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DESIGN AND FABRICATION OF ADVANCED AERIAL ROBOT QUADCOPTER

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ABSTRACT

This paper explains about the Fabrication of aerial robot quadcopter with advanced avionics system for the use of spraying pesticides and fertilizers in agricultural land. Construction of Quadcopter with multi rotor setup will be most promising task for the unmanned aerial vehicle designers. The fabricated vertical takeoff and landing aerial robot quadcopter has four motors mounted on its four arms. Brushless motor of 1000 to 1500 rpm and propeller of 10×4.5 have been inbuilt with this Quadcopter for obtaining range up to 700 meters. The Experimental flying test of advanced aerial robot quadcopter is carried out and it can lifts up to 4kgs weight as a payload.

Keywords: advanced aerial robot quadcopter, multi-rotor, vertical take-off and landing, range, brushless motor.

INTRODUCTION

Introduction to Quadcopter

A quad copter is a multicopter air borne and propelled by four rotors. In this project we aimed to build a quad copter which can stabilize itself while flying. This quad copter also consists of manual control system (transmitter-receiver) for our project we are going to build the quad copter frame in a simpler way having symmetrical four arms on which a motor with a propeller is mounted on every arm. In order to make this quad copter self-stabilized, we are going to use arduino platform to program and applied pid algorithm to calculate the output values of motor commands by using input values from transmitter and sensors. We will use Inertial Measurement Unit (IMU) sensors which give values regarding angles and angular velocities of quad copter frame.

Mechanism

To maintain balance of the quad copter it must be continuously taking measurements from the sensors and making adjustments to the speed of each rotor to keep the bod level. Usually these adjustments are done autonomously by a sophisticated control system on the quad copter in order to stay perfectly balanced. A quad copter has four controllable degrees of freedom: yaw, roll, pitch, and altitude. Each degree of freedom can be controlled by adjusting the thrusts of each rotor.

- Yaw (turning left and right) is controlled by turning up the speed of the regular rotating motors and taking away power from the counter rotating; by taking away the same amount that you put in on the regular rotors produces no extra lift (it won't go higher) but since the counter torque is now less.
- Roll (tilting left and right) is controlled by increasing speed on one motor and lowering on the opposite one.
- Pitch (moving up and down, similar to nodding) is controlled the same way as roll, but using the second set of motors. This may be kind of confusing, but roll and pitch are determined from where the "front" of the thing is, and in a quad rotor they are basically interchangeable; but do take note that you have to decide which way is front and be consistent or your control may go out of control.

CONSTRUCTIONS

Basic Components of a Quad Copter

For someone new to the multicolor, putting together your first quad copter parts list can be extremely daunting. Trying to figure out what to buy and what parts will work together is tough, especially for people who don't come from a background in radio controlled planes or helicopters. Forums are packed with people who want to build a quad copter but don't know where to start. Itcan be frustrating trying to sort through the thousands of posts on forums and blogs and figure out what to do. We've heard from a lot of readers who are in similar positions and this post is designed to spell out exactly what you need for your first quad copter build. While we will recommend a complete list of specific parts that we have used and tested for a complete quadcopter build, the main purpose of this post is to provide a general overview of the parts needed to build a quad copter. Here's what you'll need:

Table-1. Showing the basic components of quadcopter.

S. No	Electronics	Mechanical
1	Motor	Frame
2	Electronic speed controller	Propellers

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3	Battery with charger	
4	Flight control board	
5	Transmitter &receiver	
6	Power distribution board	

You will also need some miscellaneous things like zip ties, double sided tape and/or Velcro, a small amount of heavy gauge wire, battery strap, and some female to female servo leads or jumper wires. As far as tools go, you will want to have access to a soldering iron, small screwdrivers, hex wrenches, needle-nose pliers, and a hot glue gun. Now we'll go over each partin detail and provide a specific recommendation.

Electronics Components

Motor

The motors have an obvious purpose: to spin the propellers. There are tons of motors on the market suitable for quad copters, and usually you don't want to get the absolute cheapest motors available, but you also don't want to break the bank when some reasonably priced motors will Suffice. Motors are rated by kV and the higher the kv rating, the faster the motor spins at aconstantvoltage. When purchasing motors, most websites will indicate how many amps the esc you pair it with should be and the size of propeller you should use. We have found that a 1000kv motor is a good size to start with.

ESC (Electronic Speed Controller)

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 quad copter, one connected to each motor. The ESCS are then connected directly to the battery through either a wiring harness or power distribution board. Many ESCS come with a built in battery eliminator circuit (BEC), which allows you to power things like your flight control board and radio receiver without connecting them directly to the battery. Because the motors on a quad copter must all spin at precise speeds to achieve accurate flight, that's why esc is very important.

Battery

Quad copters typically use li-po batteries which come in a variety of sizes and configurations. We typically use 3s1p batteries, which indicate 3 cells in parallel. Each cell is 3.7 volts, so this battery is rated at 11.1 volts. Li-po 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 bedrawn from the battery and the power rating describes how much power the battery can supply. Larger batteries weigh more so there is always a trade-off 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 quad copter can lift the additional weight. Charging li-pos is a complex process, because there are usually multiple cells within the battery that must be charged and discharged at the same rate. Therefore you must have a balance charger. We recommend the Imax b6 ac balance charger. It is affordable and reliable.

Flight Control Board

The flight control board is the 'brain' of the quad copter. It houses 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. A great flight control board for first time quad copter builders is the kk2.1.5. It is affordable, easy to set up, and has strong functionality. It can handle just about any type of multicolor aircraft so if you later want to upgrade to a hex copter or experiment with a tri-copter, you won't need to purchase another board. The inertial measurement unit (IMU) in the kk.2.1.5 is an electronic sensor device that Measures the velocity, orientation and gravitational forces of the quad copter .These measurements allow the controlling electronics to calculate the changes in the motor speeds. The IMU is a combination of the 3-axis accelerometer and 3-axis gyroscope; together they represent a 6dof IMU. Sometimes there is also an additional 3-axis magnetometer for better yaw stability (in total 9dof).

Figure-1. Flight control board.

Transmitter and Receiver

The radio transmitter and receiver allow you to control the quad copter. There are many suitable models available, but you will need at least four channels for a basic quad copter with thekk2.1.5 control board. We recommend using a radio with 8 channels, so there is more flexibility for later projects that may require more channels. The fly sky 6 channel is a great choice for a first radio. It's inexpensive yet still has some advanced functionality.

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Power Distribution Board

Power distribution board is used in quad copters in order to make the esc connection with batteries easier. The 4 esc s from the four motors are directly connected to the pdb which is again connected to the battery.

Table-2. Showing the power distribution.

Kv(rpm/v**)**	**1000**
Weight (g)	52
Weight (g)	21
Resistance(mh)	0
Max voltage(v)	15
Power(w)	210
Shaft a (mm)	3.17
Length b (mm)	30
Diameter c (mm)	28
Can length (mm)	14
Total length e (mm)	45

Mechanical Components

Frame

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. Every quad copter or other multi-rotor aircraft needs a frame to house all the other components. Things to consider here are weight, size, and materials. A quad copter frame consists of two to three parts which don't airily have to be of the same material:

- The centre plate where the electronics are mounted
- Four arms mounted to the centre plate
- Four motor brackets connecting the motors to the end of the arms.

Figure-2. Quadcopter frame.

Propellers

A quad copter has four propellers, two "normal" propellers that spin counter-clockwise, and two "pusher" propellers that spin clockwise. The pusher propellers will usually be labeled within 'r' after the size. For the quad copter configuration in this post, we're using 10×4.5 props.

This is a good size for the motors and ESCS we're using. With a well-balanced motor and Propeller combination, your quad copter should achieve great efficiency, not only improve battery life time, but also allows great user control experience. For larger quadcopter that carry payloads, large propellers and low-Kv motors tend to work better. These have more rotational momentum, and will more easily maintain your aircraft's stability

As a rule of thumb, required thrust = (weight x 2) / 4

For example if we have a quad copter with the flying weight might be around 1 kg. Using the equation above, we now know we're looking for a total thrust of 2 kg and 500g per motor. Of course you will have to guess the final weight of your quad copter, when estimating, don't forgetto add the weight of the motors and propellers which vary. Although you can choose the motors for the weight you want to carry, it's always a good idea to carry as little weight as possible. Lightness is very important to all aircraft because any excess weight could reduce your battery life and maneuver ability.

For a successful take off:

Total thrust > total vehicle weight

Total thrust = (thrust of one motor) * (no. Of motors)

Total vehicle weight = (weight of motors + esc + frame + battery + external components

CONCLUSIONS

The detailed specification of components of aerial robot quadcopter with advanced avionics system is presented in this paper. The quadcopter is constructed for the use of spraying pesticides and fertilizers in agricultural land. These type of advanced aerial robots need to lift more amount of payload while flying. This constructed quadcopter can lift a payload of 4 kg and they can do perfect maneuverability. The experimental flying test is carried out for the stability analysis and the application oriented test also carried out. This advanced aerial robot quadcopter will be very useful for next generation agricultural application.

REFERENCES

[1] Bernard Tat Meng Leong, Melanie po-LeenOoi, Sew Ming. Low cost micro controller based hover control design of a quadcopter. International symposium on robotics and intelligent sensors. 2012, 41: 458-64.

[2] Kunja-Dong, Kwangjin-Ku, Seoul. Fuzzy logic based closed loop strap down attitude system for unmanned aerial vehicle (UAV). Sensor Actuator A.2003; 107: 109-18.

[3] Moon Jongki, Prasad JVR. Minimum time approach to obstacle avoidance constrained by envelope protection for autonomous UAVs. Journal on Mechatronics. 2011; 21: 861-75.

[4] Nicol C, MacnabCJB. Robust adaptive control of a quad copter. Journal on Mechatronics. 2011; 21: 927-38.

[5] Richert D, Cortes J. Optimal leader allocation in UAV formation pairs ensuring cooperation. Journal on Automatica. 2013; 49: 3189-98.

[6] Rehman Abdur, Samar Raza. Autonomous terrain-following for Unmanned Air Vehicles. Journal on Mechatronics. 2011; 21: 844-60.

[7] Slawomir Grzonka, Giorgio Grisetti, Wolfram Burgard. A fully autonomous indoor quadcopter. IEEE transactions on robotics. February. 2012; 28(1).