**Mustard Yellow: Why Walk When You Can Fly?**

# Drone Motors and ESCs

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## Introduction

One of the primary concerns with all quad copter drones is the limited energy supply available. It is vitally important to have efficient energy use and efficient motor rotation to help achieve maximum thrust and flight time. The brushless DC (BLDC) motor is the most popular and efficient motor in quadcopters due to the minimal friction and energy loss in the motor. This is especially important for our project because and loss in efficiency would decreased the package size that the drone can carry or reduce the flight time.

Additionally, the speed of the motors must be carefully controlled using the electric speed controllers (ESCs) to ensure a stable and precise flight. Any variation could result in one motor running faster or slower than the other three and drive the drone off course or even cause a crash. The general setup for a quadcopter consists of two pairs of identical fixed pitched propellers, two clockwise and two counter clockwise propellers.

## Brushless DC Motors

The brushless motor has two main parts, the rotor and a stator. The rotor consists of a permanent magnet that has two north and two south poles going N,S,N,S that can either be on the inside of the motor in an in runner brushless motor or on the outside for an outrunner brushless motor. The stator consists of the spokes of the motor with coils on the spokes with a current passed through the coil in order to create a magnetic field. The magnetic field created by the current through the coil will attract the magnetic poles of the rotor which creates the rotation needed for the propellers to turn. Two opposite coils can be wound together to generate opposite poles to the rotator poles which doubles the attraction force and rotates the motor more efficiently.

Two coils can be energized at the same time creating alternative magnetic fields so that one coil has an opposite magnetic charge, pushing the motor along as the other coil has an attracting magnetic force, pulling the motor forward. This contributes to creating an efficient motor with high torque and minimal energy loss.

For a motor with 6 spokes or coils, 6 steps or intervals are required. In each interval, there will be one phase with positive current, one with negative current, and one turned off. The free end points of each phase can be connected together to share current or use one current to energize two phases at once. This allows the motor to be rotated using just 3 connection points to the esc by turning on the proper two mosfets for each of the intervals

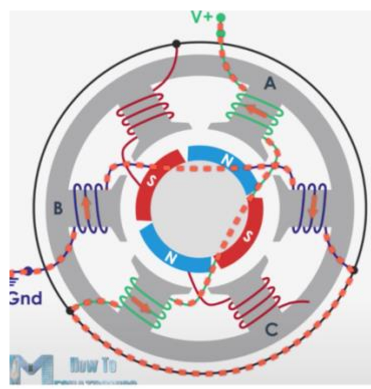


*Figure 1. Brushless DC Motor*

## Electric Speed Controllers

The electric speed controllers (ESCs) take in the commands from the flight controller and adjust the speed of the individual motors accordingly. The ESCs control how fast the motors spin as well as increase and decrease the speed of specific motors to turn and bank in flight. For our project, the flight navigation will be automated instead of using a physical controller. The motor with 6 coils is activated using two mosfets to create a rotating magnetic field that turns the brushless motors. The motor speed can be increased by cycling through these intervals at a higher frequency.

The ESC has to know when to activate the next phase based on the position of the motor. The position can be found using a Hall effect sensor to sense the magnetic field in the motor. By carefully controlling the speed that the rotor turns, the 4 porpellers are rotated allowing the drone to lift off, fly forward, turn, and land. In our project, the AR 2.0 drone will complete 28,000 revolutions per minute while hovering and require 14.5 Watts with a speed of 11 meters/second.

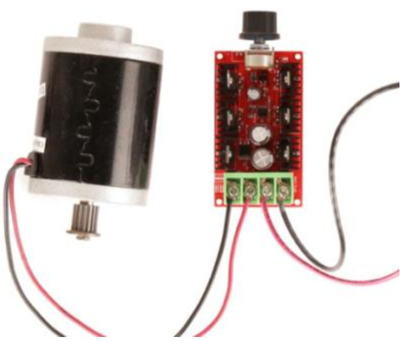

*Figure 2. Electric Speed Controller connected to Motor*

## Conclusion

The performance of the ESCs and motors is crucial toward achieving and maintaining a steady flight. A failure would result in a crash or deviation from the flight path. With the addition of a payload this is much more important with the increase in weight and battery consumption.

*Figure 3. Parrot AR 2.0*


**References**

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