

# Design and Fabrication of Quadcopter

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**Abstract**— This project is to build a quad copter that can accomplish a variety of practical tasks like delivery of drugs and medicines with parallel video surveillance. The market for multipurpose drones has the potential to be expansive once proper regulations by government are passed. A Quad copter can achieve stable vertical flight and can be used to monitor or collect data in a desired region. Advancement in technology have reduced the cost and increased the performance of low powered microcontrollers that allow enthusiasts to develop their own Quad copter.

**Keywords:** Quadcopter, VTOLs, ESC

a single, main rotor. This was wasteful and inefficient. Engineers developed quadcopters to solve the problems that helicopter pilots had with making vertical flights. The first was the Omnichen 2, invented in 1920 by Etienne Omnichen. This craft made 1000 successful flights and flew a recorded distance of 360 meters (1181.1 feet).The Convertawings Model A quadcopter. designed by Dr. George E Bothezat, appeared in 1956. It was the first to use propulsion, or a propeller's forward thrust, to control an aircraft's roll, pitch and yaw. The Curtis Wright V27, developed by the Curtis Wright Company, followed in 1958.

## I. INTRODUCTION

Over the last few years we have seen a massive growth in the manufacture and sales of remote control airborne vehicles known as Quadcopters. 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.

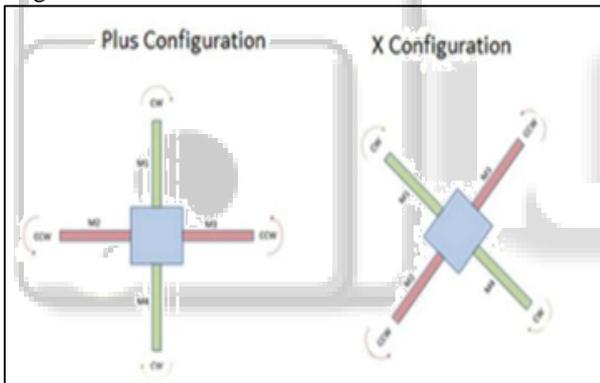


Fig. 1: Quadcopter Configurations

They are sometimes referred to as Drones, Quadrotors or Quadcopters. In the standard format two propellers will spin in a clockwise direction with the other two spinning in an anticlockwise direction allowing the craft to vertically ascend, hover in the air and fly in a designated direction. The Quadcopter is a simple format with very few moving parts and has rapidly become a favorite vehicle for remote control enthusiasts and is widely being used as an effective Aerial photographic platform. A large majority of the Quadcopters were originally built by hobbyists who understood the simplicity of the vehicle. By adding four motors and four propellers to a lightweight frame constructed of light wood, carbon fiber, or fiber glass then connecting it to a remote control transmitter via a small control board fitted with a gyroscopic stabilization system and connected to a Lipo battery these craft were relatively simple to construct.

## II. HISTORY

Quadcopters were among the first vertical take-off and landing vehicles(VTOLs).Earlier helicopters used tail rotors to counterbalance the torque, or rotating force, generated by



Fig. 2: Actual Setup of Quadcopter.

### A. Component Specifications

#### 1) FDI Frame:

This is the glass fiber quadcopter frame which is very simple and easy to build frame This Flame wheel is one of the most popular frames out there for a number of good reasons: It's relatively inexpensive:

- 1) It's relatively inexpensive.
- 2) Itis famously durable.
- 3) The centre plate doubles as a power distribution board which tidies things up quite a bit and allowed me to get rid of my ugly DIY wiring harness.
- 4) The design is really well thought out – it's a compact frame. Plenty of room for receiver, control board, ESCs, and battery, with mounting options and room to spare for a GoPro or other camera setup.



Fig. 3: FDI Frame

## 2) Electronic Speed Controller (ESC):

The electronic speed control, or ESC, is what tells the motors how fast to spin at any given time. You need four ESCs for a quadcopter, one connected to each motor. The ESCs are then connected directly to the battery through either a wiring harness or power distribution board.



Fig. 4: ESC

ESCs are normally rated according to maximum current. We are using 30 A. Generally the higher the rating, the larger and heavier the ESC tends to be which a factor when calculating mass is and balance in airplanes. Many modern ESCs support nickel metal hydride, lithium ion polymer and lithium iron phosphate batteries with a range of input and cut-off voltages. The type of battery and number of cells connected is an important consideration when choosing a Battery eliminator circuit (BEC), whether built into the controller or as a stand-alone unit.

## 3) DC Brushless Motor:

Brushless DC electric motor (BLDC motors, BL motors) also known as electronically commutated motors (ECMs, EC motors) are synchronous motors that are powered by a DC electric source via an integrated inverter/switching power supply, which produces an AC electric signal to drive the motor. In this context, AC, alternating current, does not imply a sinusoidal waveform, but rather a bi-directional current with no restriction on waveform.



Fig. 5: DC Brushless Motor

Brushless motors may be described as stepper motors; however, the term stepper motor tends to be used for motors that are designed specifically to be operated in a mode where they are frequently stopped with the rotor in a defined angular position. This page describes more general brushless motor principles, though there is overlap. Two key performance parameters of brushless DC motors are the motor constants KV and Km.

## 4) Propellers:

Here in this project quadcopter there arises the need of two types of propellers to need the purpose of flight. A pair of clockwise (CW) and anticlockwise (ACW) propellers are needed. The care should be taken in finalizing the dimensions of the propellers.

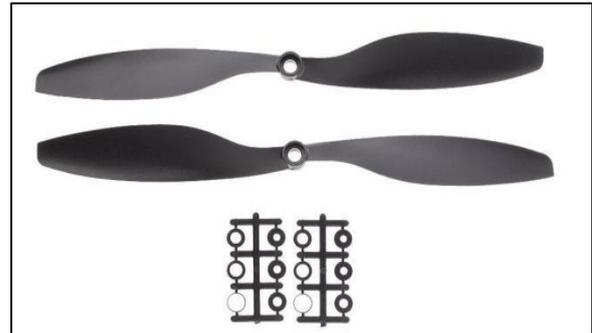


Fig. 6: Propellers

A propeller is a type of fan that transmits power by converting rotational motion into thrust. A pressure difference is produced between the forward and rear surfaces of the air foil-shaped blade, and a fluid (such as air or water) is accelerated behind the blade. Propeller dynamics can be modelled by both Bernoulli's principle and Newton's third law. A marine propeller is sometimes colloquially known as pitch of the screw. Generally, increased propeller pitch and length will draw more current. Also the pitch can be defined as the travel distance of one single prop rotation. In a nutshell, higher pitch means slower rotation, but will increase your vehicle speed which also use more power.

## 5) Flight Controller:

The KK2.1.3 is next big evolution of the first generation KK flight control boards. The KK2.1.3 was engineered from the ground up to bring multi-rotor flight to everyone, not just the experts. The LCD screen and built in software makes install and setup easier than ever. A host of multi-rotor craft types are pre-installed, simply select your craft type, check motor layout/propeller direction, and calibrate your ESCs and radio.

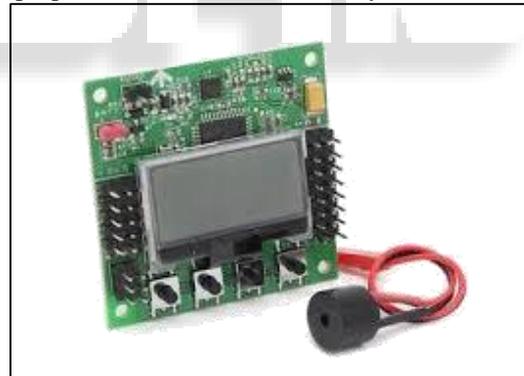


Fig. 7: Flight Controller

The original KK gyro system has been updated to an incredibly sensitive 6050 MPU system making this the most stable KK board ever and allowing for the addition of an auto-level function. At the heart of the KK2.1.3 is an Atmel

Mega644PA 8-bit AVR RISC-based microcontroller with 64k of memory. An additional polarity protected header has been added for voltage detection, so no need for on-board soldering. A handy piezo buzzer is also included for audio warning when activating and deactivating the board.

a) Specifications:

Size: 50.5mm x 50.5mm x 12mm

Weight: 21 gram (Inc. Piezo buzzer)

IC: Atmega644 PA

Gyro/Acc: 6050MPU Inven Sense Inc.

Auto-level: Yes

Input Voltage: 4.8-6.0V

6) *Fly Sky Transmitter and Receiver:*

a) Transmitter:

Fly sky Transmitter and Receiver which we are using is CT6B which has 6 channels. It Requires a PC to change the channel variables, mixing and servo reversing. The radio transmitter and receiver allow you to control the quadcopter. There are many suitable models available, but you will need at least four channels for a basic quadcopter with the KK2.1.3 control board. In electronics and telecommunications a radio transmitter is an electronic device which, with the aid of an antenna, produces radio waves.



Fig. 8: CT 6B Radio Transmitter

The purpose of most transmitters is radio communication of information over a distance. The information is provided to the transmitter in the form of an electronic signal, such as an audio (sound) signal from a microphone, a video (TV) signal from a TV camera, or in wireless networking devices a digital signal from a computer. The transmitter combines the information signal to be carried with the radio frequency signal which generates the radio waves, which is often called the carrier. This process is called modulation.

b) Receiver:

A radio receiver is an electronic circuit that receives its input from an antenna, uses electronic filters to separate a wanted radio signal from all other signals picked up by this antenna, amplifies it to a level suitable for further processing, and finally converts through demodulation and decoding the signal into a form usable for the consumer, such as sound, pictures, digital data, measurement values, navigational positions, etc. The receiver is the receiving end of a communication channel. It receives decoded messages/information from the sender, who first encoded them. Sometimes the receiver is modelled so as to include the decoder. Real-world receivers like radio receivers cannot be

expected to receive as much information as predicted by the noisy channel coding theorem.



Fig. 9: Receiver of CT 6B Transmitter

c) Specifications:

- Channels: 6channels
- Model type: Heli, Airplane, Glider
- RF power: less than 20db
- Modulation: GFSK
- Code type: PCM
- Sensitivity: 1024
- Low voltage warning: LED warning
- DSC port: yes
- Range: 1 KM (Approx)
- Charger port: yes
- Power: 12V DC(1.5AAA\*8)
- Weight:680g
- ANT length:26mm

7) *LIPO Battery:*

A lithium polymer battery, or more correctly lithium-ion polymer battery (abbreviated variously as LiPo, LIP, Li-poly and others), is a rechargeable battery of lithium-ion technology in a pouch format. Unlike cylindrical and prismatic cells, LiPos come in a soft package or pouch, which makes them lighter but also less rigid.



Fig. 10: Lipo Battery

Quadcopters typically use LiPo batteries which come in a variety of sizes and configurations. We typically use 3S1P batteries, which indicates 3 cells in parallel. Each cell is 3.7 volts, so this battery is rated at 11.1 volts. LiPo batteries also have a C rating and a power rating in mAh (which stands for milliamps per hour). The C rating describes the rate at which power can be drawn from the battery, and the power rating describes how much power the battery can supply. Larger batteries weigh more so there is always a tradeoff between flight duration and total weight. A general rule of thumb is that doubling the battery power will get you 50% more flight time, assuming your quadcopter can lift the additional weight.

### 8) Principle of Operation:

Frame principle: Frame is the structure that holds all the components together. The Frame should be rigid, and be able to minimize the vibrations coming from the motors. Quadcopter frame consists of two to three parts which don't necessarily have to be of the same material:

- The center plate where the electronics are mounted.
- Four arms mounted to the center plate.
- Materials Available For a Frame:

- 1) Carbon Fibre
- 2) Aluminium
- 3) Wood, such as Plywood or MDF (Medium Density Fibreboard)

Carbon fiber is most rigid and vibration absorbent out of the three materials but also the most expensive. Hollow aluminum square rails are the most popular for the Quadcopters' arms due to its relatively light weight, rigidity and affordability. However aluminum could suffer from motor vibrations, as the damping effect is not as good as carbon fiber. In cases of severe vibration problem, it could mess up sensor readings. Wood board such as MDF plates could be cut out for the arms as they are better at absorbing the vibrations than aluminum. Unfortunately the wood is not a very rigid material and can break easily in Quadcopter crashes.

As for arm length, the term "motor-to-motor distance" is sometimes used, meaning the distance between the centers of one motor to that of another motor of the same arm in the Quadcopter terminology. The motor to motor distance usually depends on the diameter of the propellers. To make you have enough space between the propellers and they don't get caught by each other.

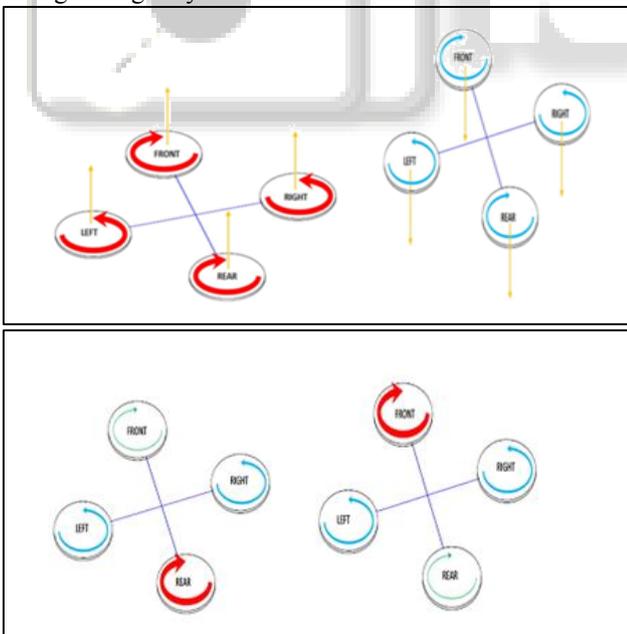


Fig. 11: Principle of operation

### 9) Principle and Working:

The principle and working of a propeller is based on Bernoulli's Principle and Newton's Third Law. Bernoulli's principle states that for an inviscid flow, an increase in the speed of the fluid occurs simultaneously with a decrease in pressure or a decrease in the fluid's potential energy. Newton's third law states that every action has an equal and

opposite reaction. An aero foil of a propeller is shaped so that air flows faster over the top than under the bottom. There is, therefore, a greater pressure below the aero foil than above it. This difference in pressure produces the lift. Lift coefficient is a dimensionless coefficient that relates the lift generated by an aerodynamic body such as a wing or complete aircraft, the dynamic pressure of the fluid flow around the body, and a reference area associated with the body.

### 10) Mechanism:

Quadcopter can be described as a small vehicle with four propellers attached to the root located at the cross frame. This aim for fixed rotors is used to control the vehicle motion. The speeds of these four rotors are independent. By independent pitch, roll and yaw attitude of the vehicle can be controlled easily. Pitch, roll and yaw attitude of Quadcopter.

### 11) Connections of PCB & ESC's:

Chassis which is inbuilt with HJ-450 frame has to be soldered for connecting ESC'S. Chassis works as a PCB printed Board for power supply. We have used Insulating material for soldering. While soldering we must make sure that there is no open or close circuit.

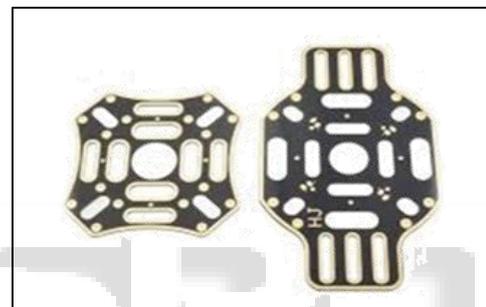


Fig. 12: Chassis works as a PCB printed Board for power supply

### 12) Connection of ESC'S:

After Soldering is done 4 ESC'S has to be connected to Chassis of HJ-450 frame. Proper Care should be taken so as not to get short circuit.

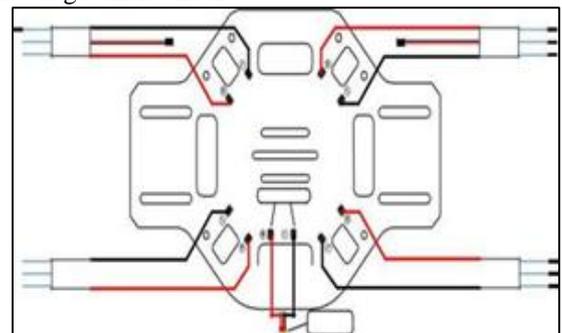


Fig. 13: Connection's Of ESC's

### 13) Advantages:

- 1) It has high stability and high reliability.
- 2) It can do vertical lift off thus no need of runway.
- 3) It is also suitable for indoor applications.
- 4) Easy to build.
- 5) Easy to traverse difficult terrain.
- 6) Shorter routes.
- 7) No need of "Costly" human pilot.

### 14) Dis-advantages:

- 1) Does not work with fixed wing drones.
- 2) Adds bulk to smaller drones.

- 3) Adds to the overall weight
- 4) Replacement parts could suffice versus buying guard in the short run.
- 5) Immoral.
- 6) Low resistance to weather.
- 7) Cannot refuel in flight.

15) Applications:

a) Civil and Commercial Applications:

- 1) Pick and drop
- 2) Air inspection
- 3) Communication Purpose
- 4) Aerial Photography
- 5) Ambulance Drone

b) Military Applications:

- 1) Tracking.
- 2) Drones with the help of gps can track particular person or vehicle movement.
- 3) Identifying enemy movements.
- 4) In search and rescue operations.
- 5) Many military operations uses drones for live coverage of the mission .Rescuing hostages and civilians is the main objectives of these operations. Drones are used to check the condition of the hostages.

6) Video surveillance.

c) Environmental Applications:

- 1) Fire Control.
- 2) Wild life surveillance.

d) Industrial Applications:

- 1) Inspection in areas where humans can't go.
- 2) Spotting leakages.
- 3) Construction/Surveying.

e) Agriculture Applications:

- 1) Pesticide sprinkler.

### III. FUTURE SCOPE

Future of a quad-copter is quite vast based on various application fields it can be applied to. Quad-copter can be used for conducting rescue operations where it's humanly impossible to reach. In terms of its military applications it can be more widely used for surveillance purposes, without risking a human life. As more automated quad-copters are being developed, there range of applications increases and hence we can ensure there commercialization. Thus quad-copter can be used in day to day working of a human life, ensuring their well-being.

### IV. CONCLUSION

As per the design specifications, the quad copter self stabilizes using the array of sensors integrated on it. It attains an appropriate lift and provides surveillance of the terrain through the camera mounted on it. It acts appropriately to the user specified commands given via a remote controller .Its purpose is to provide real time audio/video transmission from areas which are physically in-accessible by humans. Thus, its functionality is monitored under human supervision, henceforth being beneficial towards military applications. It is easy to manoeuvre, thereby providing flexibility in its movement. It can be used to provide surveillance at night through the usage of infrared cameras. The system can further be enhanced for future prospects. The GPS data logger on the

quadcopter stores its current latitude, longitude, and altitude in a comma separated value file format and can be used for mapping purposes. This project required members not only to interface and program the components of the quadcopter, but also exposed them to mechanical components and reality of project management to accomplish the project objectives.

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