Asian Journal of Applied Science and Technology (AJAST)
Volume 1, Issue 3, Pages 311-315, April 2017

Design of Quadcopter for Aerial View and Organ Transportation Using Drone Technology

S.Selvaganapathy[1] and A.Ilangumaran[2]

[1]*UG Scholar, Department of Electronics and Communication Engineering, IFET College of Engineering, Villupuram, Tamilnadu, India.*
[2]*UG Scholar, Department of Electronics and Communication Engineering, IFET College of Engineering, Villupuram, Tamilnadu, India.*

Article Received: 17 April 2017 *Article Accepted: 28 April 2017* *Article Published: 30 April 2017*

ABSTRACT

The goal of this project was to develop a "Human Organ drone delivery systems" and autopilot is necessary to allow a quadcopter to make it autonomously locate and land on a station's target with certain pay loading capability. The purpose of this UAV system was to outline the framework for a quadcopter based emergency human organ delivery through airways instead with heavy traffic roadway that copes with the relatively short battery life of these rapid mobile drones by consistently landing safely in the designated recharging checkpoints to extend through long distance. The 3D robotics Arducopter was chosen as the brain for the quadcopter since it is capable of autonomously hovering in targeted hospital locations and is capable of carrying human organs in faster manure thereby act as a best alternative method for "Green corridor" operation formed by a special police department force in every state. And also make this prototype work a one step ahead into futuristic research work with lots of further advancement in drone technology.

Keywords: Quadcopter, UAV, Green corridor and Weight lifting.

1. INTRODUCTION

In nowadays the development of small UAV is under the interest of many researchers and wants to explore the application. There is currently a large range of projects and research topics emerging in this field. Preliminary research has shown that the most versatile and mechanically easy to construct UAV is a quadrotor helicopter. This is due to the fact that quadrotor aerial robot is an automatic system which is an unmanned VTOL (vertical take-off and landing) helicopter. Quadrotors can be controlled by varying the speed of the four rotors and no mechanical linkages are required to vary the rotor blade pitch angles as compare to a conventional helicopter. Unlike most helicopters, Quadcopters use 2 sets of identical fixed pitched propellers, 1st set consists of 2 clockwise (CW) and 2nd set consists of 2 counter-clockwise (CCW). These use variation of Revolutions Per Minute to control lift and torque. To maintain balance the Quadcopter must be continuously taking measurements from the sensors i.e. gyroscope and accelerometer, and making adjustments to the speed of each rotor to keep the body level. These adjustments are done by a sophisticated control system like Arducopter on the Quadcopter in order to stay perfectly balanced. A Quadcopter 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.

2. MOTIVATION

The quadcopter, is able to take off without a runway, be able to reach in difficult terrains, take a picture from a particular position and finally maneuver through tight spaces as required. The quadcopter can also be used for sensing various climatic conditions such as heat, pressure and humidity in a foreign land. The quadcopter also provides a superior payload capacity when compared to the helicopter and is a more stable platform.

3. COMPONENT DESCRIPTION

***1) BLDC Motor*:** Motors are a bit similar to normal DC motors in the way that coils and magnets are used to drive the shaft. Though the motors do not have a brush on the shaft which takes care of switching the power direction in the coils, and so it is called as brushless motors. Instead the brushless motors have three coils on the inner of the motor, which is fixed to the mounting. For a small scale Quadcopter the DC Brushless motor used is of 1000 KV rating. It operates at 7.4-14.8 volts.

2) ESC: The brushless motors are multi-phased, normally 3 phases, so direct supply of DC power will not turn the motors on. That is where the Electronic Speed Controllers (ESC) comes into play. The ESC generating three high frequency signals with different but controllable phases continually to keep the motor turning. The ESC is also able to source a lot of current as the motors can draw a lot of power.

3) Propellers: On each of the brushless motors there are mounted a propeller. The 4 propellers are actually not identical the motor torque of and the law of physics will make the Quad copter spin around itself if all the propellers were rotating the same way, without any chance of stabilizing it. The larger diameter and pitch the more thrust the propeller can generate. It also requires more power to drive it, but it will be able to lift more weight.

***4) 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 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 trade-off between flight duration and total weight.

***5) Flight Controller**:* The flight controller consist of Micro Controller, built in Gyroscope, Accelerometer sensors.

6) 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 is directly connected to the power distribution board which is again connected to the battery.

***7) 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.

***8) Propeller**:* 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 forget to 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)

4. ARCHITECTURAL DESIGN

The architectural diagram explains about the working principle of the autonomous navigation for flying robot where in the initial stage is receiving the signal from the Wireless Signal which is connected to the android mobile device and operates based on the directions which is given by the user who is handling the device. The input signals from the device are fed to the flight controller. The input signals are in the form of digital signals. The output from the flight controller is directly fed to the motors via the ESC.

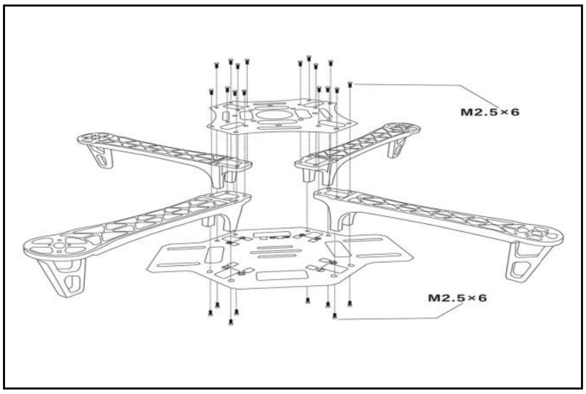

Fig.1. Software Tools (3D BUILDER)

5. 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.

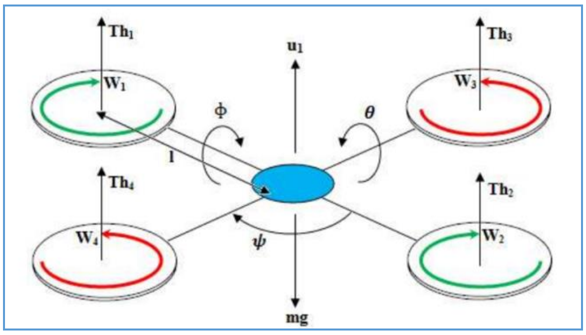

Fig.2. Aerodynamics of quadcopter

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.

TAKE-OFF/LANDING- 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.

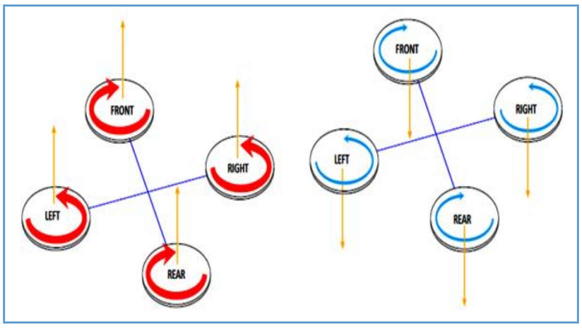

Fig.3. Take-off and landing motion

FORWARD/BACKWARD- 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.

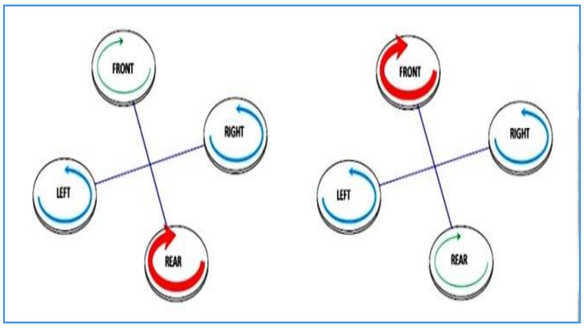

Fig.4. Forward/backward motion

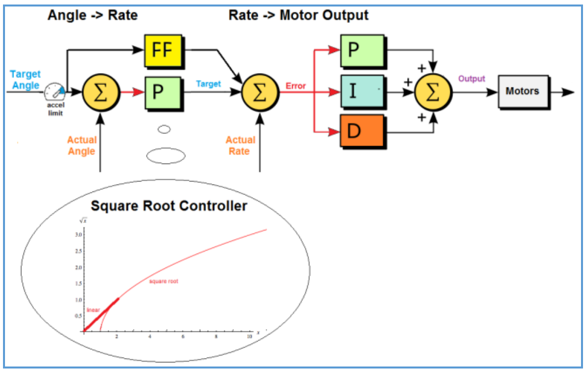

Fig.5. PID Algorithm

6. REASON FOR FLIGHT STABILITY

PID ALGORITHM

A PID controller (proportional-integral-derivative controller) is a control loop feedback mechanism widely used in control systems. A PID controller calculates an "error" value as the difference between a measured variable and a desired set-point. The controller attempts to minimize the error by adjusting the control inputs.

In multicopter terms this means the PID controller will be taking data measured by the sensors on the flight controller (gyros / accelerometers etc) and comparing that against expected values to alter the speed of the motors to compensate for any differences and maintain balance.

- P depends on the present error
- I on the accumulation of past errors
- D is a prediction of future errors, based on current rate of change

Ratio=Thrust / weight =ma / mg = a / g

Total Thrust = 2*(Total weight of Quadcopter)

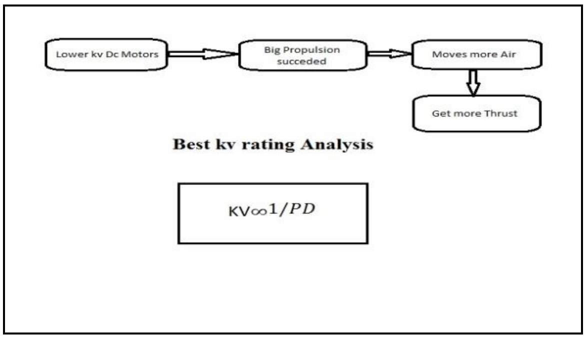

Fig.6. Kv rating of BLDC motor

7. SOFTWARE DESCRIPTION

7.1. Mission Planner Tool

Now we'll select which firmware to download to APM by clicking the corresponding icon Quad, Hexa, Y6, plane, rover, or others. The firmware screen will not appear if you have already selected Connect, so ensure that Mission Planner shows a disconnected icon in the upper-right corner to access the firmware.

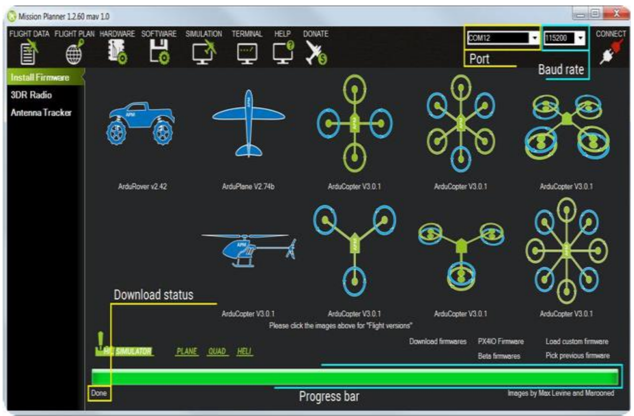

Fig.7. Mission Planner

Once you select your frame, Mission Planner will craft and prompt you to confirm the download. Select "Yes" to download the firmware onto APM. When the download status reads done, your firmware download is complete.

7.2 Connect to Mav-Link

Select Connect (upper-right corner of the screen) to load Mav-Link parameters to APM. When the window displays Done and Mission Planner shows the Disconnect option in place of Connect, your APM firmware has been downloaded successfully.

Fig.8. Mission planner tool

Fig.11. Aerial footage

8. OPERATIONS

8.1. Altitude Hold Mode

When altitude hold mode is selected, the throttle is automatically controlled to maintain the current altitude. Roll, Pitch and yaw operate the same as in Stabilize mode meaning that the pilot directly controls the roll and pitch lean angles and the heading.

8.2. RTL Mode

RTL mode (Return-To-Launch mode) navigates Copter from its current position to hover above the home position. The behavior of RTL mode can be controlled by several adjustable parameters. This page describes how to use and customize RTL mode.

9. BLOCK DIAGRAM

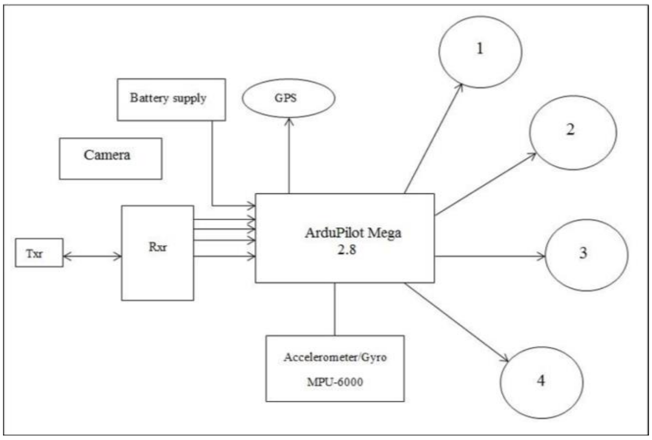

Fig.9. Block diagram

10. OUTPUT

Fig.10. Prototype work

11. CONCLUSION

We have briefly described each module to develop an UAV drone system which has proven capable of taking aerial footages. Our ultimate goal for choosing this project is to develop a quadcopter for aerial view and organ transportation with payload capability. The PID stabilization of quadcopter takes place using the array of sensors integrated on it as per the design specifications. It attains appropriate lift and thus provides surveillance of the terrain through the camera mounted on it. The user specified commands given via a remote controller intends to work it appropriately. Its purpose is to provide real time audio or video transmission from areas which are physically inaccessible by humans. Thus, its functionality is monitored under human supervision. The three parameters P, I and D are the key for stabilization of the quadcopter. Sonar technique is used for implementing an enhanced system of obstacle and collision avoidance.

REFERENCES

[1] Anezka Chovancova, Tomas Fico, Lubos Chovanec, Peter Hubinsk, Mathematical Modelling and Parameter Identificarion of Quadcopter (a survey), *Procedia Engineering*, Volume 96, 2014, Pages 172-181, doi:10.1016/j.proeng.2014.12.139.

[2] Astroma, K.J. Hagglunda, T. Hangb, C.C. Hob, W.K. Automatic tuning and adaptation for PID controllers - a survey, *Control Engineering Practice*, Volume 1, Issue 4, August 1993, Pages 699– 714.

[3] Bhavik Gupta, Ankit Patel, Anurag Kumar, Mohit Ujjwal, “Autonomous Intelligence Surveillance Quad Copter”, *SRM University NCR Campus*, 2015.

[4] Guneshwor Singh, O. Self-Navigating Quadcopter, *PES Institute of Technology Bangalore, Karnataka*, India, 2015.

[5] Hyon Lim, Jaemann Park, Daewon Lee, H.J Kim, Build Your Own Quadcopter, Digital Object Identifier 10.1109/MRA.2012.2205629, Date of publication: 10 September 2012, *IEEE Robotics & Automation Magazine*, *http://robotics.snu.ac.kr/upfiles/papers/Build%20Your%20 Own%20 Quadrotor.pdf.*

[6] Javir, A.V. Ketan Pawar, Santosh Dhudum, Nitin Patale, Sushant Patil, “Design, Analysis and Fabrication of

Volume 1, Issue 3, Pages 311-315, April 2017

Quadcopter”, *Rajendra Mane college of Engineering And Technology, Ambav (Ratnagiri) Mumbai University, India*, 2015.

[7] Johnson, M. A. and Moradi, M. H. “PID Control,” *Springer Verlag,* London, 2005.

[8] Kalpesh, N. Shah, Mr. Bala J. Dutt, Hardik Modh, "Quadrotor – An Unmanned Aerial Vehicle”, *Dept. of Mechanical engineering, A D Patel Institute of Technology, New V.V.Nagar, Anand, Gujarat, India,* 2014.

[9] Lucas M. Argentim, Willian C. Rezende, Paulo E. Santos, Renato A. Aguiar, PID, LQR and LQR-PID on a Quadcopter Platform, *Informatics, Electronics & Vision (ICIEV), 2013 International Conference*.

[10] Mohamed, A. Abdelkhalek, Mohamed S.El-Demerdash, Ahmed A.ElTahan, Attitude Stability of Quadcopter Using Classic Control with Angular Acceleration, *Aerospace Engineering Department Cairo University Cairo, Egypt*, 2015.

[11] Moses, A. Rutherford, M. and Valavanis, K. “Radar-based detection and identification for miniature air vehicles,” in Control Applications (CCA), *2011 IEEE International Conference* on sept.2011, pp.933– 940.

[12] Mark Dupuis, Jonathan Gibbons, Maximillian Hobson-Dupont, Alex Knight, Artem Lepilov, Michael Monfreda, George Mungai, Design Optimization of a Quad-Rotor Capable of Autonomous Flight, *Worcester Polytechnic Institute,* April 24, 2008.

[13] Meister, O. Frietsch, N. Ascher, C. and Trommer, G. “Adaptive path planning for a vtol-uav,” *in Position, Location and Navigation Symposium, 2008 IEEE/ION,* may 2008, pp. 1252 –1259.

[14] Peter, O. Basta, Quad Copter Flight, *California State University, Northridge,* May 2012.

[15] Sima Mitra, “Autonomous Quadcopter Docking System”, 2013.

[16] Tamilselvam, N. Abirami, P. Logasundari, S. Azhaguraja, P., Banumathi and Malarvizhi, B., Design and Fabrication of Advanced Aerial Robot Quadcopter, *Department of Aeronautical Engineering, Adhiyamaan College of Engineering, Hosur, Tamilnadu,* India, 2016.

[17] United states department of defense, 2014. *[Online]. http://www.defense.gov/news/newsarticle.aspx?id=122308.*

[18] Vaishali Nirmal, Dengale Supriya, Divekar Pallavi, Dipti Shah, “A Wireless Control Quadcopter with Web Camera and Self-Balancing System”, *PREC Loni (Electronics Engg.),* 2015.

[19] Wyglinski, A., Huang, X., Padir, T., Lai, L., Eisenbarth, T., Venkatasubramanian, K. (2013). Security of autonomous systems employing embedded computing and sensors. Micro, *IEEE, doi: 10.1109/MM.2013.18*.

[20] Xing Huo, Attitude Stabilization Control of a Quadrotor UAV by Using Back stepping Approach, *Hindawi Publishing Corporation Mathematical Problems in Engineering,* Volume 2014.