Wireless speed control of DC drives from MATLAB GUI using PWM Technology

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Abstract - *We are living in an automation era and with the advancement of technology, we are preferring automation products more than manually operated products.Similarly in industrial areas automation products are used for reducing labor costs and increasing efficiency of production. In this paper I have developed a technology to control the speed of DC machines used in industries wirelessly from a remote PC/Laptop using a user designed MATLAB GUI application.*

We have used PWM technology to control the speed of DC motor and used RF technology for wireless control of DC drives.

Key Words: **MATLAB GUI, PWM Technology, RF technology, efficiency of Production, PC/Laptop**

1. INTRODUCTION

Speed control of DC motor is necessary in several industrial applications. Pulse width modulation is the most popular technology for getting a variable DC output from microcontroller PWM channel which we can use for variable speed DC drives.

Speed control of dc motor could be achieved using mechanical or electrical techniques. In the past, speed controls of dc drives are mostly mechanical and requiring large size hardware to implement. The development has again made it possible to control the dc motors using advanced techniques. Some important applications are: rolling mills, paper mills mine winders, hoists, machine tools, traction, printing presses, textile mills, excavators and cranes. Fractional horsepower dc drives are widely employed -as servo means for positioning and tracking [1]. Controlled rectifiers provide a variable dc voltage from a fixed dc voltage. Due to their ability to supply a continuously variable dc voltage, controlled rectifier and dc choppers made a revolution in modern industrial equipment and variable speed drives [2]. Adjustable speed drives may be operated over a wide range by controlling armature or field excitation.

Switching devices such as Power Transistor, MOSFETs along with various analog/digital chips used in firing or controlling circuits have made dc drives more efficient for control in various areas of applications. Recent developments in the area of semiconductor technology have

made compact, faster processing. As microcontrollers and Microprocessors are available at a reduced cost, it is an added advantage for us to use it in our drive applications [3].

Here in this paper I have used H-bridge circuit to control the speed of DC motor. We have used ATMEGA16 Microcontroller for PWM signal generation and the H-bridge IC made it possible to control the DC drives using PWM signals.

1.1 PWM Technology

PWM stands for Pulse width modulation. As the name suggests it refers to the control of width of output control signals to vary the output voltage. In other words, we have to vary the duty cycle of the signal which will control our output voltage.

The simplest way to generate a PWM signal is by comparing the predetermined waveform with a fixed voltage level. It is basically a modulation technique, in which the width of the carrier pulse is varied in accordance with the analog message signal [4].

1.2 MATLAB GUI Application

This is most important and interesting part of this paper. Our control input is fed from a MATLAB Graphical User Interface (GUI) customised by the user. Our MATLAB application has a feature to transfer digital data serially to hardware communication Port of Laptop. Hence our system can directly communicate with our hardware.ATmega16 microcontroller is fed with inbuilt instructions to generate different PWM signals at different values of PC.

1.3 Wireless communication

Here we are using Radio frequency (RF) communication for controlling the motor wirelessly from a remote place. For this purpose we are using RF encoders and Decoder circuits.

These circuits are widely used for control and working applications and are also reliable over a small range. The RF circuits consist of transmitter and receiver which are independent of each other. All the control signals

and commands are sent via wireless medium in between transmitter and receiver [5].

2. System Design and hardware implementation:

For hardware implementation of the proposed system we have to design necessary components such as power supply, motor driver, Microcontroller board, Serial communication board etc. Then we should connect them as per our programming setup.

2.1 ATMEGA16 Microcontroller

A Microcontroller can otherwise be known as "Artificial Brain". Because it is a reprogrammable electronic device which can give a specific digital output under required input conditions. Here in my system I have used ATmega16 microcontroller as the controller which is used to generate PWM signals of required duty cycle.

ATmega16 microcontroller has its inbuilt PWM channels through which it can produce required PWM signals. Some of the important Features of this controller is listed below [6].

- 32 x 8 General Purpose Working Registers
- Fully Static Operation
- Up to 16 MIPS Throughput at 16 MHz
- Advanced RISC Architecture
- 16 Kbytes of Self-programmable Flash program memory
- 512 Bytes EEPROM
- 1 Kbyte Internal SRAM
- Four PWM Channels
- 8-channel, 10-bit ADC
- Programmable Serial USART

Pin diagram of ATmega16 is depicted below:
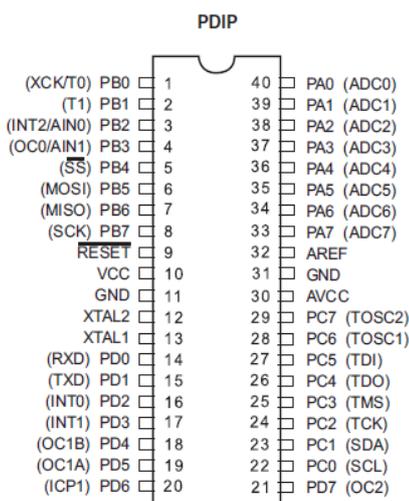
Fig 1: ATmega16 Pin out

2.2 H-bridge Motor driver (L293D)

H-bridge motor driver IC is a device which is used to control bidirectional motion of DC Motor of higher voltage (4.5v-36v) from low voltage microcontroller control signal. It can drive two DC motors simultaneously. Moreover it can control the speed of either motor connected with it using its inbuilt enable PWM pins.

Some of the features of this IC is noted below [7]:

- Wide Supply-Voltage Range: 4.5 V to 36 V
- Separate Input-Logic Supply
- Output Current 600mA per Channel
- Output Clamp Diodes for Inductive transient Suppression (L293D)

Pin diagram of L293D is given below:
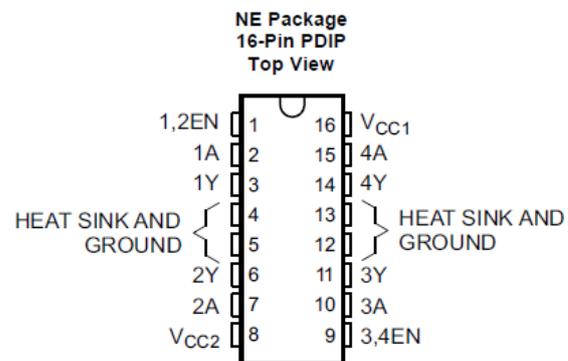
Fig 2: L293D Pin diagram

2.3 RF Transmitter and Receiver:

Radio frequency (RF) is a frequency or rate of oscillation within the range of about 3 Hz to 300 GHz. This range corresponds to frequency of alternating current electrical signals used to produce and detect radio waves.

RF transmitter and receiver modules are used to send 4 bit parallel data wirelessly to receiver end from which we can read the data by using microcontroller. Here I have used 433 MHz RF transmitter and receiver.

2.4 Serial Communication:

Serial communication refers to single channel communication between two nodes. Here we are using serial communication technique to form a communication medium between our PC and Microcontroller.

Usually a Microcontroller operates at TTL (Transistor-Transistor Logic) of about 0-5V.But a PC works on RS232 standards that is (-25 to +25V). So it is not possible to interface a PC directly with a Microcontroller and this is exactly where a MAX232 IC comes into Play. This IC is used to convert TTL/CMOS logic levels to RS232 Logic levels during the process of serial communication.

The pin diagram of MAX232 is depicted below:
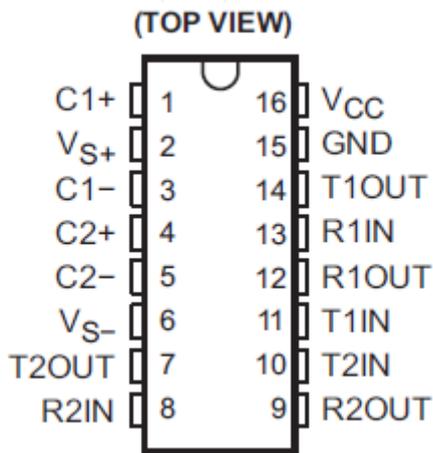
Fig 3: Max 232 Pin out

3. Methodology:

3.1 Transmitter side

The working of transmitter side of my project is given as below. The serial data is given by the user from the MATLAB GUI and it is fed to ATmeag16 through Max232 logic converter. Then microcontroller sends the data corresponds to the serial data wirelessly to the receiving end by the help of RF transmitter circuit.
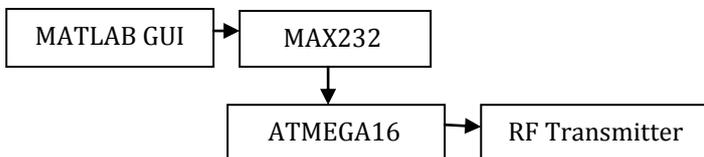
3.2 Receiver side

In the receiver end, RF Receiver circuit receives the data sent from transmitter end and fed it to the microcontroller. Microcontroller processes the data and gives corresponding PWM command to the motor drives to run the motor at entered speed.
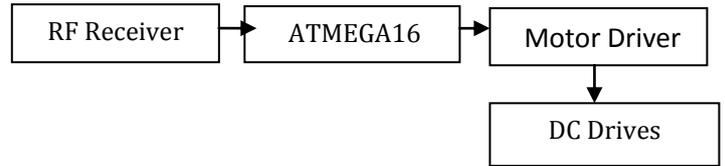
4. Result

After all the connections are made, the hardware of the proposed system was tested. The screenshot of the designed GUI application in MATLAB is shown as below.
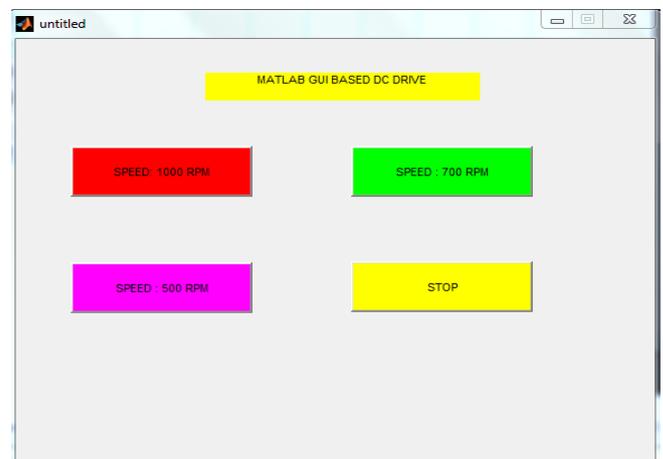
The Hardware working model of my proposed system is depicted below.

5. CONCLUSION AND FUTURE WORK

5.1 Conclusion

The speed control of DC drives is experimentally tested and it can be concluded that the proposed system is very much suitable in case of industrial automation. The efficiency of the system is also very good. We can control the loads from remote locations using efficient wireless technology. As we know that PWM method is the most efficient method of speed control, this makes the model more reliable and Robust.

5.2 Future work

This system can be improvised using high range wireless network such as Ethernet or Zigbee so that range of communication will be more.

We can use renewable energy to power the control circuitry. So that the circuit will be more efficient and energy saving.

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BIOGRAPHY

Debasis Parida pursuing M. Tech. in Power Electronics and Drives from IGIT, Sarang, and Odisha.
He is currently working on hardware implementations of power converters and Electric drives. He has very depth knowledge of his research areas.