COMMERCIAL GRADE BLDC MOTOR DRIVER

FACULTY OF ENGINEERING AND NATURAL SCIENCES

Sabancı Üniversitesi

Students:
ADNAN ÖMER BAĞDATLI
MAHMUT NİHAT DEMİRLİ
TUĞBERK ŞENGEZER

Faculty Member:
Dr. Ahmet Onat

Company Advisor:
KADİR ERDEM

AKSA MOTOR FAN
AIRCOL

ABSTRACT

Nowadays, brushless DC motors have been preferred more than the other electric motors because of their advantages.

Principal advantages; high efficiency, high reliability, less maintenance, silent operation, being easily cooled, long life (no brush and commutator erosion) and being easily controlled.

These motors have been widely used in a variety of applications in automobile industry (hybrid vehicles), space and computer technology, medical electronic, military areas, industrial automation, robotic applications and household products.

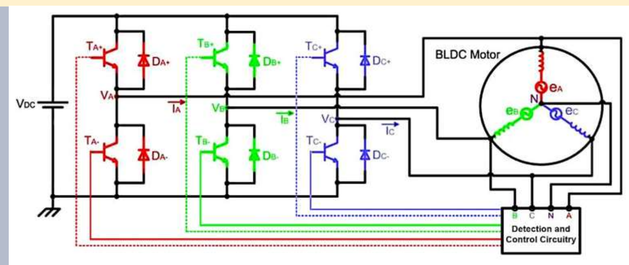
The BLDC motor is an AC synchronous motor with permanent magnets on the rotor (moving part) and windings on the stator (fixed part). Permanent magnets create the rotor flux and energized stator windings create electromagnet poles. The rotor is attracted by the energized stator phase.

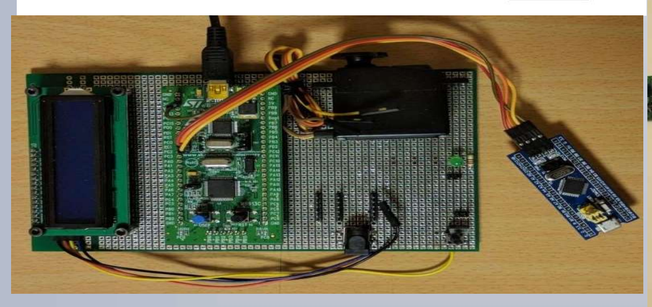
INTRODUCTION

In the industry today, whether it be robotic systems, space technology, automotive industry, computer systems and home appliances, Brushless DC, BLDC, motors are preferred over other motors. A BLDC motor is an AC synchronous electrical motor. The difference between a BLDC and a DC motor is that the BLDC uses an electric commutator rather than a mechanical commutator. This provides the BLDC motor with advantages over a DC motor. Some of these advantages are:

- Better speed vs torque characteristics
- High dynamic response
- High efficiency
- Long operating life
- Noiseless operation
- Higher speed ranges

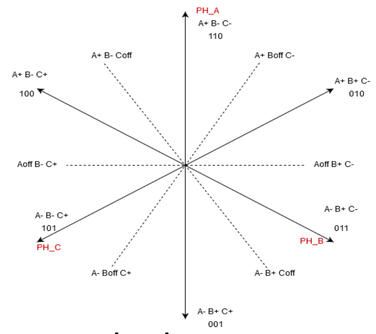
There are two main configurations of the BLDC motor, two-phase and three-phase. In this project, a three-phase motor will be used because of its popularity in various industries.





METHOD

The first step in driving the motor was to obtain the hall sensor communication sequences. This was relatively easy, a matter of connecting the three hall sensor outputs to LEDs and connecting the three coils to either positive or negative voltage and observing the LEDs. The figure below is the obtained sequence; the three digits are the outputs from the hall sensors.

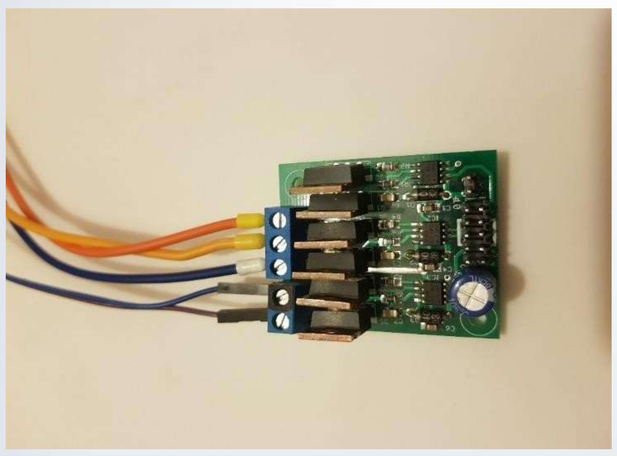


With the obtained communication sequence, a communication table was derived. Since for any given hall sensor output, the next step can be seen from the obtained sequence. The table below is the communication table.

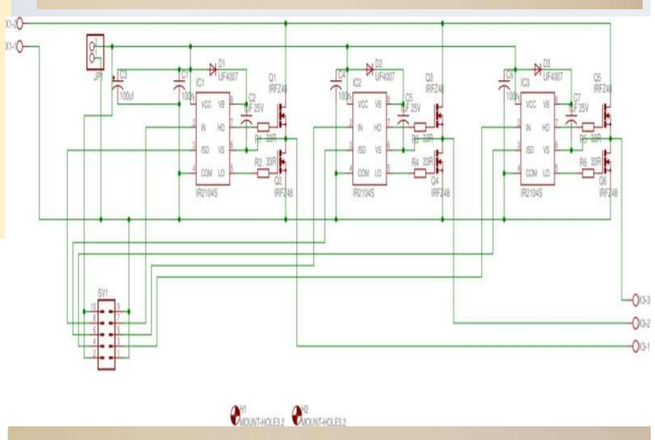
Hall Readings:	CWA	CWB	CWC
001	1	0	-1
010	-1	1	0
011	0	1	-1
100	0	-1	1
101	1	-1	0
110	-1	0	1

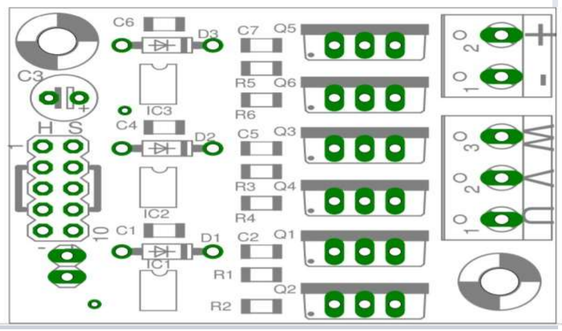
The table is hardcoded as an array and the hall readings refer to an index of said array. When a signal from the sensors is received, a function is triggered which points to the right index; which is then converted into a PWM signal and sent to the driver. With this method, a trapezoidal wave is generated.

Project Details
Hardeware Control

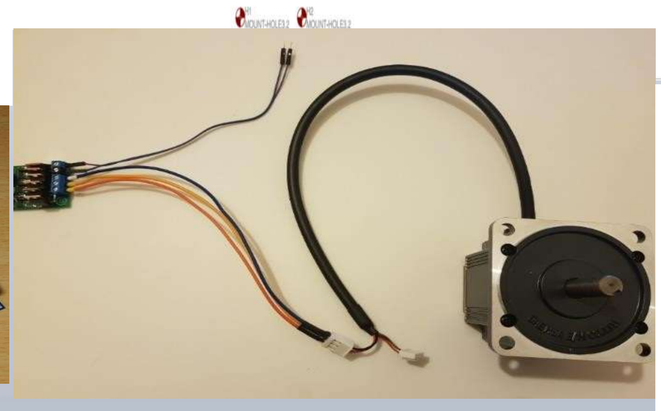


You can see our motor driver. It includes 6 pieces of Mosfet, 3 pieces of half- bridge driver and other necessary electronics (resistors, diodes, capacitors) materials. We have achieved the necessary power by making these connections one by one. Our card that has been used in our preliminary design was designed and built by Dr. Onat. It has 5 cable connections, two of them are connected to power and the other three are connected to the BLDC motor.





You can see the connection between the BLDC motor and the motor driver. This three connections are for supplying necessary power to rotate the motor. Also the motor has 5 more connections, 3 of which are outputs for the Hall effect sonsors, with the other to bwing power and ground for the said sesnors.



Software Control

The software and programming was done within the GNU Compiler Collection (GCC) toolchain. GCC is the compiler which compiled the written code. GNU Make was also used in order to aid with compiling the code and generate the .bin files which are loaded onto the microcontroller. The last piece of software used was STM32 ST-Link Utility; which provides the connection between the computer and the microcontroller in order to write the said .bin file onto the microcontroller.
The software is used to generate PWM, pulse width modulation; a technique of creating analog like signals with digital means by continually turning an output on and off.

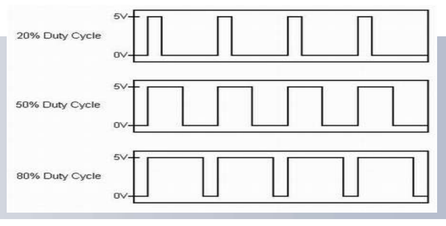


Figure above is a generic PWM signal at different duty cycles, a duty cycle is the percentage of time the signal is on compared to off. As duty cycle increases, the signal is on for longer, thus increasing total power.

CONCLUSION

In conclusion, with the method and hardware described, the motor was successfully driven. It took some time to fine tune the code, as well as the driver and the connections between them, and bring it to a state where the motor spins without too
much torque ripple. However, with a trapezoidal wave there will always be torque rippling which might lead to some vibration and sound at low speeds. To eliminate this, a sinusoidal wave must be utilized.

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