Chapter 1

Introduction

Quadcopter is a type of multi-rotors helicopter. The word ‘quad’ originated from a Latin word ‘quattro’ which means four to indicate the number of rotors that give it the thrust it needs to move. They are divided to two sets of identical, fixed pitch propellers- two spin clockwise and the other two, counter-clockwise. The control of the craft is achieved by using remote control transmitters to change the speed of the rotors. Among the multi-rotors group, quadcopter is actually the most famous one and is widely accepted by the R/C hobbyist. Quadcopter is normally referred as an unmanned aerial vehicle and better known in a small scale size but back in the 1920s and 1930s, there were many manned versions but did not gain popularity because of their poor performance and were very hard to navigate as the pilot on board had to do a lot of works to control all four rotors to achieve stability even when only hovering. There were too much decision to be made by the pilot. The only solution to that is with the help of electronic controller and sensors and that is why the electronic parts of the quadcopter are as important as
the mechanical parts. The harmony collaboration of mechanical and electronic part made navigating the quadcopter much easier. And the rapid development of computers microelectronics technology completed the puzzle that made quadcopter as a reliable rotorcraft.

Nowadays there are already multiple choices of commercial quadcopters can be found. Among the famous one are X4-Flyer, STARMAC II, Draganfly XPro, AR. Drone, Parrot Rolling Spider and DJI Phantom 2 Vision+. Some are used only for acrobatic purpose and some are for photography or both. Currently trending quadcopters among the enthusiasts are the type of First Person View (FPV) as the pilot can experience on-board view of the quadcopter by wearing the virtual reality goggles.

As mentioned before, history of quadcopter has showed that it is almost impossible for a human to control the rotational speed of four motors simultaneously with precision to balance the quadcopter in the air. The only way it can be done is with the help of flight controllers (FC) which is a small circuit board of varying complexity used to direct the RPM of the motors individually in response to input. The pilot just have to command which direction the quadcopter will go and the command signal is fed into flight controller, which decides how to manipulate the motors accordingly. In other word, the flight controller is the brain of the quadcopter. A suitable analogy for the function of the flight controller would be like a situation when a mother tell her son to go buy groceries at the shop. The pilot is the mother and the quadcopter is her son. She just have to tell him where to go and his son, using his brain, determines which part of his body to move to go to the place as demanded. And just like a human brain, a flight controller would need sensors to help making the right decision. Common sensors used are gyroscopes, magnetometer, barometers and accelerometer.

Quadcopters also rely on sturdy and lightweight hull. It usually has a simple and symmetrical shape as it is where most components will be mounted to and where the center of gravity supposed to be. To avoid damaging the important and expensive components, a frame needs to be both strong and stiff while being light enough to move around in the air easily. Another mechanical parts of the quadcopter are the arms. Usually this part can be found as very cheap and should be easy to replace because it is more preferable to have the arms break in the event of a crash in order to absorb all the impact from reaching the hull. It is like the cyclist helmet that breaks when hitting the ground, absorbing all the impact from the high speed collision and thus protecting the cyclist’s head. As the arms are the only part that have direct link with the rotors, all the vibration from the spinning rotors will be most likely passed on through them. So, vibration issue is definitely one of the considerations when choosing the right
material for the arm. The scale of a quadcopter is often determined by the diagonal measurement in millimeters from motor to motor through the center of the frame. If a model includes numbers in the title, they probably refer to this measurement. A DJI F450 is around 450 mm across, for example. The F330 is 330 mm, and so on.

No matter how the mechanical setup is, it should be modelled as mathematical expression first before translated into lines of coding into the flight controllers. From the mathematical model, simulation can be done to test the functionality of the controller before real flight. Test flights on a real platform should be done too to measure the accuracy and performance of the controller in the hardware.