# INTRODUCTION

Permanent-magnet excited brushless DC motors are becoming increasingly attractive in a large number of applications due to performance advantages such as reduced size and cost, reduced torque ripples, increased torque-current ratio, low noises, high efficiency, reduced maintenance and good control characteristics over a wide range in torque–speed plan.

In general, Brushless DC motors such as fans are smaller in size and weight than AC fans using shaded pole or Universal motors. Since these motors have the ability to work with the available low voltage sources such as 24-V or 12-V DC supply, it makes the brushless DC motor fans convenient for use in electronic equipment, computers, mobile equipment, vehicles, and spindle drives for disk memory, because of its high reliability, efficiency, and ability to reverse rapidly.

Brushless dc motors in the fractional horsepower range have been used in various types of actuators in advanced aircraft and satellite systems. Most popular brushless DC motors are mainly three phases which are controlled and driven by full bridge transistor circuits. Together with applying permanent magnet excitation, it is necessary to obtain additional torque components. These components can be obtained due to a difference in magnetic permeance in both quadrature and direct axis; therefore, reluctance torque is developed, and torque null regions are reduced significantly.

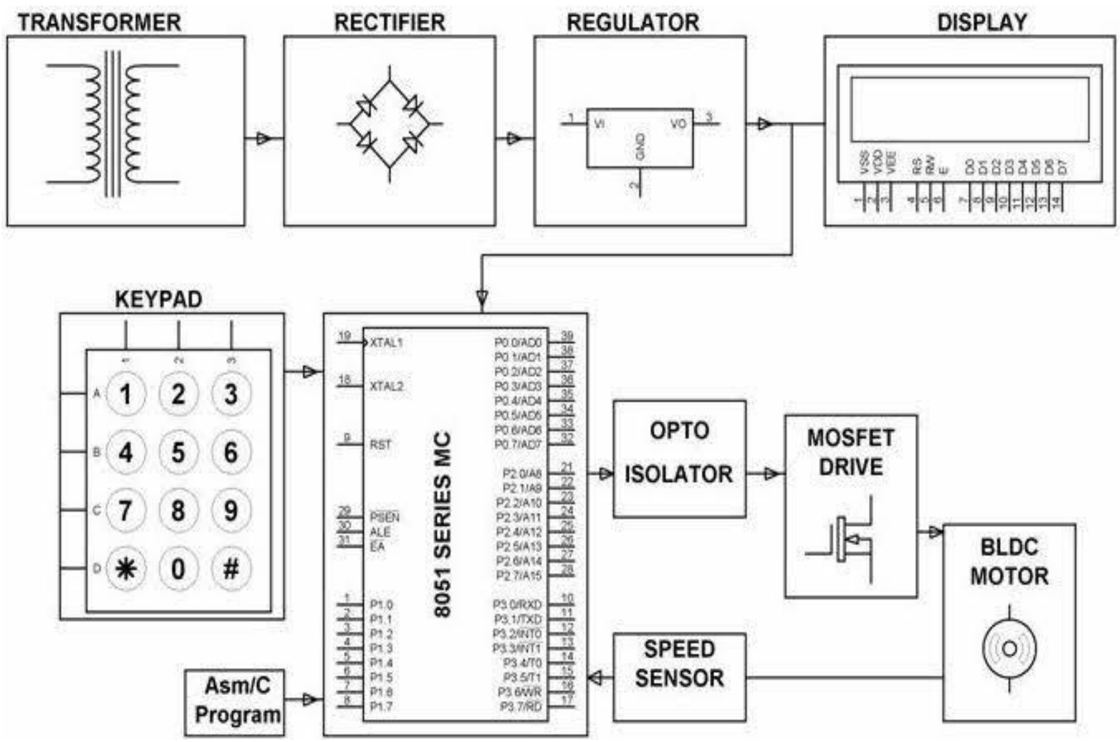
In this project, a brushless DC motor with distributed winding and a special form of PM-rotor with special stator periphery are described. Which develop a speed control system for a BLDC motor by closed loop control technique. The proposed system uses a microcontroller of the 8051 family and a rectified-power 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. Optocoupler 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 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.

# BLOCK DIAGRAM




- Transformer
- Rectifier
- Regulator
- LED Display
- 4*4 Matrix Keypad
- 8051 Microcontroller IC
- BLDC Motor

# DESCRIPTION OF PROJECT

BLDC motors are very popular in a wide variety of applications compared with a DC motor; the BLDC motor uses an electric commutator rather than a mechanical commutator, so it is more reliable than the rotor’s magnetic flux, so BLDC motors achieve higher efficiency.

It has become possible because of their superior performance in terms of high efficiency, fast response, weight, precise and accurate control, high reliability, maintenance free operation, brushes construction and reduced size, torque delivered to motor size is higher making it useful in applications where space and weight are critical, thermal overload and under load protection is provided.

The inverter used is a three-phase bridge inverter making use of IGBT switches and suitable gate pulses are provided. Brush less DC motor requires external commutation circuit to rotate the rotor.

Rotor position is very important. HALL SENSOR senses the position of the coil accurately. The commutation logic used here is to both turn ON and OFF the IGBT switches using gate pulses regulated in a suitable manner so that only two switches are turned ON at a time, others being.

The current reference is determined by a PI regulator, which maintains the rotor average speed constant. The PI controller is used here suitably as the error dealt is steady state error. PI controller will eliminate forced oscillations and steady state error resulting in operation of on-off controller and P controller respectively.

However, introducing integral mode has a negative effect on speed of the response and overall stability of the system. Thus, PI controller will not increase the speed of response. It can be expected since PI controller does not have means to predict what will happen with the error in near future. This problem can be solved by introducing derivative mode which has ability to predict what will happen with the error in near future and thus to decrease a reaction time of the controller. PI controllers are very often used in industries, especially when speed of the response is not an issue.

# OPERATING PRINCIPLE

Brushless DC motors were developed from conventional brushed DC motors with the availability of solid-state power semiconductors. Brushless DC motors are like AC synchronous motors.

The major difference is that synchronous motors develop a sinusoidal back EMF, as compared to a rectangular, or trapezoidal, back EMF for brushless DC motors. Both have stator created rotating magnetic fields producing torque in a magnetic rotor.

The basic construction of a brushless-dc consists of a fan blade attached to a permanent magnet rotor that surrounds the electromagnetic coils of the stator and associated control electronics.

A typical biphase brushless fan motor is made from a permanent magnet rotor assembly that surrounds four electromagnetic coils. The coils work in pairs, with coils A and C forming one phase and coils B and D the other phase. A Hall-effect sensor monitors rotor position, providing feedback to the embedded MCU for commutation, speed regulation, and fault detection.

Commutation between the two-phase windings in the dc fan takes place electronically by alternately applying power to L1 and L2. Dead zones between the power pulses limit current for speed control and helps minimize a cogging effect when the rotor magnets align with the stator coils.

The on-and-off power of the commutation period resembles the output from a pulse-width modulator, or PWM. The MCU uses a PWM to control the period of the motor drivers and, thus set fan speed.

Feedback from the Hall sensor monitors actual fan rpm and indicate when communication should take place. The MCU continuously monitors motor speed by measuring the output period of the Hall effect sensor. A period that run shorter than the target length indicates motor speed is too fast. The schematic diagram of closed loop control 1 of BLDC motor.

## OPERATION OF COMPONENTS

**TRANSFORMER:** The function of a transformer is to step down alternating voltage for Electronic circuit works at less voltage.

**RECTIFIER:** This device is used to convert the alternating current to direct current.

**REGULATOR:** The voltage regulator is needed to keep voltages within the prescribed range that can be tolerated by the electrical equipment using that voltage.

**MATRIX KEYBOARD:** A matrix keypad consists of a set of push button or switches which are arranged in a matrix format of rows and columns by using this, the user can decide the speed of motor**.**

**LED DISPLAY:** It displays the speed of motor running.

**BLDC MOTOR:** A brushless DC electric motor (BLDC motor or BL motor), also known as electronically commutated motor (ECM or EC motor) and synchronous DC motors, are synchronous motors powered by direct current (DC) electricity via an inverter or switching power supply which produces an alternating current (AC) electric current to drive each phase of the motor via a closed loop controller..

**8051 MICROCONTROLLER:** Microcontroller 8051 contains code memory or program memory 4K so that is has 4KB Rom and it also comprise of data memory (RAM) of 128 bytes. Bus: Fundamentally Bus is a group of wires which functions as a communication canal or mean for the transfer Data.

# CONCLUSION

The hardware used for closed loop control of BLDC motor using microcontroller is designed. By using PWM technique speed of the BLDC motor was controlled and it was made to run at exactly entered speed.

In future this hardware will be implemented in space and the speed control will be observed. A few applications, for example, a vehicle (Windscreen viper), require the motor to have a genuinely constant speed for various burdens. DC motor, for example, shunt and compound work sensibly well in these applications, however a BLDC motor with CLOSED LOOP CONTROL controller enhances the execution.

# REFERENCE

[3] E. Grochowski and R.F. Hyot. 1996. Future trends in hard disk drives. IEEE Tran. On Magnetics. 32(3): 1850-1854, May.

[4] J.D. Ede, Z.Q. Zhu and D. Howe. 2001. Optimal split ratio control for high speed permanent magnet brushless DC motors. In: Proceeding of 5thInternetaional Conference on Electrical Machines and Sytems. 2: 909-912.

[5] S.X. Chen, M.A. Jabbar, O.D. Zhang and Z.J. Lie. 1996. New Challenge: Electromagnetic design of BLDC motors for high speed fluid film bearing spindles used in hard disk drives. IEEE Trans. Magnetics. l32(5): 3854-3856, Sep.

[6] T. Kenzo and S. Nagamori. 1984. Permanent Magnets and Brushless DC Motors. Tokyo, Japan, Sogo Electronics.

[7] J.R. Hendershot and Miller. 1994. Design of Brushless Permanent Magnet Motors. Oxford Univ. Press.

[8] S.W. Cameron. 1995. Method and apparatus for starting a sensorlesspolyphase dc motors in dual coil mode and switching to single coil mode at speed. U.S.Patent 5455885, Nov.28.

[9] T. Gopalaratnam and H.A. Toliyat. 2003. A new topology for unipolar brushless dc motor drives. IEEE Trans. Power Electronics. 18(6): 1397-1404, Nov.

[10] Bhim Singh and Sanjeev Singh. 2009. State of art on permanent magnet brushless Dc motor Drives. Journal of Power Electronics. 9(1): 1-17 Jan.