CONTROL OF DC MOTOR USING GSM TECHNOLOGY

Tola, O. J [1], Agbachi O. E [2], Ambafi J.G. [3] and Olutoye S[4]
Department of Electrical and Electronics Engineering, Federal University of Technology,
Minna, Niger state

Corresponding Author: E-mail: omokhafe@futminna.edu.ng

Abstract

Electric drive systems used in many industrial applications require higher performance, reliability, and ability to vary the speed. One of the attractive features of the DC motor over all other types of motor is the relative ease with which speed control can be achieved. In this paper, speed control of DC motor using GSM technology has been investigated. It is a closed-loop real time control system, where the control circuit is coupled to the motor shaft to provide the feedback speed signal. A cell phone is attached to the control circuit which serves as a trigger. Pulse Width Modulation (PWM) technique is used, where its signal is generated in the microcontroller. The PWM signal will be send to motor driver to vary the voltage supply to motor. Controlling the PWM duty cycle is equivalent to controlling the motor terminal voltage, which in turn adjusts directly the motor speed, switch ON or switch OFF the motor supply. The microprocessors computes the actual speed of the motor by sensing the terminal voltage and the current, it then compares the actual speed of the motor with the reference speed and generates a suitable control signal which is fed into the triggering unit. This unit drives Power MOSFET amplifier, which in turn supplies a PWM voltage to the DC motor. Dual-tone multi-frequency (DTMF) signaling is used for telephone signaling over the line in the voice-frequency band to the call switching center**.**

Keywords: DC motor, GSM technology, PWM, speed control

1. Introduction

The advances in the technologies related to wireless communication has led to the emergence of several engineering designs to aid the human requirements. As we all know, Industries play a significant roles in any developing country like ours (Nigeria) and implementing mobile communication device to facilitate Industrial tasks is the basic idea of this project.

Direct current motors are usually found where the load requires is adjustable speed and simple control of torque. Typical application for DC motors are rolling mills, overhead cranes, elevator, battery driven vehicles and machines tools requiring precise speed control.

The DC motor electrically consists of two circuits; called the field circuit and the armature circuit. The field circuit consists of stationary windings and the armature circuit is found in the rotating winding.

There are basically three types of DC motors: the series motor, the shunt motor, and the compound motor.

Internally and externally, all three types of Dc motor are practically the same. The main differences between the motors are in the way in which the field coil and armature coil circuit are arranged

The three most common speed-control methods are adjustment of the flux, usually by means of field-current control, adjustment of the resistance associated with the armature circuit, and adjustment of the armature terminal voltage (Fitzgerald A.E *etal*, 1996).

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 DC electric Motor control system using GSM technology is an automatic control system which is capable of receiving a set of command instructions via mobile phone and performs the necessary predefined actions. The mobile unit is interfaced with an intellectual device called Micro controller so that it takes the responsibility of reading

the received commands and before it performs any task.

The aim of this work is to design a speed control system of DC Motor by using GSM technology. This system will be able to switch ON and OFF the DC motor regardless of the distance and to control the DC motor speed at desired speed.

With GSM technology, we can access the operations of a DC electric motor remotely. The DC electric motor control system for Industrial Applications encompasses lighting, security, telecommunications, access and safety, information and entertainment systems and thermal comfort systems (Moazzem I. *etal* 2012).

Besides the Switching and the speed control of the DC electric motor, the system is for automation of Industrial applications which will also give auxiliary control to the user and to enable the user perform any operation from a remote place, thus making this system truly global (Thomas E.K., 2000).

2. Methodology

The system provides a DTMF in-band signaling control for a compound DC electric motor via a microcontroller. A DTMF signaling scheme will be initiated to allow for a real-time control/feedback realization. Speed control "from full-Off to full-On" is initiated by the user via a mobile phone, which is capable of generating DTMF.

The DTMF receiver at the load end receives and decodes the DTMF sequences and evaluates the correctness or otherwise of the DTMF sequences, and executes the desired command contained in the input audio tones. The speed information is contained in the DTMF sequences consisting of a 4-digit user changeable password and a single digit speed selection i.e. pppps# command terminator. Speed setting (0-5) 4digits user PIN.

An audible feedback is sent to the user by the control unit indicative of either a command error or a command successfully executed. If the password is correct then it will check whether the message is for switch ON or OFF the Motor. The device is password controlled,

therefore only the people who know the password is capable to control the device.

Non volatile storage of the system parameters is provided by the On-Chip (EEPROM) on the AT Mega 8515, the pulse width modulation hardware of which is used to generate the duty-cycle modulated drive for a DC motor via a high-power transistor

This system describes the design and implementation of the GSM based control DC motor. The motor to be controlled is fed by a DC source through a rectifier. The controller controls the speed of a DC motor by using PWM techniques. In implementing this work frequency independent PWM output with variable duty cycle that can vary from 0% to 100% is generated.
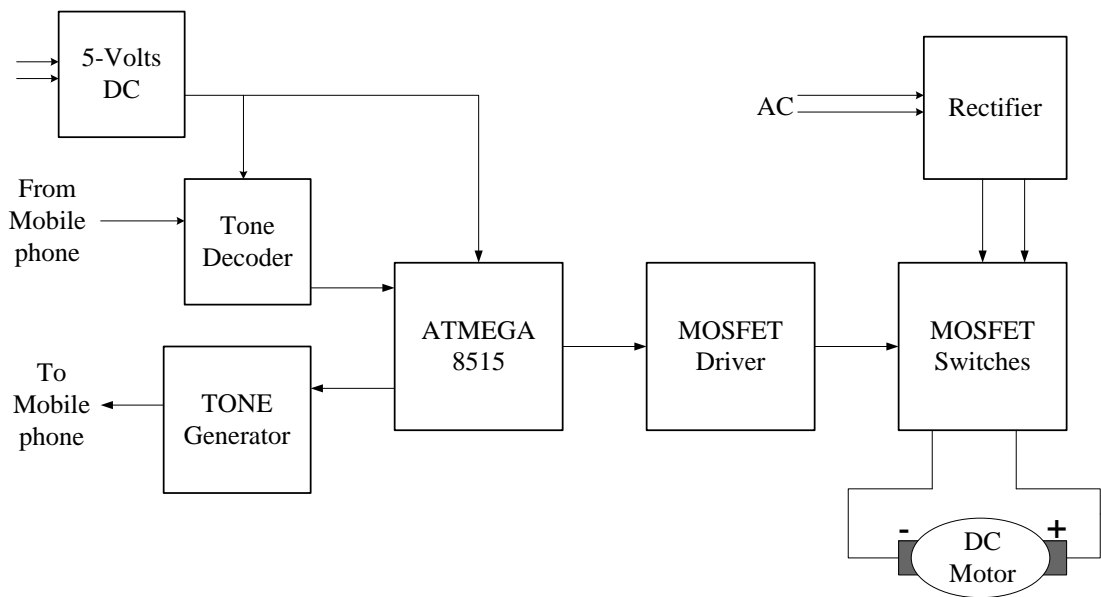

Figure 1:Block Diagram of the System

2.1 Pulse width modulation (PWM)

The speed of the motor depends on three factors: (a) load, (b) voltage, and (c) current. For a given fixed load we can maintain a steady speed by using a method called pulse width modulation (PWM). By changing (modulating) the width of the pulse applied to the DC motor we can increase or decrease the amount of power provided to the motor, thereby increasing or decreasing the motor speed. Notice that, although the

voltage has fixed amplitude, it has a variable duty cycle. That means the wider the pulse, the higher the speed. PWM is so widely used in DC motor control that some microcontrollers come with the PWM circuitry embedded in the chip. In such microcontrollers all we have to do is load the proper registers with the values of the high and low portions of the desired pulse, and the rest is taken care by the microcontroller. This allows the microcontroller to do

other things. For microcontrollers without PWM circuitry, we must create the various duty cycle pulses using software, which prevents the microcontroller from doing other things. The ability to control the speed of the DC motor using PWM is one reason that DC motors are preferable over AC motors. AC motor speed is dictated by the AC frequency of the voltage applied to the motor and the frequency is generally fixed
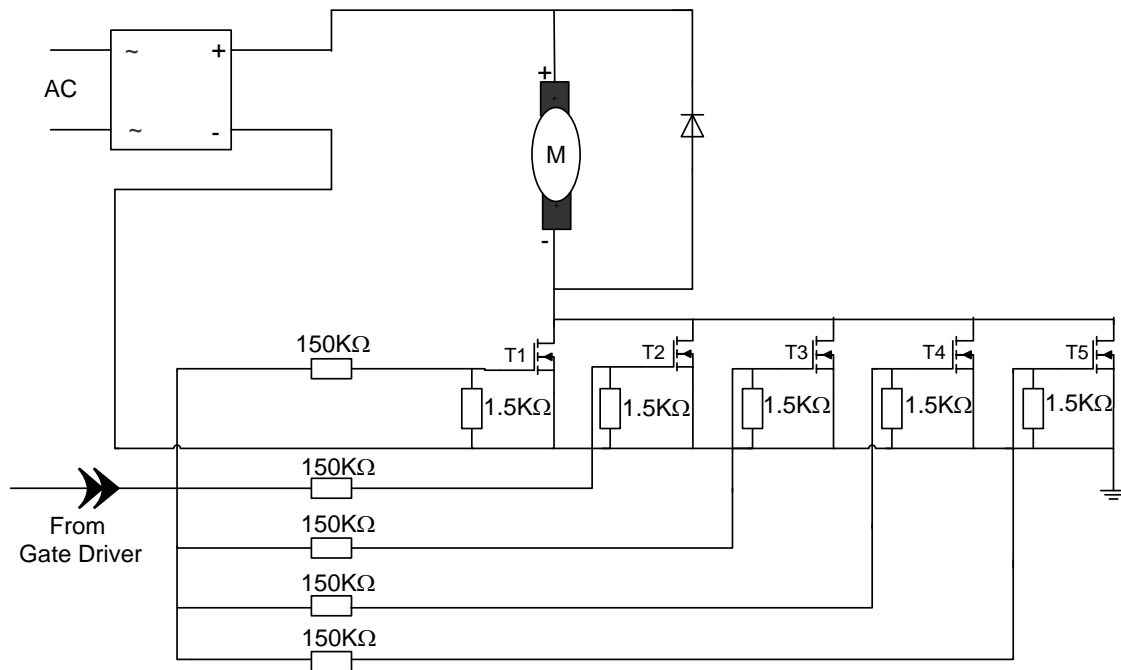

Figure 2:Circuit Diagram of the System

2.3 Circuit description

1. The circuit is based on PWM technique. ATmega-8's timer portion

has this special feature. By adjusting register values (ocr, tccr etc) duty cycles can be controlled.

2. When motor run at 70% of duty cycle, the techogenerator gives a Voltage corresponds to that speed. Now if any load occurs, desired speed will be decreased. Hence the

2.4 SYSTEM OPERATION

At power-up, the firmware loads the last speed setting and ramps the motor speed setting and ramps motor speed up from zero to the preset speed. This takes 5 seconds. The firmware then loops around a code block monitoring the DAV strobe from the CM8870 decoder. When DAV is asserted high, the firmware invokes the code block that reads the user-inputted DTMF sequence.

voltage drop will be less. This voltage is fed into the ADC of microcontroller. By comparing the previous value microcontroller can sense the decrease in the speed.

Two operations are possible, which are speed change and password change; based on the length of the received DTMF sequence either the speed change routine or the PIN change routine is involved. Both operations are preceded by the user inputting the correct 4-digits PIN. The data formats for the operations are shown in Table 1.0

Table 1.0 System Operations Data formats

SPEED CHANGE		
Password	Speed	Delimiter
4	1	1
PIN CHANGE		
Password	New password	Delimiter
4	4	1

Any data sequence not correspondent with either is reported to the remote user as a command error. When a valid command sequence is received, the password content is checked against the last password saved in EEPROM for a match. If the compare passes, the firmware then executes the invoked operation; otherwise a command error is reported over the GSM link.

During data entry, a maximum timeout of 10 seconds is inserted after receiving a valid tone pair. If the command delimiter '#' is not received within the timeout window, or another tone pair is not received, the software exits and invokes the command error code block.

The maximum allowed data length is 11bytes, though the valid commands are 6 bytes and 9 bytes in length. A PIN change command causes an over-write of the last user PIN with newly-offered PIN, and a command okay status report is transmitted to the user.

A speed change command also updates the preset speed to the new speed value, then ramps motor speed up or down to the desired speed, and then generates a command okay report. The limits of speed settings are '0' and '5'. The '0' corresponds to a duty cycle of 0, while '5' corresponds to the maximum duty cycle of 1mS. Speed values between the limits correspond to fractional increments in the duty cycle as in 1/5 increments.

3. Results and Discussion
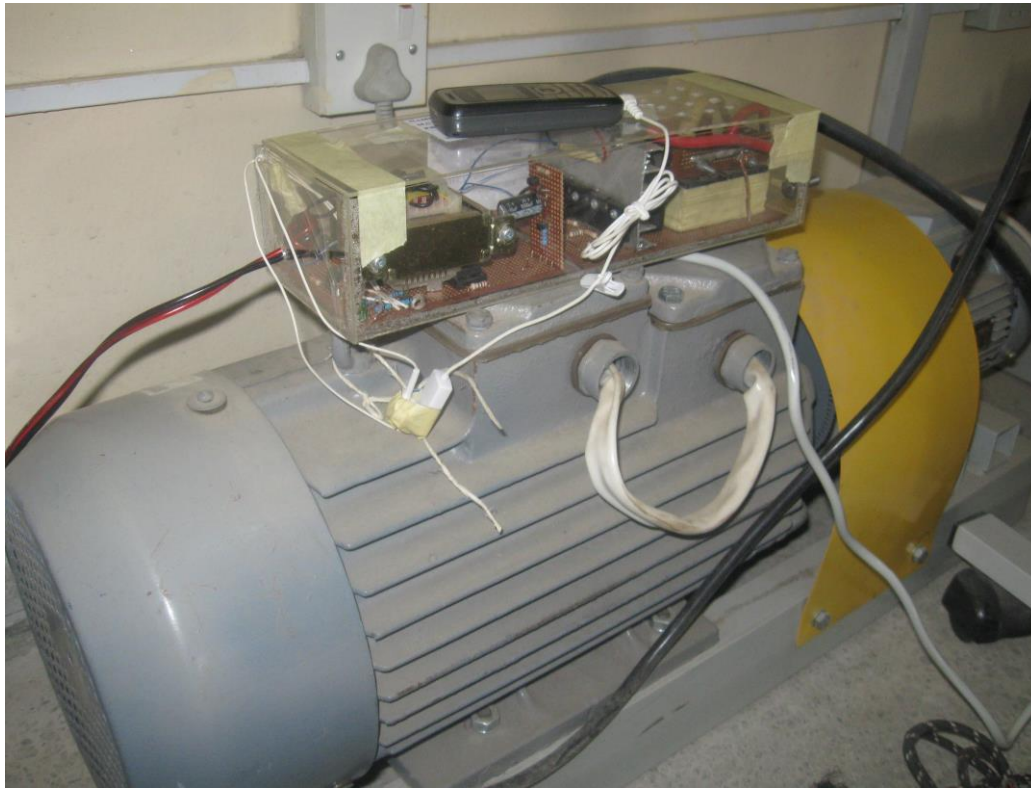
The results obtained are discussed as follows.

Fig. 1:The Control System with the Motor

A pulse with fixed frequency is generated by the microcontroller, which is fed to the base of transistor. Transistor acts here as a switch. The output voltage of the motor is dependent on the amount of the on time of the transistor. The more time transistor remain on more the voltage will produce. A Freewheeling diode is used for back e.m.f. protection.

Table 1.1 Showing the variation of DC voltage across the load due to change in PWM duty cycles. The applied load here is a low voltage adjustable speed controller for pump in other to improved flow at higher pressures. Motor specifications are 48 volts 1800 rpm, 78 Amps DC motor, powered by rectified AC supply.

Table 1: Motor terminal voltage at various duty cycles:

Reference Speed Setting	Reference Duty	PWM Cycle	Input voltage (AC)	Voltage dropped across the Load (DC)
0	0 milli-sec (off)		230 volts	0.00 volt
1	0.2 milli-sec		230 volts	45.60 volts
2	0.4 milli-sec		230 volts	46.30volts
3	0.6 milli-sec		230 volts	47.20 volts
4	0.8 milli-sec		230 volts	47.68volts
5	1.0 milli-sec (max.)		230 volts	47.95volts

Based on table 1.1, we can observe that the reference pulse width modulation (PWM) varies as the reference speed setting changes. At 230 volts input to the system, the voltage dropped across the applied load (48 volts DC Motor) increases as the reference PWM duty cycle increases sequentially due to change in the speed setting from one level to another. However, the duty cycle is a function of the speed of the motor simply because it influences the voltage dropped across the load at different speed setting.

Conclusion

In the control of DC motor, GSM Technology made it possible by the control circuit which is couple with the motor shaft to control the speed of the motor. It is real time control systems which can switch ON and switch OFF the DC motor from any distance using cell phone serves as a trigger.

References

Fitzgerald A.E., Charles K. Jr. and Stephen D. U, Electric Machinery Fourth Edition, McGraw Hill pg 247- 248

Moazzem I., Rahman S. and Matin M.A "Microcontroller based closed-loop automatic speed control of DC motor using PWM" retrieve from

http://www.ieeehtn.org/htn/index.php/GSM_Based_Device_Control (10/2/2012)

Thomas E. K, A Text of Industrial Electronics, 2ⁿᵈ Edition, Person Educational Ltd, Prentice Hall Professional, 2000.