

Autonomous Intelligence Surveillance Quad Copter

Pankaj Singh

Assistant Professor
Department of ECE
SRM University NCR Campus
Modinagar

Bhavik Gupta, Ankit Patel, Anurag Kumar, Mohit Ujjwal

B.Tech Student
Department of ECE
SRM University NCR Campus
Modinagar

ABSTRACT

Nowadays, UAVs (Unmanned Aerial Vehicles) are used in various applications such as military operations, agricultural surveillance etc. Their use has increased drastically because they are multifunctional and reliable. In this research paper we choose Quad copter because it is a very balanced UAV which can be used for weight lifting purposes. In this copter, there are four rotors attached to a certain spin axis. The aim of this project is to make an effective quad copter platform using various components such as ESC (Electronics Speed Controller), Propellers, brushless motors, lithium ion battery, chases etc.

Keywords-: ESC, motors, control system, IMU, propellers.

INTRODUCTION

Today various researchers and scientists are interested in exploring the various applications of UAVs among all the variants of UAV family, quad copter is the one which is most feasible and easy to construct. It is because this design of a quad rotor is autonomous in nature (protects human life) and it is responsible for its take-off and landing itself. Quad copter is controlled by four rotors via propellers. It is closed loop controlled and feedback biased, thus very stable in nature.

As we know this model has 4 rotors, so for the motion of the quad copter the 4 rotors are used to push the air downwards and thus creating a thrust in order to keep the quad copter aerial. The orientation (position) is controlled by the FCU (Flight Control Unit). FCU is the heart of the quad copter's control system. It works by controlling different motors with relatively different outputs(Pulse Width Modulated Signals).UAV's movement is controlled by a HMI(Human Machine Interface).This paper also describe the design methodology of the quad copter.

UAVs(unmanned aerial vehicle) are basically radio controlled helicopter which are highly used for searching remote areas . They are used in remote sensing operation, surveillance and other purposes. These vehicles are autonomous in nature. They are particularly useful where human life in danger such as disaster relief. Our research paper focuses on this autonomous multi-copter especially quad copter.

ABOUT QUADCOPTER

We chose Quad copter platform because it balances the amount of weight they generate. They are used to monitor air quality in large area and very helpful for alarming civilians in the case where air quality is unhealthy. These UAVs are used predominantly in military as these UAVs can operate in dangerous location while keeping human life safe.

AXES PROPERTY

Net forces must be balanced on a flying vehicle for a success flight. There are three axes on the quad copter on which the forces acts in space and time .These axes are YAW, PITCH and ROLL axes^[1]. The motion of the quad copter is decided by the resultant of these forces. The axes can be explained as following-:

ROLL AXIS: - This axis is horizontally parallel to the quad copter plane from left to right .When the quad copter is moving in stable direction then the rotational force vector of the motors acts at the centre, thus cancelling out each other. The quad copter moves either right or left respectively when the resultant rotational force vector is either positive or negative respectively.

PITCH AXIS:- This axis is horizontally parallel o the quad copter plane from the front and the back. When the quad copter is moving in a stable direction, then the rotational force vector of the motors acts at the centre (thus cancelling out each other). The quad copter moves either forward or backward respectively when the resultant rotational force vector is either positive or negative respectively^{[4][3]}.

YAW AXIS:- This axis is vertically parallel to the quad copter plane. When the quad copter is moving in stable direction, then the rotational force vector of the motors acts at the centre (thus cancelling out each other). The quad copter rotates around this axis either clockwise or anti-clockwise respectively when the resultant rotational force vector is either positive or negative respectively^{[2][7]}.

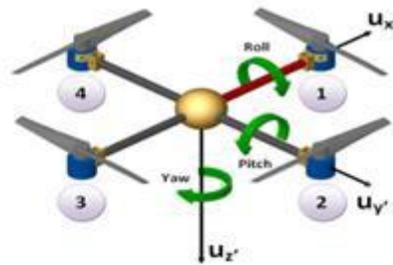


Figure 1. Yaw, pitch and roll rotations

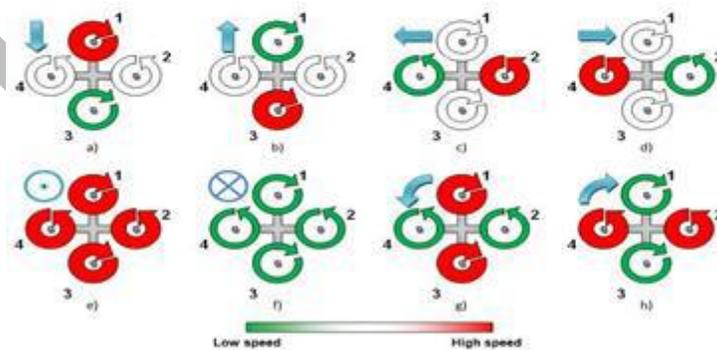


Figure 2. Multicopter's movements

MOVEMENT

The motion of quad copter is a mechanism of unstable forces. The quad copter system remains stable at any point in the space at any time period when the net forces acting on the quad copter are balanced. When there is a change in the forces of any axis (roll, pitch and yaw), then the quad copter moves in the direction of the net force. That is how quad copter moves. The motion of the quad copter is explained in the following way:-

UPWARD/DOWNWARD- The thrust generated by the propellers is responsible for this type of movement of the quad copter. Thrust is directly proportional to the altitude (more thrust high altitude). This is because the thrust is simply the downward force generated by the propellers.

FULL ROTATION- Yaw axes is responsible for this rotation .The rotation is done by increasing the thrust of two diagonally opposite motors with increase thrust than the thrust of the other diagonally opposite motors .

FORWARD/DOWNWARD- Pitch axes is responsible for this type of quad copter motion. When the thrust of the forward and backward pair of motors is increased or decreased then the quad copter moves in front and back direction respectively.

SIDEWARD MOTION- Roll axes Is responsible for the sideward (left or right) motion. When the thrust is increased or decreased in either side of the quad copter motors then the quad copter moves in the other direction. In other words if the quad copter is intended to go on the right then the thrust of the left motor pair is increased and vice-versa^[5].

SYSTEM CONTROLLERS

Apart from forces acting on the axes of the quad copter, there other forces acting on the quad copter as well such as external wind condition. This tough job earlier was a part of the work of the pilot but now with the Fly By Wire technology, the stability dynamic of the quad copter system are monitored these days today. Fly By Wire technology is a class of specific systems designed for aeronautical vehicles (not stable by design).Fly By Wire technology uses sensors and a microcontroller which monitors the values from the sensor and take the controlling action as required for the system.

INERTIAL MEASURE UNIT (IMU)

This sensing element determines the speed and position of the copter. This sensor has a wide range of application such as satellite, aerial vehicle of armed forces. This sensing element is used in navigation in navy systems as well. Dead reckoning is a process where firstly the collection of data is done and then the orientation of the system is known. Sensor used can be a piezoelectric, capacitive etc. Two type of IMU are there –

USE OF MAGNETOMETER

They are helpful in finding in the direction of magnetic field and its strength. Several types of magnetometer are there (classified upon their use). The ones used in aeronautical vehicles are vector magnetometer. It poses the quality of measuring electric field components. For finding the orientatation dip, three orthogonal magnetometers are required. This method is called magneto resistive measuring. A magnet film is made of thin strips of a magnetic alloy in nature). The resistance of the alloy varies with variation in electric field. This Magnetometer has a very good sensitivity. Their response time is very low (in regard to others) being less than one microsecond. Measurement of frequency can be done up to one kilo hertz.

Mathematically magnetic field can calculated as by the following method:-

$$\phi H = R_0 - R_H / R_H$$

Where,

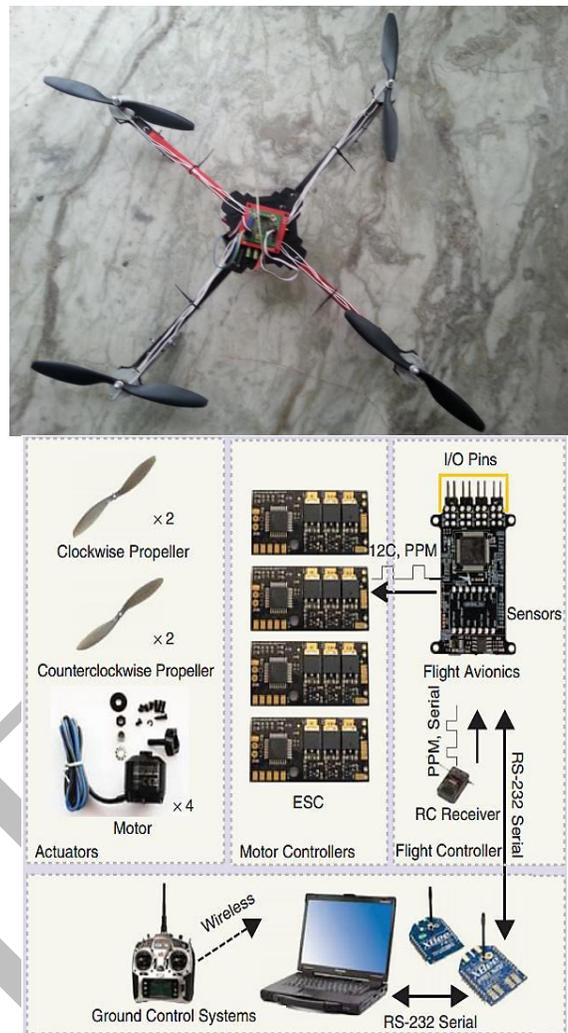
ϕH = Current magnetic field

R_0 = resistance at zero magnetic field

R_H = resistance at a given magnetic field

QUADCOPTER SYSTEMS

It comprises a transistor and receiver module, gyroscope, ESC (electronic speed controller), dc motor and a lithium ion battery. The transistor generates a PWM signal which is later on received by the receiver as the command signal. Gyroscope is used for changing the signal by using the axes information (yaw pitch and roll) before transmitting the signal to ESC^[5]. This change is done so as to keep the level of chases w.r.t ground. For regulating the variation (change) in speed of the motors, ESC, modules and changes the functions to do so.



ABOUT MOTOR:

Motor required in quad copter is a DC motor (brushless). It comprises a group of magnetic material (laminated together) and a group of miniature (small coil). The rotor of this motor is an assembly of strong magnet. These motor are fixed or joined with the mounting of the quad copter. Magnets are attached to a shaft via cylinder, thus eliminating any need for brushes. Friction factor is low, so the speed of this out runner brushless dc motor is higher

than the speed of a conventional dc motor. The speed of the motors is varied to carry on the desired, motion of the quad copter^{[6][4]}.

USE OF PROPELLERS

For achieving proper yaw, pitch and roll angles, we need a very good and stable propeller. Pitch propeller is used in quad copter with opposite propellers (pairs) moving in same directions. The propeller blade curvature (pitch) required more power or higher power thus making it harder to drive. For motors having high speed, propellers with low pitch must be selected. The diameter of the propeller is also inversely proportional to the pitch (more the diameter less the pitch).

Li-ION POWER SUPPLY

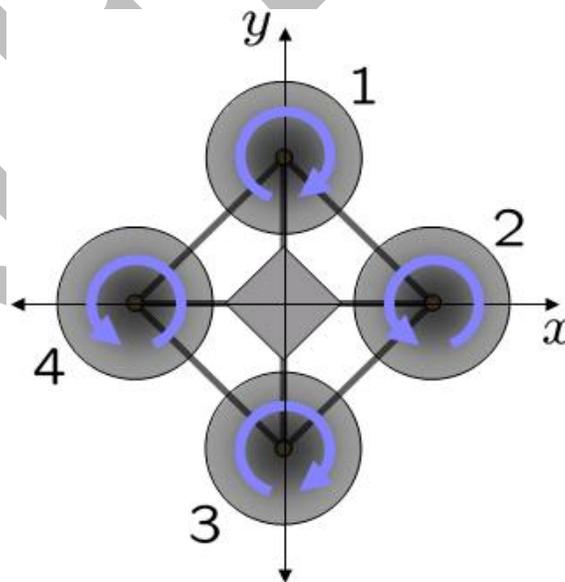
These power supplies are used as they have high power capacity and low less weight. They are available in market in different range. Two types of combination i.e. series and parallel are used for achieving proper power required. There is a rating available on the batteries for determining how fast a battery is discharged. This rating is known as C rating. A 2400 mAh battery has 12c rating i.e. it can discharge at the rate of 1/12 per hour.

CHANGES OF QUADCOPTER

Two properties of quad copter are there which makes them easy to operate:

- High amount of stability
- Power of lifting

The quad copter design has a symmetry of four motors commonly attached with an X shaped frame. Two motors spin in the clockwise direction and the other two counteract by moving anticlockwise direction. This eliminates the requirement of a yaw establish in rotors used generally in copters. Since multiple motors are used, thus the quad copter has a high weightlifting capacity. For example if the motor used have a lifting force of 3.5kgs each, the net mass of the quad copter will be 7kgs. Aerial maneuvers and supplying of materials can be done by using quad copters^{[7][5]}.





PROJECT RESERACH

In this project we have made a quad copter. This quad copter can take a flight off 2 mts. When the user operates the quad copter then the control systems of the quad copter controls the mesh combinations of the quad copter. Also the stability of the the quad copter depends on its tuning. Tuning must be done when the quad copter is in the aerial mode so as to determine a proper output gain. This is because the testing cannot be done while it is on the ground (stands) due to the factor of friction at each frame at its joint.

CONCLUSION:-

In this decade, the interest in the field of UAV development has increased exponentially. Our project uses a basic UAV quad copter platform with basic components. So we have not included any GPS, monitoring system or any sort of surveillance system in our quadcopter. But we have made some important and significant changes in the hardware of the UAV, thus improving the reliability and tuning of the quad copter.

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