduino. The main advantage of using LabVIEW with Arduino is the cost and simple in structure. The other

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speed control methods like FPGA method, fuzzy control, using 555 timer and PID controllers are having the drawback of complicated design involved, unreliable control, difficult in the online monitoring with high speed motors. As observed in paper [6] here also for achieving better performance a dedicated data acquisition card should be used instead of Arduino board.

The paper DC Motor Speed Control using Fuzzy Logic based on LabVIEW [8], presents the implementation of speed control of a separately excited DC motor using Fuzzy Logic Controller (FLC), DAQ card model PCI-6024 and LabVIEW program. The FLC is based on human knowledge and linguistic description to perform a task and the performance of the controller depends on the rules and membership functions used. It also compares the speed response of PID and FLC controllers and is observed that the system was able to overcome the conventional sensitivity issues.

Paper [9], investigates two different controller techniques, the Proportional-Integral-Derivative (PID) controller and the Hybrid Fuzzy PID controller. In latter, fuzzy logic is used for auto tuning the parameters of PID controller and for this the error is changed in the entire process to adjust the three gain parameters of the PID controller which gives better static as well as dynamic performances. The paper compares the performances of both the controllers and according to the result obtained it is concluded that the Hybrid Fuzzy PID controller gives a better performance over the conventional PID controller in terms of rise time, settling time, dead time and steady state error. PID-Fuzzy toolkit available in the LabVIEW software along with NIDAQ-6009 is used for the real time implementation of the system.

The paper Real Time Simulation of DC and AC Motors Based on Labview FPGAs [10] describes real time simulation models of DC and AC machines on FPGAs (Field Programmable Gate Arrays) in state space. Xilinx FPGA used in this paper is programmed using LabVIEW which is a graphical program. Here the performance of both DC and AC motors had been analyzed under various conditions. They had also compared the system with offline simulation techniques and from the results it is concluded that the real time simulation techniques gives better performance.

III. CONCLUSION

The paper gives a description about available speed control methods using PID and fuzzy logic controllers and also, the role of virtual instrumentation in control mechanism is discussed. It is observed that both PID and fuzzy logic controllers have several merits and demerits over one another and researches can be carried out for evaluating and comparing the performances of the above discussed controller techniques along with the implementation of virtual instrumentation for remote monitoring and controlling of the system.

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