

Development of BLDC Motor Drive for Automotive Water Pump Systems

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Abstract - In order to save resources and prevent global warming, there has been a present need in recent years to reduce the volume of CO2 emission and it improves the fuel consumption of automobiles. The trend in the automotive applications is to improve efficiency and to reduce volume and weight. Under these circumstances, the mechanical parts in the automobile industry are being replaced by electronics method growing interest in energy efficiency. The trend in the automotive application is to improve fuel consumption, efficiency and to reduce volume and weight. Under these circumstances, the mechanical parts in the automobile industry are being replaced by electronic methods. Especially, to improve vehicle engine efficiency, power transmission and around the field of devices according to driving conditions need to be properly cooled. Conventional mechanical water pumps are directly connected by the engine belt for this reason, regardless of coolant circulation, the conventional mechanical water pump is always operated. The way which the mechanical water pump is replaced by electric water pump could reduce energy consumption. In this project, the implementation of the integrated BLDC drive for water pump system for automotive application is carried out.

Keywords: BLDC, Motor Drive, Water Pump System.

I. INTRODUCTION

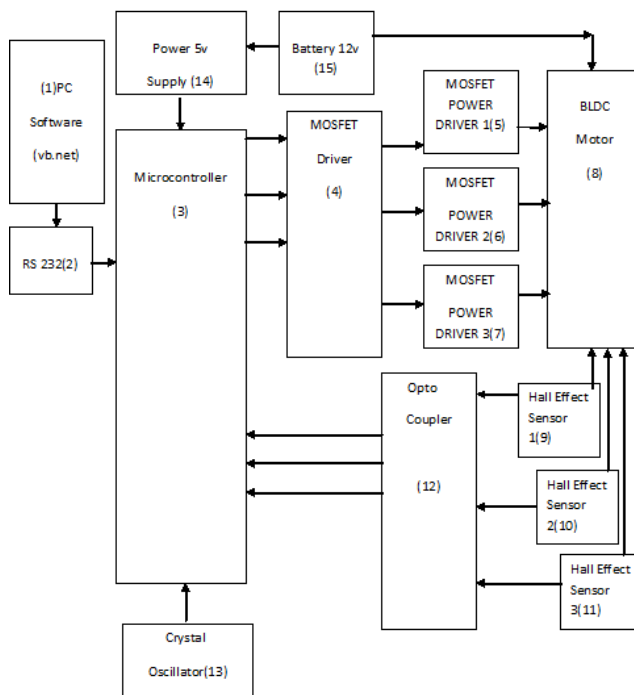
DC motors have ever been prominent in various industrial applications because their characteristics and controls are simple. In an industrial point of view, the dc motor is still more than others at low power ratings. However, dc motor drives have bulky construction, low efficiency, low reliability and need of maintenance. Those features are unsuitable for automotive applications.

In recent years, the brushless dc (BLDC) motor is attracting growing attention for automotive applications. This is due to the total elimination of the brush/commutator assembly, which reduces audible noise and RFI problems. Moreover, BLDC motor has a number of advantages such as high efficiency, high power factor, and low maintenance cost. Newer units using brushless motors are beginning to appear on the market, while other advanced designs are in various stages of development by various automotive suppliers around the world. This project investigates a promising

approach for designing an electric water pump system consisting of a brushless machine combined with its electronic controller by using 8 bit microcontroller for a hardware model implementation.

II. SYSTEM MODEL

Block Diagram of Project



Block diagram description

Following are the no. Of blocks which shows the working of each block.

- (1) In this section a pc is used to interface the driver circuit. A specially developed vb.net graphical interface enables to control the operation of the motor with on/off or other pre set value selections. The serial com port is used to interface hardware with pc.

- (2) The RS 232 converter is the logic level converter in which the pc voltages are different than cmos microcontroller logic value. So to have compatibility with both the unit this converted is used. It is build around max232 ic. This receives serial data and transfers this data to the microcontroller input.
- (3) As this serial data is received the program stored in controller will be followed and driver stage is enabled. The enabled signal will trigger the driver transistor to start conduction by mosfet as the sequence and drive time are defined in program. The feedback location of motor rotor is monitored by Hall Effect sensor. Complete operation will be performed by the microcontroller.
- (4) Mosfet driver circuit is configured around driver ic which is transistor enabled switch. The gate signal is passed to the respect mosfet through switching device enabled by controller signal. Each mosfet has each driver unit separately.
- (5) (6) & (7).These block are identical and same performs the same function of turning on and off the load. The load is the winding of motor; the winding is connected to power source with respect to configured circuit. The delay in switching and operation timing is calculated by the controller. The power handling is done by these mosfets.
- (8) BLDC motor it is latest technology enabled motor which has a highest efficiency. It is a three phase motor 12 volt type; permanent magnet motor .each phase is connected to each mosfet. Also 3 Hall Effect sensors are installed along the phase winding to detect the magnetism reversal. The detected signal is used to synchronise the driver pulses. The rotation of the motor can be controlled by the timing of pulses.
- (9) (10)(11) these are hall effect sensor used to detect the magnetism reversal by placed at each phase used to synchronise the feedback loop to define the rpm and rotational movement of motor.
- (12) Opto coupler device which is used to couple the Hall Effect sensor output to the controller without loading the controller. The optical linkage is formed, so the maximum isolation will be offered. The sensor are very sensitive against loading effect, to remove these losses optical coupler is used.

(13) Crystal oscillator is used to produce the operating frequency of the controller, so the controller can perform the operation.

(14) The power supply is the regulated supply since all the devices we are used need a constant 5 volt supply. The regulator maintains the fix 5v extracted by the 12 v battery supply.

(15) The battery here used is 12 volt which is standard value to power the motor and circuit.

III. PREVIOUS WORK

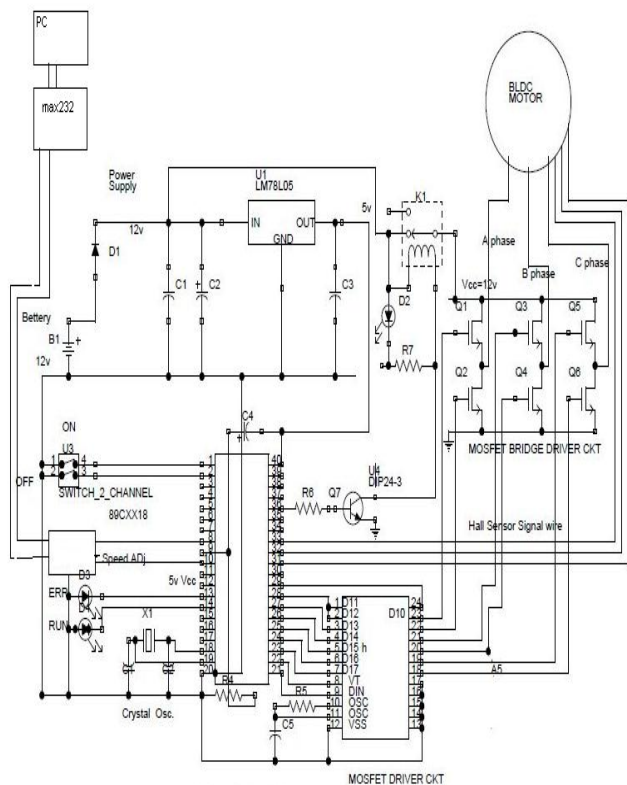
H. Hembach, S.A.Evans members of IEEE presents paper on “Systematic comparison of BLDC Motors for small automotive water pump applications” in which they compare BLDC motor with seven different motors to find out the result of BLDC motor. But working is not done on speed control. Comparison is based on the dimensions and constructions of motor.

Joon sung park, Joon Hyuk Choi senior members of IEEE presents paper on “BLDC drive control of electric water pump for automotive applications” in which they are using a BLDC motor for automotive water pump using a PWM technique.

IV. PROPOSED METHODOLOGY

When we press start button on the Software GUI then the serial data is send to the microcontroller. That data is received by the microcontroller and compared with the program in its memory. then the high signal is set on pin 21 of the microcontroller, that is connected to the relay driver circuit build using transistor Bc548 NPN. As the signal is high that is 5v the transistor conducts due to the base voltage is more than the 0.7v.collector circuit starts to flow in the collector circuit and the relay coil is connected and through this current flows and the magnetism generates which then operates the plunger of the relay contact and the circuit get complete and the voltage of 12v which is coming through the 12v battery. The battery is sealed maintenance free type battery. The diode (In4007) is a forward conduction mode in forward bias; it conducts the voltage to the power supply on the microcontroller board. The capacitors c1 and c2 are filtering purpose only to eliminate the ripples present due to the inductive load BLDC motor. The Ic 7805 is a three terminal 5v fixed voltage regulator as pin1 as input and pin 2 is gnd and pin3 is output. Capacitor c3 also is a filtering

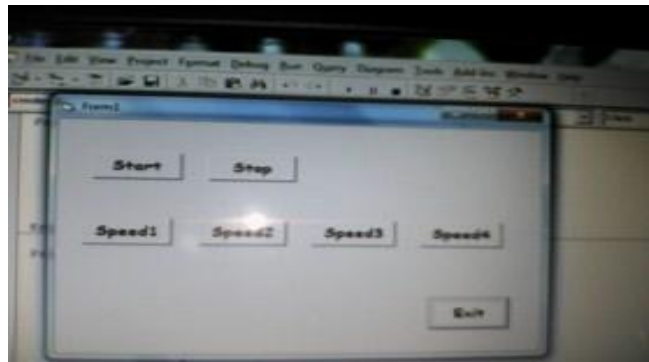
capacitor. Power indicating LED is there which lights when the 5v is available. Capacitor c4 and r4 forms the power on reset circuit connected on pin9 of microcontroller, which when power on resets the microcontroller to initial position where program counter and other registers are initialised.



BLDC motor it is latest technology enabled motor which has a highest efficiency. It is a three phase motor 12 volt type; permanent magnet motor .each phase is connected to each mosfet. Also 3 Hall Effect sensors are installed along the phase winding to detect the magnetism reversal. The detected signal is used to synchronise the driver pulses. The rotation of the motor can be controlled by the timing of pulses. These are Hall Effect sensor used to detect the magnetism reversal by placed at each phase used to synchronise the feedback loop to define the rpm and rotational movement of motor. Opto coupler device which is used to couple the hall effect sensor output to the controller without loading the controller. The optical linkage is formed, so the maximum isolation will be offered. The sensor are very sensitive against loading Effect, to remove these losses optical coupler is used. Crystal oscillator (11.0592 MHz) is used to produce the operating frequency of the controller (, so the controller can perform the operation.

IV. SIMULATION/EXPERIMENTAL RESULT

BLDC motors offer a number of advantages over conventional motors. The removal of brushes from a motor eliminates a mechanical part that otherwise reduces efficiency, wears out, or can fail catastrophically. In addition, the development of powerful rare earth magnets has allowed the production of BLDC motors that can produce the same power as brush type motors while fitting into a smaller space.



V. CONCLUSION

Overall the performance of BLDC drive was satisfactorily completed. We found it to be commercially feasible.

If we use SMD (Surface Mount Devices) devices we can able to reduce the size of the circuit so that a integrated circuit board can be developed for the pump with BLDC motor and it can be made to fit inside the Pump body.

Generally the automotive pump which directly works on the engine is bulky and it is running constantly and coolant is circulating. With our project the power is reduced and size is reduced and the price is reduced and the life of the pump is increased.

VI. FUTURE SCOPES

We suggest a advancement in future that, motor speed will be controlled according to the temperature of engine and the amount of the cooling is needed, as every vehicle nowadays have ECM or microcomputer which monitors and controls the operation of vehicle so temperature is monitored and according to the need of the temperature is high or low, speed is varied using PWM technique a command is send by the microcomputer and the microcontroller will control the speed. Also if there is no need for cooling then the pump can be turned off or on as per need automatically. The main goal of this project was that the low cost. The total cost was expected to be less when selecting hardware components clearly this goal has been achieved.

By using this system we can conclude that it is efficient and durable and low cost and the pump system will be low power consuming and that it will be very much useful in today's automotives

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