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Speed Control of Brushless Dc (Bldc) Motor Using Infrared Ray (IR) Sensor of Controllers

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Abstract- **Brushless DC (BLDC) motor speed control using Infrared Ray (IR) sensor is presented in this paper. Because of various advantages of BLDC motors over conventional DC motors the brushless DC motors are widely used. Fast and accurate speed responses of the system, quick recovery of speed from any disturbance and sensitivity to motor parameters are the requirements of the high speed motor. Operations of the motor at proper reference speed IR sensors are used. High control accuracy, increased efficiency, adaptability, decreased startup time and increased starting torque benefits can be attained in the present system. In the present work IR sensors are used for the speed control of BLDC motors. IR sensor connected to microcontroller unit is used to control the motor speed and know the motor live speed on LCD. Microcontroller automatically takes necessary action like speed control, etc. There will be a particular format that needs to be set the speed and get the speed from the BLDC motor. The Microcontroller used is programmed using Embedded C language. The "BLDC motor speed Synchronizer" using PIC16F73 microcontroller is an exclusive project which is used to control speed and direction of BLDC motor using IR SENSOR and PWM technique. BLDC motor status will display on LCD.**

Index Terms— Brushless DC motor (BLDC), Microcontroller, Infrared Ray (IR) sensor, pulse width modulation (PWM)

1. INTRODUCTION

The purpose of this project is to control the speed of BLDC Motor using Microcontroller and IR sensor. This uses a PWM (Pulse Width Modulation) technique to control the speed of motor from 0% to 100%. The speed of the motor is measured using contact-less speed measurement technique. Speed control is done using PWM (Pulse Width Modulation) method. IR sensor connected to microcontroller unit is used to control the motor and know the motor live speed on LCD. Microcontroller automatically takes necessary action like speed control, etc. There will be a particular format that needs to be set the speed and get the speed from the BLDC motor. The Microcontroller used is programmed using Embedded C language. In this paper, a brushless DC motor with distributed winding and a special form of PM-rotor with special stator periphery are described which develop a speed control system for a BLDC motor by closed loop control technique. The proposed system uses a microcontroller of the 8051 family and a rectified-power supply. A set of IR transmitter and photodiode are connected to the microcontroller for counting the number of rotations per minute of the DC motor as a speed sensor. Opto coupler is connected to trigger the MOSFET for driving the BLDC motor which is duly interfaced to the microcontroller. A matrix keypad is interfaced to the microcontroller for controlling the speed of the motor. The speed control of the BLDC motor is archived by varying the duty cycles (PWM Pulses) from the microcontroller according to the program. The microcontroller receives the percentage of duty cycles from the keypad and delivers the desired output to switch the motor driver so as to control the speed of the BLDC motor. The speed sensed by the IR sensor is given to the microcontroller to display it on the LCD display.

II. LITERATURE SURVEY

According to Lin Bai, et al (2011), electric drive system with BLDC motor has better dynamic responses. It is determined that BLDC motor is the best choice for high efficiency motor. The control system for BLDC motor is designed and simulated using MATLAB/Simulink. The output shows that the control system can work properly and the dynamic response is good. Moreover different BLDC motors can be applied into control system. Chun, et al (2014) develops the brushless dc (BLDC) motor sensorless control system for an automotive fuel pump. The sensorless techniques that are based on a hysteresis comparator and a potential start-up method with a high starting torque are suggested. The hysteresis comparator is used to compensate for the phase delay of the back EMFs due to a low-pass filter (LPF) and also prevent multiple output transitions from noise or ripple in the terminal voltages.

Lee B K et al (2001) have given an overview of reduced parts converter topologies and control strategies for power correction and they have reviewed and developed a motor control systematic design methodology. The detailed operational principles are examined and the performance comparison is discussed with all the merits and demerits. By

following this several low cost power converters are developed.

Ali Keyhani, et al (2002) have developed an integrated virtual learning system for the motor drive systems were developed and they discuss about the DSP based control schemes for motor drive applications. They also discuss about the circuit design and control algorithm development of a pulse width modulation (PWM) voltage source inverter (VSI) for 3 phase brushless DC (BLDC) motor control applications.

The literature survey on basics of PMBLDC drive system, various converter topologies and fuzzy logic controlled PMBLDC drive system are presented in this chapter. The buck converter fed PMBLDC drive system is compared with and without snubber, similarly an interleaved buck converter fed PMBLDC motor drive is analyzed with PI, PID and Fuzzy logic controller. This work explores the possibility of using best a more appropriate converter for PMBLDC motor drive and Sensors to control the PMBLDC drive.

III. PROJECT OVERVIEW

An embedded system is a combination of software and hardware to perform a dedicated task. Some of the main devices used in embedded products are Microprocessors and Microcontrollers.

Microprocessors are commonly referred to as general purpose processors as they simply accept the inputs, process it and give the output. In contrast, a microcontroller not only accepts the data as inputs but also manipulates it, interfaces the data with various devices, controls the data and thus finally gives the result.

The "BLDC motor speed Synchronizer" using PIC16F73 microcontroller is an exclusive project which is used to control speed and direction of BLDC motor using IR SENSOR and PWM technic. BLDC motor status will display on LCD.

IV. PROPOSED METHODOLOGY

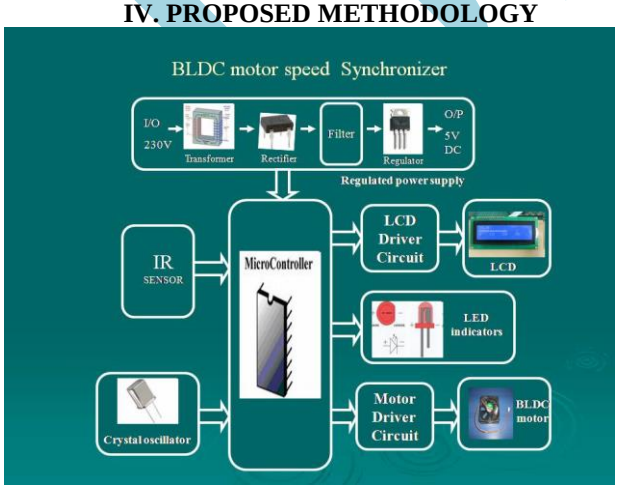


Fig. 1 Block diagram of SMS based BLDC motor speed controller

This project mainly consists of following blocks:

1) Microcontroller
2) Regulated power supply
3) IR sensor
4) BLDC motor
5) Comparator
6) Crystal Oscillator

Software/IDE Using:

- IDE AVR-v4 Compiler/Embedded C Programming
- Prog ISP-7 pit4me pumping code into 1.**microcontroller**
- Proteus-7 or Hardware simulation/circuit designing

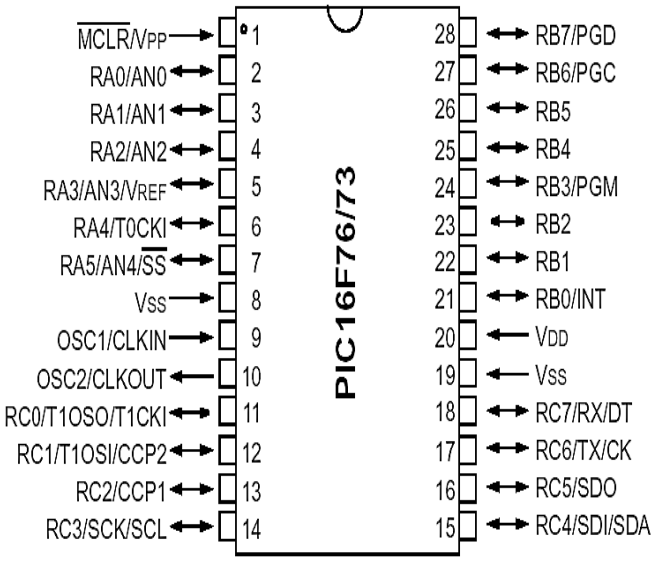
1. Microcontroller:

Fig. 2 Microcontroller PIC16F73

The PIC16F73 CMOS FLASH-based 8-bit microcontroller is upward compatible with the PIC16C73B/74B/76/77, PIC16F873/874/876/877devices. It features 200 ns instruction execution, self-programming, an ICD, 2 Comparators, 8 channels of 8-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, a synchronous serial port that can be configured as either 3-wire SPI or 2-wire I2C bus, a USART, and a Parallel Slave Port.

A. Pin description

PIC16F73 has a total of 28 pins. It is most frequently found in a DIP28 type of case but can also be found in SMD case which is smaller from a DIP. DIP is an abbreviation for Dual in Package. SMD is an abbreviation for Surface Mount Devices suggesting that holes for pins to go through when mounting aren't necessary in soldering this type of a component.



2. Regulated power supply:

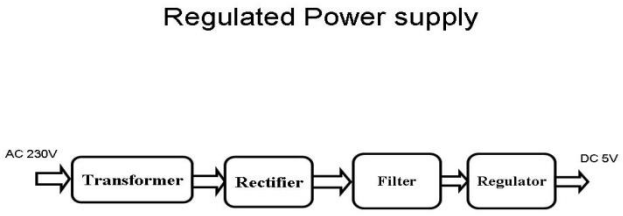


Fig. 3 Regulated Power Supply

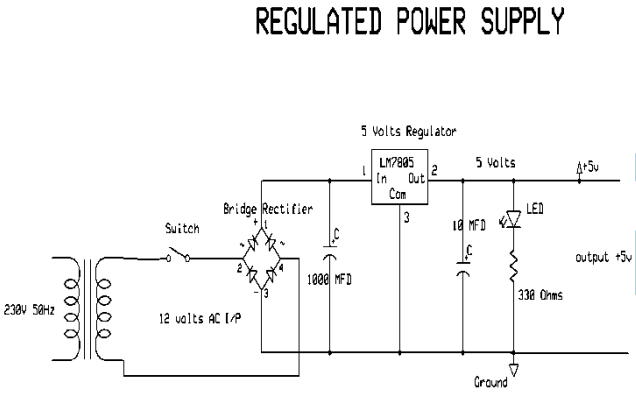


Fig. 3 Circuit diagram of Regulated Power Supply with Led connection

The components mainly used in above figure are

- 230V AC MAINS
- TRANSFORMER
- BRIDGE RECTIFIER(DIODES)
- CAPACITOR
- VOLTAGE REGULATOR(IC 7805)
- RESISTOR
- LED(LIGHT EMITTING DIODE)

3. IR sensor:

A.IR transmitter and receiver

Basics of IR transmitter and receiver transmitter and receiver are commonly used in engineering projects for remote control of objects. In particularly, in Robotic system uses transmitter and receiver. Here we would like to describe the basics if IR transmitter and receiver. An electroluminescent IR LED is a product which requires care in use. IR LED's are fabricated from narrow band hetero structures with energy gap from 0.25 to 0.4 eV. Infrared transmitter emits IR rays in planar wave front manner. Even though infrared rays spread in all directions, it propagates along straight line in forward direction. IR rays have the characteristics of producing secondary wavelets when it collides with any obstacles in its path. This property of IR is used here is when IR rays gets emitted from LED, it moves in the direction it is angled. When any obstacle interferes in the path, the IR rays get cut and it produces secondary wavelets which propagates mostly in return direction or in a direction opposite to that of the primary waves, which produces the net result like reflection of IR rays.

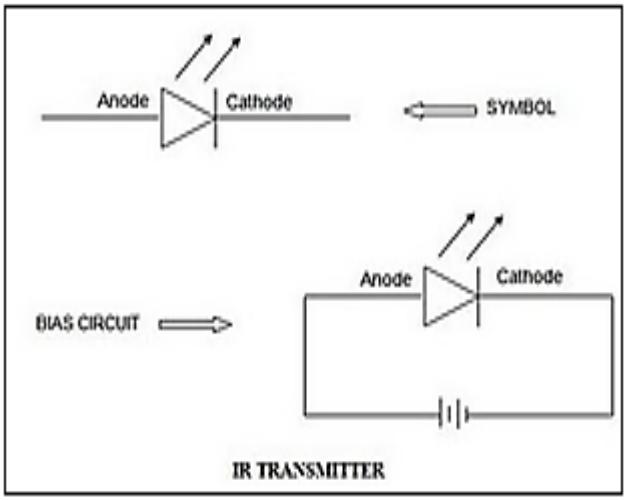


Fig. 4 IR Transmitter

B. Basics of IR receiver:

Infrared photo receiver is a two terminal PN junction device, which operates in a reverse bias. It has a small transparent window, which allows light to strike the PN junction. A photodiode is a type of photo detector capable of converting light into either current or voltage, depending upon the mode of operation. Most photodiodes will look similar to a light emitting diode. They will have two leads, or wires, coming from the bottom. The shorter end of the two is the cathode, while the longer end is the anode. A photodiode consists of PN junction or PIN structure. When a photon of sufficient energy strikes the diode, it excites an electron thereby creating a mobile electron and a positively charged electron hole. If the absorption occurs in the junction's depletion region, or one diffusion length away from it, these carriers are swept from the junction by the built-in field of the depletion region. Thus holes move toward the anode, and electrons toward the cathode, and a photocurrent is produced.

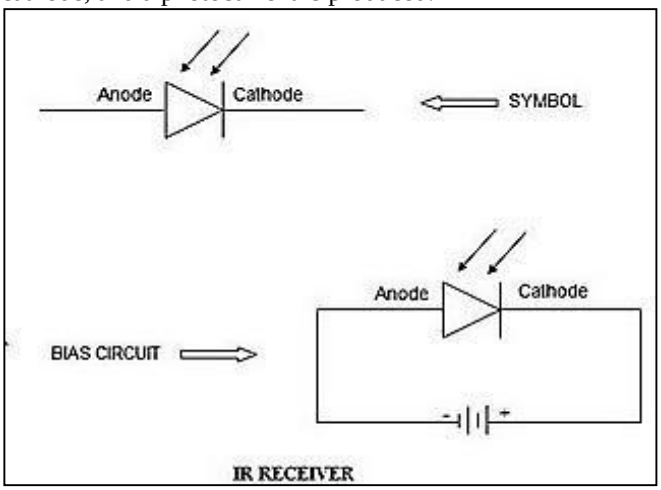


Fig. 4 IR Receiver

C. Obstacle Sensor:

Fig. 5 Obstacle Sensor

This sensor is a short range obstacle detector with no dead zone. It has a reasonably narrow detection area which can be increased using the dual version. Range can also be increased by increasing the power to the IR LEDs or adding more IR LEDs

4. BLDC motor:

Brushless DC motors may have:

An external PM rotor and internal electromagnet stator
An internal PM rotor and external electromagnet stator

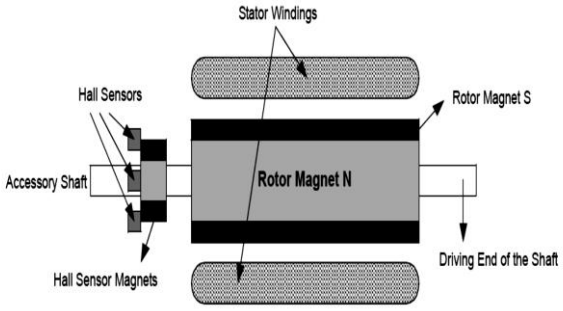
Many of the limitations of the classic permanent magnet "brushed" DC motor are caused by the brushes pressing against the rotating commutator creating friction

- As the motor speed is increased, brushes may not remain in contact with the rotating commutator
- At higher speeds, brushes have increasing difficulty in maintaining contact
- Sparks and electric noise may be created as the brushes encounter flaws in the commutator surface or as the commutator is moving away from the just energized rotor segment
- Brushes eventually wear out and require replacement, and the commutator itself is subject to wear and maintenance

Brushless DC motors avoid these problems with a modified design, but require a more complex control system.

A. Working of BLDC Motor:

A brushless DC motor uses electronic sensors to detect the position of the rotor without using a metallic contact .Using the sensor's signals, the polarity of the electromagnets' is switched by the motor control drive circuitry .The motor can be easily synchronized to a clock signal, providing precise speed control.



BLDC Motor Specifications:

- Standardized Modules
- Brings high volume pricing to low volume orders
- Makes product performance easy to specify
- Ensures maximum product quality
- Flexible Performance
- Operates from 12-48V dc power sources
- Operates in speed or torque mode
- 4 quadrant closed loop or 2 quadrant open loop
- Compact integrated encoder option

5. Comparator

A comparator is a device that compares two voltages or currents and outputs a digital signal indicating which is larger. It has two analog input terminals and one binary digital output terminal.

6. Crystal oscillator:

A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a precise frequency.

7. LCD Display:

A. LCD Background:

One of the most common devices attached to a micro controller is an LCD display. Some of the most common LCD's connected to the many microcontrollers are 16x2 and 20x2 displays. This means 16 characters per line by 2 lines and 20 characters per line by 2 lines, respectively.

Basic 16x 2 Characters LCD

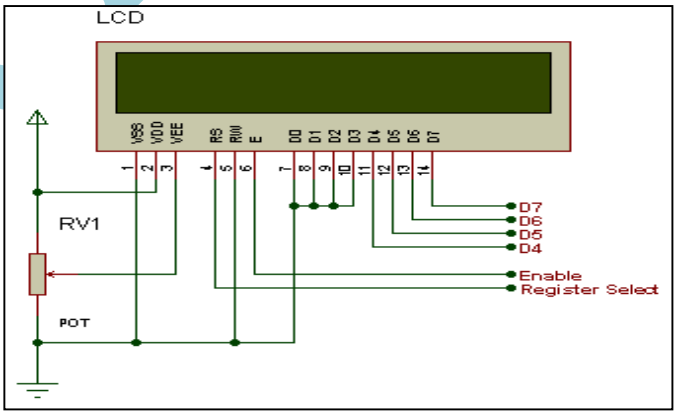


Fig. 6 LCD Pin Diagram

V. SOFTWARE DESCRIPTION

This project is implemented using following software's:

- Express PCB – for designing circuit
- PIC C compiler - for compilation part
- Proteus 7 (Embedded C) – for simulation part

A. Express PCB:

Express PCB is a software tool to design PCBs specifically for manufacture by the company Express PCB (no other PCB maker accepts Express PCB files). It is very easy to use, but it does have several limitations.

- It can be likened to more of a toy then professional CAD program.

• It has a poor part library (which we can work around)
• It cannot import or export files in different formats
• It cannot be used to make prepare boards for DIY production
Express PCB has been used to design many PCBs (some layered and with surface-mount parts. Print out PCB patterns and use the toner transfer method with an Etch Resistant Pen to make boards. However, Express PCB does not have a nice print layout. Here is the procedure to design in Express PCB and clean up the patterns so they print nicely.

B. Pic Compiler:

PIC compiler is software used where the machine language code is written and compiled. After compilation, the machine source code is converted into hex code which is to be dumped into the microcontroller for further processing. PIC compiler also supports C language code. It's important that you know C language for microcontroller which is commonly known as Embedded C. As we are going to use PIC Compiler, hence we also call it PIC C. The PCB, PCM, and PCH are separate compilers. PCB is for 12-bit opcodes, PCM is for 14-bitopcodes, and PCH is for 16-bit opcode PIC microcontrollers.

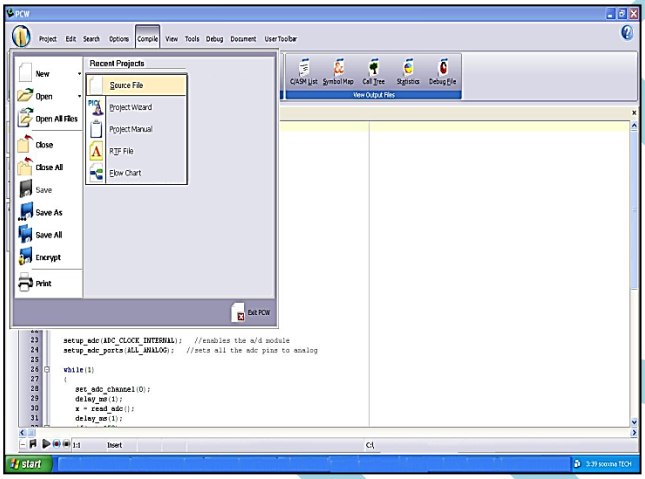


Fig 7: Picture of opening a new file using PIC C compiler

C. Proteus:

Proteus is software which accepts only hex files. Once the machine code is converted into hex code, that hex code has to be dumped into the microcontroller and this is done by the Proteus. Proteus is a programmer which itself contains a microcontroller in it other than the one which is to be programmed. This microcontroller has a program in it written in such a way that it accepts the hex file from the pic compiler and dumps this hex file into the microcontroller which is to be programmed

VI. CONCLUSION

In this paper BLDC motor speed controller was designed to operate a BLDC motor using IR sensor and PWM techniques .Status will display on LCD. Integrating features of all the hardware components used have been developed in it. Presence of every module has been reasoned out and placed carefully, thus contributing to the best working of the unit. Secondly, using highly advanced IC's with the help of growing technology, the project has been successfully implemented. Thus the project has been successfully designed and tested.

VII. FUTURE SCOPE

In future scope we are adding GSM Modem connected to microcontroller unit is used to control the motor and know the motor live speed on LCD. Microcontroller automatically reads the SMS messages stored in the SIM card and takes necessary action like speed control, etc. There will be a particular format that needs to be sent through SMS to set the speed and get the speed from the BLDC motor. The Microcontroller used is programmed using Embedded C language. This project can be extended by using GPRS technology, which helps in sending the monitored and controlled data to any place in the world. The temperature controlling systems like coolant can also use in places where temperature level should be maintained.

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