# Radio Control Unmanned Aerial Vehicle

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*Abstract*— The main purpose of our project is related to some fields like in firefighting, agriculture and for marketing purpose. In the field of firefighting the use of UAV is that it measure different parameters of building. It can measure the temperature of fire and it also concludes that how man power and the amount of the water will require. In the field of marketing we use some basic components like small speakers and banners for advertisement purpose and in future we also may be use a projector for visual projection. In agriculture field we use different sensors which sense the temperature and humidity. With the help of this we measure the evaporation of water in farm.

***Key words:*** BLDC, Sensors, Controller

## I. INTRODUCTION

Now-a-days drones are increasingly being integrated into working task to replace humans, especially to perform the respective task. In general drones are mainly classified into two categories working drones and racing drones. The working drones are mainly used in the working area to fulfill the requirement of human being. Currently drones are used in many fields of applications including military, industries, photographs, agricultures, dangerous environment, journalism, for delivery purpose, surveillance, there for a drone can be replace human to do work.

### *A. Problem Specification*

In many applications for measuring the different parameters in that area where human can't reach the quadcopter device is used. Human can control it by itself and fly away surround that environment. It also have been use for the advertisement purpose in marketing field

### *B. Materials/Tool Required*

In this project we required a flight control board for controlling the quadcopter. We require a power distribution board to distribute the same power to all components. We require an electronic speed control to control the speed of all motor separately. We use basic wooden and aluminum material for basic frame of quadcopter.

## II. IMPLEMENTATION

### *A. Structure of quadcopter:*

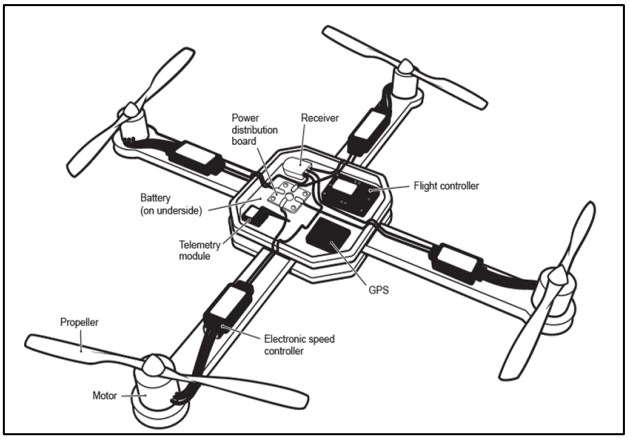


Fig. 2.1: structure of quadcopter

The figure shows the basic structure of the quadcopter. In the basic structure of the quadcopter there is require a main frame and it can be made from the different materials like aluminum, plastic, wooden, fiber etc. At the end of each side of the frame there is brushless dc motor is connected. As we use here the quad configuration so the frame includes four sides. We can choose the appropriate brushless dc motor as per our requirement. Here we choose the 1000kv dc motor. The propellers are connected at the top of the motor. Main function of propellers is it produces the thrust at bottom side of the quadcopter so the quad can lift up. The electronic speed controller is connected to the brushless dc motor. It can use for control the speed of the dc motor. We can maintain the speed of dc motor for controlling the quadcopter. We move our quadcopter at right side, left side, up and down as per our requirement. The main block or the device of quadcopter is flight control board. It can control all the action of the quadcopter. All the device of quadcopter is connected to the flight control board. It is basically a programming board.

The other component is power distribution board which used for distribute a require power to all ESCs.

Receiver is connected to the flight control board and it is use for receive all the signals which is given by the transmitter. Also Transmitter is one of the most necessary devices of quadcopter which is not mention in above diagram. It can transmit all the signals which are given by the operator and operator can control the quadcopter with help of this device.

### *B. Parameters:*

The movement of the aircraft is based on the rotational speed of each of the narrow airfoils; change of speed changes the position.

 

The aircraft primarily is governed by control of the three major axes namely; pitch, roll and yaw.

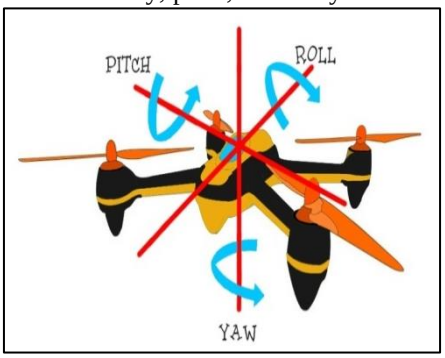


Fig. 2.2: parameters

*1) Yaw:*

It is the vertical axis that passes through the geometric center of the quadcopter. Rotational force vector of all the four motors acts at the center and cancels out each other at the exact geometric center, in conditions when it does not cancel and the resultant vector has net positive or negative magnitude the quadcopter rotates about this axis clockwise or anti clockwise respectively.

*2) Pitch:*

It is the axis that passes horizontally parallel to the plane of quadcopter extending towards the front and back end of the quadcopter. Rotational force vector of all the four motors acts at the center and cancels out each other at the exact geometric center, in conditions when the resultant of the rotational force vector is not zero but either positive or negative the quadcopter moves in the forward or backward direction respectively.

*3) Roll:*

It is the axis that passes horizontally parallel to the plane of quadcopter extending from left to right.

Rotational force vector of all the four motors acts at the center and cancels out each other at the exact geometric center, in conditions when the resultant rotational force vector is not zero but either positive or negative the quadcopter moves in the right or left Direction respectively. [5]

*C. working principle:*

The quadcopter has 4 motors whose speed of rotation and the direction of rotation changes according to the users desire to move the device in a particular direction (i.e. tack off, landing, forward, backward, left, and right)

*1) Rotating:*

As shown in the figure there is four motors are used in the quadcopter. Here the motor no. 1 and 3 are rotate in clockwise direction and motor no. 2 and 4 are rotate in counterclockwise direction. The reason behind this is If all the four motors and hence the propellers rotate in the same direction, the net moment about the center of mass of the quadcopter will become non zero. With this non zero value of net moment on the center of mass, the quadcopter will rotate about the axis parallel to the motor shafts through center of mass. [6]So if we do not rotate the motors in the same direction then the center of mass of the quadcopter will becomes zero and it can fly upward.

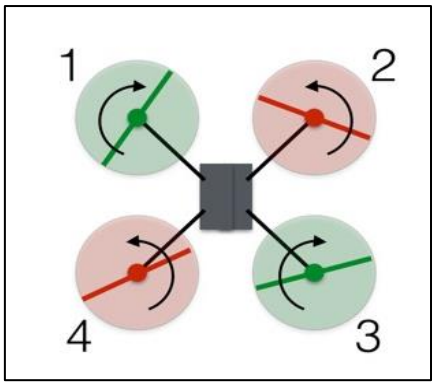


Fig. 2.3: Rotation of motor

*2) Working principle of direction:*

The working principle of direction of quadcopter is basically based on the speed of motor. The signal from microcontroller goes to ESC's which is turn control the speed of motor.

a) Takeoff and landing motion:

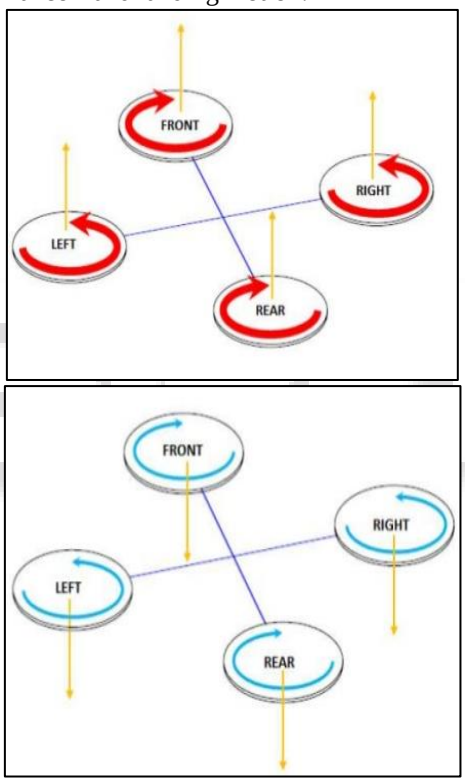


Fig. 2.4: Tackoff and landing motion

For tackoff the quadcopter upward direction motion of all the motors at the same speed and for the landing the same principle use.

b) Forward and Backward motion:

For the forward motion of the quadcopter the speed of rear motor is fast compare to the backward motor and the other two motors are at the same speed. For backward motion the speed of front motor is fast compare to rear motor.

 

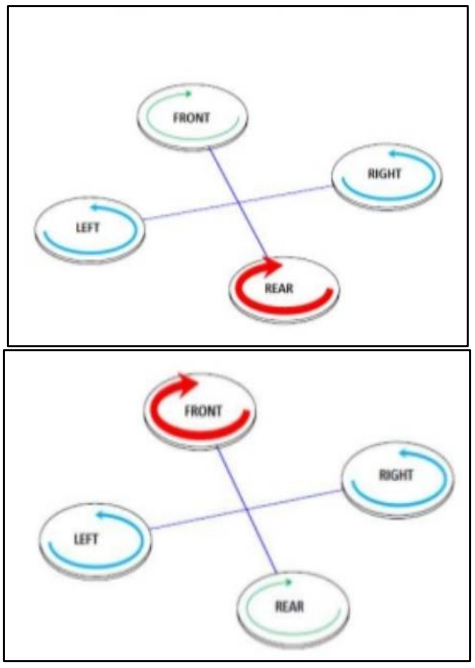


Fig. 2.5: Forward and Backward motion

c) Right and Left motion:

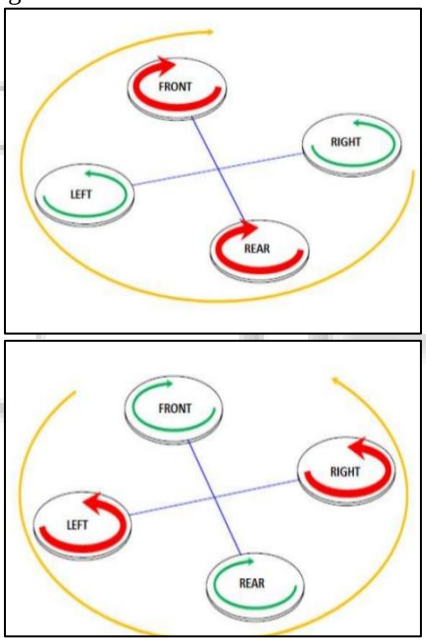


Fig. 2.6: Right and Left motion

For right motion of quadcopter the front and rear motor are rotate at the same speed and other two motors are at same speed but the rotation of front and rear motor is much fast compare to the left and right motor. For left motion of quadcopter speed of left and right motor is higher than the speed of rear and front motor.

*D. Component list:*

The following components are used in our project.

- Airframe
- Brushless dc motor
- Propeller
- Electronic speed control
- Power distribution board
- Flight controller
- Battery
- Transmitter
- Receiver

*E. Airframe:*

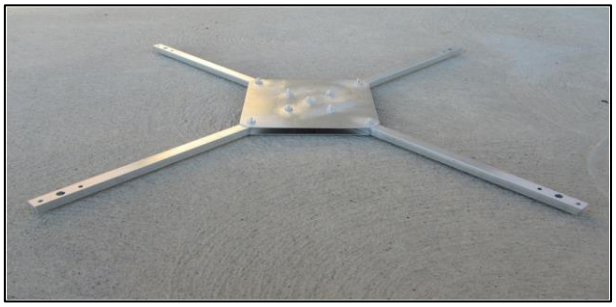

Fig. 2.7: Quadcopter Airframe

Above figure shows the basic airframe of the quadcopter. This includes a wooden base and the 4 aluminum sides. Our basic configuration is quad so here we can choose the frame which has 4 sides.

Every quadcopter or other multi-rotor aircraft needs a frame to house all the other components. Things to consider here are weight, size, and materials. A rule of thumb is required Thrust per motor = (weight × 2) ÷ 4 (1)We can choose the appropriate frame as per our requirement. The number of frame available made from the different materials. There are wood airframes, plastic ones, and metal ones. [7]

*1) Advantages*

This frame has many advantages which mention bellow

1) Appearance
   This frame has main benefit is that it easy to assemble and it have a good appearance.
2) Material:
   Here we choose the wooden material for the base and the aluminum for sides. Both the material is light in weight and comfortable for component placement.
3) Price
   The price of both the materials is low so at the end it will help overcome the price of allover device.
4) Strength
   The basic but the main problem in quadcopter is that whenever it fall down due to run out of battery or any technical error in the device the airframe of quadcopter is damage. Here we use the materials which have a better strength so we can overcome the damage of airframe at considerable level.

*F. Propellers:*

Fig. 2.8: Propellers

 

The above figure shows the propellers of the quadcopter. There are many factors which are consider during selection of appropriate propeller like, Speed of dc motor If we choose the dc motor which have a higher rpm then we can choose the small propellers and if we can choose the lower rpm dc motor then big propellers are used. Because of if we choose the propellers having a larger diameter than it can produce a large thrust in less number of rotations, it requires a less current so it can work on less power requirement. [8] There are basically a two types of propellers are used; pushers and pullers. Pushers propeller These are the propellers which give thrust when they are rotated in clockwise direction.

Pullers propeller These are the propellers which give thrust when they are rotated in anti-clockwise direction.

*G. Electronic Speed Control (ESC):*


Fig. 2.9: Electronic speed control

Electronic speed controller is device which controls the speed of BLDC. ESC is going to take feedback from motor and give pulses accordingly back to motor. [9]

*1) Block diagram of ESC:*

It can be seen from fig. that components present in ESC are

1) Controller
2) Driver
3) Inverter

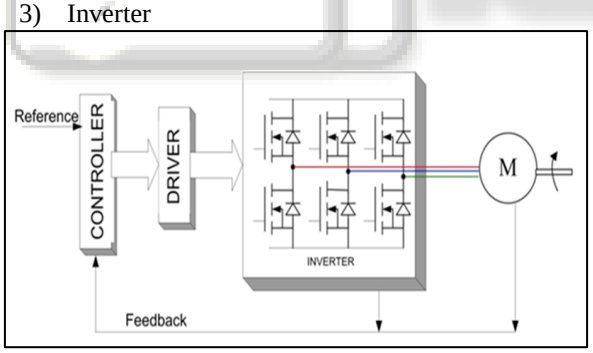


Fig. 2.10: block diagram of ESC

ESC takes reference voltage as input which ranges between 0 to 1V based on change in reference voltage output of ESC changes as result speed of motor changes. [10]

1) CONTROLLER:
   Controller mostly is a microcontroller which process input by taking feedback from motor and drives inverter through motor driver accordingly.
2) DRIVER:
   Microcontroller generally does not have capability to drive inverter so motor driver is used to amplify power of microcontroller such that it can drive inverter. If an attempt is made to drive inverter directly using microcontroller, it gets burned.
3) INVERTER:
   It is known that BLDC requires AC supply but we are giving DC supply to ESC so this is converted into AC by inverter. Frequency of output AC voltage depends upon the input reference voltage given to ESC.

*H. Power Distribution Board:*

The bellow figure shows the power distribution board of quadcopter. Here the power distribution board is used to give power supply to all the motors equally.

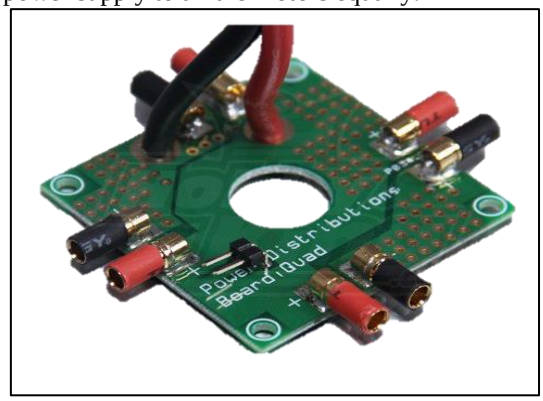


Fig. 2.11: Power Distribution Board

Because we cannot keep battery to each of the four motors as it is cost effective and also increases the weight of the quad. The BLDC motor is connected to the power distribution board through the electronic speed control. [11]

Features

- Small, low package profile
- Good temperature stability

*I. Brushless DC Motor (BLDC):*

BLDC is a hybrid motor which involves of concepts of both AC and DC motors.There are mainly two types of dc motors: ordinary dc motor and brushless dc motor.In the ordinary dc motor there is stator and rotor and also include a brushes but in the brushless dc motor there is absence of brushes and other structure is same as the ordinary dc motor that's the reason why the name is brushless dc motor. In the brushless motor the inner part is stator and the outer part is rotor. [12]Broadly Brushless DC motors are classified in to two types:

1) Sensor Brushless DC motors.
2) Sensor less Brushless DC motors.

BLDC works on 3-phase supply as that of synchronous motor.

Fig. 2.12: Brushless DC Moto

*J. Working principle of BLDC:*

Working of BLDC is shown in figure 3.13. If all figures in 3.13 it is observed it can be seen that there is gray strip over

 

RGB lines, this gray strip shows at different time intervals of time what is voltage at each phase. Common thing that can be seen is at any instant of time only two phases are conducting. In fig.3.13 (a) it can be seen that GREEN phase is conducting +ve and BLUE phase is conducting –ve as a result direction of resultant flux is in the direction of black arrow shown. At another instant of time shown in fig.3.13 (b) RED phase is conducting +ve and BLUE phase is conducting –ve. Now it can be seen that field is rotating with respect to stator as a result rotor locks with that field and rotates at that speed. But if rotor does not lock with rotating field motor does not rotate. So it is required to get position of rotor as feedback so according to that we'll be commutating emf across R, G and B wires. As our motor does not consist of any kind of sensors how can we get feedback? It is seen above that one of the phase does not conduct at any instant of time i.e. floating phase. Some back emf is induced in floating phase, based that ESC (Electronic Speed Controller) is going to figure out position of rotor and gives pulses to other two terminals accordingly.

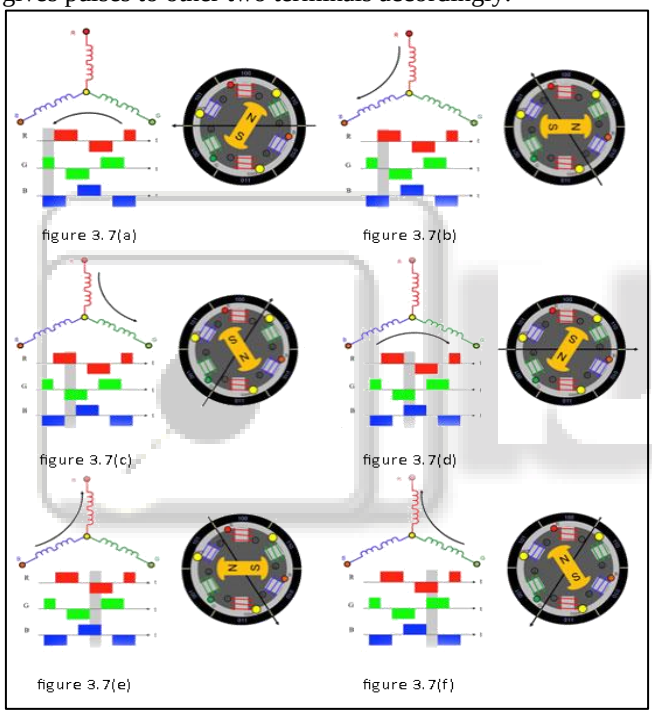


Fig. 2.13: working principle of BLDC

## K. *Flight controller:*

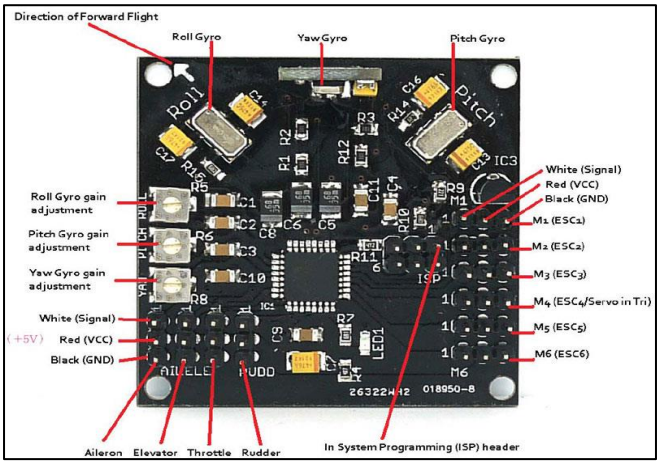


Fig. 2.14: Flight controller

*1) Control board description:*

The board we are using for our Quad rotor is KKCOPTER v5.5. It is having accelerometer and gyro sensors which are used for stabilization and feedback control. The connections from ESC and Receiver are given to this board. No direct power supply from battery is given to this board. The board will be having AT Mega 168 microcontroller which will process the inputs and give the outputs accordingly. [13] The microcontroller here is mounted on the board which we call it as Surface Mount Technology. It will be having a number of capacitors and resistors which will actually filter the noise signals and act as filters. It is having an ISP (In System Programming) header from where you can program the board using KKMulticopter Flash software. We can see a blue led (LED 1) which will glow once the programming is done and it will also glow once it starts receiving the signal from the transmitter. It is having trim pots (potentiometers) for YAW, PITCH and ROLL using which we will calibrate the quad rotor. The wires from receiver are given to pins where it is written Aileron in board to channel 1 in receiver, Elevator to channel 2, Throttle to channel 3 and Rudder to channel 4. The pins from receiver are given to signal pins. Then the wires from ESC are given to M1 to M4 respectively, the ESC will be having three wires where the white (or yellow) is the signal pin in it which is always the innermost pin in the board.

*2) Accelerometer sensor:*

It's an electromechanical device that measures acceleration forces and tilt angles by using the MEMS (Micro Electro Mechanical Systems) technology, where acceleration is the rate of change of velocity with respect to the time. Acceleration forces may be Static acceleration or Dynamic acceleration depending upon the way one uses the accelerometer.

Example: ADXL335

*3) Working principle of accelerometer:*

Accelerometer works by sensing the changes in the capacitance. If one places two microstructures next to each other, then they'll have a certain capacitance between them. If an accelerative force moves one of the structures, then the capacitance will change. Adding some circuitry to convert from capacitance to voltage, and one will get an accelerometer- where the output voltage can be used to send signals for microcontroller.

There are even other methods like including the use of piezo resistive effect, hot air bubbles, and light.

*4) Microcontroller:*

The Microcontroller we will be using is AT Mega 168. It is having two ports PB and PD with 8 pins each and one port PC with 7 pins. It is also having Pulse Width Modulation (PWM) pins and Analog to Digital Conversion (ADC) pins.

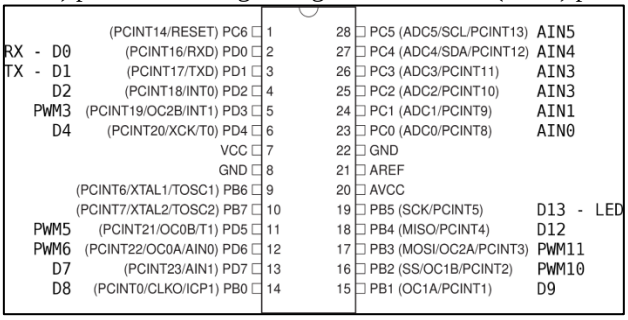


Fig. 3.15: Pin diagram of AT Mega 168

 

*5) Gyro sensors:*

Apart from accelerometer sensors it is also having Gyro sensors which will sense even the smallest changes. Gyro sensors, also known as angular rate sensors or angular velocity sensors are devices that sense angular velocity. It senses motions which human eye is not capable of capturing or noticing. [15]

*L. Transmitter:*

A RC transmitter (TX) is a device that allows the pilots to control the aircraft wirelessly. The signal/commands are then received by a radio receiver (RX) which is connected to a flight controller. Whole action of the drone such as movements and any other action are done through the transmitter. [16]

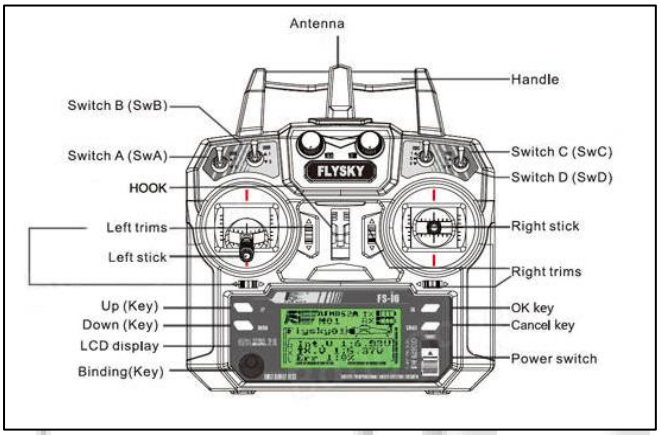


Fig. 2.16: Transmitter

Specifications:

| | | |
|---|---|---|
| Channels | : | 6 Channels |
| Model Type | : | Glider/Heli/Airplane |
| RF Range | : | 2.40-2.48GHz |
| Bandwidth | : | 500KHz |
| Code Type | : | GFSK |
| Low Voltage Warning | : | less than 4.2V |
| ANT length | : | 26mm*2(dual antenna) |
| Weight | : | 392g |
| Size | : | 174x89x190mm |

Transmitter description:

1) switch
   There is total four number of switches are used in this transmitter which is switch A, B, C and D. These switches are used for the channel selection.
2) Sticks
   There are two sticks which are used for the control purpose.
3) Power switch
   The power switch is used for turn and off the transmitter.
4) LCD display
   It used for monitor the control action of transmitter.
5) Up and down keys
   These keys are used whenever we change the settings.

*M. Li - Po Battery:*


Fig. 2.17: Li – Po battery

The term li – po stands for Lithium Polymer. Here the li – po battery is used for the power supply. Lithium polymer cells are constructed using a flexible, foil-type case containing an organic solvent. In lithium-ion cells a rigid case presses the electrodes and the separator onto each other whereas in polymer cells external pressure is not required because the electrode sheets and the separator sheets are laminated onto each other Lithium polymer batteries, the next

Generation power source since no metal battery cell casing is needed, the weight of the battery is reduced and it can be formed to shape. The denser packaging without inter cell spacing and the lack of metal casing increases the energy density of Li-Po batteries to over 20% higher than that of classical Li-ion batteries. Lithium polymer cells are considered fully charged when the cell terminal voltage reaches 4.2 V and are fully discharged when the cell terminal voltages decreases to a voltage of 3.0V. A variety of Li-Po batteries are commercially available consisting of different series and parallel configuration of cells making up the required battery voltage and current characteristics. [17]

Advantages:

In UAV applications the obvious benefit of using Li-Po batteries is the higher energy density Offered. Advantages of Li-Po batteries can be summarized as follows:

1) High energy density;
2) Low self-discharge properties;
3) The flexible casing of the polymer batteries allow for design freedom in terms of profile thicknesses; and
4) Low maintenance

*N. Receiver:*

It's important to know that a TX only works with radio receiver (aka RX) from the same manufacturer generally. For example, if you get the Frsky Taranis, you will have to use Frsky RX's, or other Frsky compatible RX. [16]

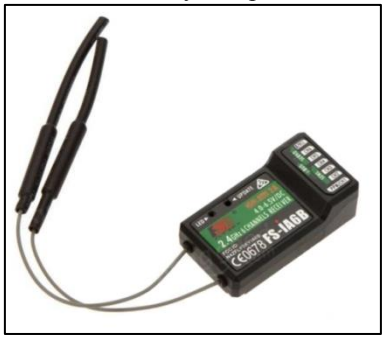


Fig. 2.18: Receiver

 

Specification:

| | | |
|---|---|---|
| Number of channel | : | 6 |
| Modulation | : | GFSK |
| Channel resolution | : | 1024 steps |
| Power | : | 4.0 – 6.5V DC |
| Weight | : | 6.4g |
| Antenna length | : | 26mm |
| Size | : | 40.4*21.1*7.35m |

*O. Project Photo:*

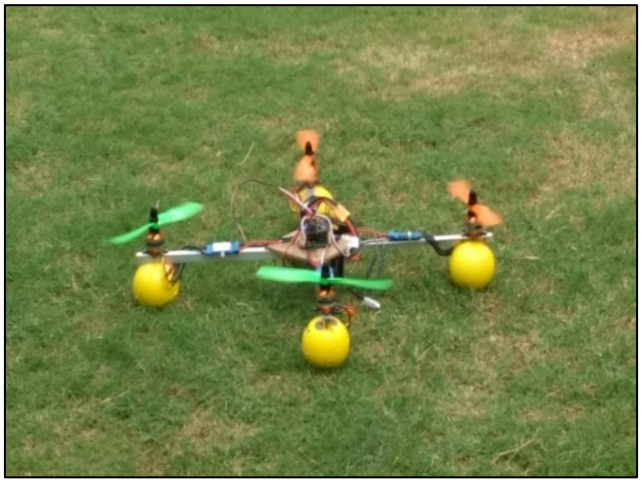

Fig. 2.19: project photo

## III. Conclusion

After work on this project we can conclude that the different parameters of this device are easily adjustable the device can easily work on the different situations. The operation of the device is user friendly. We can easily expand the applications by attaching appropriate devices.

*A. Future scope:*

In this project if we connect a different sensors than we ca easily measure some more parameters of surrounding environment. After some changes in the power source the flight duration can considerable increase. Also change in the transmitter and receiver specifications we can increase the flight area of quadcopter

## Acknowledgement

With a deep sense of gratitude and respect, we would like to extend our sincere thanks to Prof. R. J. Thummar for their kind attention and guidance which have made the Project successful. It is a matter of proud to study under such an experienced and expert faculty to understand and address current problem. Apart from technical skill we also learned the quality of 'accuracy in documentation'. He has also given us current project topics for seminar preparation which helped us in better preparation of presentation during Project review. We would like to express our heartfelt gratitude to Prof. R. B. Vaghasiya (H.O.D, Electronic and communication department) to provide us full support in utilizing the lab resources to perform our dissertation work. Apart from resources he also motivates and inspires us to keep our performance standard as maximum as possible.We are also thankful to our family and friends for their support during this project work.

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