

Speed Control, Temperature Monitoring and Speed Synchronism using Variable BLDC Motor with DC Motor using Microcontroller

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Abstract – Recent advent in Machine Technologies is outpacing current Industry Standards due to which Industries are racing to incorporate these latest technologies to increase their overall efficiency and improve productivity. Sometimes these changes result in changing the existing infrastructure completely which may incur heavy capital cost. Therefore, there is a dire need to incorporate new technologies without replacing existing infrastructure. This project tries to fulfill these parameters by improving efficiency of current infrastructure. Industries rely on multiple motor setups for which they rely on Conventional Setups i.e., systems comprising of gears, pulleys, shafts etc. Especially synchronism between these motors is at heart of their operations of various Industries ranging from Textile to Paper Mills. The basic objective behind synchronism run these motors at the same speed to prevent damage to product. This project is developed to minimize differential speed error and to regulate speed of each motor using a single controller. Further a temperature monitoring sensor is also connected to provide temperature of motors. Data aggregated from this system can be displayed to display unit via serial communication device which can be beneficial from maintenance point of view.

Key Words: Microcontroller, Brushless DC Motor, DC Motor, Synchronism, Electronic Speed Controller

1. INTRODUCTION

The Multiple motor units which are installed at Industries such as Textile, Paper Mills must run at same synchronized speed in order to avoid issues like Differential Speed Error for this Industries deploy speed controller for each motor which have increased cost as well as maintenance. Therefore, deployment of PIC16F886 microcontroller as universal module for speed control of these multiple motor system will reduce complexity of overall operations. The Brushless DC (BLDC) Motor as well as DC Motor are backbone of various Industries for their operations. BLDC Motor rely on closed loop Pulse Width Modulation (PWM) technique for its speed control. Speed Control or Speed Regulation is accomplished by changing voltage level which is done by adjusting duty cycle of PWM.

Basically, Duty Cycle of PWM is generated using timer of microcontroller by varying pulses of input voltage for the on and off duration which causes the PWM voltage control with high accuracy which in turn transmit signal to DC Motor Driver to drive the DC Motor. Also, an LM35 temperature sensor is connected to these motors for real time

temperature monitoring. This data is collected and displayed on a monitor.

2. PROPOSED SYSTEM:

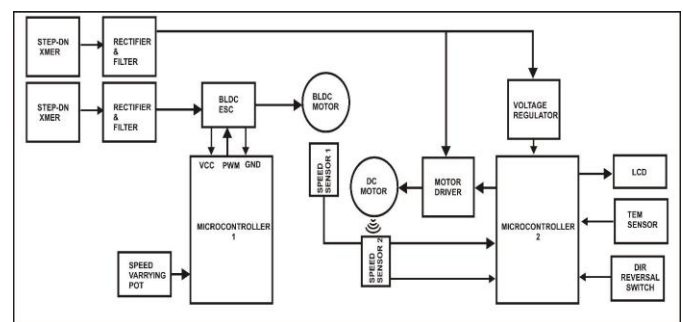


Fig-1: Block Diagram of Proposed System

2.1 HARDWARE REQUIREMENTS:

1. PIC16F886 Microcontroller:

This microprocessor is a preferred choice for this proposed system as it checks all the right boxes for this proposed system. The 28-pin microcontroller is perfect for interfacing with motors due to its easy interfacing capability as well as high flash memory rewrite cycle with support of serial communication.

2. PIC12F675 Microcontroller:

The 12-pin Microcontroller is based on flash architecture but devoid of features such as USART, SPI and I2C. However, features like In-Circuit Serial Programming, Watchdog Timer and Oscillator start up timer make this device an ideal candidate for real time applications.

3. Step Down Transformer (12V/2A):

12-0-12 V Center-Tap Transformer is used for powering the circuit. It has a high current drain (2A) which is required for this type of system.

4. Brushless DC (BLDC) Motor:

Due to its better speed versus torque characteristics, its high dynamic response, noiseless operation, long operating life making it a preferred choice for wide range of applications such as in Appliances Industries, Medical, Automation Industries to name a few. Inclusion of motor for this system

is to explore its synchronizing capability and analyze its future prospects.

5. DC Motor:

For a long time, DC Motors are used for various applications such as synchronizing of multiple motor system etc. It boasts features such as rugged design, low maintenance, operate reliably in any environment. In this proposed system, 12 V, 2400 rpm DC Motor is with gearbox is used for speed control and synchronization between multiple motors.

6. Electronic Speed Controller (ESC) for BLDC Motor:

The Electronic Speed Controller controls speed by activating the appropriate MOSFET's for creating rotating magnetic field for rotation of motor. It follows a speed reference signal (from any manual input) and varies the switching rate of a bunch of field effect transistors. By adjusting the duty cycle or switching frequency of these transistors, the speed of motor is regulated. The rapid switching of transistors is responsible to produce its characteristics high pitched whine especially at lower speed.

7. L289N Motor Driver:

This dual bidirectional motor driver, is based on the very popular L298 Dual H-Bridge Motor Driver Integrated Circuit. The circuit will allow user to easily and independently control two motors of up to 2A each in both directions. It is ideal for robotic applications and well suited for connection to a microcontroller requiring just a couple of control lines per motor. It can also be interfaced with simple manual switches, TTL logic gates, relays, etc.

8. IR Proximity Sensor:

These sensors are designed to detect obstacles in front of sensor. A continuous beam of infrared light is transmitted, when an object comes in path of sensor it obstructs the beam causing to register the reflected light as output. In this project, it has been used for monitoring speed of motors.

9. LM35 Temperature Sensor:

It is a temperature measuring sensor having analog voltage proportional to the temperature. It provides output voltage in centigrade. It doesn't require any external calibration circuitry. Sensor's sensitivity is 10mV/degree Celsius.

10. CP2102 USB to Transistor-Transistor Logic (TTL) Module:

The CP2102 is a highly-integrated USB-to-UART Bridge Controller providing a simple solution for updating RS-232 designs to USB using a minimum of components and PCB space. The CP2102 includes a USB 2.0 full-speed function controller, USB transceiver, oscillator, EEPROM, and asynchronous serial data bus (UART) with full modem control signals in a compact 5 x 5 mm MLP-28 package. No

other external USB components are required. This module is used for serial communication.

11. Trimpot (Trimming Potentiometer):

A Trimpot or trimmer potentiometer is a small potentiometer which is used for adjustment, tuning and calibration in circuits. When they are used as a variable resistance (wired as a rheostat) they are called preset resistors. Trimpot or presets are normally mounted on printed circuit boards and adjusted by using a screwdriver. The material they use as a resistive track is varying, but the most common is either carbon composition or cermet.

12. Other Components:

Components such as Crystal Oscillator, Filter capacitors, 7805 Voltage Regulator IC, Freewheeling Diode, Storage Capacitors, 16x2 Alphanumeric LCD Display, Ceramic Capacitors, Resistors and Diodes are also connected.

3. EXPERIMENTAL SETUP:

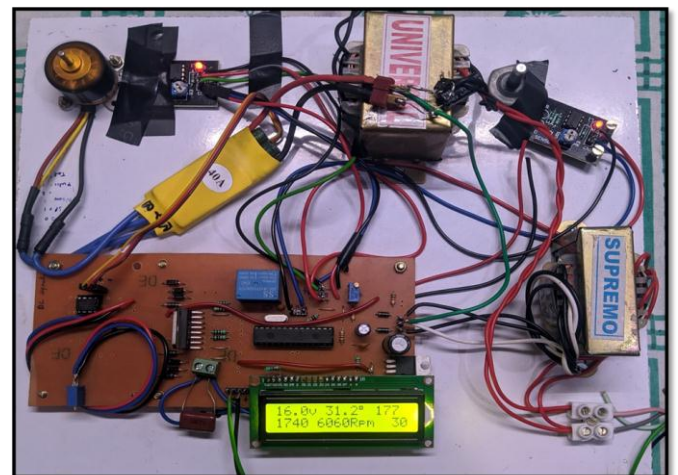
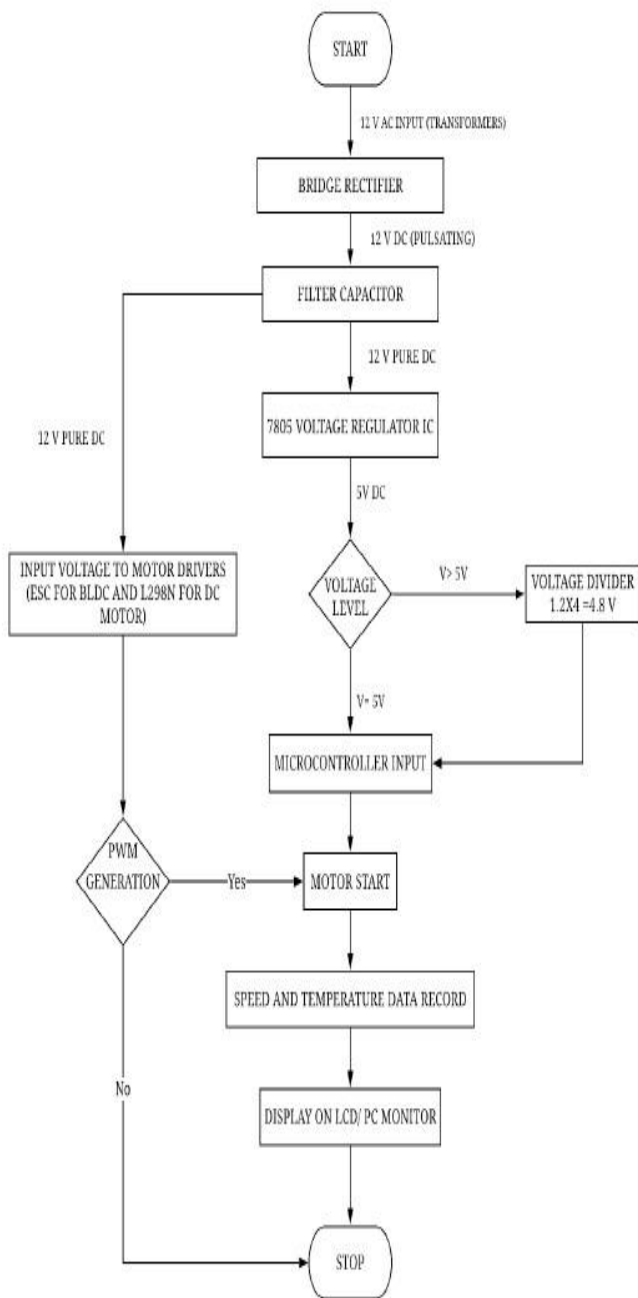


Fig-2: Hardware Setup

The experimental setup as shown above comprises mainly two motors Brushless DC Motor and DC Motor respectively controlled by a single microcontroller PIC16F886. Another microcontroller PIC12F683 Microcontroller is deployed for sensors interfacing and for real time data collection. An IR proximity sensor and LM35 temperature sensor is interfaced for speed and temperature data collection which is relayed via CP2102 USB Module to a display unit at a real time basis.

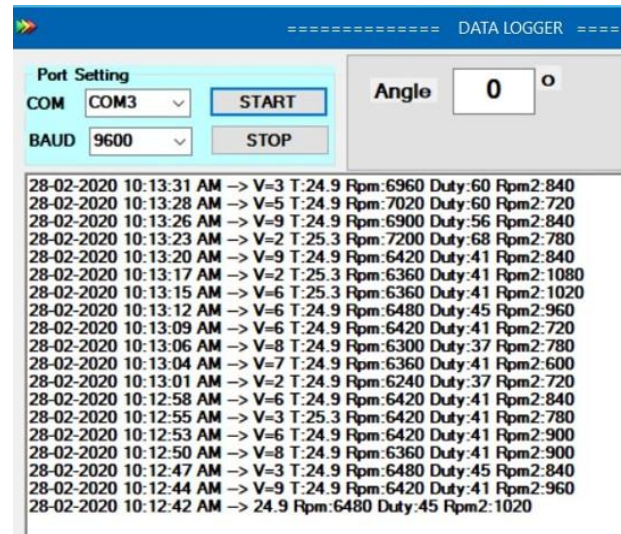
4. FLOWCHART:



Above flowchart represents a brief overview of working of proposed system

5. RESULTS:

The results obtained on controlling speed, monitoring temperature of both motors BLDC and DC Motors respectively using a single PIC16F886 microcontroller.



The above results show speed (in RPM) of both motors in which RPM1 is of BLDC Motor and RPM2 is of DC Motor. Temperature is represented by T.

6. CONCLUSION:

As shown above it is possible to control experimental motor setup using a single microcontroller. In a cost-efficient move proposed system used USB module instead of wireless. In future prospect Wireless Modules such as Wi-Fi, Bluetooth, ZigBee etc. can be used. The proposed system also demonstrated that any type of motor setups can be operated. If two or more than two motors of similar types are installed for example two BLDC Motors or two DC Motors are connected then speed synchronism is can be achieved using existing system.

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