Chapter 1

INTRODUCTION

The multirotor helicopter also known as a quadrotor or quadcopter is equipped with four rotors to create lift. It is a true helicopter in that lift force is created by narrow-chord horizontally rotating air foils. There are a variety of descriptors associated with quadcopters. Probably the most general description of a quadcopter is an Unmanned Aerial Vehicle (UAV). UAV has also been interpreted as an Uninhabited Aerial Vehicle, which is precisely the same meaning as Unmanned Aerial Vehicle. Two descriptions that are more specific would be those of Remotely Operated Aircraft (ROA) and Remotely Piloted Vehicle (RPV). The last two descriptions mean that no pilot is physically carried by the aerial vehicle and all vehicle control is accomplished either by a pilot using a remote ground station or autonomously by the vehicle. UAV, ROA, and RPV are the most popular and well-known descriptions for the quadcopter type of vehicle. There is also one other popular descriptor: micro aerial vehicle (MAV), which refers to any very small-sized UAV with all length, width, or height dimensions of 15 cm or less. MAVs are actively being developed along with swarming control techniques in a variety of research projects. Developers of some of these projects hope to implement insect biomimicry into their MAVs in an attempt to achieve the performance and capabilities of their real-world counterparts.

Fig1.1: Unmanned Aerial Vehicle

Fig1.2: Micro Aerial Vehicle

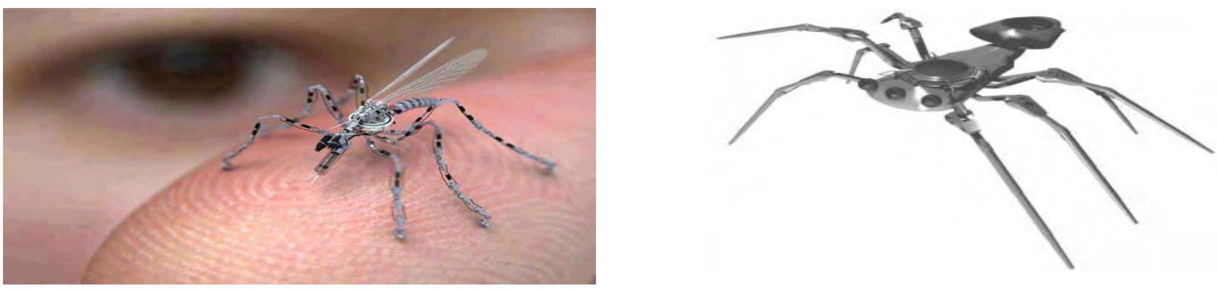

Fig1.3: Insect Biomimicry in Micro Aerial Vehicle

1.1 Types Of Multicopters

Multicopters may be classified as:

a) Bicopter or Two Motor Multicopter:

The Bicopter has two motors that can be moved by servos. It is considered as the cheapest multicopter because it uses only two motors and two servos, but it's the least stable platform and is hard to tune. It is also the least robust and have less lifting power.

b) Tricopter –3 Motors multicopter:

The Tricopter has 3 motors in a "Y" shape usually 120 degrees apart, or sometimes "T" shape. Two propellers on the front arms pointing to the sides or slightly forwards, and one arm backwards. The rear motor can be tilted laterally via a servo to enable the yaw mechanism.It's a relatively cheap configuration because it only requires 3 motors (although you also need an additional servo but they are generally cheaper than brushless motors). It's generally less stable than multicopters with more motors and it's not as robust especially the tail servo and mechanics in crashes. It's also harder to build because of the yaw mechanism. It also has lower lifting power because of the smaller motor numbers.

Fig 1.1.1: Bicopter

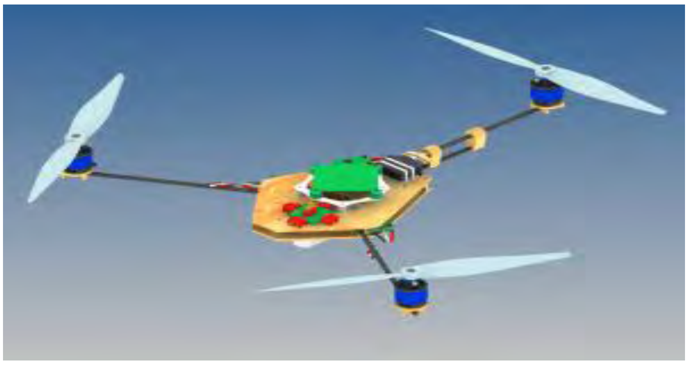

Fig 1.1.2: Tricopter

c) QuadCopter – 4 Motors multicopter

A typical quadcopter has 4 motors mounted on 4 arms of a frame that is symmetric, each arm is 90 degree apart (for X4 config). There are two sets of CW and CCW propellers mounted on the motors to create opposite force to stay balance.

d) Pentacopter – 5 Motors

There isn’t much information on this config because it’s not a popular setup, due to possible underlying issues. One obvious advantage of the pentacopter is the wide angle of the two front arm which allows the propellers to stay out of the camera as far as possible.

Fig 1.1.3: Quadcopter

Fig 1.1.4: Pentacopter

e) Hexacopter – 6 Motors

The hexacopter has 6 motors mounted on 6 arms 120 degree apart on a symmetric frame, with three sets of CW and CCW propellers.It's very similar to the quadcopter, but it provides more lifting capacity with the larger number of motors. It's also possible that if one motor fails, the aircraft can still land safely.

f) Octacopter – 8 Motors

A typical octocopter has 8 motors on the same level with four sets of CW and CCW propellers.Again is similar to quadcopter and hexacopter. It's an upgrade version of the hexacopter with even more lifting capacity. It's also reliable because if one or two of the motors or ESCs fail, it should still be supported by other working motors and able to land safely.

Fig 1.1.5: Hexacopter

Fig 1.1.6: Octacopter

1.2 Frame configuration

These**Unmanned Aerial Vehicles** have four arms and fixed pitch propellers which are set in an X or + configuration with X being the preferred configuration.

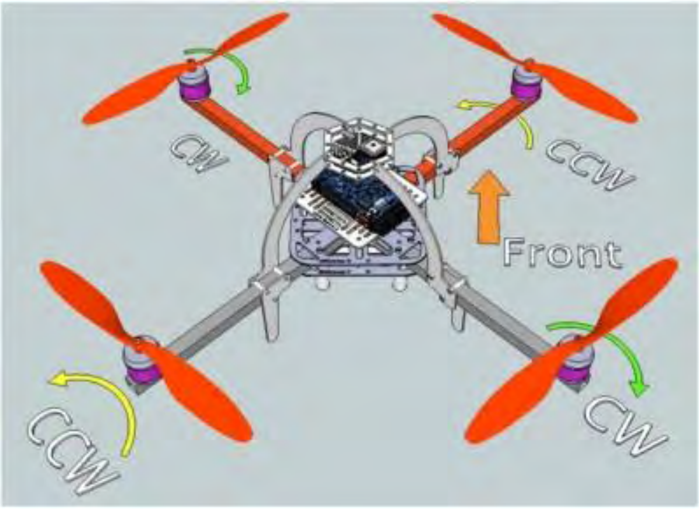

Fig 1.2.1: Quadcopter X configuration

While the + configuration looks like this:

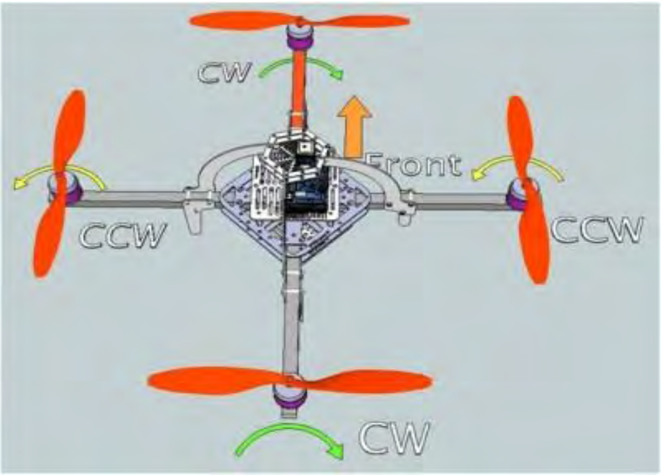

Fig 1.2.2: Quadcopter + configuration

The difference is how the motors have to be controlled. For the + configuration the motor controlling is fairly simple as it has one motor assigned to each direction. The negative aspect of the + configuration is that, it only has a single motor to provide extra thrust (speed up) when one want to move to another direction. In the X configuration it will always have two motors working together on changing direction.

1.3 Quadcopter Physics

1.3.1 Steering

While flying amultirotor, it is very important to understand how the multirotor moves and how to control it. At the root of all the multirotor movements is the rotational speed of the motors. By adjusting the relative speeds of the motors in just the right ways, keeping in mind that the rotational speed of the motors determines how much lift each prop produces, the flight controller is able to cause the multirotor to rotate around any of the directional axes (roll, pitch, and yaw), or make the multirotor gain or lose altitude.

1.3.2 Roll and Pitch

To make the multirotor rotate about the roll or pitch axes, the flight controller makes the motors on one side of the multirotor spin faster than the motors on the other side. This means that one side of the multirotor will have more lift than the other side, causing the multirotor to tilt.

So, for example, to make a quadcopter roll right (or rotate about the roll axis clockwise), the flight controller will make the two motors on the left side of the multirotor spin faster than the two motors on the right side. The left side of the craft will then have more lift than the right side, which causes the multirotor to tilt.

Similarly, to make a quadcopter pitch down (rotate about the pitch axis clockwise) the flight controller will make the two motors on the back of the craft spin faster than the two motors on the front. This makes the craft tilt in the same way that our head tilts when we look down.

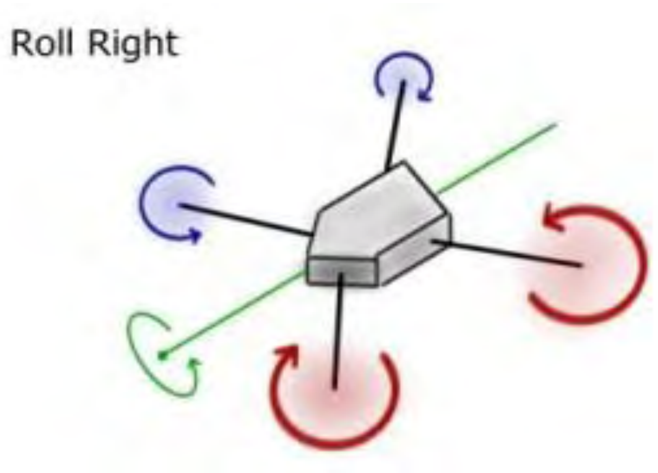

Fig 1.3.1: To describe the orientation of the quadcopter, we use three angles: roll, pitch, and yaw.

1.3.3 Yaw

Controlling the multirotor's rotation about the yaw axis is a bit more complex than controlling its rotation about the roll or pitch axes. First, let's discuss how to prevent rotation about the yaw axis. When assembling and programming multirotors, we set up the motors so that each motor spins in the opposite direction than its neighbors. In other words, using a quadcopter as an example again, starting from the front-left motor and moving around the multirotor clockwise, the motors' rotational directions alternate, CW, CCW, CW, CCW. We use this rotational configuration to neutralize, or cancel out, each motor's tendency to make the multirotor rotate.

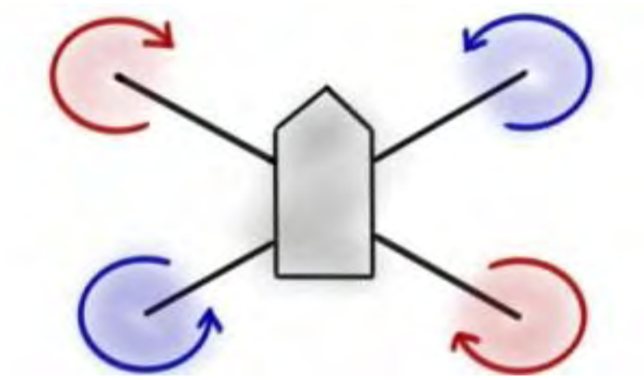

Fig 1.3.2: We configure each motor to spin in the opposite direction than its neighbors.

We see, when a prop spins, it encounters friction with the air, also known as aerodynamic drag.So, when a prop spins clockwise, its friction with the air generates a counter-clockwise force, which tends to make the craft spin counter-clockwise.

Fig 1.3.3: When the rotors spin clockwise, the multirotor would start spinning uncontrollably in a counterclockwise direction.

So therefore, when we actually want the multirotor to rotate about the yaw axis, the flight controller will slow down opposite pairs of motors relative to the other pair. This means the frictional forces between the props and the air are no longer in balance and the craft rotates. We can make the multirotor rotate in either direction by slowing down different pairs of motors.

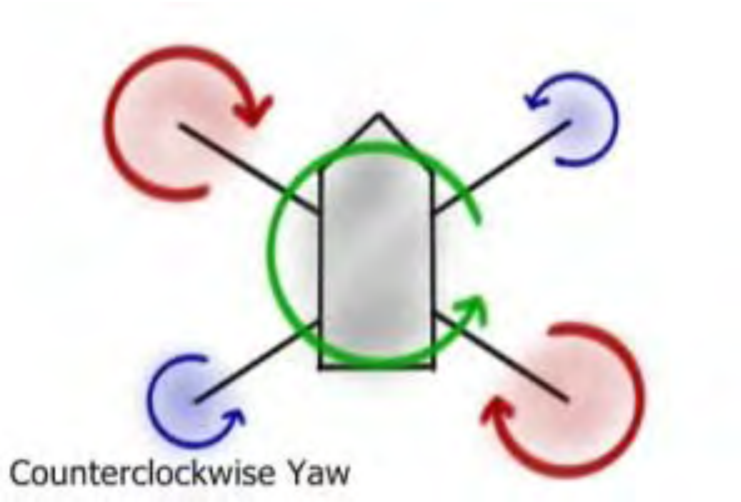

Fig 1.3.4: Counterclockwise Yaw

By making diametrically opposite motors (that spin in the same direction) spin at different rates, the craft can be made to yaw. In this case, the clockwise-spinning motors are faster than the counterclockwise-spinning motors, so the craft yaws counterclockwise.

1.4 Objectives of the project, highlighting its importance

1.4.1 Objective:

Quadcopter can be used for delivery and defense purpose.

1.4.2 Importance:

- It can lift weight for delivery.
- It can be used in defensepurpose taking snapshots of enemy area at different angles n transfer data to 3d print the area to strategize military attack.
- It can be used for rescue missions using more similar quadcopter as swarm robotics having one mother quad can be used for cinematography.