EE 316 - Electronic Design Project

Project: P2

DC Motor Speed Controller

First Project Report

11 March 2019

Objective

This project can be examined in the three-part. First part is controlling dc motor accurately. Importing point is driving motor with PWM signal which we adjust with duty cycle. In the second part, another signal is generated to count rpm which is produced in the first part, with using led and phototransistor. The aim of the last part is monitoring rpm on the BCD screen so that the accuracy of the second part can be checked. Briefly, duty is driving the motor with a specific duty cycle and generate another signal to control its accuracy.

Group Members

Common efforts: Controlling motor with using PWM, Generating Signal and Error Detection, Using 3-Digit Display

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1. Background Information

1.1. Controlling Motor with PWM

Pulse Width Modulation (PWM) [1] is a method for controlling analog devices with digital outputs by generating discrete parts. Discrete parts determine as duty cycle which produced by a timer. With Half-Bridge Driver, the signal (generated pulses) transformed to DC form so that driver can control motor depends on the width of the pulse in a period.

Timer or can be named counter is basically a clock that measures time intervals in embedded systems. [2]

Half Bridge Driver IC is switching element generally used to drive motors bidirectionally. [3]

Output Voltage of Half-Bridge Driver is equal to;

$$V_{out} = V_{DD} \ x \ \frac{T_{on}}{T}$$

1.2. Generating the Signal and Error Detection

Phototransistor produces current depending on the intensity of light falling on it. [5] With using a trans-impedance amplifier, the current is converted to the voltage. A comparator compares 2 analog inputs and converts them into one digital output. [4]

1.3. Using 3-Digit Display

Each peak of comparator's output signal corresponds to one turn of dc motor. Using with 3-digit BCD counter, peaks can be counted. To display the number of rpm 3-digit seven segment display can be used. To drive each digit of display BCD to seven segment drive should be used.

2. Methods and Proposed Solutions

2.1 Overview

The rpm of the DC motor should be adjustable with the potentiometer in the PWM generating unit. [6]

An Infrared led emits light which placed the bottom of the DC motor's shaft. Phototransistor which placed in front of the led converts light into a current, the amount of current depends on the intensity of light. Thanks to the trance-impedance circuit, produced current will convert and amplified to voltage. The converted sinusoidal signal is not exactly square wave so Comparator Circuit should use to make it expected waveform. Idealized pulses used to create an error signal and count the motor rotation.

Pulses send to BCD Up/Down counter to count rpm of the motor and displayed on 3-digit 7 segment display.

2.2. Controlling Motor

NE555 integrated circuit is used to generate a PWM signal. The duty cycle can be adjustable with a potentiometer which connected to NE555 along with capacitors and resistors. After generating the PWM signal, half bridge driver (L293 [7]) helps us to drive the motor at the set duty cycle level which adjusted with a potentiometer.

2.3. Generating the Signal and Error Detection

An Infrared led placed the bottom of the motor's shaft. A phototransistor placed in front of the led. The phototransistor is a better option for this project because it has a bigger output current than a photodiode. Between led and transistor, a perforated disc attached to the motor's shaft. When the motor starts running, the disk will turn, and phototransistor detects some light from infrared led. Phototransistor converts light to sinusoidal current wave because the perforated disc is rotating so the intensity of the light is changing. This current will be converted to voltage and amplified in the trans-impedance amplifier IC (LM358). An ideal square wave will be generated from that voltage with using the comparator. The output signal from comparator will be converted to voltage with using frequency to voltage converter. That voltage must have the same value with the voltage what input of the motor has. To make sure that these values are equal to each other, an IC or feedback circuit should be used.

2.4. BCD up-down counters

The peak value of the comparator IC's output signal corresponds to one round of dc motor. To count the peaks MC14553 IC will be used and to display the number of rpm 3-digit seven segment display will be used. To drive the display MC14543 IC will be used. The displayed number represents the 1 in 10 rpm every second. [8], [9]

References

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4. A Wikipedia article on "**Comparator**"
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