Reverse Engineering: Drone

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Abstract:

Taking apart this drone was a huge blast! While looking for things that would be an interesting project to take apart, I stumbled upon a drone that wasn't really in use, and I knew that it would be the perfect device to take apart! I have a deep love for drones, owning a total of five, the latest being a beautiful DJI mini-2, and I have always been fascinated with how they work. I started by removing the legs to gain access to the screws that held the two halves of the drone together, and right away the sturdy design of the drone became increasingly apparent. The plastic was quite lightweight, yet sturdy - as was proven by the numerous unintentional drop tests; oops! After removing a total of 20 screws, 2 from the legs and 3 holding the halves together, multiplied by four sides. Inside was a simpler setup; consisting of four motors, each with their own LED, all connected in the center to a flight controller. The entire drone is powered by a 3.7V Li-ion battery (commonly known as a Lithium-Ion battery). The drone is a Quadcopter design, which means that it has four propellers, each at 90-degree angles from each other (see Diagram x for more details) which allows for optimal flight for smaller drones. The gyroscopic sensor - the sensor that allows the drone to detect the angle at which it is tilted at - is arguably the most vital component for the drone to function properly. For the drone to be capable of flight in the x and z axis, the propellors change their rotation speed, effectively tilting the drone to a specific side, allowing for flight in that direction. (See Diagram y for more details) The gyro sensor ensures that the drone is at the correct angle, and using PID is able to regulate the angle, allowing for more controlled flight. While taking apart this drone, it was easy to see lots of the similarities to vex. Ad I saw through this project, the precise activation of motors could not only make a machine drive around and pick up disks, but it also enables for flight! The gyro (or inertial in the case of vex) sensor as I just talked about is a crucial part of any good Autonomous. Accuracy is crucial for an excellent Autonomous, and as we have seen through experience, the surrounding variables can change, anything from a misplaced disk to a gust of wind can send our robot into a wall, or our drone into a tree-yikes! The gyro sensor ensures that the robot is following its programed path smoothly, and if any turns or movements are messed up, using PID (proportional integral derivative) to correct its path and ensure a near perfect execution.

Overall, I learnt tons even from taking apart this simple drone, and I am excited to see how I will be able to apply my findings in the future!

Drone: Exploded View

Diagram 1: Exploded View

Key

1. Landing Gear
2. Propellors
3. Propellor guard
4. Flight controller
5. Motor
6. LED
7. Screws
8. Li-ion Battery
9. Cover

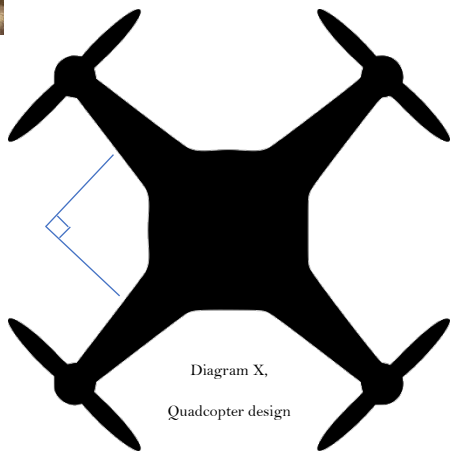


Diagram X,

Quadcopter design

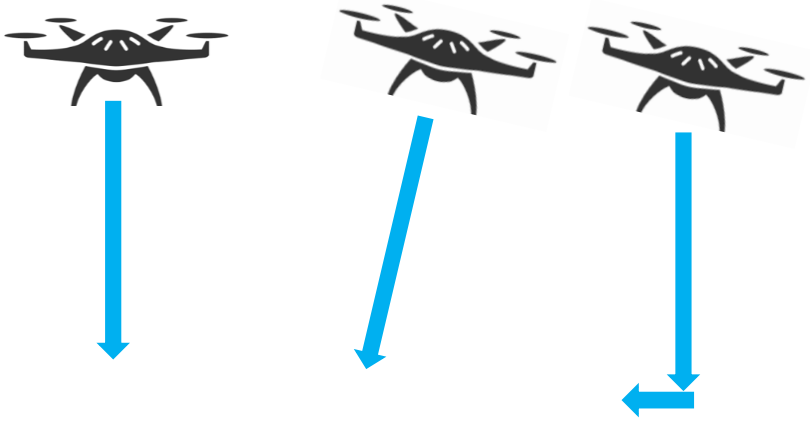
So, how does it work?

Diagram

Key:

Thrust

Movement



While hovering, the drone uses its propellors to thrust air down to counterbalance gravity. This allows the drone to stay in place mid-air

As the drone tilts, the thrust is applied at an angle, which can be drawn as an x and y component. This allows the drone to stay at the same y height while moving in a direction

In order to tilt, the drone slows down the motors on the side it wants to tilt to, circled in red above, and will increase or continue the speed of the other two motors, circled in green. The gyro sensor is crucial for the drone to fly correctly.

Structure

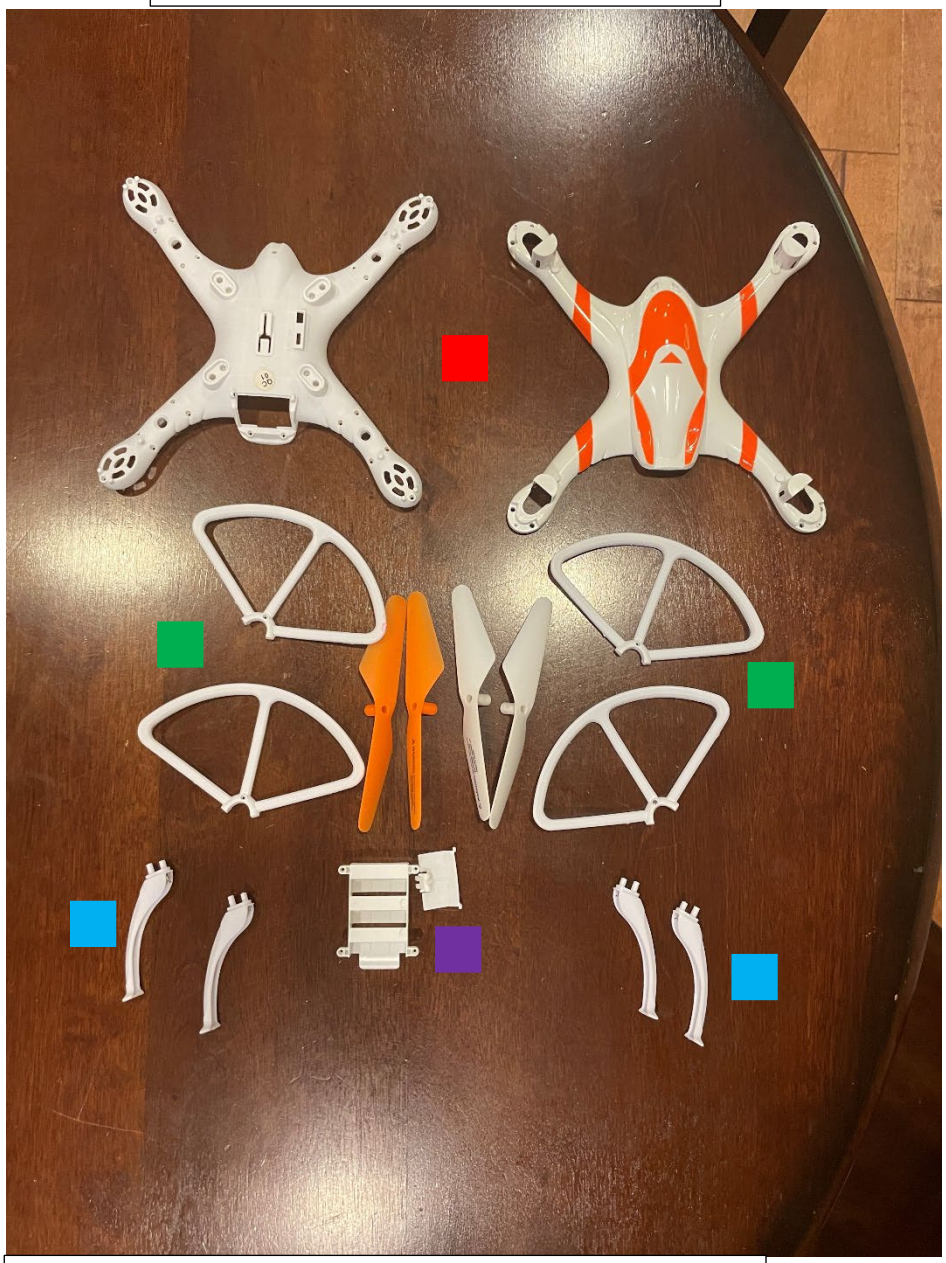


Diagram 2: Structure

The two halves of the cover help protect the flight controller and other internal electronics from the outside elements

The propellors are shaped very finely to allow them to push the air down, effectively keeping the drone up. The propellor guards ensure that the propellors are unobstructed, and prevent damage to them in the case of a crash

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The battery cover keeps the battery secure in place

Electrical Components:

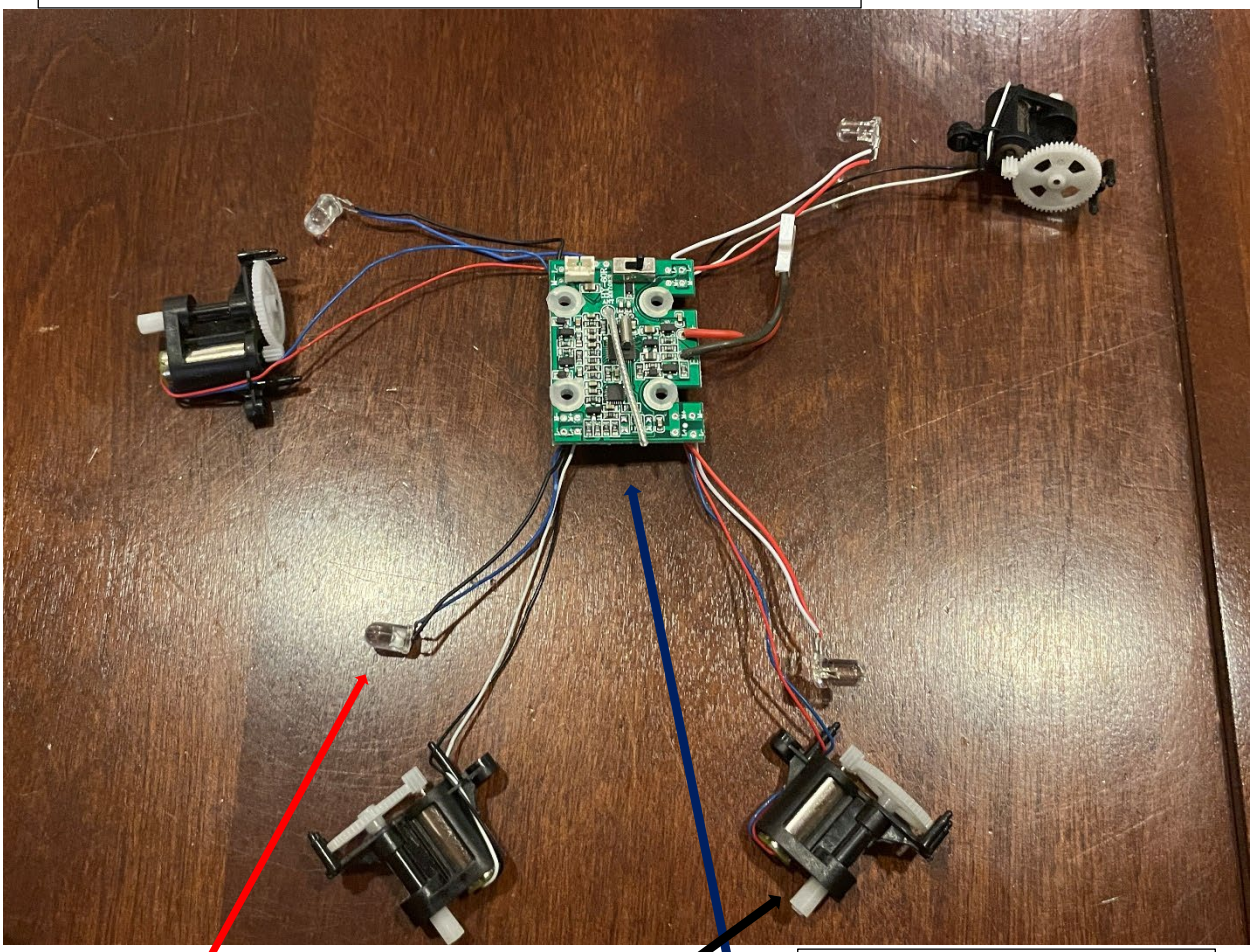
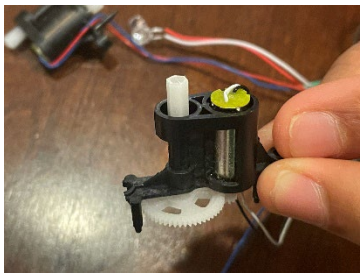


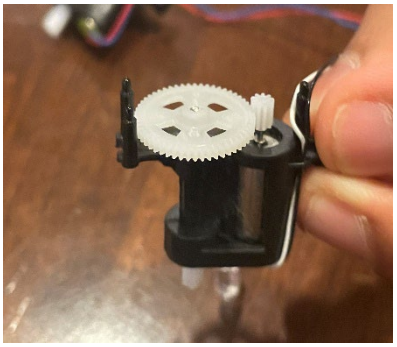
Diagram 3: Electrical components

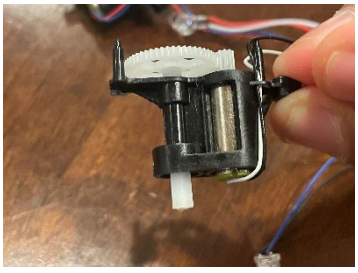
The LEDs help the drone be visible even when there isn't lots of light.

The flight controller is where the magic happens. Without it, the drone cannot do anything. This component tells all other electrical components what to do, and when to do it, which is vital for the drone to function properly, as timing is everything!

These DC Motors are what make the drone move. 9XX motors are the most common type of motor because they are high performance motors that are designed for speed.







The battery is the power supply. It is a Lithium Ion 3.7V battery.