"WIRELESS SPEED MONITORING DC MOTOR USING RADIO FREQUENCY"

*Ashwini.B.Pendhar[#1] Nitin.D.Sonawane[#2] , Sushil More[*3] , Samadhan Avhad[#4]*

[#1*2#3*4#5] *MET's Institute of Technology – Polytechnic, Bhujbal Knowledge City, Adgaon, Nasik, Maharashtra, India.*

[2]sonawanenitin21@gmail.com
[3]manmad836@gmail.com

ABSTRACT- The speed of the DC motor is directly proportional to the voltage applied across its terminals. Hence, if the voltage across motor terminal is varied, then the speed can also be varied. This project uses the above principle to control the speed of the motor by varying the duty cycle of the pulse applied to it (popularly known as PWM control). At the transmitting end using push buttons, commands are sent to the receiver to control the movement of the robot and make it move forward/backward besides incrementing and decrementing its speed. An RF transmitter acts as a remote control that has the advantage of adequate range (up to 200 meters) with proper antenna. The receiver decodes the commands before feeding it to another microcontroller to drive a DC motor via motor driver IC for necessary work. PWM (Pulse Width Modulation) is generated at the output by the microcontroller as per the program. The program can be written in Assembly language or in Embedded C. The average voltage given or the average current flowing through the motor will change depending on the duty cycle (ON and OFF time of the pulses), so the speed of the motor will change accordingly. The motor driver IC is interfaced to the microcontroller for receiving PWM signals and delivering desired output for speed control of the DC motor.

Furthermore, the project can be enhanced by using power electronic devices such as IGBTs to achieve speed control higher capacity industrial motors.

Key words- ***DC motor, 8051 microcontroller, remote control.***

I. INTRODUCTION

The title of our project is High-performance low-cost low-loss wireless DC motor speed control unit. Nowadays, there are lots of good-quality motor speed controls on the market. However, their costs are relatively high. A speed control with both low cost and good performance will be highly marketable, especially for small mobility applications. On the other hand, the wireless connectivity has a nature of low cost and less environmental limitations. Combining these ideas together, we came up with this project.

For speed control of dc motor many methods are available which are either be a mechanical or electrical for example armature control, field control, flux control method etc but this methods required large size hardware to implement. So for easy control of speed and the direction control of dc motor the wireless speed and direction control of dc motor by using radio frequency technique is very much essential and economical to used. For variable dc voltage we can used a controlled rectifiers which are converted a variable dc voltage from fixed dc voltage. Due to their ability to supply a continuously variable dc voltage. Many analog and digital chips are used in firing or controlling circuits but transistor and thyristor control are more accessible due to their innumerable application in various industry. Recent development in the area of semiconductor technology have made faster ,very small size microprocessors and microcontroller are available at in much reduced cost. The microcontroller can provide a controlling of width of pulse provide to a controlling a voltage of motor terminal simultaneously the speed of motor can controlled. For that purpose the Pulse Width Modulation phenomena is used for controlling the width of pulse.

II. CONTROL UNIT

Electronic control units can be classified into two main categories:

A. Wireless control units (systems)

This system use the transfer of information between two or more points which are not directly connected through an electrical conductor. Controlling the different parameters of a DC motor such as direction (clockwise and counterclockwise) and speed control, is made possible at a distance. Such as a few meters away.

B. Manual control units (systems)

In this systems the control of our systems can be obtained in the following ways;

- Engaging personnel to manually control the system at its location.
- Having to manually operate the control unit, physically.

And thus it comes at a great expense such as time consuming and expensive since more personnel will be involved.

III. PROJECT JUSTIFICATION

The successful design and implementation of the Wireless DC Motor control will enable the wireless supervision of robots and machines that utilize DC Motors. It develops a combination of mechanical engineering, electronics, programming, controls, and motors, while also providing us with a chance of hands on experience with design and development. It can be justified in the many practical applications and broad scopes of engineering in details. As discussed earlier our main focus of justification is its entertainment, security and military value. Entertainment wise it will be is an extremely durable and fun project. It’s easy to use and appeals to all age groups making it very marketable. Military wise, it could change everything about our armies. Instead of shipping human lives into dangerous and life threatening situations we could send a machine to keep the peace. It’s safer, risk free and will save lives, something no one can put a price on. As for security we could remotely control CCTV cameras.

A. Advantages

- Speed and direction control from a remote place.
- The WDCM is easy to operate.
- The system has high sensitivity and not much sensitive to the environmental changes.

B. Project Applications

DC Motor possess excellent torque speed characteristics and offer a wide range of speed control, and due to this the demand for DC motors will be undiminished.

- Commercial wireless applications such as door announcers, gate control, remote activation.
- Consumer products including electronic toys, home security, gate and garage door openers, intercom, fire and safety systems and irrigation controllers
- Bottle filling systems, conveyer application.
- Automotive companies employing RF for wireless remote control, remote keyless entry and safety applications.

C. Project Scope

This project covers DC Motor control hardware and software design and implementation. The software system entailed developing a program for microcontroller using Atmel Studio 6.0 platform and Proteus simulation software which simulates real time circuit. The hardware system involved the design and construction of a properly working microcontroller based control unit.

IV. HARDWARE AND SOFTWARE COMPONENTS

USBasp, Breadboard, RF module 433MHz, l293d h-bridge IC, HT12E/HT12D encoder and decoder, Atmega 32 microcontroller, connecting wire, DC Motor, push buttons, resistors, capacitors, LEDs, personal computer running atmel Studio.

V. RF module (RX-TX MODULES (434MHz)

The RF module, as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz & 300 GHz. In this RF system, the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK).

Transmission through RF is better than IR (infrared) because of several reasons.

- Firstly, signals through RF can travel through larger distances making it suitable for long range applications.
- Also, while IR mostly operates in line-of-sight mode, RF signals can travel even when there is an obstruction between transmitter & receiver.
- Next, RF transmission is more strong and reliable than IR transmission.
- RF communication uses a specific frequency unlike IR signals which are affected by other IR emitting sources.

This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver (Tx/Rx) pair operates at a frequency of 434 MHz. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps - 10Kbps.The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter. The RF module is often used along with a pair of encoder/decoder. The encoder is used for encoding parallel data for transmission feed while reception is decoded by a decoder.

This radio frequency (RF) transmission system employs Amplitude Shift Keying (ASK) with transmitter/receiver (Tx/Rx) pair operating at 434 MHz; the transmitter module takes serial input and transmits these signals through RF. The transmitted signals are received by the receiver module placed away from the source of transmission. The system allows one way communication between two nodes, namely, transmission and reception. The RF module has been used in conjunction with a set of four channel encoder/decoder ICs. Here HT12E & HT12D have been used as encoder and decoder respectively. The encoder converts the parallel inputs (from the remote switches) into serial set of signals. These signals are serially transferred through RF to the reception point. The decoder is used after the RF receiver to decode the serial format and retrieve the original signals as outputs. These outputs can be observed on corresponding DC motor.

VI. HT12D DECODER

HT12D is a decoder integrated circuit that belongs to 2^{12} series of decoders. This series of decoders are mainly used for remote control system applications, like burglar alarm, car door controller, security system etc.

It is mainly provided to interface RF circuits. They are paired with 2^{12} series of encoders. The chosen pair of encoder/decoder should have same number of addresses and data format. In simple terms, HT12D converts the serial input into parallel outputs. It decodes the serial addresses and data received by, say, an RF receiver, into parallel data and sends them to output data pins. The serial input data is compared with the local addresses three times continuously. The input data code is decoded when no error or unmatched codes are found. A valid transmission in indicated by a high signal at VT pin. HT12D is capable of decoding 12 bits, of which 8 are address bits and 4 are data bits. The data on 4 bit latch type output pins remain unchanged until new is received.

A. PMW

A method, which is extensively used in motor controller, is the pulse width modulation (PWM). PWM switching technique is a best method to control the speed of DC motor as compared to any other method. The duty cycle can be varied to get the variable output voltage.

The Pulse-Width-Modulation (PWM) in microcontroller is used to control duty cycle of DC motor drive. PWM is an entirely different approach to controlling the speed of a DC motor. Power is supplied to the motor in square wave of constant voltage but varying pulse-width or duty cycle. Duty cycle refers to the percentage of one cycle during which duty cycle of a continuous train of pulses. Since the frequency is held constant while the on-off time is varied, the duty cycle of PWM is determined by the pulse width. Thus the power increases duty cycle in PWM.

The expression of duty cycle is determined by:

$$\% \text{ Duty cycle} = \text{ON time} / \text{Total Time} * 100\%$$

Since PWM is a method of transmitting information on a series of pulses. The data that is being transmitted is encoded on the width of these pulses to control the amount of power being sent to a

3

load. PWM is very handy tool, you can use it for power delivery, voltage regulation and amplification and audio effects. In this document we will go through the basic understanding of PWM, register configuration for different modes of PWM in atmega32. Analog voltage and current can be used to control devices directly like speed of a DC Motor.

In a simple analog controller, a knob is connected to a variable resistor. As you turn the knob, the resistance goes up or down. As that happens, the current flowing through the resistor increases or decreases.

TABLE NO.1:

Pin number	function	name
1	8 bit address pins for input	A0
2		A1
3		A2
4		A3
5		A4
6		A5
7		A6
8		A7
9	GROUND(0V)	GROUND
10	4 bit data pins for output	D0
11		D1
12		D2
13		D3
14	Serial data input	INPUT
15	Oscillator output	OSC 2
16	Oscillator input	OSC 1
17	Valid transmission	VT
18	Supply voltage	Vcc

B. Frequency

Using the switch example, the frequency would be how fast the switch was turned on and off. If the frequency is too low (switch is changed slowly), then the motor will run at full speed when the switch is on, and completely stop when the switch is off. But if the frequency is too high, the switch may mechanically fail. In reality there is no switch, but rather an electronic board named an H-Bridge that switches the motor on and off. So in electrical terms; if the frequency is too low, the time constant of the motor has enough time to fully switch between on and off. Similarly the upper limit on the frequency is the limit that the H-Bridge board will support, analogous to the mechanical switch.

The maximum frequency of this H-Bridge Board is 500 kHz, but the recommended frequency of the PWM for this board is 31.25 kHz.

C. H BRIDGE

An H-Bridge is an electronic power circuit that allows motor speed and direction to be controlled. Often motors are controlled from microcontroller to accomplish a mechanical goal. The microcontroller provides the instructions to the motors, but does not provide the power required to drive the motors. An H-bridge circuit inputs the microcontroller instructions and amplifies them to drive a mechanical motor. The H-bridge takes in the small electrical signal and translates it into high power output for the mechanical motor.

Basically current is amplified which takes a low-current signal from MCU and gives a proportional higher current signal to which can control and drive a motor. In most cases, a transistor can as a switch and perform this task.

Most DC Motors can rotate in two directions depending on how the battery is connected to the motor. Both the DC motor and the battery are two terminal devices that have positive and negative terminals. In order to run the motor in the forward direction, connect the positive motor wire to the positive battery wire and negative to negative. However, to run the motor in reverse just switch the connections; connect the positive battery wire to the negative motor wire, and the negative battery wire to the positive motor wire. An H-Bridge circuit allows a large DC motor to be run in both direction with a low level logic input signal.

The H-Bridge electronic structure is explicit in the name of the circuit H -Bridge. The power electronics actually form a letter H configuration, as shown below.

The switches are symbolic of the electronic Power;

If it is desired to turn the motor on in the forward direction, switches 1 and 4 must be closed to power the motor. If it is desired to turn the motor on in the reverse direction, switches 2 and 3 must be closed to power the motor.

This section will explain what the "switches" above actually are in terms of electronic components. The switches are power transistors that have certain properties that allow them to switch high currents based on an input signal. The transistors are used in two

Regions of operation; Cut-off mode and Saturation mode which correspond to switched off and switched on respectively.

In the H-Bridge case, to put a transistors into the Cut-off mode, the input signal (Gate Voltage) to the transistors must be grounded. However, to turn ON the transistors and put them into saturation mode requires a more complicated process. Transistors are three terminal devices with the terminals being the Base, Collector and Emitter.

D. L293D IC

It generally comes as a standard 16 dual-in line package. This can simultaneously control 2 small motors in either direction forward reverse with just four microcontroller pins;

1. Output current capability is limited to 600mA per channel with peak output current limited to 1.2A (non-repetitive). Also note the words "non-repetitive"; if the current output repeatedly reaches 1.2A, it might destroy the drive transistors.
2. Supply voltage can be as large as 36 Volts.
3. L293D has an enable facility which helps you enable the IC output pins. If an enable pin is set to logic high, then state of the inputs match the state of the outputs. If you pull this low, then the outputs will be turned off regardless of the input states.
4. The datasheet also mentions an "over temperature protection" built into the IC. This means an internal sensor senses its internal temperature and stops driving the motors if the temperature crosses a set point
5. Another major feature of L293D is its internal clamp diodes. This fly-back diode helps protect the driver IC from voltage spikes that occur when the motor coil is turned on and off (mostly when turned off)
6. The logical low in the IC is set to 1.5V. This means the pin is set high only if the voltage across the pin crosses 1.5V which makes it suitable for use in high frequency applications like switching applications (upto 5 KHz)
7. Lastly, this integrated circuit not only drives DC motors, but can also be used to drive relay solenoids, stepper motors etc.

VII. TESTING PROCEDURE

1. Test the control signal frequency generator through an oscilloscope; observe if the output is a perfect square wave. Check if the duty cycle and frequency can be controlled by varying the variable resistor.
2. Check the waveform of the modulated signal with an antenna directly connected to the channel 1 of the oscilloscope. Connect the channel 2 to the receiving RF transceiver and see if the received waveform is the same. Also, perform this test in a hotter environment and see the noise is affecting the received signal quality. Since a running motor can produce additional thermal noise.
3. Check the processed signal waveform at each level of the signal recovery stage. The amplitude of the output at each stage should be large enough to drive the next stage. Most importantly, the final output signal strength should be amplified to two different levels in order to drive the microcontroller unit and the Buck converter respectively.
4. Setup a basic Buck converter, feed in a square wave from a function generator and see it reaches 90% power efficiency. Also check the overload requirements. If the requirements are not met, change to different resistors and capacitors until the requirements are fulfilled.
5. Connect the load controlled transistor to the buck converter in series with the motor. Check if it is able to shut down the motor.
6. Check the feedback control and see if we can output a digital 1 when the input is higher than 2V and a digital 0 otherwise.
7. Test the microcontroller unit, see if can detect the "open" state and "close" state.
8. Input a digital 1 as the output of the feedback controller to the microcontroller and see if it will output a digital 1 after 70 seconds.
9. Connect the Buck converter, motor, feedback controller, microcontroller and the turn off motor gate driver and check if the converter can meet all the specifications.

10. Assemble the entire project and see everything is working properly.
11. If all tests are passed, the product may still not meet the performance requirement perfectly because the circuit is very sensitive to temperature. However, due to the $12 budget as required, we cannot replace our circuit with less sensitive components because they are relatively expensive.

A. Component Placement

- Preferably, place the component in X-Y direction subjected to mechanical construction.
- All components should be flat mounted i.e. flat placed to avoid of leads and for easy requirements. However in case of space limitation the components such as resistors, diodes, etc. may be mounted vertically which doesn't affect the performance.
- In case separate analog and digital ground.
- Orientation of multi-lead components (e.g. switches, Ics) should be connected in between the analog and digital ground .
- Sufficient clearance is provided around component so that inversion or replacement ands repair is easy.
- The design should such that minimum jumpers are allowed.
- It is preferable that, components like present, coils, and trim pots, etc. which alignment of calibration are placed in such that, they are accessible after the assembly of the PCB on cabinet also.
- If the components are not flush mounted, provide the sleeve for leads.

B. Testing And Troubleshooting

1. Before soldering in components:

- Check that component agree with the parts list (value and power of resistors, value and voltage rating of capacitor, etc.) if in any doubt double check the polarized components (diodes, capacitor, rectifiers etc)
- If there is a significant time elapse between circuit, take the trouble to read the article; the information is often given in a very condensed from. Try to get most important point out of the description of the operation of the circuit, even if you don't understand exactly what is supposed to happen.
- If there is any doubt that some component may not be exact equivalent, check that they are compatible.
- Only use good quality IC sockets.
- Check the continuity of the tracks on the PCB (and through plated holes with double sided boards) with a resistance meter or continuity tester.
- Make sure that all drilling, filling and other 'heavy' work is done before mounting any components.
- If possible keep any heat sinks well isolated from other components.
- Make a wiring diagram if the layout involves lots of wires spread out in all directions.
- Check that the connectors used are compatible and that they are mounted the right way round.
- Do not reuse wire unless it is of good quality. Cut off the ends and strip it a new.

2. After mounting the component:

- Inspect all soldered joints by eye or using a magnifying glass and check them with a continuity tester. Make sure there are no dry joints and no tracks are short circuited by poor soldering.
- Ensure that the positions of all the component agree with the mounting diagram
- Check that any links needed are present and that they are in the right positions to give the desired configuration.
- Check all ICs in their sockets (see that there are no pins bent under any ICs, no near ICs are interchanged etc.)
- Check all the polarized components (diodes, capacitor etc) are fitted correctly.
- Check the wiring (watch for off cuts of components leads) at the same time ensure that there are no short-circuits between potentiometer, switches, etc. and there immediate surrounding (other components or the case). Do the same with mounting hardware such as spacers, nuts and bolts etc.
- Ensure that the supply transformer is located as closely as possible to the circuits (this could have a significant improvement in the case of critical signal level).
- Check that the connections to the earth are there and that they are of good contact.

- Make sure the circuit is working correctly before spending any time putting it into a case.

3. And if it breaks down:

- Recheck everything suggested so far.
- Re-read the article carefully and carefully anything about which you are doubtful.
- Check the supply voltage or voltages carefully and make sure that they reach the appropriate components especially pins of the ICs (test the pins of ICs and not the soldered joints).
- Check currents (generally they are stated on the circuit diagram or in the text). Don't be too quick to suspect the ICs of overheating.
- If possible check the operation of the circuit in the separate stages as a general rule follow the course of the signal.
- While checking voltages, currents, frequencies or testing the circuits with an oscilloscope work systematically and take notes.
- And don't forget to switch the power on and check the fuses.

VIII. FUTURE SCOPE

In future if this motor is used in fans then we can get variable speed by just pressing of push buttons.

The DC motor speed control has a scope of four speeds. The control speed include high, medium, low & off.

IX. CONCLUSION

This is the one of the method in controlling the speed, which is employed for DC motor drives. The speed control of DC Motor is performed using wireless technology by RF Module and 89S52 microcontroller. It has high reliability and long life at low cost and compact. The experimental results are analyzed and, it's found that the speed of the induction motor is controlled in Normal, step up, step down speed requirement smoothly using wireless technology keeping 22 meters as the distance between transmitter and receiver section.

X. REFERENCES

1. Design and construction of DC motor system by Deepak Daine.
2. The speed control system by Wikipedia.
3. https://en.wikipedia.org/wiki/crystal_oscillator
4. Speed control of DC motor using pulse width modulation by Prof. N. D. Sonawane.
5. www.google.com