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Remote Speed Control of DC Motor using DTMF Technology

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Abstract:
Direct current (DC) motor has already become an important drive configuration for many applications across a wide range of powers and speeds. The ease of control and excellent performance of the DC motors will ensure that the number of applications using them will continue to grow for the foreseeable future. This project is mainly concerned on remotely controlling the speed of DC motor using DTMF technology. DTMF technology has been used here as a means of acoustic communication for the control of speed of a DC motor by changing its voltage level from anywhere of this world via mobile network. It is a closed-loop real time control system, where optical encoder is coupled to the motor shaft to provide the feedback speed signal to controller. The desired signal for certain speed of the motor is remotely generated by Mobile phones, which is then sent to the Microcontroller through acoustic communication. The control algorithm in the microcontroller controls the speed of the motor at that desired value. Use of DTMF technology as an alternative for RF communication with the advantage of simplicity and audibility .Hence the system stands to be simple, rugged and cost effective. The experimental results show that the system has good linearity and repeatability.

Keywords: *DTMF Technology, acoustic communication, mobile phone, closed loop real time control system*

1. Introduction

Direct current (DC) motors have variable characteristics and are used extensively in variable-speed drives. DC motor can provide a high starting torque and it is also possible to obtain speed control over wide range. An electric motor is a device that transforms electrical energy into mechanical energy by using the motor effect. In home appliances, washers, dryers and compressors are good examples. In automotive, fuel pump control, electronic steering control, engine control and electric vehicle control are good examples of these. In aerospace, there are a number of applications, like centrifuges, pumps, robotic arm controls, gyroscope controls and so on . This project is mainly concerned on remotely controlling the speed of DC motor using DTMF technology. DTMF technology has been used to control of speed of a DC motor by changing its voltage level from anywhere of this world via mobile network. It is a closed-loop real time control system, where optical encoder having a slit cut is coupled to the motor shaft in turn the feedback speed signal is sent to controller. The desired signal for certain speed of the motor is obtained with the help of a mobile phone remotely placed. The tone which is generated is the DTMF tone (Dual tone multiple frequency). This is then decoded by the DTMF decoder MT8870. This generated digital bits are then sent to the Microcontroller through acoustic communication. The control algorithm using Proportional control in the microcontroller controls the speed of the motor at that desired value. Here DTMF technology is used as an alternate for RF communication with the advantage of simplicity and audibility and also overcoming the disadvantage related to distance of transmission. Hence the system stands to be simple, rugged and cost effective.

2. Research Method

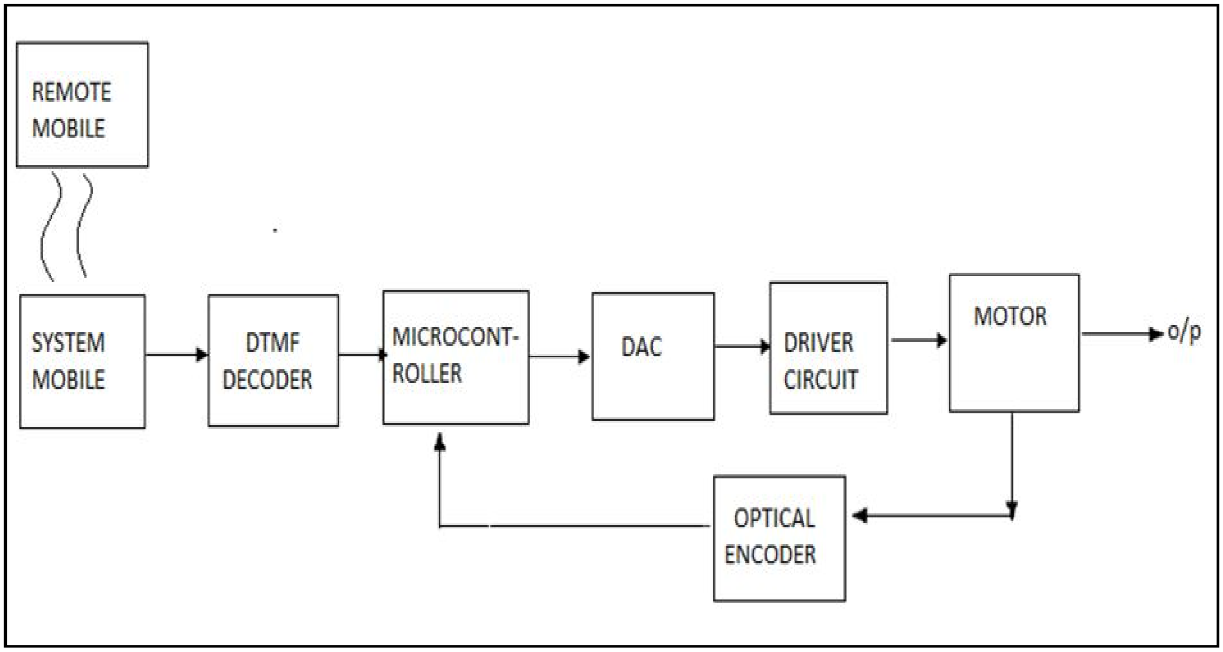

Figure 1: Block Diagram of the Whole System

In this project, two mobile phones are used. The user side phone is connected to the system via mobile network. At the receiving end or system side the mobile is in auto receiving mode. The keys that are pressed at the user side phone sends the generated DTMF tone which is received by the receiver and then decoded by the DTMF decoder circuit. This decoded signal which is the desired set point is sent to the microcontroller .The microcontroller (AT89C51) sends equivalent digital bits to the DAC for its conversion to analog voltage. This in turn will rotate the motor. This is a closed loop system hence an optical encoder with a single slit is attached to the rotating shaft of the motor which in turn passes through the opto coupler built with LED and the phototransistor. The number of rotations of the encoder disk gives us the rpm of the DC motor. The feedback speed is again sent back to the controller. Where it is compared with the set point speed and fed to the output port multiplied with a proportional constant for better control. The" **P"** control algorithm in the microcontroller controls the speed of the motor. Thus the process is executed.

3. Flow Chart

Here the set point is provided by pressing keys at the remote mobile which in turn is received by the system mobile. When DTMF tone is detected it is transmitted to the microcontroller input ports. From its output port the signal is sent to the driver circuit, i.e the power transistor for driving the motor. Receiving the signal the motor starts rotating at the set point speed. Instantaneous pulses are generated from the sensor output, i.e the encoder disk and the Led and the photo transistor.

Figure 2: Flow Chart

These received pulses are counted using a counter which gives the feedback rpm. This is compared with the setpoint speed provided by the DTMF tones. If the setpoint speed equals the feedback speed then the motor rotates at the set point speed itself which is the desired speed .If both are not equal then the signal again goes back to the microcontroller for further operation. In this process when the set point speed becomes zero the motor stops rotating further. Or else signal goes back to the microcontroller and the process keeps on repeating itself. The system goes on anonymously.

4. Result Analysis

The keys pressed at the user side mobile phone generates the required DTMF signal .This tone is detected and decoded by the decoder ic. This decoded bits and its equivalent decimal value is shown in the table.

SL no	**Key positions Pressed at the User side mobile**	**Decoded output bits**				**Equivalentnt Decimal Value**
		q^3	q^2	q^1	q^0	
1.	1	0	0	0	1	14
2.	2	0	0	1	0	13
3.	3	0	0	1	1	12
4.	4	0	1	0	0	11
5.	5	0	1	0	1	10
6.	6	0	1	1	0	9
7.	7	0	1	1	1	8
8.	8	1	0	0	0	7
9.	9	1	0	0	1	6
10.	0	1	0	1	0	5
11	*	1	0	1	1	4
12	#	1	1	0	0	3

Table 1: Decoded Bits and Its Equivalent Decimal Value.

The graph (Fig:3)below is the plot of RPM of the motor at the corresponding voltages from DAC .When the corresponding keys are pressed at the mobile the generated Tone from the decoder is passed through the microcontroller and particular voltages are obtained from the DAC. These are voltages from DAC but are not controller output. These are not subjected to the controller. The graph obtained is linear.

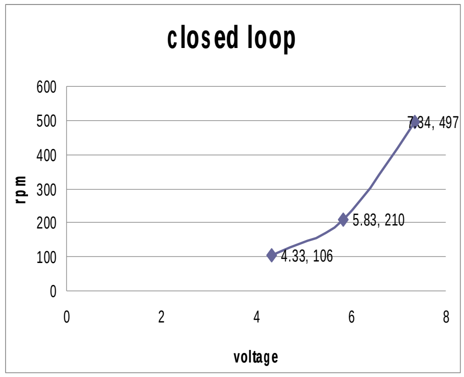

Figure 3: Rpm of the Motor Vs. Dac Output Voltage

The curve below is obtained from the controller output vs. set point RPM. The DTMF output from the decoder is passed through the microcontroller where it is processed with the P control algorithm and the controlled output voltage is obtained. At this voltage the motor rotates at a certain speed which is said to be the controlled output RPM. When the set point voltages are provided to the motor by pressing certain keys at the mobile keypad the motor starts to rotate at certain rpm i.e said to be the set point RPM and this is the desired speed of the motor .The system seems to be quite linear hence bringing the success of this project.

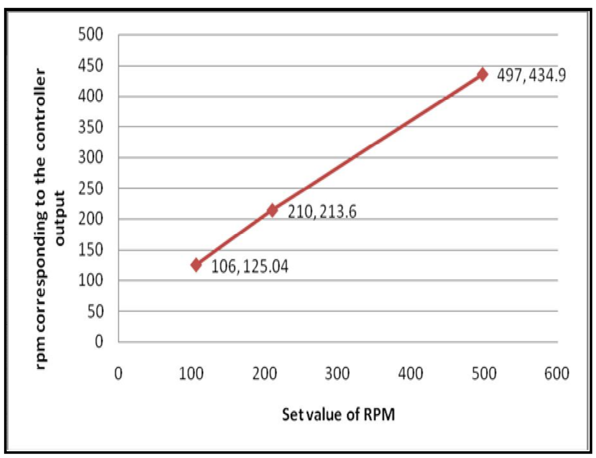

Figure 4: Rpm Corresponding to the Controller Output Vs Set Value of RPM

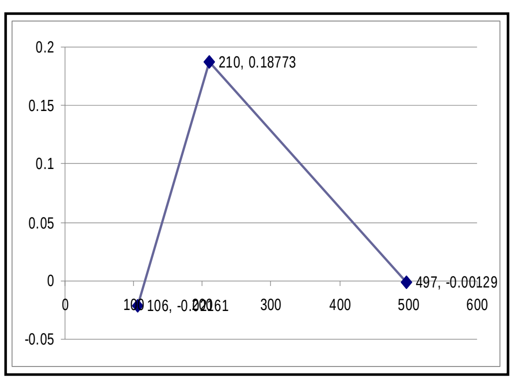

Figure 5: Error Curve

Fig 5 shows the error curve of the set point rpm vs the controller output rpm. The error lies from the range of + 0.18 to -0.021.There is a small percentage of error in the result due to the few manual reasons,i.e the mounting of the motor at the shaft was not perfect which has introduced few errors to the system. But overall the experimental results indicate that the system has good linearity and repeatability.

5. Conclusion

In this Dissertation the remote speed controlling of DC motor using DTMF technology is described. Here set point values are provided to the system via mobile network by acoustic communication. The speed of the DC motor is controlled according to the specified voltages which in turn may be used in various applications. As conventional RF wireless system has distance limitation, DTMF technology has been used here as an alternative method. The percentage error lies in the range + 0.18 to -0.021. It is found that there is a small amount of percentage of error. The error is due to the mounting of the encoder to the shaft. Overall, error is almost negligible. Hence the system is proved to be quite linear. The system developed in this project is very much simple, rugged, and cost effective

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