# Quad-copter using The Flight Controller

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***Abstract:*** **This is the research paper which represents remotely operated Quad-copter system. The multi-rotor helicopter also known as a quad rotor or quad copter is designed with four rotors to create lift. Quod-copter is controlled through a flight controller and RF transmitter and receiver. There are two modes for operating the quad-copter which are X-mode and + mode. The X-mode gives good stability and balancing of the quad-copter. And, the developed system is able to cope with load disturbance up to 250 g during the hover position. We are using Mode 2 transmitter which have 6 channels. We are using 2200 mAh Lipo battery. Maximum battery time of Quad-copter is ten minutes in indoor and 8 minutes in outdoor.**

***Keywords :*** **Quadcopter, Flight controller, RF transmitter and RF recevier, Camera.**

## Introduction

Quad-copter, also known as quad rotor, is a helicopter with four rotors. The rotors are directed upwards and they are placed in a square formation with equal distance from the center of mass of the quad-copter. The quad-copter is controlled by adjusting the angular velocities of the rotors which are spun by electric motors. Quad-copter is a typical design for small unmanned aerial vehicles (UAV) because of the simple structure. Quad-copters are used in surveillance, search and rescue, construction inspections and several other applications.

The purpose of designing quad-copter is to present the quad-copter modeling for surveillance application in the society. This is completed with two aims. The first aim is to study the mathematical model of the quad-copter dynamics. The second aim is to develop proper methods for stabilization and proper control of the quad-copter.

The mechanical design of quad-copter is simpler than the conventional helicopter which makes easy handling and maintains of quad-copter. Quad-copter changes direction by manipulating the individual propeller's speed and does not require cyclic and collective pitch control.

There are four movements of the quad-copter which are totally depends on control surfaces. These control surfaces are: Aileron, Elevator, Throttle and Rudder (AETR).

These are on the transmitter side and by using hand movements we control these control surfaces are as below:

- Control the roll of quad-copter**:-**rotate the hand left and right (Aileron).
- Control the pitch of quad-copter**:** - rotate the hand up and down (Elevator).
- Control the speed of quad-copter**:** - fingers motion change the speed (Throttle).
- Control the yaw of quad-copter rotate the hand left and right (Rudder).

By considering above hand movements there are four directions which are as below:

1. Yaw Rotation: It is for turning left and right. Each of the rotors on the quad-copter produces both thrust and torque. Given that the front-left and rear-right motors both rotate counter-clockwise and the other two rotate clockwise, the net aerodynamic torque will be zero. A yaw is a counterclockwise rotation about the Z-axis.
2. Hovering: It lifts the quad-copter from ground level to stable level. To move the quad-copter climb/decline the speed of every motor is increased / decreased.
3. Roll: Roll movement is for tilting left and right. It is controlled by increasing speed on one motor and lowering on the opposite one. A roll is a counterclockwise rotation about the X-axis.
4. Pitch: Pitch is for moving up and down. In this we are using the second set of motors.
   A pitch is a counterclockwise rotation about the y-axis.

## Literature Survey

We have gone through past researched work for our project; also we have gone through journals and visited videos related to our project these are as follows:

Apart from e-books we have also gone across scholarly articles which are as below:

- International Journal of Engineering Trends and Technology (IJETT) – Volume 17 Number 2 – Nov 2014, 'Quad-copter – Obstacle Detection an Collision Avoidance', Prathamesh Salaskar1,SaeeParanjpe2,Jagdish Reddy3, Arish Shah4 Atharva College of Engineering University of Mumbai, India.
- Zhang.Y. et al. "Development of the model and hierarchy controller of the quad-copter." Proceedings of the Institution of Mechanical Engineers, Part G: Journal of Aerospace Engineering 222.1 (2008): 112.

## Proposed Work

The Quad-copter is multi-rotor device. Here we are using using four rotors. The objective of this project is to build a quad-copter that can be controlled by hand movements wirelessly. User is able to control motions of the quad-copter in three dimensions and also it captures and records the objects. This quad-copter can be mainly used in the areas where human entrance is impossible or dangerous for capturing of images or recording the objects.

Here we are using the KK flight controller for balancing the quad-copter which consists of ATmega 1644PA. Along with controller it also consists of IMU (Inertial Measurement Unit). IMU is combination of Accelerometer and gyroscope sensors. Accelerometer gives orientation for the quad-copter and Gyroscope control the speed motors.

To keep quad-copter self-stable automatically it should use specific algorithm, the best algorithm for this task is PID controller. The quad rotor will use a Proportional-Integral-Derivative(PID) control which a closed-loop feedback system, it will be tuned to determine the optimum response and settling time. The controller calculated the difference between the desired orientation and the current orientation and adjusts output value (U) accordingly.

The equations for a PID controller are as follows:

U=P+I+D

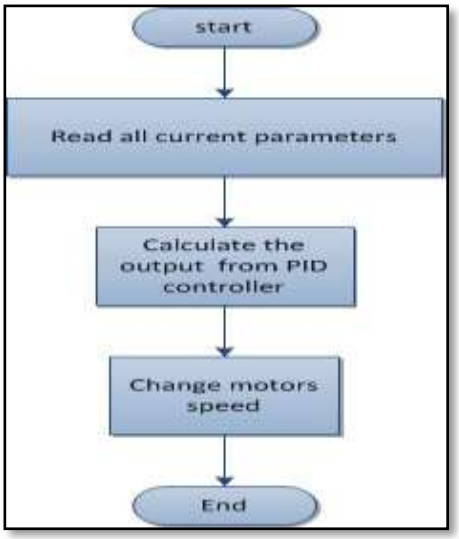
e (t) = ed (t) - ea(t)

**P** = KP * e (t),

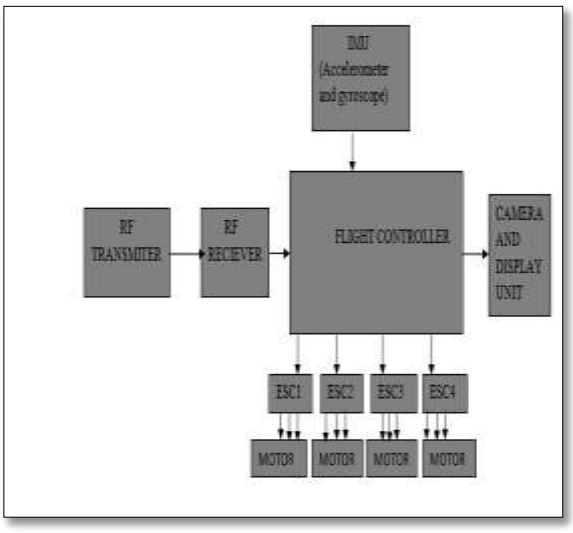
**I** = KI $\int_0^T e(t)dt$ ,

**D** = KD $de/dt$.

Following figure shows the process of flight control.




## Block Diagram




## Description

From RF transmitter we give the commands for the quad-copter's movement as per the user's requirement. There are six channels at the TX side out of which 5 channels are used and these are aileron, elevator, throttle, rudder and auxiliary .Auxiliary unit is always kept in enabled mode which indicates accelerometer and gyroscope sensors are ON the in the flight controller. The flight control board is the 'brain' of the quad-copter. It contains the sensors such as gyroscopes and accelerometers that determine how fast each of the quad-copter's motors spin. Flight control boards range from simple to highly complex. The receiver is built on the flight controller.

The power is distributed from main power battery to ESC (Electronic Speed Controller), then to flight controller. From flight controller it goes to receiver. ESC converts the battery pack DC voltage to a three phase alternating signal which is synchronized to the rotation of the rotor and applied to the armature windings. The motor speed is set by the ESC in response to a pulse width modulated control signal.

The battery used is of 12V.The motor is 3 wired connections; one is for signal, second is for VCC and third is for GND. By taking X-mode of quad-copter for the right side movement 2nd and 4th motor along with propeller are made to rotate in clockwise direction. Similarly for the left side movement motoe1st and 3rd along with propeller are made to rotate in anti-clockwise direction. Here camera is been placed on quad-copter.

## Scope

The proposed project is designed for small UAV. The controlling of quad-copter is done manually by using wireless RF transmitter and receiver. The camera placed in

the quad-copter helps in capturing the images and recording purpose in the area where human entrance is dangerous or impossible. The proposed system uses micro-controller ATmega 1644PA.Flight controller model is used for proper balancing and maintain the quad-copter.

In future, the flight controller model can be advanced by adding GPS features into it, which makes quad-copter the autonomous device with constant altitude, latitude and gravity.

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