Fire Extinguisher and Video Recorder Quad Copter

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of

Bachelor of Science in Computer Science and Engineering

by

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Abstract

This thesis demonstrated the **Fire Extinguisher and Video Recording Quad Copter** activities. It's mainly controlled by Flight Controller and move remotely. The Quad copter can achieve vertical flight in a stable manner and high definition camera to collect data. The main uses of the Quad Copter exit fire. Individual components were tested and verified to work properly. Calibration and tuning of the PID (Proportional Integral Derivative) controller was done to obtain proper stabilization on each axis using PID test benches. Currently the Quad Copter can properly stabilize itself. Most of the goals in this project have been achieved, resulting in a stable and maneuverable Quad Copter. The future plan of the project is to build, modify and set GPS tracker to find exact location and information of a surrounding area.

APPROVAL

The Thesis Report "**Fire Extinguisher and Video Recording Quad Copter**" submitted by MDJAHIRUL ISLAM ID: CSE05106546, HALIMA AKTER ID: CSE05106564, to the Department of Computer Science, Stamford University Bangladesh, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of Bachelor of Science (B.Sc.) in Computer Science & Engineering and as to its style and contents.

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Date: 02.08.2017

Declaration

We, hereby, declare that the work presented in this Thesis is the outcome of the investigation performed by us under the supervision of Tamanna Haque Nipa, Assistant Professor, Department of Computer Science & Engineering, Stamford University Bangladesh. We also declare that no part of this Project and thereof has been or is being submitted elsewhere for the award of any degree or Diploma.

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Date: 02.08.2017

Dedicated to our family

Acknowledgements

First of all we would like to thank the almighty ALLAH. Today we are successful in completing our work with such ease because she gave me the ability, chance, and cooperating supervisor.

We would like to take the opportunity to express our gratitude to **Tamanna Haque Nipa**, our supervisor. Although she was always loaded with several other activities, she gave us more than enough time in this work. She not only gave us time but also proper guidance and valuable advice whenever we faced with some difficulties. Her comments and guidance helped us in preparing our thesis report.

We would like to thank **Tarin Kazi** our batch advisor who inspired us in every step. We also thankful to our teachers who helped us in a number of ways by providing various resources and moral support.

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1 Introduction

1.1 What is Quad Copter?

A Quad Copter, or Multi rotor, is a simple flying mechanical vehicle that has four arms, and in each arm there is a motor attached to a propeller. Multi copters with three, six or eight arms are also possible, but work on the same principal as a quad copter. Two of the rotors turn clockwise, while the other two turn counter clockwise. Quad copters are aerodynamically unstable, and require a flight computer to convert your input commands into commands that change the RPMs (Revolution per Minutes) of the propellers to produce the desired motion.

A quad copter, also called a quad rotor helicopter or quad rotor is a multi-rotor helicopter that is lifted and propelled by four rotors. Quad copters are classified as rotorcraft, as opposed to fixed-wing aircraft because their lift is generated by a set of rotors. [1][2]

1.2 Why Fire Extinguisher and Video Recorder Quad Copter?

There are many quad copters and multi-rotors in the robotics field. The main reason to use our "Fire Extinguisher and Video Recorder Quad Copter" is its external features that it can pump water and capture video where it pumping water. Its main use in the fire affected areas. One of the most disadvantages of a quad copter is stability. Our Quad copters are more stable than regular Quad Copter.

1.3 Research Overview

We would incorporate into it. After a lot of research on the web, we found a couple of forums that discussed open source electronic and software components suitable for making a Quad copter. Also, very basic but highly customizable Quad copter bodies were available that were suitable for us to use to create our baseline system.

After deciding to create the Quad copter, we had to decide what electronics to use and which sensors We presume that the Quad copter would be a good design starting point since it could lift off vertically, travel some distance to a specific location, record video of an object and water pumping to fire exit where if necessary. This scenario led us to the conclusion that we would need sensors including, flight controller and receiver and transmitter. We would also need payload components including a camera to capture video and pipe to water pumping. Furthermore, we would need a control mechanism that would allow flight beyond the line of sight since that was also a requirement.

Fig. 1.1 Video Capturing Quad Copter

We thought of two approaches to control beyond the line of sight. One was to use the camera and video to allow us to view the flight path from the Quad copter point of view while guiding it with an RC controller. Second, a more ambitious approach would be to use and guidance and a waypoint system to send commands to the Quad copter via the flight controller which the Quad copter would execute autonomously. We decided to attempt the second goal as a stretch goal for our project. At this point in the design process, we presume that it would be possible to perform most of the maneuvers.

1.4 Objectives

The goal of our thesis is to design, implement, and test a stable flying Quad copter that can bused to take image capture by a camera, to gather and log data autonomously. We choose an existing Quad copter kit and add the required components. After this goal, we will also like to design and implement some autonomous commands that may help water pumping to fire exit. It includes the auto-landing command, auto-move command, auto-homing command, and hold position command.

The final Quad copter design had to meet the following specifications:

- The Quad copter must be capable of flying and landing in stable manner.
- The Quad copter must be capable of determining capture images.
- The Quad copter must be capable to flying far meter high.
- The Quad copter must be capable to flying stable 10 to 20 minute about.

The Quad copter must be able to perform the following commands:

- Remote landing.
- Remote moving.
- Hold position.

1.5 Problem Statement

There are several problems in the below:

- Mixing the aileron and Elevator.
- The Propeller can’t render enough thrust.
- Motor’s Jamming.
- ESC burnt up

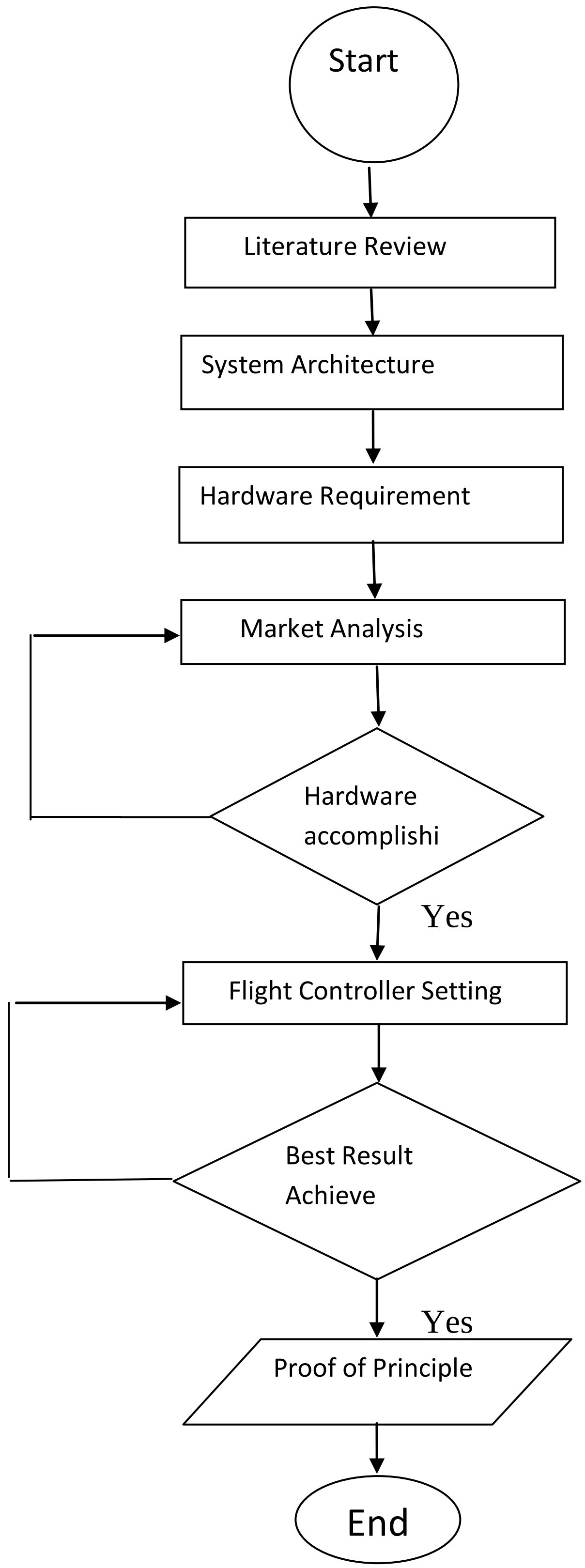


Fig.1.2 Flow Chart

1.6 Methodology Adopted for Assembling of a Drone

- We are making a frame is required with light weight material.
- Quad copter is a device with an intense mixture of electronics, Mechanical and mainly on the principle of Aviation.
- The Quad Copter 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 (Takeoff motion, Landing Motion, Forward motion, Backward motion, Left motion, Right motion)
- The rotation of Motors changes as per the transmitted signal send form the 6-Channel transmitter.
- The signal from flight controller goes to ESC'S which in turn control the speed of motor.

Fig. 1.3 Sketch Design of a Quad copter

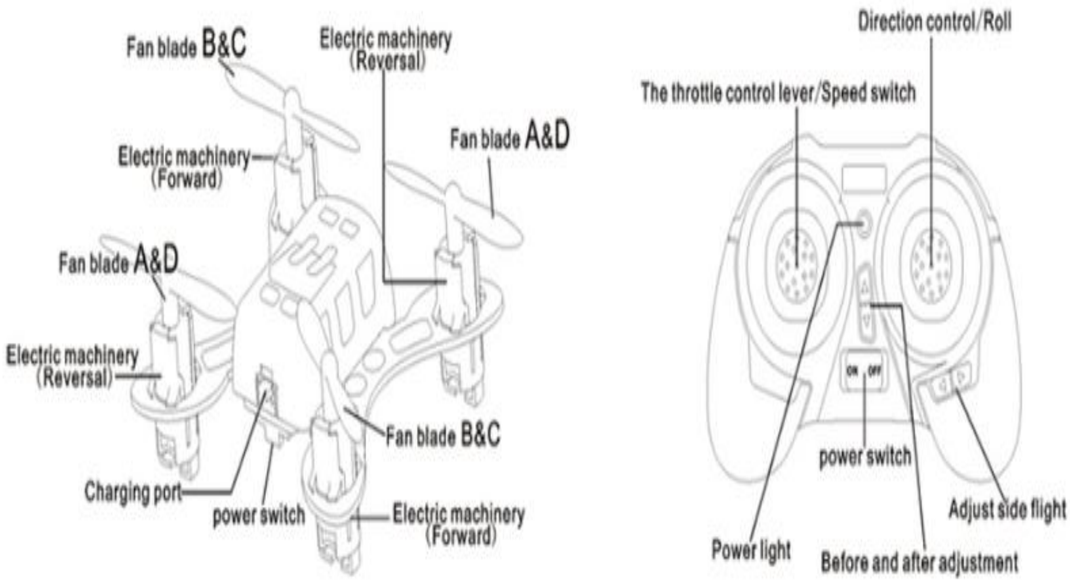


Fig.1.4 Design of all Parts.

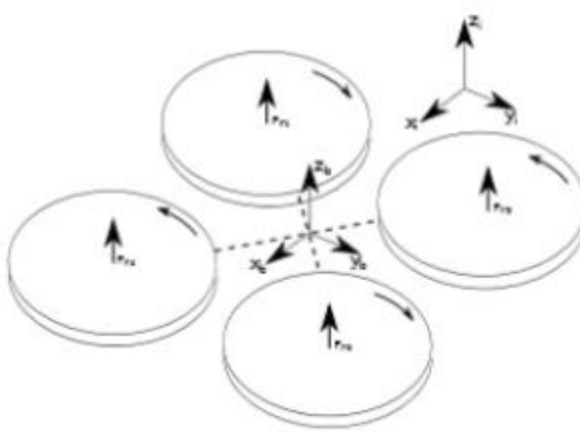
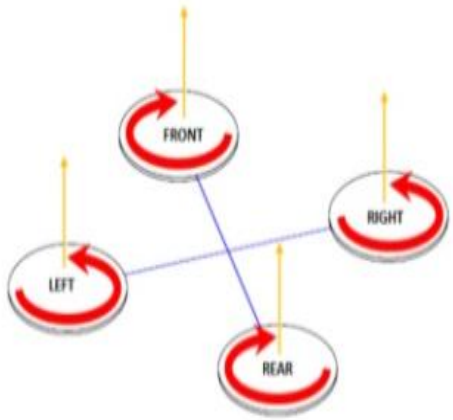


Fig. 1.5 Axis of a Drone



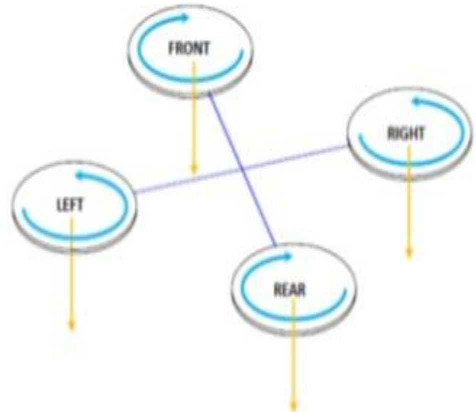


Fig.1.6 Take off Motion **Fig. 1.7 Landing Motion**

1.7 Research Motivation

Currently there are many safety issues relished about Quad Copter in the Robotics field. We want to create the Fire Extinguisher and Video Recorder Quad Copter to help people. We also think that the quad copter can help which village and others areas are flood affected and no one can reach here but it's possible that the quad copter can reach here and carry some food and capture the whole areas situation. So finally we are most interested and too much motivated to make the "Fire Extinguisher and Video Recorder Quad Copter" and with the help of our Almighty Allah we successfully complete our dream Quad Copter.

1.8 Contribution of the Research work

There are many constructed and many journals have been published in the world about the quad copter and we also design and developed a quad copter. Our quad copter is different from the other quad copter. The specialty of our quad copter is that, it has heavy energy and flies a long time on the air and its fly more than 100 meters. The main specialties of our quad copter are pumping water to exit fire. It's more stable and user friendly and cheaper than other quad copter. Another specialty of our quad copter is video monitoring more than 31 GB. It's stay more than 30 minutes on the air. It's also use to pump water on the garden.

1.9 Organization of thesis

In the first chapter we have discussed about problem statement and our research motivation. In chapter two we discussed about the Quad Copter and literature review. In chapter three we discussed about the features of the materials and measure the capabilities of those materials. In chapter four we discussed the problem what we face to do this research. In chapter five we discussed setting and calibration. At last, in chapter six we discussed about the conclusion and future work.

2 Literature Review

2.1 Overview

Etienne Oehmichen was the first scientist who experimented with rotorcraft designs in the 1920s. Among the six designs he tried, his second multicopter had four rotors and eight propellers, all driven by a single engine. The Oehmichen used a steel-tube frame, with two-bladed rotors at the ends of the four arms. The angle of these blades could be varied by warping. Five of the propellers, spinning in the horizontal plane, stabilized the machine laterally. Another propeller was mounted at the nose for steering. The remaining pair of propellers was for forward propulsion. The aircraft exhibited a considerable degree of stability and controllability for its time, and made more than a thousand test flights during the middle 1920s. By 1923 it was able to remain airborne for several minutes at a time, and on April 14, 1924 it established the first-ever FAI distance record for helicopters of 360 m. Later, it completed the first 1 kilometer closed-circuit flight by a rotorcraft.

After Oehmichen, Dr. George de Bothezat and Ivan Jerome developed this aircraft, with six bladed rotors at the end of an X-shaped structure. Two small propellers with variable pitch were used for thrust and yaw control. The vehicle used collective pitch control. It made its first flight in October 1922. About 100 flights were made by the end of 1923. The highest it ever reached was about 5 m. Although demonstrating feasibility, it was, underpowered, unresponsive, mechanically complex and susceptible to reliability problems. Pilot workload was too high during hover to attempt lateral motion.[9]

2.2 Conversion

Convert wings Model Quad rotor (1956) was intended to be the prototype for a line of much larger civil and military quad rotor helicopters. The design featured two engines driving four rotors with wings added for additional lift in forward flight. No tail rotor was needed and control was obtained by varying the thrust between rotors. Flown successfully many times in the mid-1950s, this helicopter proved the quad rotor design and it was also the first four-rotor helicopter to demonstrate successful forward flight. Due to a lack of orders for commercial or military versions however, the project was terminated. Convert wings proposed a Model E that would have a maximum weight of 42,000 lb (19,000 kg) with a payload of 10,900 lb (4,900 kg).

2.3 Recent Development

Recent quad rotors or quadropters which are being manufactured and used in aerospace industry are listed below:

Aromatic Spa's Anteos is the first rotary wing RPA (remotely piloted aircraft) to have obtained official permission to fly (Permit To Fly) issued in the civil airspace, by the Italian Civil Aviation Authority (ENAC), and will be the first able to work in non-segregated airspace.

Aero Quad is an open-source hardware and software project which utilizes Adriano boards and freely provides hardware designs and software for the DIY construction of Quad copters.

ArduCopter is an open-source multi-copter UAV. Based on Arduino, it supports from four to eight motors, as well as traditional helicopters, and allows fully autonomous missions as well as RC control. Open Pilot is a model aircraft open-source software project. Parrot AR Drone is a small radio controlled quad copter with cameras attached to it built by Parrot SA, designed to be controllable with iOS or Android devices. Parrot ARDrone 2.0 carries a HD 720P camera and more sensors, such as altimeter and magnetometer.[7][8]

2.4 Scope in present Aerospace Industry

Quad copters are uninhabited or unmanned aerial vehicles which are widely being used in modern aerospace industry. The wide area of operation and high maneuverability makes quad Copter even more useful. Quad copters are used in scientific research, geological survey, aerial photography, weather sensing, spying, and reconnaissance.

Quad copters are not limited to the above specified practices. They are light in weight, maneuverable, easy to build, easy to deploy, portable, and can be extended and optimized as per the specific task.

3 System Design

3.1 Overview

There are the materials of our project which we almost use in this project. In this chapter we have shown step by step of our materials.

3.2 Body of frame

Fig. 3.1 Body of the frame

3.3 1400KV Motor

We used 1400KV motor in our Quad Copter. The figure of the motor and feature given below

Fig. 3.2 1400kv Motor

Features of the Motor

Name: D2826-10 1400kv Out runner Motor Specs: Rpm/V: 1400kv, Shaft: 3.17mm, Voltage: 2S~3S (7.4v to 11.1v) ,Weight: 50g, Watts: 205w, Max Current: 21A, ESC: 40A, Suggested Prop: 7x4(3S) ~ 9x4.7 (2S) , Mounting Hole Bolt Circle: 16mm or 19mm

3.4 LiPo battery

We used LiPo high power battery in our Quad copter to run properly: Features are given below;

Fig. 3.3 *LiPo* Battery

Features

LiPo batteries should never be discharged below 3.0V/cell, or it may permanently damage them. Many chargers don't even allow you to charge a LiPo battery below 2.5V/cell. So, if you accidentally run your plane/car too long, you don't have your low voltage cutoff set properly in the ESC (Electronic Speed Controller), or you leave the power switch on, forget to unplug the LiPo, get your plane stuck overnight in a tree (the same tree, three separate times, for foolishly flying in areas too small because you are too excited to fly and it's almost dark), etc. etc., you may find yourself in a situation where you've discharged your LiPo down well below 3.0V/cell.

3.5 KK Flight controller

Features

Size: 36x36x11.5mm (mounting holes 30.5x30.5mm), Weight: 8.6g, IC: Atmega644 PA,Gyro/Acc: 6050MPU Inven Sense Inc, Auto-level: Yes, Input Voltage: 4.8-6.0V,AVR interface: standard 6 pin. Signal from Receiver: 1520us (5 channels)Signal to ESC:

1520usLCD size: 24*18mm, Mini buttons size:Four 3.3*4.2mm, Voltage sensor: One red positive pin header for.Input rail: Single row 2.54mm pitch pin header for input signal, Firmware Version: 1.6:Pre-installed firmware.DualcopterTricopterY6, Quadcopter +,Quadcopter X, Hexcopter +, Hexcopter X, Octocopter +, Octocopter X,X8 +, X8 X, H8, H6, V8, V6. Singlecopter 2M 2S, Singlecopter 1M 4S.

Fig. 3.4 KK Flight Controller

3.6 Transmitter

We used RC controller. Features are given below;

Fig. 3.5 Transmitter

Features

Channel: 6, Model Type: fixed –wing/glider/heli, RF range: 2.405-2.475 GHz, Band: 142, RF power : less than 20 dBm, RX Sensitivity: 105 dBm, 2.4G system: AFHDS 2A, Code Type:

GFSK, ANT length: 26mm, Weight: 6.4g, Power: 4.0-6.5V,Size: 40.4*21.1*7, Color: black, Certificate: CE0678,FCC,I-BUS port: NO, Data Acquisition port: NO.

3.7 Receiver

We use 6 channel receivers. Features are given below;

Fig. 3.6 Receiver

Features

Reliable, interference free 2.4GHz AFHDS 2A signal operation, Ultra-light weight design, Dual antennas for most reliable interference free operation , Turing iA6 Receiver Specs: ,Channel: 6 , Frequency: 2.4g ISM Frequency Range Power: 4.5V~6.6V/<30ma ,Net Weight: 6.4g, Dimensions: 40.4x21.1x7.35mm.

3.8 ESC (Electronic Speed Controller)

We used four ESC. Figure and features given below;

Fig. 3.7 ESC

Features

The break function can be turn on/off by the jumper. Battery type can be chosen by a jumper. For LiPo the threshold for each cell is 3.0v, less than the threshold ESC will gradually reduce the output power. PWM frequency is 2KHz.Over heat protection over 110CThrottle signal loss for 1sec will gradually reduce the output power, after 2sec completely cut-off

Spec.

Cont Current: 30A

Burst Current: 40A

BEC Mode: 5v/1A

Lipo Cells: 2-3

NiMH : 4-10

Weight: 21g

Size: 45x21x8mm

3.9 Zip Ties

We have used zip ties to bind ESC (Electronic speed controller) with frame.

Fig. 3.8 Zip Ties.

3.10 Camera

Fig. 3.9 Bottom Camera

Features

Video Format: 352*288CIF AVI or 640*480CIF AVI.

Supported System: Support ME/2000XP/MACOS/LINUX and automatically.

Distinguish operating system.

Working time: With Lithium battery can keep working more than 3 hours.

Battery Type: High Capacity Polymer Li-io Battery.

Charge Voltage: DC-5V.

USB Type: USB Standard port with no drive or circumscribed electric neither Power source.

3.11 Capability of Materials

We have selected 1400KV motor, which is ideal for our design .There is an opposite relation between RPM and torque of the motor. Higher the RPM is lower the Torque of the motor and the Torque relates to propeller size.

Higher the torque is, the longer the prop size it can take. For our motor, we have found 8' diameter prop ideal and our pitch is 4.5 which is modeled as 8045. And our motor draws almost 25 amps in critical situation.

So we need an ESC higher than that. So, we have chosen 30 amps ESC. For keeping the limit of weight optimum, we have chosen 2200 mah battery which is ideal for 6-8 mins flight time.

For our tx and rx, we have chosen 6 channel radio system. It covers up almost range of 1.5 km.

And we are using the 5 channels of the radio for controlling our drone. And it also comes with 2.4 GHz system, which has special binding identification system for avoiding interference.

For our flight controller, we have chosen KK multi copter board which is an open source flying platform.

It calibrates PID separately. This also supports up to 8 motors. The Frame size is 450 mm. The smaller the frame is, higher the trouble it faces when flying.450 mm frame is ideal for windy weather and messy situations. So our whole system is compatible with each other.

3.12 Cost of Materials

Table 3.10: Cost Table

Name	Quantity	Cost
3s 2200 mah Lipo Battery	1	2,100/=
450 Frame	1	1,200/=
1400kv Motor	4	4,600/=
Propeller	4	3,60/=
ESC	4	3,400/=
FC KK 2.1.5	1	2,000/=
Transmitter & Receiver	1	4,800/=
ZIP Ties	100	1,00/=
Peripheral Cost	1	5,00/=
Total Cost :		19,060/=

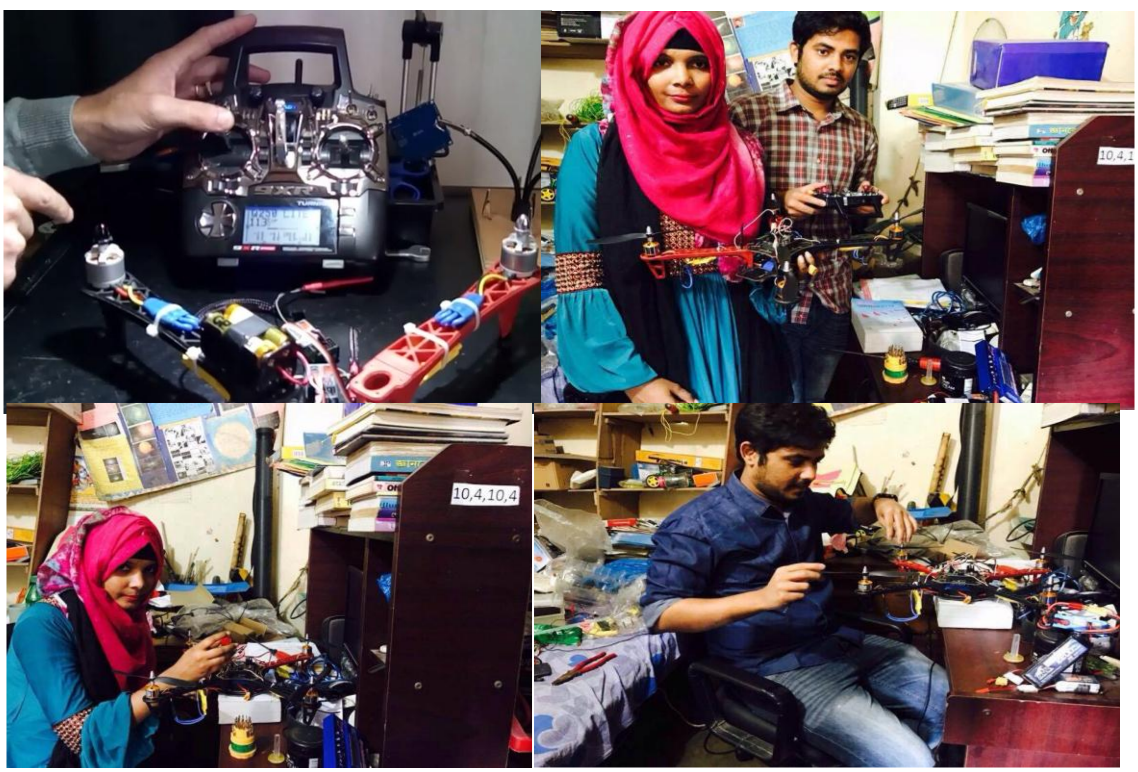
4 Implementations and Result

4.1 Overview

When developing the quad copter, we have faced several problems, which later was recovered by trial and errors and debugging. This includes motors, PROPs, ESCs and power distribution board. We have given several problems and solution in below:

4.2 Mixing the Aileron and Elevator

We have got our drone done in X-Copter Mode. We are controlling our pitch by Elevator control, and our role is controlled by aileron. But when we did calibration of our flight controller, our elevator value almost got higher. But for a stable flight motor's channel value of aileron and elevator, need tootle balanced. We calculated our aileron and elevator value by using this formula tan-71 = 89. 89 degree is almost close to 90 degree and our each are 90 degree a part from each other's.



Some picture of execution time.

4.3 The Propeller can’t render enough thrust

We have used 8’’ diameter and 4.5” pitch Propeller. But the propeller width before was given laser. So the enough thrust was not generated. But we gave propeller width bigger in the next time. So, our thrust problem was solved.

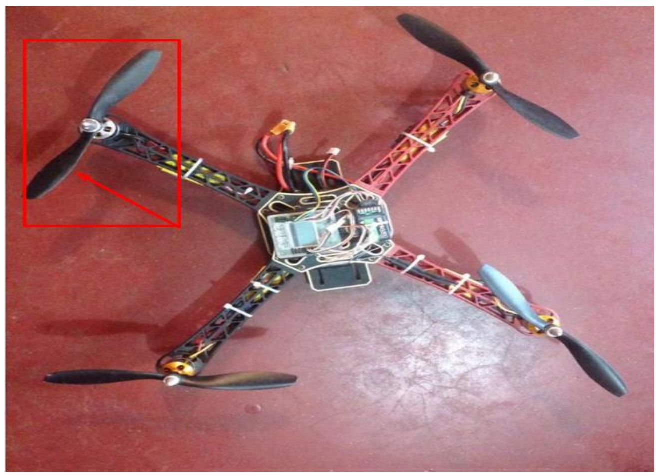


Fig. 4.1 Propeller

4.4 Motor’s Jamming

We needed all the hardware rightly chosen for our drone and it costing of vertical flight and loading system. But the motor was given for this drone is specially made for planes and planes motor sits horizontally. So it’s not suitable for our vertically landing and takeoff.

Fig. 4.2 Motor Jamming

More especially plane BLDC motors are made of pressure baring which get jammed when it gets hot and when pressure applied for a large amount of time horizontally. So we got solved our problem by changing to BLDC Motors.

4.5 ESC burnt up

This problem is encountered when the pilot doesn't give balance throttle to the ESCs. When the ESCs get rapid throttle the extra large amount of current pusses through the ESC which is very dangerous, even fry up flight controller. So always rapid throttle should be avoided and balance throttle should be given by experienced pilot.

Fig. 4.3 ESC Burn Up

5 Setting and Calibration

5.1 Overview

Many Multi rotors, Quad copter software, such as clean flight, Multi Wii, allow users to change PID values to adjust the performance of their quad copters. In this post we will explain briefly what PID is, how it affects aircraft stability, and how to tune PID for your quad copter.

Be warned, this article is a bit on the "academic" side. We tried to explain it in a more practical way in this simplified PID explained post, so make sure you check it out also! Apart from PID, Rates and expo are just as important to quad's flight performance and control.

5.2 Defining PID

PID (proportional-integral-derivative) is a closed-loop control system that tries to get the actual result closer to the desired result by adjusting the input. Multi-copters use PID controller to achieve stability.

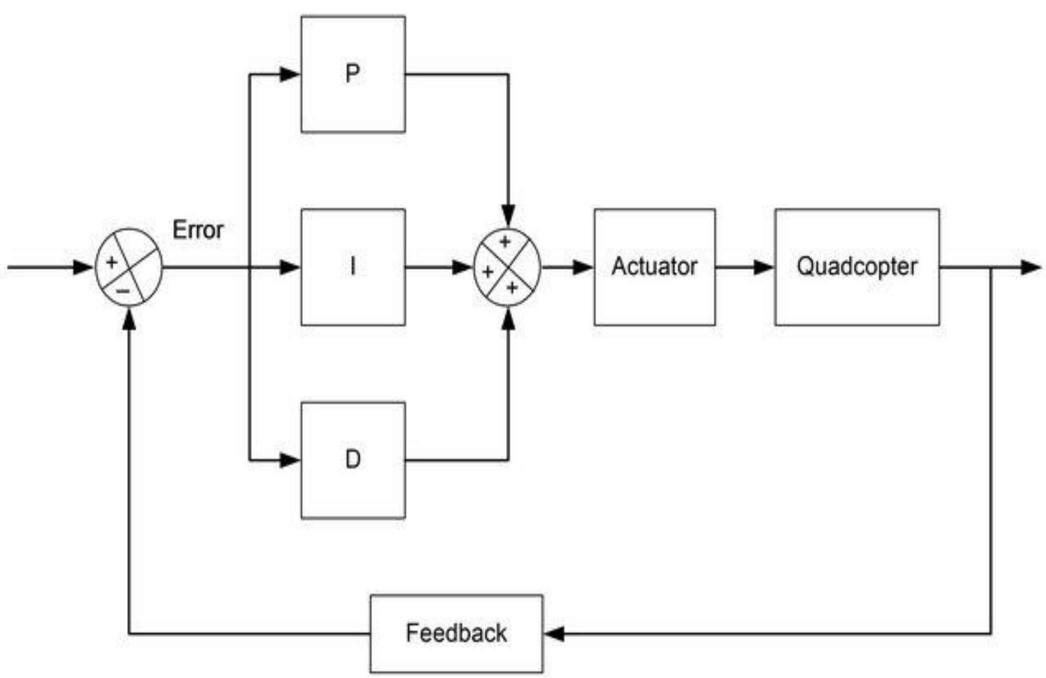


Fig. 5.1 Defining PID

There are 3 algorithms in a PID controller, they are P, I, and D.P depends on the present error; we on the accumulation of past errors; while D is a prediction of future errors based on the current rate of change.

To have any kind of control over the quad copter we first need to measure the quad copter sensor output (for example what angle the quad is on each axis). Knowing what desired angle we want the quad to be, we can estimate the error. We can then apply the 3 control algorithms to the error, to get the next outputs for the motors aiming to correct the error. Each of these control algorithms would introduce some unique effects to the craft's flight characteristics, which we will explain further later.

As RC multi-rotor pilots, there are **three parameters** that we can adjust to improve better quad copter stability based on different situations. These are the coefficients to the 3 algorithms we mentioned above. The coefficients basically would change the importance and influence of each algorithm to the output. Here we are going to look at what are the effects of these parameters to the stability of a quad copter.

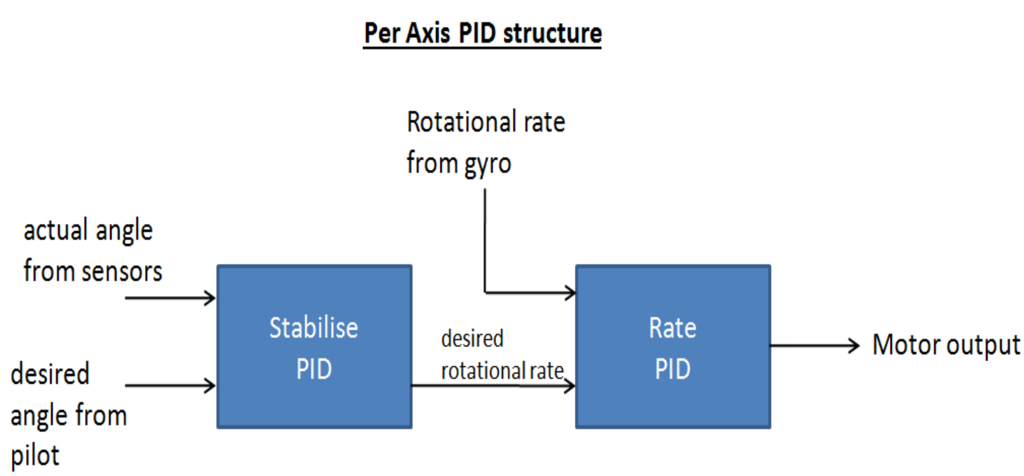


Fig. 5.2 per Axis PID Structure

You don't need to fully understand how PID controller works in order to fly a Quad Copter. However, if you want to read more on the theory, here is a very interesting explanation of PID controller with examples.

5.3 The Effect of Each Parameter

On a multicolor there are 3 axis, and each axis there is a PID controller. That means we will have a separate set of PID coefficients for each axis (**Pitch**, **Roll** and **Yaw**)

Generally, altering PID has the following effect on a quad copter's behavior:

- **Proportional Gain coefficient**: Quad copter can fly with just P gain even without the other 2 parameters. This coefficient determines which is more important, human control or the sensor measurement from Gyroscopes. The higher the coefficient, the more sensitive and stronger the quad copter reacts to angular change. If it is too low, the quad copter will appear to be more sluggish and softer, and harder to stay steady. One negative impact when P gain is too high is oscillation and over-correcting.

- **Integral Gain coefficient**: This coefficient influences the precision of the angular position. This term is especially useful with in windy situation; with low I gain your quad copter will simply drift away with the wind. However, when we value gets too high your quad copter might begin to have slow reaction and a decrease effect of the Proportional gain as consequence. It will also start to oscillate like having high P gain, but with a lower frequency.

- **Derivative Gain coefficient:** In a quad copter, this coefficient works as a dampener and reduces over-correcting and overshoots caused by P term.

Aerobatic Flight

- Requires a slightly higher P
- Requires a slightly lower I
- Higher D to compensate for the P

Gentle Smooth Flight

- Requires a slightly lower P
- Requires a slightly higher I
- Lower D

5.4 Tuning quad copter PID Gains

PID values by at least half, to make sure they are definitely not too high to start with. Then slowly It's best to tune your quad in Rate Mode (aka Acro Mode).Before I start, I always lower all the increase them until you find the perfect flight characteristics.

We usually tune one axis at a time, roll, pitch then yaw. And at each axis, we adjust one value at a time starts with P gain, we and then D gain. We need to constantly go back to fine tune the values as one value could affect the effectiveness of another value.

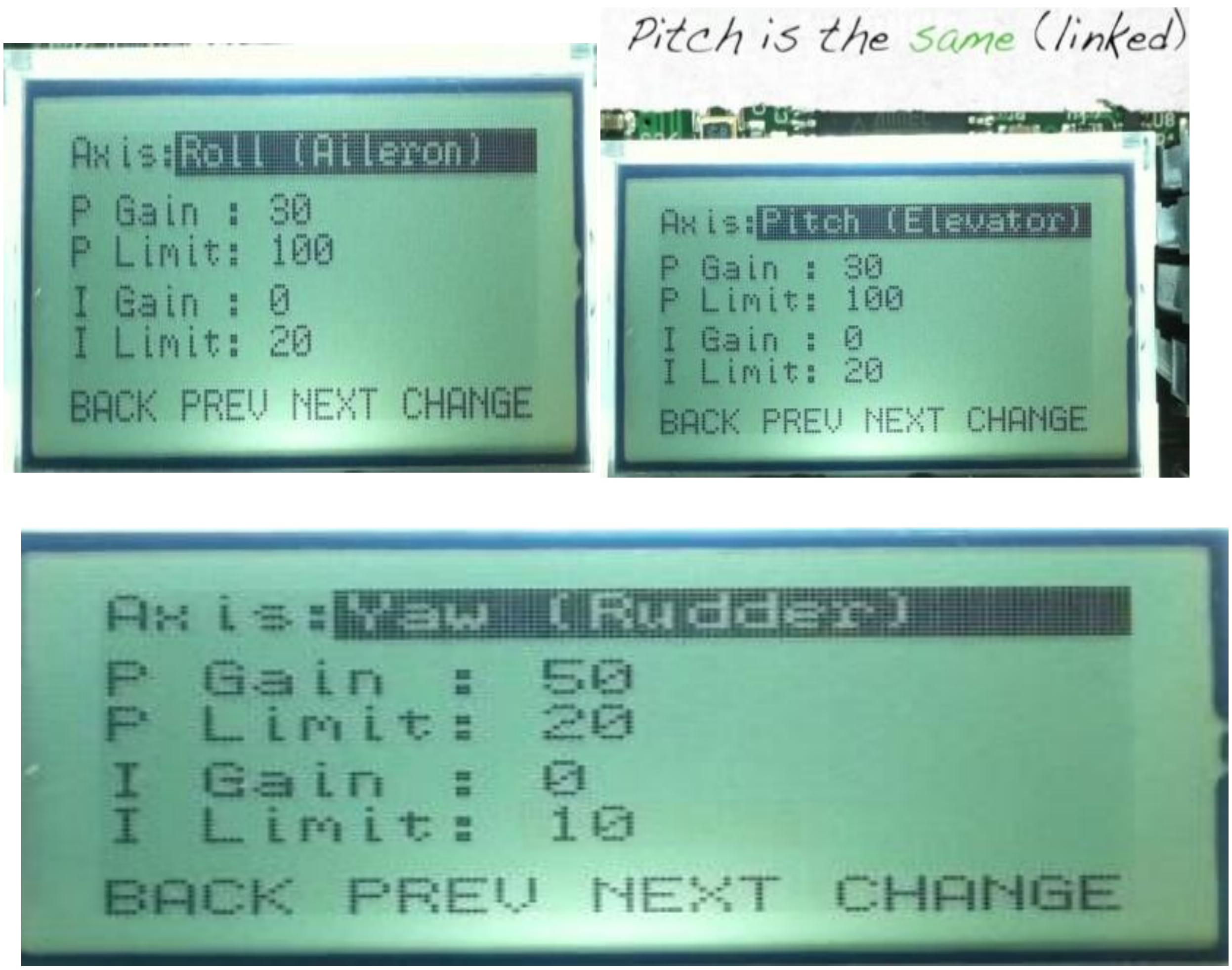


Fig. 5.3 Screen sort of the flight controller settings.

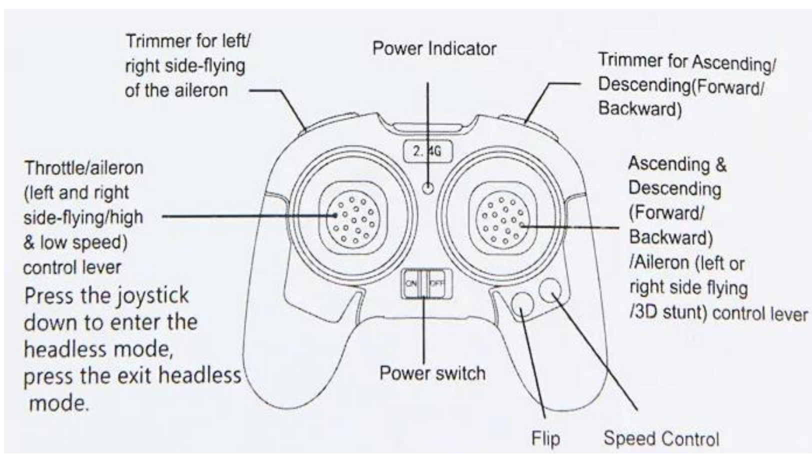
In figure 5.3 we have shown screen shots of settings of the flight controller.

For **P gain**, we first start low and work my way up, until we notice its producing oscillation. Fine tune it until you get to a point it's not sluggish and there is not oscillation.

For the **gain**, again start low, and increase slowly. Roll and pitch your quad left and right and center your stick immediately. Pay attention to the angle changes. You want to get to a point where it just stays in the same angle as you release the stick. You might also want to have a stronger we gain for windier weather. For **D gain**, we tend to keep this as low as we can. We use just enough to eliminate any overshooting when we am doing rolls or flips.

5.5 Method of Uses

5.5.1 Operating the Drone



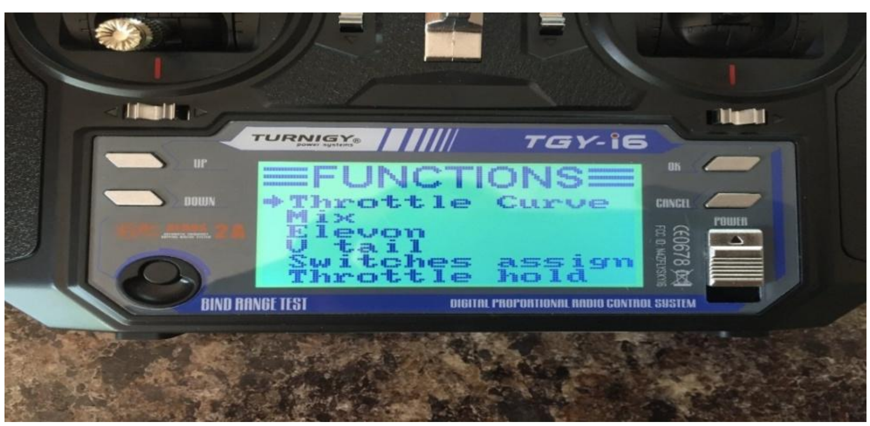


Fig. 5.4 Operating the drone [12]

6 Conclusions

Longer flight time is a matter of tradeoff between two variables, the efficiency of the thrust developed by the motors and the battery capacity (weight). The efficiency of the thrust has two factors, the propeller design and the efficiency of the motor itself. We used higher twist propellers for this project which provided more lift at lower motor RPM and afforded some increased efficiency of battery life. The motors are brushless motors which are designed for this purpose and are relatively efficient. Battery capacity relates directly to weight and there are many different capacity batteries available. The LiPo battery is also designed for this application and is very efficient. However, it would be possible to run an experiment to determine maximum flight time for a fixed maximum thrust by changing motors, propellers, and batteries. Unless one of these variables is non-linear however, we do not expect this experiment will yield significant results.

While we were able to demonstrate most of the goals we set out at the beginning of the project, there were issues of robustness that plagued us throughout the project. For example, we experienced sudden motor failures that resulted in crashes, “glitches” in flight where control was momentarily lost, occasional instabilities, occasional failure to arm properly, and intermittent sonar glitches. Future work will have to address these issues before reliable missions can be flown with this design. In addition to these stability issues, if the copter were to be moved to production there are additional concerns. Our prototype is an evolving project consisting of components and subsystems from many different sources tied together in a manner sufficient for demonstration of concept mission support. Basic electronics subsystems could be built and delivered in large quantity but the Quad copter would have to be redesigned to accommodate rapid assembly and test, and better sensor payload interfaces would have to be created to make customization easier. Also, the UAV technology base is rapidly changing because of the significant interest in this field. This rate of change results in rapid component obsolescence and makes technology freezes difficult.

6.1 Limitations

Our thesis have some limitations such as shortest flight time like as 10-15 minutes it's need more time to fly on air. Our Quad Copter's power supplier is not enough for more energy to carry much water. Our camera can't start automatically and can't send data in run time.

6.2 Future work

Our project demonstrated extensive tethered and unmetered flight using either our custom GUI or an RC control system. Additionally, we demonstrated limited autonomous flight as well as remote camera control. Future work could include more focus on longer flight times, robust operation, autonomy, or mission scenarios.

Our plan for the Quad copter is to set the GPS to find location automatically and we will use sensors to use commercially. We will also use high battery to fly long time and high quality sensors to move quad copter automatically. No physical control of the Quad copter will be required unless we want to take over manual control. The mission would a string of commands for the Quad copter to systematically go through. The Quad copter will first set its home location and altitude so that it knows where is home and if that is the landing spot it will know the relative altitude. From there it will take off, achieve a safe predetermined altitude and then move to designated way points. Once it is done flying to each way point which will be a specific GPS location it will return home and land its self. Also, it would be interesting to fly the copter using the onboard camera to locate landing spots or avoid obstacles.

With these capabilities working then complete autonomous missions could be developed and demonstrated. Completion of these efforts would require a more stable platform and a significant amount of engineering effort but would be a very interesting follow-on activity.

Appendix

ESC	Electronics Speed Controller
UAV	Unmanned Ariel Vehicle
PID	Proportional Integral Differential
P	Proportional
I	Integral
D	Differential
UAS	Unmanned Ariel System
KV	Measurement of Rotation per minute when single volt applied
FC	Flight Controller
RPM	Rotation per Minute
AMP	Ampere
TX	Transmitter
RX	Receiver
FPS	Frames per Second
ESC	Electronic Speed Controller
LIPO	Lithium ion Polymer

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