IDENTIFY THE CRACKS OF BRIDGE

A Project submitted in partial fulfilment of the requirements for the Award of Degree of.
Bachelor of Science in Electrical and Electronic Engineering

Submitted By

Taufiq Ahmed
ID: 153-33-3022

Mst. Ayesha Siddika
ID: 153-33-2901
&
Md. Abu Yousuf Sarker
ID: 153-33-2972

Supervised by
Mr. Md. Dara Abdus Satter
Assistant Professor
Department of EEE

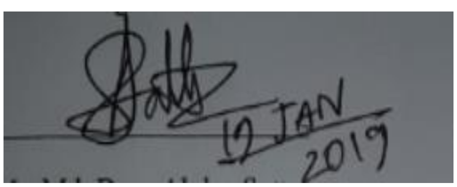
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING
FACULTY OF ENGINEERING
DAFFODIL INTERNATIONAL UNIVERSITY

December 2018

APPROVAL

This project work at **“IDENTIFY THE CRACKS OF BRIDGE”** submitted by Taufiq Ahmed ID:153-33-3022,Mst Ayesha Siddika ID:153-33-2901,Md.Abu Yousuf Sarker ID:153-33-2972 to the Department of Electrical and Electronics Engineering, Daffodil International University, has been accepted as satisfactory in partial fulfillment of the requirements for the degree of **Bachelor of Science in Electrical and Electronics Engineering** and approved as style and contents. The presentation has been held on.

Countersigned



Mr. Md. Dara Abdus Satter
Assistant Professor
Department of Electrical and Electronic Engineering Faculty of Engineering

Daffodil International University.

CERTIFICATION

This is to certify that this project entitled **"IDENTIFY THE CRACKS OF BRIDGE"** is done by the following students under my direct supervision and this work has been carried out by them in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfilment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering. The presentation of the work was held on December 2018.

Signature of the candidates

Name: Taufiq Ahmed	Mst. Ayesha Siddika	Md. Abu Yousuf Sarker
ID: 153-33-3022	ID: 153-33-2901	ID: 153-33-2972

BOARD OF EXAMINERS

____

Dr. Engr. ···
Professor

Department of EEE, DIU

Chairman

____

Dr. Engr. ---
Professor

Department of EEE, DIU

Internal Member

____

Dr. Engr. ---
Professor

Department of EEE, DIU

Internal Member

ACKNOWLEDGEMENT

First of all, we give thanks to Allah or God. Then we would like to take this opportunity to express our appreciation and gratitude to our project Mr. Md. Dara Abdus Satter, Assistant Professor of Department of EEE for being dedicated in supporting, motivating and guiding us through this project. This project can’t be done without his useful advice and helps. Also thank you very much for giving us opportunity to choose this project.Apart from that, we would like to thank our entire friends for sharing knowledge; information and helping us in making this project a success. Also thanks for lending us some tools and equipment.To our beloved family, we want to give them our deepest love and gratitude for being very supportive and also for their inspiration and encouragement during our studies in this University.

Dedicatedto

My Parents

ABSTRACT

In this paper we propose a crack quantification method based on 2D image analysis. The detection of cracks is a crucial task in monitoring structural health andensuring structural safety. The manual process of crack detection is painstakingly time consuming and suffers from subjective judgments of inspectors. This study establishes an intelligent model based on image processing by MATLAB. It is proposed to preprocess the image threshold by the MATLAB. The goal of this method is to meliorate the accuracy of the crack detection results. Experimental results point out difference between two images of the same object to detect crack defects in digital images. Therefore, the constructed model can be a useful tool for building management agencies and construction engineers in the task of structure maintenance.

CONTENTS

Approval i
Certification ii
Board of Examiners iii
Acknowledgement iv
Abstract v
List of Figures ix
List of Tables x
List of Abbreviations x

Chapter -1

INTRODUCTION 1-4

1.1 Introduction 1
1.2 Problem Statement 1
1.3 Objectives 2
1.4 Methodology 2-3
1.5 Project Outline 3-4
1.6 Summary 4

Chapter-2

LITERATURE REVIEW **5-7**

2.1 Introduction 5
2.2 History of Remote Sensing 6
2.3 Related Work 6-7
2.4 Summary 7

Chapter-3

DRONES AND BASICS

3.1 Introduction 8
3.2 Basic Principle 8
3.2.1 Working mechanism of Quad-Copter 8-9
3.2.2 Multi-rotor coordinate system 9-10

3.3	The physics of Quad-Copter flight	10
3.3.1	Steering	10
3.3.2	Roll and Pitch	10-11
3.3.3	Yaw	12-14
3.3.4	Hovering/Altitude Control	14
3.3.5	Movement	14-15
3.4	Different types of multi-rotor	15
3.4.1	Tri-Copters	15-16
4.2	Quad-Copter	16-17
3.4.3	Hexa-Copter	17
3.4.4	Octa-Copter	18
3.5	Summary	18

Chapter-4

	HARDWARE AND SOFTWARE OF DRONE	19-37
4.1	Introduction	19
4.2	Overall Connection and Structure of Quad-Copter	19-21
4.3	Hardware	21
4.3.1	Hardware for Communication Unit	21
4.3.1.a	Flight Controller	21-22
4.3.1.b	Motor	22-23
4.3.1.c	ESC	23-25
4.3.1.d	Gimbal	25-26
4.3.1.e	GPS	27-28
4.3.1.f	Power source	28-29
4.3.2	Hardware for Ground Station Unit	29-20
4.3.2.a	RC Controller	30-32
4.3.2.d	R9DS 10-Channel Receiver	32-33
4.3.2.e	Arbitrary Channel Mapping	34
4.3.2.f	Build-in Spectrum Analyser	34-35
4.3.2.h	Equipment Cost	35
4.4	Software	36
4.4.1	Mission Planner	36
4.4.2	Pix4Dmapper Pro	36-37
4.5	Summary	37

Chapter-5

SENSOR AND ITS CHARACTERISTIC 38-40

5.1	Introduction	38
5.2	Barometer	38-39
5.3	3axis Gyro	38
5.4	Camera	39-40
5.5	Summary	40

Chapter-6

MISSION PLANNING AND IMPLEMENTATION **41-46**

6.1	Introduction	41
6.2	Basic Instruction of Mission Planning	41-46
6.3	Summary	46

Chapter-7

RESULT AND DISCUSSION **47-49**

7.1	Introduction	47
7.2	Collect Data and Observation	47
7.3	Adjust collected data from MATLAB	
7.4	Discussion	48
7.5	Summary	49

Chapter-8

CONCLUTIONS AND SUGGESTION FOR FUTURE WORK **49-53**

8.1	Conclusions	49-50
8.2	Limitations of the Work	50
8.3	Future Scopes of the Work	51
	REFERENCES	52-53

LIST OF FIGURES

Figure
#Figure Caption Page

1.1 Block Diagram of Working Procedure 02
3.1 Orientation of Quad –copter Roll ,Pitch and Yaw 09
3.2 Quad-Copter roll left or right by altering the relative speeds of the left and right motors. 11
3.3 Quad-Copter pitch up and down by adjusting the relative speeds of the front and back Motors . 11
3.4 Configure of each motor to spin in the opposite direction . 12
3.5 We do not set up our quad-copters, or any other multi rotors, this way .If we were to have all the rotors spin clockwise ,the multi-rotor would start spinning uncontrollably in a counter clockwise direction. 13
3.6 By making diametrically opposite motors 14
3.7 Tri-copter with free motors. On rear motor, there is a servo for yaw control. 15
3.8 Quad-copters have four motors. Each motor spins in the direction opposite its neighbours so that the quad-copter does not spin while in flight. 16
3.9 Y4 quad-copters have four motors but they are arranged more like a tri-copter 16
3.19 Hexa –copters have six motors 17
4.13 Octa-copters have eight motors 18
4.1 Overall block diagram of Quad-copter. 19
4.2 Overall block diagram of ground station unit. 20
4.1 Structural design and measurement of Quad-copter. 21
4.2 ArduPilot Apm 2.8 22
4.3 DJI Brushless Motor. 23
4.430A Electronic Speed Controller 24
4.5 Two axis gimbal 25
4.6 Radio link M8N GPS SE100 Configuration
4.7 Wild Scorpion 3s 11.1volt Battery 30
4.8 RC Controller 32
4.9 R9DS – 10Channel Receiver 33

4.18 Arbitary Channel Mapping 34
4.19 Spectral Analysis 34
4.20 Interface of Mission Planner 36
5.1 Barometer 38
5.2 3axis gyro 39
5.3 Go-Pro Hero 4 39
6.1 Mission planner software interface showing the mission way Points 42
6.2 Output altitude values from the barometer during the time of Flight 44
6.3 Output altitude values from the GPS during the time of flight 50
6.4 Overlapping of altitude values of barometer and GPS during the time of flight 51
6.5 The figure showing the output values of the mission 45
7.1 Images from Drone 47
7.2 Gray Image 48
7.3 Noise Image 48
7.4 Final Image 49

LIST OF TABLES

Table	Table Caption	Page
4.1	Wild Scorpion 11.1v 3s 5500mAh	28
4.2	Equipment Cost	35
6.1	Output Value of Mission Planner	45

List of Abbreviation

RS	Remote Sensing
DEM	Digital Elevation Model
DSM	Digital Surface Model
GIS	Geographic Information System
ICT	Information and Communications Technology
UAV	Unmanned Aerial Vehicle
GPS	Global Positioning System
RTK	Real Time Kinematic
RGB	Red, Green and Blue
CAD	Computer Aided Design
CW	Clock Wise
CCW	Counter Clock Wise
GSM	Global System for Mobile Communication
USB	Universal Serial Bus
UHF	Ultra High Frequency
PWM	Pulse Width Modulation

CHAPTER 1

INTRODUCTION

1.1 Introduction

Cracks are of major concern for ensuring the safety, durability, and serviceability of structures. The reason is that when cracks are developed and propagate, they tend to cause the reduction in the effective loading area which brings about the increase of stress and subsequently failure of the concrete or other structures. Since there always exist constraints in reinforced concrete structures and buildings deteriorate overtime, cracking seems unavoidable and appears in all types of structures, for example, concrete wall, beam, slab, and brick walls. Particularly for concrete elements, cracks create access to harmful and corrosive chemicals to penetrate into the structure, which consequently damage their integrity as well as aesthetics. Identifying these issue manually is both time consuming and inefficient. In this paper I have shown how we can use drone to take images and process it through MATLAB.

1.2 Problem Statement

Bridges are immense architectural element and it is very crucial for our day to day communication. However, very often we see bridges needs maintenance as everyday huge number of vehicles are moving over it. So to avoid any unwanted scenario it is very important to keep up to date with possible flaws. For fulfilling this purpose manual labour is not at all promising in this era of technology. So, I have proposed a possible solution to overcome any inefficiency and attain accuracy.

1.3 Objective

The main objectives of this thesis is to design a system which will perform to collect necessary data and information from bridge and monitoring using a low budget UAV which can be made using locally available equipment.

The amount of damages is still monitored through on filed visit which is time consuming. Aerial monitoring using aerial vehicle can be useful sometimes but landing the vehicle is often a major problem experienced by the pilot. Therefore, one of the most efficient methods of those monitoring system is remote sensing using Land Observation Satellites. As the country does not own its own satellite the UAV based forest monitoring. Therefore, this system opens the door of a new method of bridge observation technique. The main purpose of this thesis is to make a system to help the proper authority to make their decision more effective and help them to collect data and monitor the affected area.

1.4 Methodology

The working procedure of this project is divided into five steps. They are given below

Figure 1.1 Block Diagram of working procedure

Plan: Select the area that we want to survey and make plan and simulate mapping mission and tasks.

Fly: After launching our drone, it will take-off, capture and geo-tag high resolution images and finally land. All the process is in fully autonomous mode. We used Go pro Hero 3 camera. But we will use RGB High resolution sensor camera for professional purpose by which we can have real and clear image for 3D mapping and then we can analysis.

Process: Process acquired images MATLAB and transfer them to digital 2D Deliver: Deliver impressive results to our customers in almost any industry standard format: JPEG. It's an open source software by which we can control drone automatically.

Decision: With this technology we can see the current status of the bridge and can easily compare with the previous one. Taking a bridge survey using classical methods for 1.0 KM, it might take 10 people one month to conduct a survey of, say, 100 samples. Samples are distributed across the survey area and estimations are then inferred for the content of the entire bridge. Following this example, we could first survey that size area in one flight, producing a 2D bridge image. This would enable optimal targeting of sample zones, reducing to say 20 plots. It would improve where to target these samples therefore improving inventory calculations and massively reducing timeframes and cost to do so.

The 2D image produced gives height data which, in certain respects, gives greater accuracy of information as the image is not a sample but a complete coverage of the area. Therefore, needs can be precisely identified and addressed in a far more cost effective manner.

Furthermore, the optional integration of RTK provides a highly accurate positional reference point which provides more precise height calculation than purely with GPS. Ground Control Points can be eliminated or greatly minimized which opens up significant possibilities in terms of timeframes and particularly in difficult to access areas.

Integration of other sensors than RGB, such as multispectral, infrared and thermal is offer the possibility to research such aspects as plant health, offering possibilities for highly targeted responses to disease and growth variations. Our drone is unique in having the payload capacity and our drone engineering capability to integrate multiple sensors to capture various data in a single flight.

1.5 Project Outline

This Project/thesis is organized as follows:

Chapter 1: Discuss about the problem statement, objective and methodology of this project. At the last part of this chapter, we mention thesis outline.

Chapter 2: In this chapter we discuss literature review, History of remote sensing, History of UAVs and History of UAV on remote sensing.

Chapter 3: In this chapter, we discuss about drone and its basics. Without it, we also briefly discuss about basics principle of drone, working mechanism, coordinate system and the physics of the quad-copter flight. At the last part of this chapter, we discuss about different types of multi-rotor.

Chapter 4: At the first part of this chapter, we show overall connection diagram and structure of a quad-copter. Later part, we discuss about flight controller, motor, ESC, Gimbal, radio telemetry, power source and the ground station unit. At the last part of this chapter, we discuss about software where we discuss Mission Planner, Pix4Dmapper Pro and Cloud Compare software.

Chapter 5: In this chapter, we briefly discuss about sensor and its characteristics like Barometer, 3-axis gyro and camera.

Chapter 6: This chapter is all about Mission Planer software. Here, we discuss its implementation.

Chapter 7: In this chapter, we show and discuss our experiment result.

Chapter 8: Here, we discuss about limitation and future works that may be approached and conclusion.

1.6 Summary

In this chapter, we briefly discuss about our project objective, problem statement and methodology. At the last part of this chapter, we mentioned our project outline.

CHAPTER 2

Literature Review

2.1 Introduction

Virtually, for all types of structures, surface cracks are critical indicators of structural damage and durability. Thus, as clearly stated by Thatoi et al. and Koch et al., it is crucial to visually inspect the building elements to detect cracking and appraise the physical and functional conditions. However, the task of crack detection in building, especially in developing countries, is often carried out manually. Hence, more time and effort is needed to obtain the measurements of cracks and to compile or process relevant data. In addition, manual visual inspection is inefficient in terms of both cost and accuracy because it involves the subjective judgments of inspectors. Accordingly, fast and reliable surface crack detection and analysis by means of automatic procedure is highly useful to replace the slow and subjective inspection of human inspectors. Recent reviews done in pointed out an increasing trend of applying image processing technique for boosting the productivity of detecting crack in structures. These works show that assessing the visual condition of vertical and horizontal structural elements become a vital part of civil engineering. The information of crack can be used for diagnosis and to decide the appropriate rehabilitation method to fix the damaged structures and prevent catastrophic failures. Image binarization, which is widely employed for text recognition and medical image processing, is very suitable to be used for crack detection. It is because texts and cracks have similar properties, and they feature distinguishable lines and curves. Crack detection also suffers from challenges such as low contrast, uneven illumination, noise pollution, and existence of shading, blemishes, or concrete spall in images. Better methods for image binarizing-based crack detection are constantly researched in the academic community. In the present work, an image processing model that automatically detects and analyses cracks on the surfaces of building elements in the digital image is established. The proposed model does not only automatically recognize crack pixels out of image background but also perform various measurements of crack characteristics including the area, perimeter, width, length, and orientation.

2.2 History of Remote Sensing

The term remote sensing was first introduced in 1958 by Everyln Pruitt of the U.S Office of Naval Research. To survey soil and crop scientists use to use aerial photography in various agriculture areas. During World War 2 infrared photography was developed, by using infrared technology scientists was able to understand the crop status, water management and crop-soil condition.

In 1960 new laboratories was established for crop identification and the Crop Identification Technology Assessment for Remote Sensing (CITARS) program.

In the early 1970, NASA became more concern about remote sensing and provided funding in selected universities to develop remote sensing technologies. NASA wanted to improve their future sensor systems, so the spectral band was very important as those band works under different principal and have different characteristics.

The first of the Landsat sensor configuration was launched in 1972, was able to estimate the wheat yield over wide area. NASA, NOAA and USDA was being jointed in the LACIE program. Between 1974 and 1975 the Great Plains of the US concentrate on the development of both yield estimation model and spectral 'signatures'. Subsequently various country became more concern about remote sensing including Canada and Soviet Union. LACIE program became more successful and they expand the program including various types of crop monitoring such as barley, corn, cotton rice, soybeans and wheat.

2.3 History of Related Work

U Cracking is an important indication of the degradation of structures. Detection of cracks is often required in the stage of building maintenance. In addition, inspections of the structural integrity based on crack analyses become substantial for the service life prediction of structures. Since the manual process for crack measurement is painstakingly time-consuming for large scale structures (e.g., high- rise buildings and bridges), many researchers have proposed models based on image processing, which enable a faster and more efficient way of measuring the cracks in concrete surfaces. +e general framework of these models is shown in Figure 2. Lee et al. presented an automated technique-based image processing for detecting and analysing concrete surface cracks; the crack detection is recognized from an image of a concrete surface, and the crack analysis calculates the characteristics of the detected cracks, such as crack width, length, and area. Adhikari et al. developed a model that numerically represents the crack defects; the proposed approach is also capable of crack quantification and detection. Torok et al. proposed an image based automated crack detection model for post disaster building assessment; based on the numerical experiment, the authors show that the proposed method can bring about great benefits in a post disaster analysis of building elements. Recently, Alam et al. have proposed a hybrid detection technique by combining the digital image correlation and acoustic emission. Talab et al. detected cracking defects in digital images using the Otsu method and Sobel's filtering in image processing techniques. Ebrahimkhanlou et al. performed a multifractal analysis of crack patterns with applications in reinforced concrete shear walls. Yu et al. introduced an efficient crack detection method for the tunnel lining surface cracks based on infrared images; the proposed method is capable of overcoming challenging issues such as low contrast, uneven illumination, and severe noise pollution that generally exist in a tunnel lining image. Like success on military operations, scientists were interested on UAV for doing "dull, dirty and dangerous" work. End of the cold war UAV has been improved on control and navigation system area which thrive scientists to use this technology for their research. Between 1970 to1980 NASA ran UAV based mission named "Mini Sniffer" but in 1990s "ERAST" mission was the major step for remote sensing using UAV. After the age of minimization of sensors and electronics many "Do it yourself" community evolved for UAV construction for many research purpose on early 2000. Which also help to cut down the price of UAV system. Although, many countries have regulation issues which is inversely affecting the research process based on UAV, now-a-days researchers have many options of UAV's regarding their research purpose.

2.4 Summary

Background history of anything is impressed us to work with more attentively and help us to know the dedication of a person to invent anything. Thus, in this chapter, we discuss about the background history of remote sensing, UAVs and UAV on remote sensing.

CHAPTER 3

DRONES AND BASICS

3.1 Introduction

Drones or UAVs or Unmanned Aerial Vehicles are kind of machines which can fly without having any presence of human pilot inside the vehicle. These kinds of machines can be controlled through computers or by simple remote controls. In terms of classification of these drones, there is no set standard. Drones are being design in various shapes and sizes according to our use.

3.2 Basic Principle

The design of any drone can consists of multiple-rotor with multiple propelling wings as to our requirement. Those multiple motors can induce pull action and push action such as different movement. We have design a Quad copter, having four motors with four propelling wings. The left and right induce pull action, while the front and back induce push action.

A microcontroller board can be known as the brain of the robot. These are being designed in such way so that the drone can be auto piloted.

Combination of inertial measurement unit, microcontroller can consists of 3 axis gyro, 3 axis accelerometer and a barometric pressure gauge. RC transmitter which is being used to navigate the drone, GPS chip can be introduce to the robot for further improvement as GPS chip can give us precise latitude and longitude value.

3.2.1 Working mechanism of Quad-Copter

To make anything fly, the weight need to balance to generating an equivalent force (Lift) and also balance moments about its center of gravity by generating opposite moments. By using four rotors a quad copter generates the required moments and lift force. Generating lift might be simple, but generating moments in order to stabilize the

machine and generating control forces to move its quite complex for our desired location or on a desired path.

3.2.2 Multi-rotor Coordinate System

While discussing the piloting and multi-rotor construction, a certain way of communication is require for different movements of the multi-rotor. In 1700s mathematicians described the orientation of rigid bodies in space. From there they have developed a system where a set of three angles has being explained, in this case, for the orientation of the multi-rotor three special dimensions are being used . These three dimensions or angles are known as **roll, pitch, and yaw**.

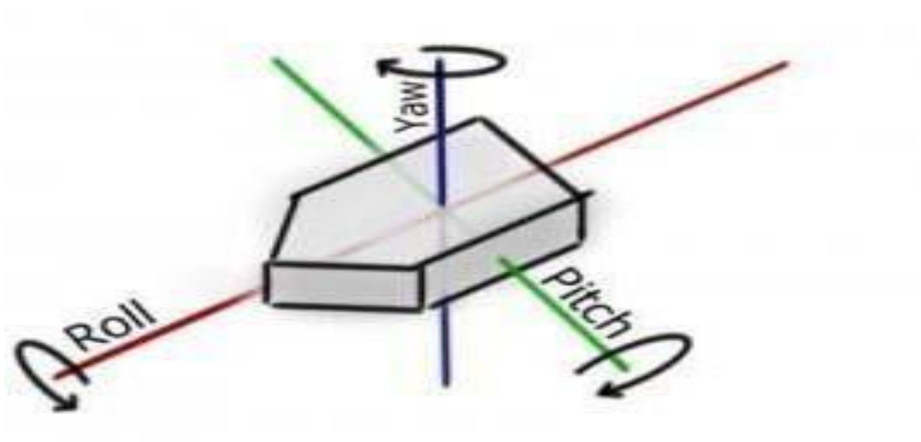


Figure 3.1: Orientation of quad-copter roll, pitch and yaw

To describe the orientation of the quad-copter, we use three angles: roll, pitch, and yaw.
The quad copter can tilt side by side and this can be described by the roll angle of the multi-rotor. If we tilt our head towards one of your shoulders the rotation of quad copter about roll axis are same. This rolling of the multi-rotor causes it to move sideways.
The forwards and backwards movement of the quad-copter is being caused for the pitch angle of the multi-rotor. When we tilt our head in order to look up or down these movements is same as the rotation about the pitch axis. As the multi-rotor pitching is the region to move forwards or backwards.

The yaw angle of the multi-rotor can able to describe the bearing, or, in other words, rotation of the craft as it stays level to the ground. When we shake our head to say “no.” this particular movement is the yaw movement of the quad copter.

The final terminology that describe orientation of a quad copter is, throttle of the multi-rotor. The altitude of the multi-rotor is being controlled by throttle.

3.3 The Physics of Quad-copter Flight

3.3.1 Steering

While flying our quad-copter, it is very important to understand the movement of the multi-rotor and how it can be control perfectly. The rotational speed of the motors causes different movements of multi-rotors. The right way is to adjust the relative speeds of the motors, keeping in mind that the rotational speed of the motors determines how much lift each prop produces. The rotation around any of the directional axes (roll, pitch, and yaw) are being determined by the flight controller as it causes the multi-rotor to rotate at different speed, also same goes to gain or lose altitude.

3.3.2 Roll and Pitch

The flight controller makes the motors to spin faster on one side of the multi-rotor than the motors on the other side causing the multi-rotor to rotate about the roll or pitch axes, by meaning one side of the multi-rotor will have to lift more than the other side, causing the multi-rotor to tilt.

So, for example, to make a quad-copter to roll right or rotate about the roll axis clockwise, the flight controller will control the movement of two motors on the left side of the multi-rotor to spin faster than the two motors on the right side. The left side of the quad-copter will then have more lift than the right side, causing the multi-rotor to tilt.

Similarly, to make a quad-copter pitch down, that is rotate about the pitch axis clockwise, now the flight controller will do the opposite. It will make the two

motors on the back of the quad-copter to spin faster than the two motors on the front, making the craft to tilt in the same way when our head tilts as we look down.

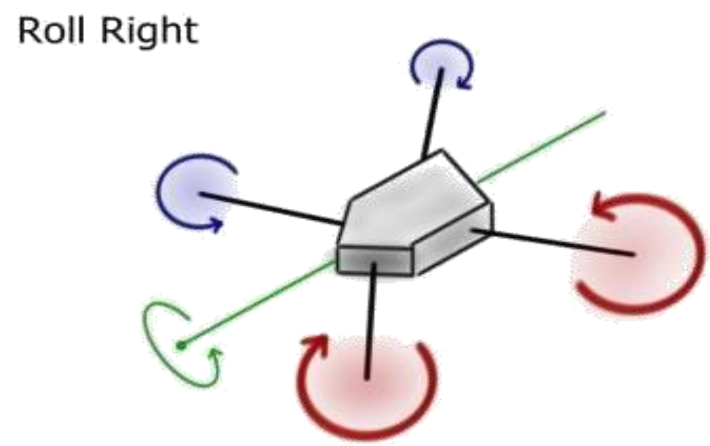


Figure 3.2: Quad-copters roll left or right by altering the relative speeds of the left and right motors.

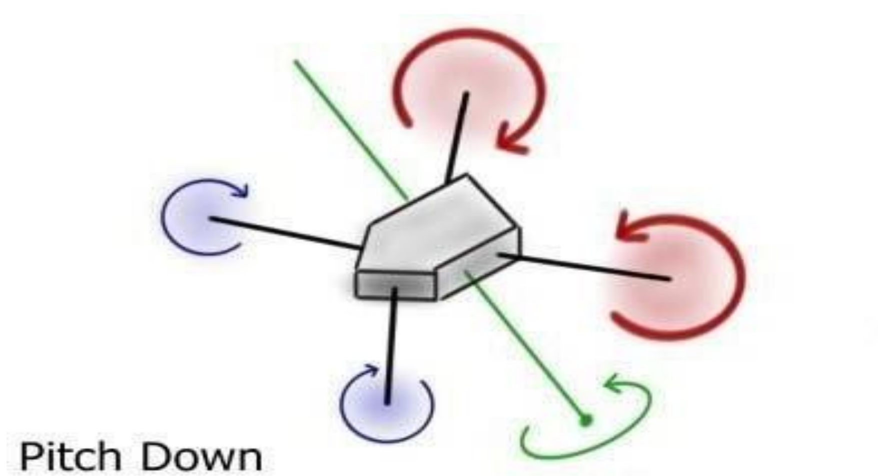


Figure 3.3: Quad-copters pitch up and down by adjusting the relative speeds of the front and back motors.

The same principles apply for multi-rotors with more than four motors as well.

3.3.3 Yaw

Controlling the multi-rotor's rotation about the roll or pitch axes is easy but complex task will be the yaw axis. First, let us discuss about how we will be able to prevent rotation about the yaw axis. When assembling and programming multi-rotors, we have setup the motors in such way so that each motor spins in the opposite direction than its neighbours. In other words, using a quad-copter as an example once again, if we start from the front-left motor, it is moving clockwise, the motors' rotational directions can alternative, CW, CCW, CW, CCW. To neutralize, or cancel out each other or motor's tendency to rotate the multi-rotor we have use this rotational configuration.

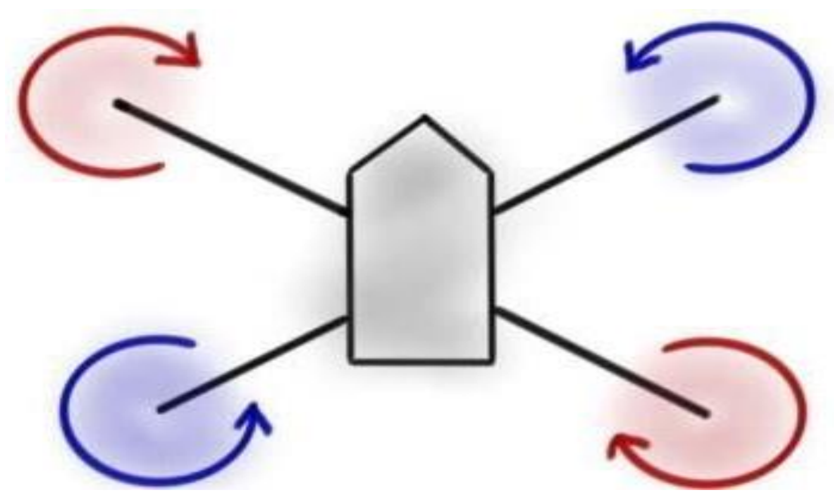


Figure 3.4: configure of each motor to spin in the opposite direction than its neighbours.

When a prop spins, for example, in clockwise rotation, the multi-rotor will have a tendency to spin counter-clockwise according to the conservation of angular momentum. This is due to Newton's third law of motion, "for every action, there is an equal and opposite reaction." The body of the multi-rotor will always tend to spin in the opposite direction than the rotational direction of the propellers.

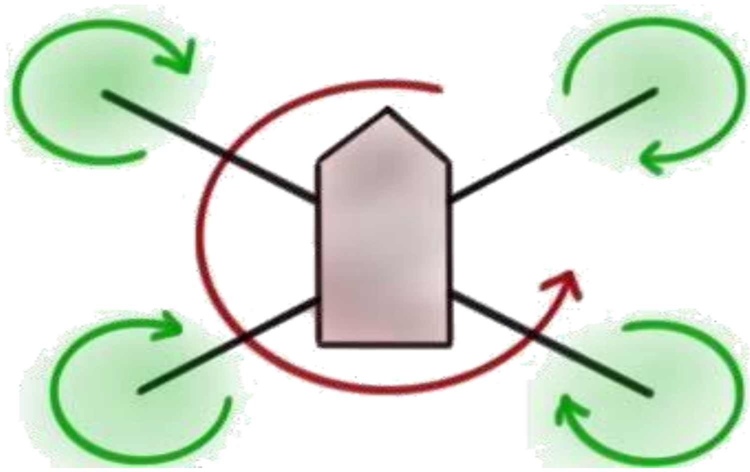


Figure 3.5: Note that we do not set up our quad-copters, or any other multi-rotors, this way. If we were to have all the rotors spin clockwise, the multi-rotor would start spinning uncontrollably in a counter clockwise direction.

As an example let us discuss about helicopter working mechanism. As helicopters have two rotors and in order to lift the aircraft the larger main rotor is the main reason behind it, and the small rotor on the tail that lets the helicopter to spin in different direction. Imaging is in mid-flight or tail rotor of the helicopter fells off the aircraft while the big main rotor kept spinning. The common thoughts probably will be, the helicopter would start spinning. According to the law of conservation of angular momentum, this kind of rotation would be caused as the rotation of the propeller in the opposite direction.

So we can say that, each of the four rotors quad-copter tends to make the multi-rotor to rotate in the opposite direction than their spin. So we are cancelling out this effect so that the multi-rotors do not spin about the yaw axis by using pairs of rotors spinning in opposite directions.

So therefore, when we actually rotate the multi-rotor about the yaw axis, the flight controller will slow down the opposite pairs of motors compare to the other pair. By meaning the angular momentum of the two pairs of props will have no balance and the craft rotates. By slowing down different pairs of motors we can make the multi- rotor rotate in either direction.

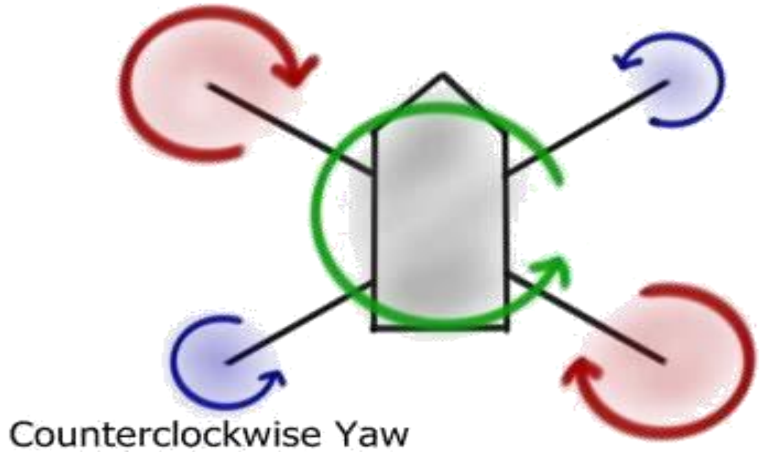


Figure 3.6: by making diametrically opposite motors (that spin in the same direction) spin at different rates, the craft can be made to yaw.

In this case, the clockwise-spinning motors are faster than the counter clockwise- spinning motors, so the craft yaws counter clockwise.

3.3.4 Hovering/Altitude Control

Now that we understand steering principle of the multi-rotor, let us quickly discuss a much simpler term, which is hovering. To make the quad-copter or multi-rotor hover, which means it will stay at a constant altitude without rotating at any other direction. For this movement a balance of forces is required. When the lift is produced by the rotors the flight controller will have to counteract the force of gravity. So we can say that the mass of the multi-rotor times gravitational acceleration is equal to the force of gravity acting on the multi-rotor. The lift produced by the multi-rotor is equal to the sum of the lift produced by each of its rotors. Therefore, to maintain a constant altitude the force of gravity has to be equal to the force of the lift produced by the motors.

To ascend or descend, therefore, the flight controller disrupts this balance. The craft will gain altitude if the lift produced by the multi-rotor is greater than the force of gravity. If the opposite is true, the multi-rotor will fall when the lift produced by the multi-rotor is less than the force of gravity acting on the multi-rotor.

3.3.5 Movement

So as far as we have discussed how, by adjusting the relative speeds of the multiple motors, the flight controller can tilt the multi-rotor in many direction. Well, the main reason we are able to move the quad-copter is the tilting of the multi-rotor. By tilting the multi-rotor in different directions, it can be made to move forward,

backward, left, or right. For example, it moves forward when the multi-rotor pitches down (clockwise around the pitch axis).

The reason the multi-rotor moves when it tilts, some of the lift produced by the rotor is directed horizontally while normally all of the lift is directed downward. It pushes the multi-rotor due to sideways component of the lift.

Now can say that we are sacrifices some of the multi-rotor's downward thrust to move the craft horizontally. While moving around multi-rotors tend to lose altitude due to less thrust is directed downward while the multi-rotor is tilting. Some flight controllers have a feature called "altitude hold" which means the flight controller have its own ability that automatically adjusts the motor speeds in order to make the craft maintain a constant altitude while its moving.

3.4 Different types of multi-rotor

Multi-rotor is being designed according to its use. There are different types of multi- rotors that can be easily differential by its design, shape and configuration.

3.4.1 Tri-copters

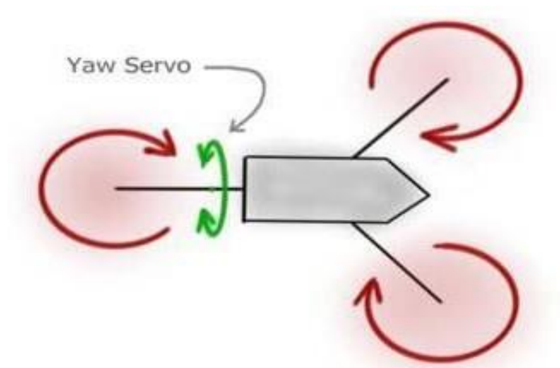


Figure:Tri_copters with three motors. On the rear motor, there is a servo for yaw control.

Tri-copters have three motors. The shape of the tri-copter can be Y shape or T shape. Two motors are being mounted in fixed positions. What it makes it unique is the rear motor, by using servo motor it is being tilted. This servo mechanism gives the multi-rotor yaw control over the craft. As they have few motors the tri-copter is least expensive because servos are generally much less expensive than the brushless motor. Another benefit is that the widest angle 120 deg. between the front two

motors. As it has few motors on the craft motors consume much power, making low lifting power. The structure of the tri-copters is not that good, if it crashes the damage can be maximum.

3.4.2 Quad-copter

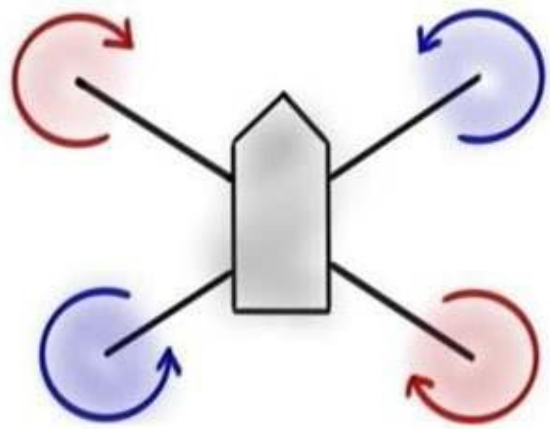


Figure 3.8: Quad-copters have four motors. Each motor spins in the direction opposite its neighbours so that the quad-copter does not spin while in flight.

Quad-copter is the most popular multi-rotor because of its structure, shape, capability, stability and ease of control. Quad-copter have four motors, the shape can be define as X configuration or Y4 configuration. Mechanically is simpler that tri-copter. Due to four motor they can lift higher weight than tri copter. The quad- copter is much more stable able stay airborne for longer period. This is less expensive than octa or penta copter. Flight time depends on design according to requirement..

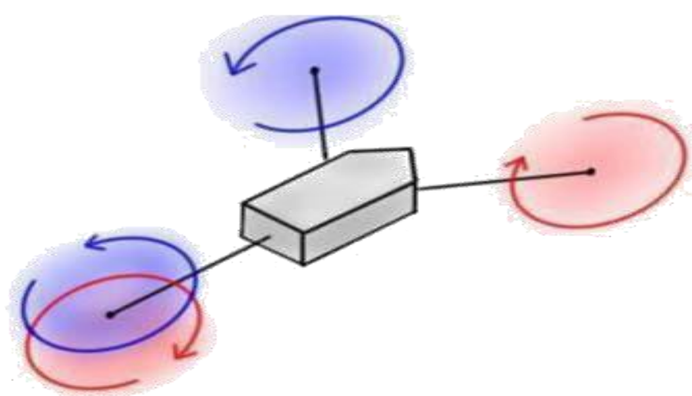


Figure 3.9: Y4 quad-copters have four motors but they are arranged more like a tri- copter. An Y4 quad-copter looks like a tri-copter, but in rear motor a servo motor is being mounted. Underneath the first motor second brushless motor being mounted that help the quad-copter to achieve yaw control. They have more lifting power and more robust due to the lack of servo mechanism.

3.4.3 Hexa-copter

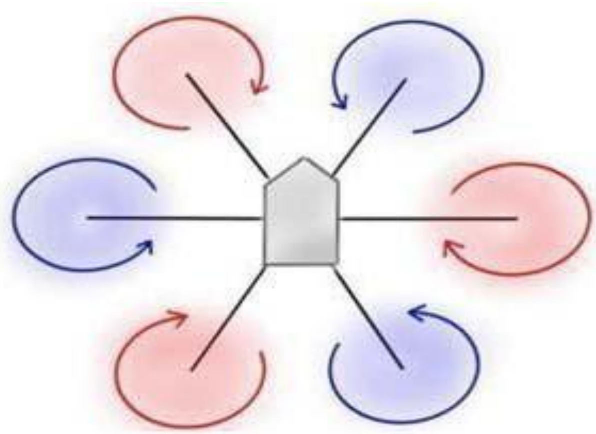


Figure 3.10: Hexa-copters have six motors.

Hexa-copter has six motor, extra two motor makes it more unique and effective. The motors on hexa-copters are arranged in pairs with one turning counter clockwise and one turning clockwise.

In other words, hexa-copter have three motors in clockwise and three motors in anticlockwise spinning rotation. Due to six motor the Hexa-copter is much more stable, if one the motors shuts down somehow, automatically the opposite motor being shut down by the flight controller, So that it works more like a quadcopter, leading it to have less chances of an accidental crash. Though it has much higher capability but the hexa-copter is much more expensive.

3.4.4 Octa-copter

Figure 3.11: Octa-copters have eight motors.

The octa-copter is something that you can fly if you need horsepower, it have eight motors which gives it a deadly look, relatively most expensive multi-rotor than quad copter or hexa-copter. X8 copter has two motors per arm mounted one on top of the other.

Looks more like a quad copter but with extra power but overall efficiency of the system is less than the efficiency of a quad-copter.

3.5 Summary

In this chapter, we discuss about drone and its basics. Without it, we also briefly discuss about basics principle of drone, working mechanism, coordinate system and the physics of the quad-copter flight. At the last part of this chapter, we discuss about different types of multi-rotor.

Chapter 4

Hardware and Software of Drone

4.1 Introduction

Design of a system is an important part of any types of engineering work. It leads us to a proper way and helps us to take a proper decision. Therefore, we can say, design is a plan or a guide line. In this chapter we show our design of project and briefly discuss about it.

4.2 Overall Connection and Structure of Quad-Copter

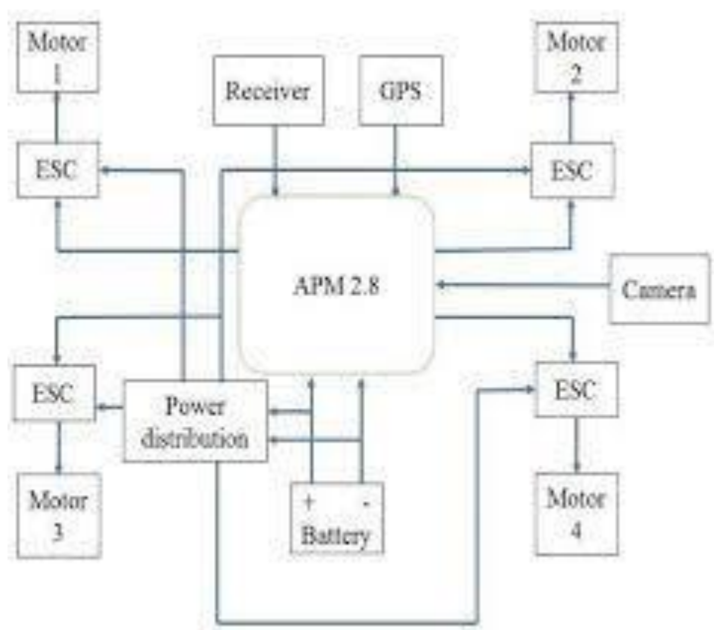


Figure 4.1: Overall block diagram of Quad-copter.

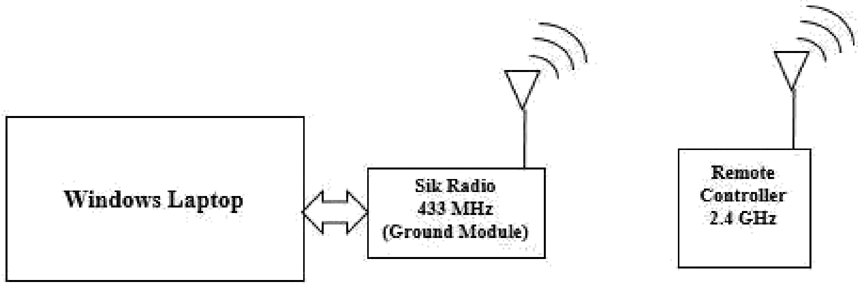


Figure 4.2: Overall block diagram of ground station unit.

We made the structure of the whole quad-copter with the locally available parts. The main frame was made with 1/2" "CPvc" pipe which is used usually in plumbing. "CPvc" pipe has less weight and more durable then "UPvc" pipe. The size of the arm is 28 cm each, thus the radius of the quad become 30 cm. The main controller is housed inside "RFL Bowl" which has simple yet durable lock system which is easily accessible. Inside the bowl we painted in black to protect the ArduPilot Apm 2.8 from direct sunlight. As it is air tightened bowl made for house hold work it also protects the flight controller from external air on flight time which makes the copter more reliable during the flight. As we are using camera gimbal for image stabilization we have to have ground clearance than the height of the gimbal thus we end up with the 10cm ground clearance from the quad-copter base. Our final weight of the copter is 2200 gram so we decide the motor capable of executing minimum of thrust of 1100 gram as the equation of motor selection is

Motor min thrust = [total weight / 4] * 2

= [2200 / 4]*2

= 1100 gm

This is sum up the motor selection. This also helps to select propeller size. We selected propeller size of 11*4.7 which can deliver 1100 gm thrust. Here, 11 = diameter of prop (in inch) and 4.7 = pitch of prop (in inch).

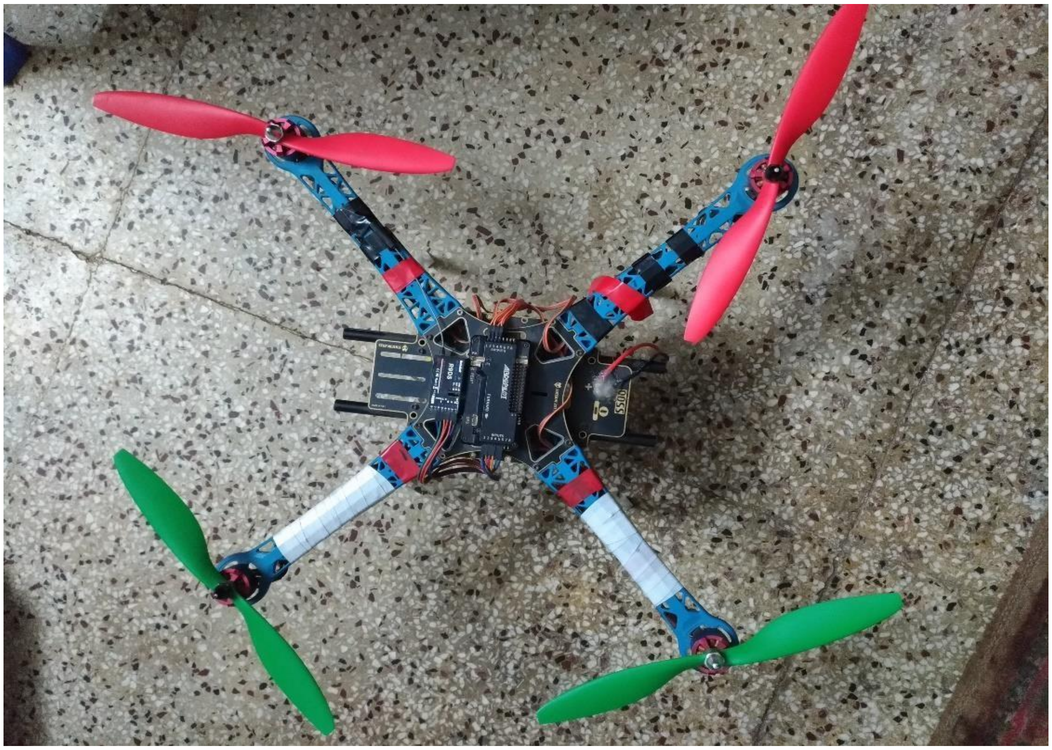


Figure 4.3: Structural design and measurement of Quad-copter.

4.3 Hardware

4.3.1 Hardware for Communication Unit

4.3.1.a Flight Controller

ArduPilot Apm 2.8:

ArduPilot Mega. **Ardupilot Mega** (**APM**) is a professional quality IMU autopilot that is based on the Arduino **Mega** platform.It is a full autopilot capable for autonomous stabilisation, way-point based navigation and two way telemetry with Xbee wireless modules.

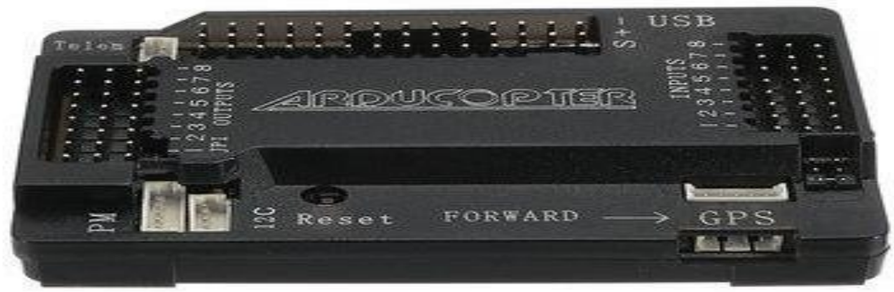


Figure 4.4: ArduPilot Apm 2.8

Features:

- Arduino Compatible!
- Includes 3-axis gyro, accelerometer, along with a high-performance barometer
- Onboard 4 MegaByte Dataflash chip for automatic datalogging
- Optional off-board GPS, uBlox LEA-6H module with Compass.
- One of the first open source autopilot systems to use Invensense's 6 DoF Accelerometer/Gyro MPU-6000.
- Barometric pressure sensor upgraded to MS5611-01BA03, from Measurement Specialties.
- Atmel's ATMEGA2560 and ATMEGA32U-2 chips for processing and usb functions respectively.
- Weight: 30g

4.3.1. b Motor

Selecting motor is one the most difficult task while building a copter, there are lots of math and aerodynamics are involved in designing a copter. To choose a motor we first need to calculate the total weight and number of motor we are using. A rule of thumb is Required Thrust per motor = (Weight x 2) / 4 from this equation we will find the thrust per motor, too much thrust can make the copter hard to control. According to our calculation the required thrust per motor is 1kg, so we have selected “DGI” Brushless

motor” due to its excellent performance and features. The prop adaptor of this series is mounted to the motor can with 3 screws, it gives better centralization and balance. The Features are given below

Figure 4.5: DJI Brushless Motor.

Features:

DJI 2212/920KV

Dimension : 28X24mm Rating : 920kv

Battery :3S,4S Shaft : 8.0mm Weight : 56gr (with Prop Adapter)

Standard Current : 15-25A Max Current : 30A

Recommended prop : Li-Poly (11.1V) : 10x4.5 Li-Poly (14.7V) : 8X4.5 Gold connector is included.

Table 4.1: DJI 2212\ KV920 Brushless Motor Datasheet

Prop Test Data		MX2212-920KV					
Voltage(V)	Propeller (inch)	Throttle	Current (A)	Watts(W)	Thrust(G)	RPM (RPM/Min)	Efficiency (G/W)
11.1	APC 9X6 SF	85%	11.2	115	470	6150	4.09
	APC 10X4.7	85%	11.3	120	680	6100	5.67
	GP 10X4.5	90%	10.5	116	685	5763	5.91

4.3.1.c ESC

ESC stands for Electronic Speed Controller. It converts the PWM signal from the flight controller or radio receiver, and drives the brushless motor by providing the appropriate level of electrical power. In terms of ESC suggestions having 20% extra Amps is a good rule of thumb to ensure the ESC do not burn out, but while in conservative flights the copter will hardly fly at max throttle, and most ESC have a burst Amp rating that they can sustain for 10-30sec. But if you are undecided about two ESC ratings, it is always better to go to the higher value, this is again a good idea, but if we are using a larger ESC can also use more battery, so it’s something to think about. We have selected 30A which supports 3s and 3s battery using CMOS technology.

Figure 4.6: 30A Electronic Speed Controller

Features :

1. Based on BLHeli firmware, further optimized to the perfect drive performance.
2. Low-voltage protection, over-heat protection, and throttle signal loss protection.
3. Separate power supply for MCU and BEC, enhancing the ESC's ability to eliminate magnetic interference.
4. Parameters of the ESC can be set via program card or transmitter.
5. Throttle range can be set to be compatible with different receivers.
6. Equipped with built-in linear BEC or switch BEC.
7. Max speed: 210,000 rpm for 2-pole, 70,000 rpm for 6-pole, 35,000 rpm for 12-pole.

Specifications:

Item	Continuous Current	Burst current (10S)	Li-xx Battery (cell)	Dimension L×W×H(mm)	Weight (g) wires Included	BEC Output	Programmable
BLHeli-6A	6A	8A	1-2	22×13×5.5	6	0.8A/5V	YES
BLHeli-12A	12A	15A	2-4	42×20×8	11	1A/5V	YES
BLHeli-20A	20A	25A	2-4	52×26×7	28	2A/5V	YES
BLHeli-25A	25A	30A	2-4	52×26×7	28	2A/5V	YES
BLHeli-30A	30A	40A	2-4	52×26×7	28	2A/5V	YES

4.3.1.d Gimbal

Gimbal is a very important hardware for aerial photography. It balances the camera horizontally throughout the flight time so that the camera remains stable. The top part

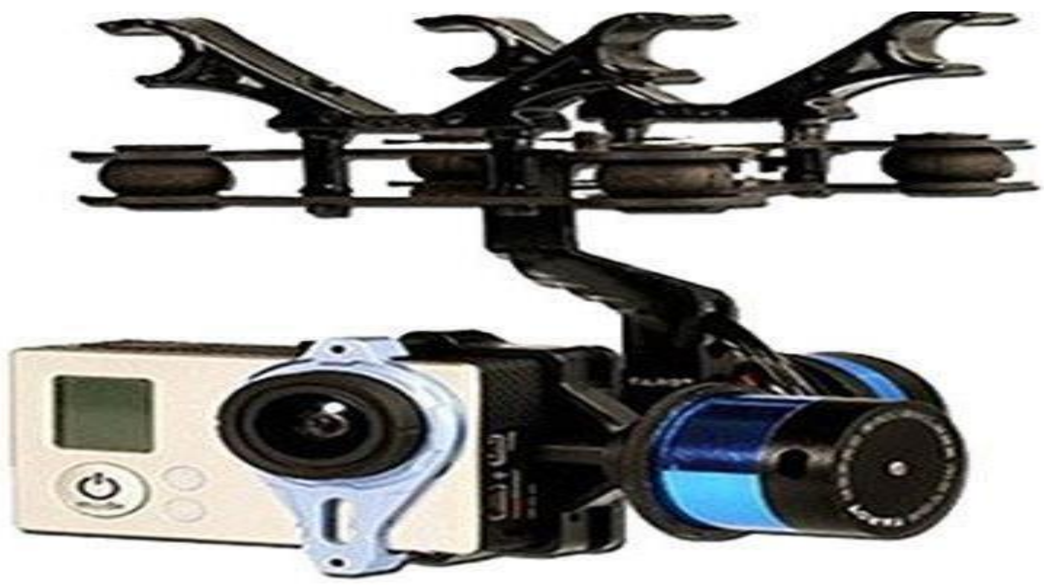


Figure 4.7: Two axis gimbal

of the gimbal contain a shock absorber it reduces the vibration while flight time. Two BLDC motor is connected with the built in circuit. Viewing angle of the camera can be set manually where the camera remains fixed on a certain position. Main advantage of gimbal is the position of the camera doesn't demands on the orientation or movement of the quad copter. If the quad copter vibration is high while in flight time it won't have any effect on the camera.

Features:

- Vibration isolation mounting
- Integrated motor and frame design
- GoPro 4 direct mounting
- Supply voltage polarity protection and voltage compensation
- Short-circuit protection
- Custom initial pitch angle
- Sensitivity parameter adjustment support and software
- Supports joystick rate mode and position mode
- Dual 32-bit high-speed ARM core processor
- Easy to use software

4.3.1d GPS

:

Figure 4.8: Neo M8N GPS

GPS decoder chip: M8N GPS, with u-blox UBX-M8030 (M8), 72-channel, MMIC BGA715L7 from Infineon, is much better than single GNSS 7N. Concurrent reception of GPS/QZSS L1 C/A,GLONASS L10F, BeiDou B1, two GNSS working at the same time. SBASL1 C/A: WAAS, EGNOS, MSAS Geomagnetic: HMC5983 from Honeywell Antenna: 2.5dbI high gain and selectivity ceramic antenna Power amplify IC: MMIC BGA715L7 from Infineon Double Filter: SAWF (Surface acoustic wave filter) form Murata

Parameter:

- Positional Accuracy: 50 CM precision when working with concurrent GNSS
- Velocity precision: 0.1m/s
- Max height: 50000m
- Max speed: 515m/s

- Max acceleration: 4G
- Max update rate: up to 18Hz
- Sensitivity Tracking & Nav.: -167dBm; Reacquisition:-163dBm; Cold start:-151dBm; Hot start:- 159dBm.
- Time to first fix: Cold start: 26s, Hot start: 1s.
    - Connect ports Power supply: voltage 5VDC, current 50~55mA
- Ports

  A. GPS UART interface, baud rate: 1.2K/4.8K/9.6K/19.2K/38.4K/57.6K/112.5K B.

  B. Geomagnetic I2C interface

4.3.1.f. POWER SOURCE:

Every device needs a power source that will make it run or useable, so for quad copter there is specific requirement in selection of power source. We have selected "Wild Scorpion 3s 11.1V battery". This Nano tech lipoly batteries were designed to have greater performance, it allows electrons to pass more freely from anode to cathode with less internal impedance. In short, have less voltage sag and a higher discharge rates than similar lithium polymer batteries. Due to higher voltage under load, straighter discharge curves and excellent performance giving the pilot stronger throttle punches.

Figure 4.12: Wild Scorpion 3s 11.1V battery

Features:

- Excellent high discharge rate
- Extra low internal impedance
- Discharge in high temperature
- Long cycle life and high quality
- Easy customized ,energy density
- Low self-discharge etc.

Specification:

- Capacity :550mAh
- Continuous discharge rate :35c
- Voltage:11.1v
- Cell:3s
- Size:138mm *44mm *30mm(0-3mm)
- Weight:413g
- 100% Brand new 1*11.1v 5500mah 35c lipo battery

4.3.1.g Others Hardware Equipment:

Features:

- Built from quality glass fiber and polyamide nylon
- Pre-threaded brass sleeves for all frame bolts
- Locating tabs for arms
- Colored arms for orientation to help you to keep flying in the right direction
- Integrated PCB connections for direct soldering of your ESCs
- Easy assembly

Specification:

Motor centers: 480mm

Height: 170mm

Weight: 405g (frame only**)**

Motor Mount Bolt Holes: 16~19~25mm

Figure 4.9: S500 Drone Frame

4.3.1f RC Controller:

To control any multi-rotor we need a controller which send and receive commands through transmitter.

Features:

- Fast response, 3ms only, which is much less than the average 20ms even 9 channels act synchronously.
- English,Chinese ,EsPanol,Deutsch,French,Italiano,Turkish,Russian&Korean menu can be switched, full types specialized helicopter 8 swash plate modes, fixed wing 2 airfoils 3 rears, gliders 4 airfoils and 2 rears, multi-copter menu.
- DSSS and FHSS spread-spectrum technology working synchronously, QPSK modulation support excellent anti-interference performance.
- Programmable mix control. Basic menu, advanced menu, graphic view for verities of throttle and servo curve.
- Support S-BUS, PPM and PWM signal.
- Unique telemetry.
- Receiver integrates signal strength and voltage telemetry sensor.

- Both R10DS and R9DS support extended engine voltage telemetry module PRM-01 and OSD info telemetry module PRM-02. PRM-02 can feedback GPS, SPEED, Voltage AT9S/AT10 display when work with flight controller APM or PIX.
- 4096 section precision, 0.25us per section, servo anti-shake rudder.
- Vibration alarm.
- Support USB online upgrade, the upgrade firmware V1.3.2 add CAR and BOAT model type.

  Four VR switches, three three-gear switches, four two-gear switches, a reset trainer switch. Support multiple aerial control mode and PTZ control.

Specifications:

- Size: AT9S- 183*100*193mm, R9DS- 41*23*14mm
- Weight: 0.88kg
- Frequency: 2.4GHz ISM band (2400MHz to 2483.5MHz)
- Modulation mode: QPSK
- Channel bandwidth: 5.0 MHz
- Spread spectrum: DSSS&FHSS
- Adjacent channel rejection: >38dbm
- Transmitter power: <100mW (20dbm)
- Operating current: <90mA
- Operating voltage: 7.4~18.0V
- Control distance: more than 900 meters ground, 1500 meters air, the actual control distance depends on the flying environment
- Channel: 9 channels
- Compatible model: include all 120 degree and 90 degree swash-plate helicopter, all fix wings, glider and multi-rotor
- Simulator model: under the simulator model the transmitter action turn off, change to power saving model
- Screen: 2.8 inches 16 colourful screen, 240*320 pixels
- Support receivers: R9DS(S-BUS&PWM), R10DS and R6DS

Figure 4.14: RC Controller

4.3.2.a R9DS – 10 Channel Receiver

This is high end receiver in the EzUHF family. 8x Servo Outputs, but 12 channel PPM capability.

Features:

- Upgraded version, antenna is improved, signal will be more stable
- Dual-way communication function
- Could send back flight data
- High sensitivity, distance up to 1.1km
- DSSS technology, reliable
- Supported S-BUS and high-voltage steering engine

Specifications

- Brand Name**:** RadioLink
- Item NO**.**: R9DS
- Frequency**:** 2.4GHz
- Channel**:** 9CH
- Color**:** Black
- Usage**:** Used for RadioLink AT9 AT10 remote controller

Figure 4.17: RD9S-10 Channel Receiver

4.3.2.C Arbitary Channel Mapping

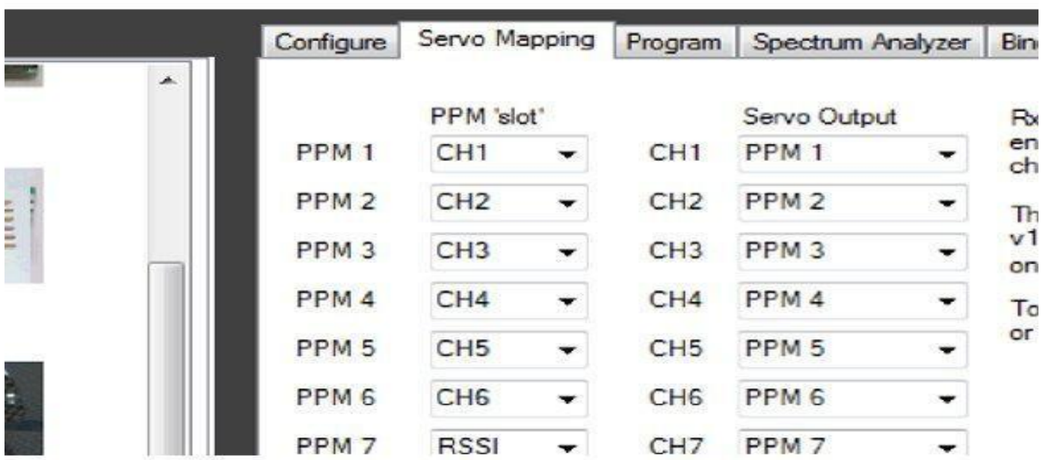


Figure 4.18: Arbitary Channel Mapping

Using the Immersion RC Tools, the servo outputs of the EzUHF 8 channel Rx may be arbitrarily remapped to suit the target model. Multi-copter wiring may be greatly simplified using a single PPM cable, easily configured using the tools. Need PWM outputs to drive Pan/Tilt servos?, no problem using the tools.

4.3.2.c Built-in Spectrum Analyzer

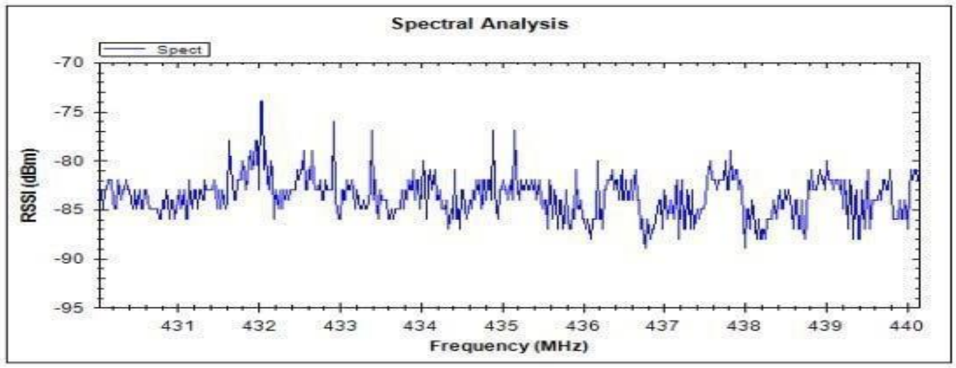


Figure 4.19: Spectral Analysis

The only commercial LRS is to include this essential feature, a built-in Spectrum Analyzer. This essential tool may be used to ensure that a model emits no interfering emissions on the UHF band, which could reduce range. Plug in a standard USB cable, install the free Immersion RC Tools, and create charts of power emitted on the UHF spectrum.

4.3.2.h Equipment Cost

Table 4.2: Equipment Cost

Equipment Name	Quantity	Price(BDT)
Flight Controller	1	3500
ESC	4	3200
GPS	1	3000
Battery	3	5500
Body	1	2200
Charger	1	500
Charger checker	1	250
Transmitter	1	10000
Motor	4	4000
Propeller	4	400
wires	1set	250
Others		2000
Total		**BDT 34,800**

4.4 SOFTWARE

4.4.1 Mission planner

Mission planner is an open source software used for conducting an aerial survey mission by integrating with the flight controller board. This software is a part of the ground station of the UAV which runs on Windows based computers.

Figure 4.21: Interface of Mission Planner

4.4.2 Pix4Dmapper Pro - only for Educational / Non Commercial use

The program is highly useful in a range of different educational and scientific applications. Pix4Dmapper takes multispectral images and converts them into highly detailed 2D and 3D maps for a wide variety of purposes. The process of creating the maps is fully automated, allowing the users to generate useful results with a single click. At the same time the maps are customisable to facilitate the creation of whichever particular diagram is needed for a specific task.

Pix4Dmapper comes equipped with both a Ray Cloud editor and a Mosaic editor. The first of these functions allows the user to measure features and assess quality to refine their projects. The second allows for the creation of pixel perfect orthomosaics. There is

also an Index calculator that compares measured reflectance to indices in order to assess the state of plants. This is chiefly used for precision agriculture.

The outputs that can be generated from the program include 3D point clouds. These are of comparable quality to those generated by a laser scanner, but can be created using a consumer grade camera. 3D textured models can also be created, with photorealistic textures that help an audience to visualise a particular scene.

Pix4Dmapper can create true orthomosaics to help users to visualise geographic data. It can also create accurate, GEO referenced digital surface models. These show elevations to help show the results of a geographical survey. Finally, it can create NVDI maps to show the health of crops as revealed by their reflectance or absorbance of light.

4.5 Summary

In this chapter, we discuss about the basics connection diagram of a quad-copter. Besides it, we also discuss hardware and software part of a multi-rotor. We hope so, anyone can easily get hardware equipment from the local market as our discussion.

Chapter 5

Sensor and Its Characteristic

5.1 Introduction

Sensor is the most important part of the modern technology. It changes way of thinking and makes our work more flexible and easier. Now-a-days, we cannot think a single project without sensor. Therefore, study of sensor is now part of parcel in this era. Thus, in this chapter, we discuss about sensor and its characteristics.

5.2 Barometer

Figure 5.1: Barometer

PIXHAWK has a highly effected barometer. The barometer PIXHAWK has updated to MS5611-01BA03 which is from measurement specialties. In our project we have kept up the height of quad 2m-50m.PIXHAWK has a barometer high resolution module of 10cm which implies the height that this barometer can vary from +-0.1m which is more precise. It is likewise viable as our one of the principle assignment is mission planning. In mission planning we set GPS co-ordinate information in quad copter, in where the quad go and take photograph. Entire this project happens in autopilot mode .There will be no control from ground station. So, in this situation

keeping up the height is most vital which this barometer can accomplish all the more decisively.

5.3 3axis gyro

Figure 5.2: 3axis gyro

Gyro is another imperative thing to keep up the balance of quad copter. It senses the angular velocity which is known as the motion. After detecting the angular velocity I offers yield PIXHAWK. PIXHAWK has utilized the MPU-6000 gyro.

5.4 Camera

Figure 5.3: Go-Pro Hero 4

We have used Go-Pro Hero 4camera in our project. The purpose for choosing is it has sensible prize furthermore meet our every demands. We could have used go pro camera as a part of our venture but it has cut thrice much prize then our camera. One of the primary centre of our undertaking is to fabricate a minimal cost quad copter and along these lines we needed to run with this camera. The sensor that has been utilized as a part of this camera is 1/3inch CMOS digital image sensor. This sensor has some astounding components. It gives fantastic execution in near infrared (IR).As we are catching the picture 80m above starting from the earliest stage. So another thing we need to consider is the resolution of the image which is 12 MP. It is additionally small in size since quad copter cannot carry bigger weight. Its weight is 58 grams with battery. Another magnificent component of this camera is the charging capacity. It can continue recording for roughly 70 minutes in 4k without giving the external power supply. It has 900mah Removable battery. Another critical component is that it is waterproof, dustproof and shockproof. We can easily mount this in the bottom of the quad copter. So, the camera we used is completely suitable for our quad.

5.5 Summary

In this chapter, we discuss the sensor that we use in our project. To control of any air vehicle, we must need to use sensor. It brings the balance of modern physics. Besides it, sensor reduce consume of time to study of high mechanical techniques.

Chapter 6

Mission Planning and Implementation

6.1 Introduction

Mission Planner is a ground control station for Plane, Copter and Rover. It is compatible with Windows only. Mission Planner can be used as a configuration utility or as a dynamic control supplement for autonomous vehicle. It is a free, open-source, community-supported application developed by Michael Oborne for the open-source APM autopilot project. In this chapter, we will briefly discuss about Mission Planner.

6.2 Basic Instruction of Mission Planning

The ground control station of the UAV is done using a software named Mission Planner. The software is integrated with the flight controller board through wireless communication system. In this project, the Sik Radio v2 is used for wireless telecommunication. During flight operation, the performance of the UAV can be monitored from the Mission Planner as it shows real-time data and position of the UAV. Moreover, the software is also used for uploading mission commands and setting of the parameters of the mission plan. The UAV based mission plan can be categorized into three types, surveillance, transportation and mapping. The mission can be automatic and manual depending on the types of mission. It is advised not to perform manual mission plan for the amateur UAV pilot. For surveillance and transportation, stability of the UAV plays a vital role for a successful mission. In automatic mission commands, the UAV will automatically fly from the home point towards the destination, finish its task by moving through the given way points and finally return to home location. The automatic mission planning undergoes less vibration and shaking, higher precise path completion and is safe for amateur UAV pilot as chances of damage is less compared to manual mission plan. The time of flight for completing the mission, number of way points and number of photos depends on the type of depends on the type of camera and the altitude value.

Figure 6.1: Mission planner software interface showing the mission way points

The purpose of the mission for this paper is to monitor a certain area to retrieve the geo-information by observing vegetation, soil and water condition of that area. The

mission is done by taking multiple aerial photos from the camera that is mounted on the UAV, then the photos are organized in mosaic format to get the whole picture of the area. The mission is done in the automatic mode to avoid shaking and due to lack of takeoff and landing space availability. The shaking will cause unfocused and blurred image quality which will make it difficult to process the images for extracting data and will maximize the errors and wrong values. On the other hand, automatic mission plan will not only enable greater stability of the UAV during time of flight but also capture greater quality pictures.

Mission planner is a very sophisticated while at the same time user friendly software and can be used by both researchers and novices. It allows the user to have a wide set of data of the mission which helps the researcher to analyse the mistakes and develop and modify the mission for a better result. Before planning the mission, we should always concentrate about the objective of the mission. For example, remote sensing based missions require high quality images so that retrieval of data through image processing will be easy and accurate. In this thesis, we should take some necessary steps for capturing better quality images. Rice fields are generally situated in plain surface where large trees are not very abundant. In this sort of situation, we had performed the mission in a lower altitude level. There is lower chance of collision between the UAV and the larger objects and most importantly, lower altitude means the area per pixel becomes smaller, producing better quality of image. In this thesis, the altitude was set to 20m for better resolution of the image. The barometer located in the flight controller board shows altitude level during the time of flight. Simultaneously, the GPS mounted on the UAV can also determine the altitude level by calculating its relative distance with the orbiting satellites. In this mission the barometer altitude level is almost equal to the GPS altitude level, which signifies that the altitude level with respect to home location is accurate. The images below shows the graph of altitude levels of both of barometer, GPS and the overlapping of the two respective graphs.

Figure 6.2: Output altitude values from the barometer during the time of flight

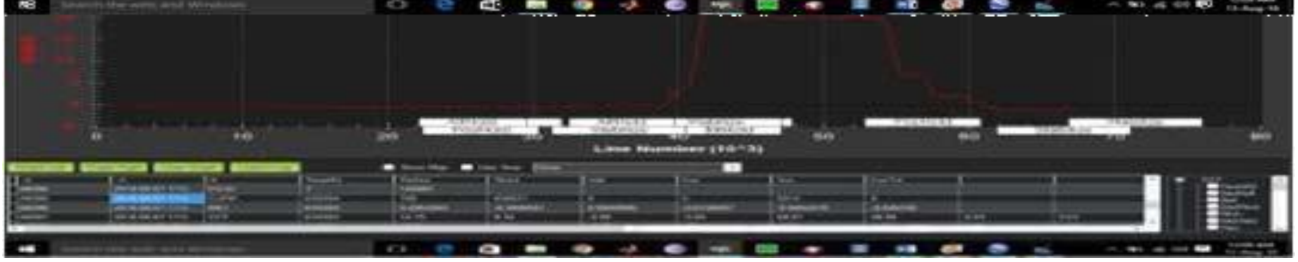
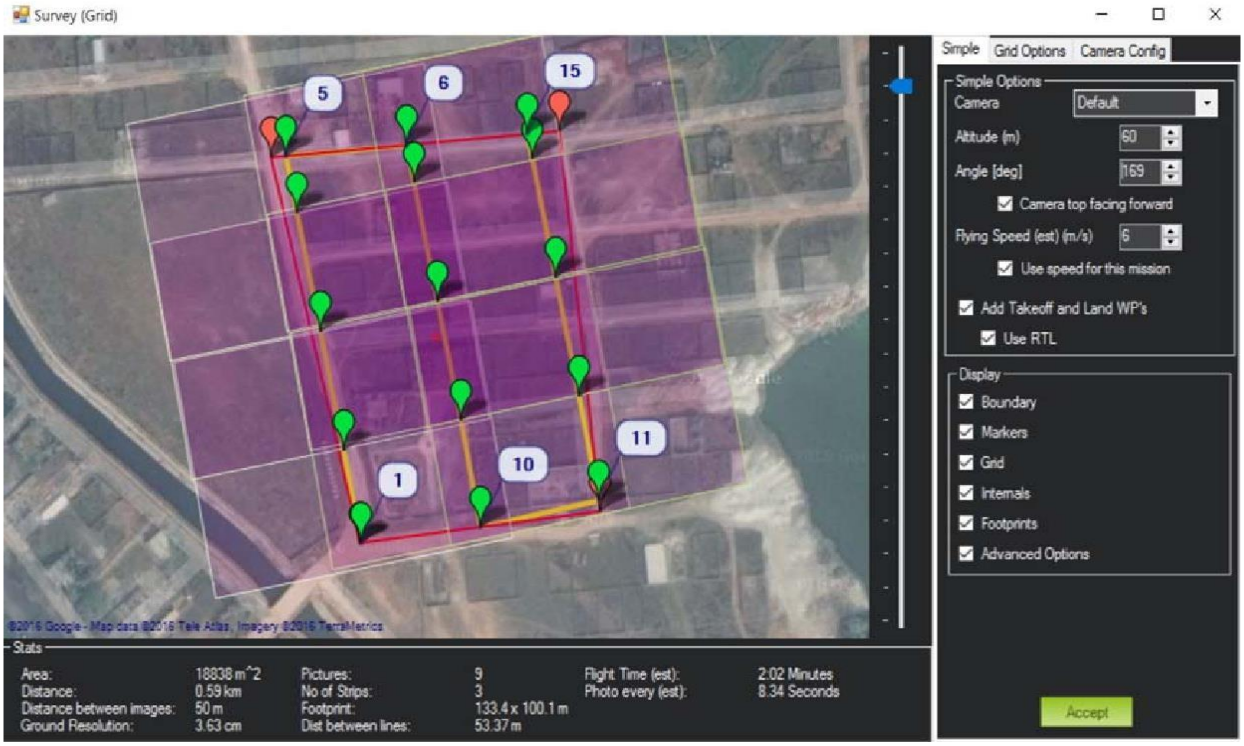


Figure 6.3: Output altitude values from the GPS during the time of flight

On the contrary, in terrain and hilly lands, or in forests, the altitude should be high enough to avoid any sort of collision, but as a result the area per pixel increases which will degrade the quality of image. The battery power is a crucial factor in any type of UAV. If the altitude is set to be very high then it will consume more power from the battery and can perform less time of flight. The mission which is performed in this project was done in an open field plain surface used for paddy cultivation. The altitude was set to 20m for better quality images but in hilly area the altitude should be set to more than 100m for performing the mission safely. From the mission planner software, the particular camera used in the mission can be selected. Using the specification of the camera, the focal length.



values and resolution was used to calculate the total area and distance covered on the mission, total number of pictures, total distance between the images. All these information and output data are shown in the mission planner.

Figure 6.5: The figure showing the output values of the mission.

Table 6.1: Output Value of Mission Planner

The area of the mission path	18838 m^2
Distance	0.59 km
Distance between images	50 m
Ground Resolution	3.63cm
Pictures	9
Number of strips	3
Footprint	133.4x100.1 m
Distance between lines	53.37 m
Flight time	2.02m Minutes
Photo every (est)	8.34 seconds

6.3 Summary

In this chapter, we discuss the basics of Mission Planner. At the last part of this chapter, we show some output. We hope so, this chapter will help us to learn and practice Mission Planner.

Chapter 7

RESULTS AND DISCUSSIONS

7.1 Introduction

Result is the output of any project. It presents the success as well as the satisfaction. It inspires us to work and keep it up. In this chapter, we show our experiment result and briefly discuss about that.

7.2 Collect Data and Observation

Figure 7.1: Images Taken By Drone

We collected the image from Kachpur Bridge, Shiddirgonj, Narayangonj on 18th November in 2018 using drone and it showed in figure 7.1.

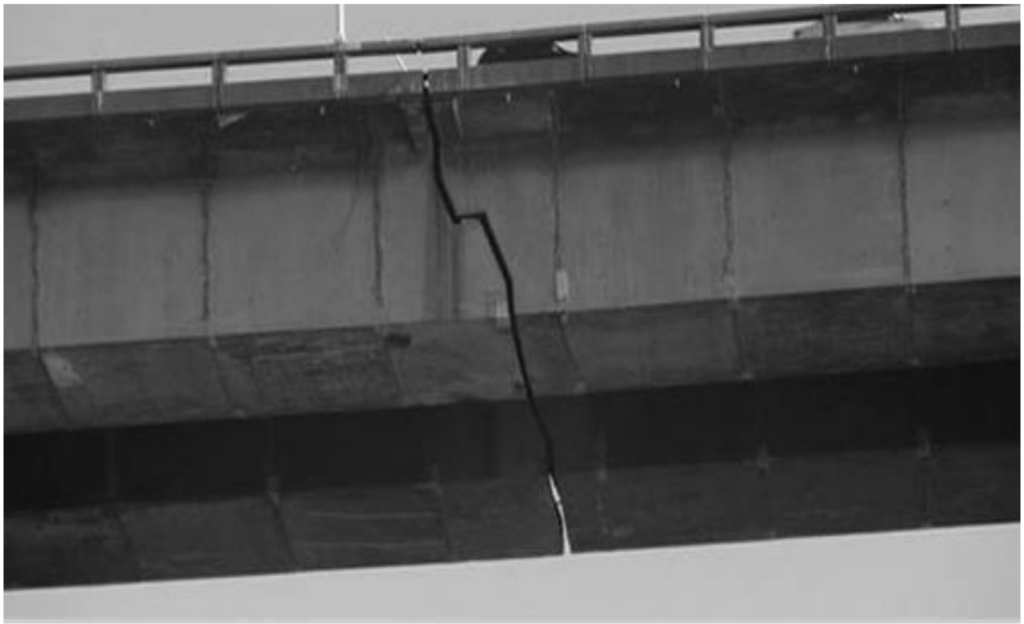


Figure 7.2: Gray Image from MATLAB

This gray image has been produced by using MATLAB. This image has been collected from original image so that we can process crack using MATLAB. Which will be processed through to ensure if there is any crack.

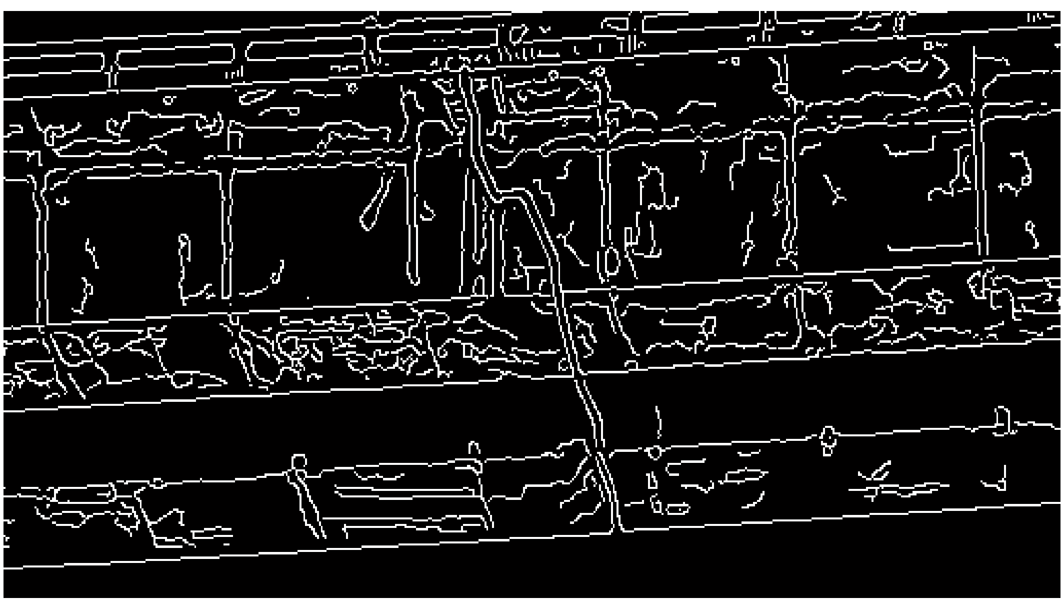


Figure 7.3: Noise Image from MATLAB

In figure 7.3, it is basically a comparison of both minor and major fractures upon the bridge. Which is actually sort of raw image before finding actual crack on the bridge. The process of getting this image with noise is called Sobel.

7.3 Adjust Collected Data from MATLAB

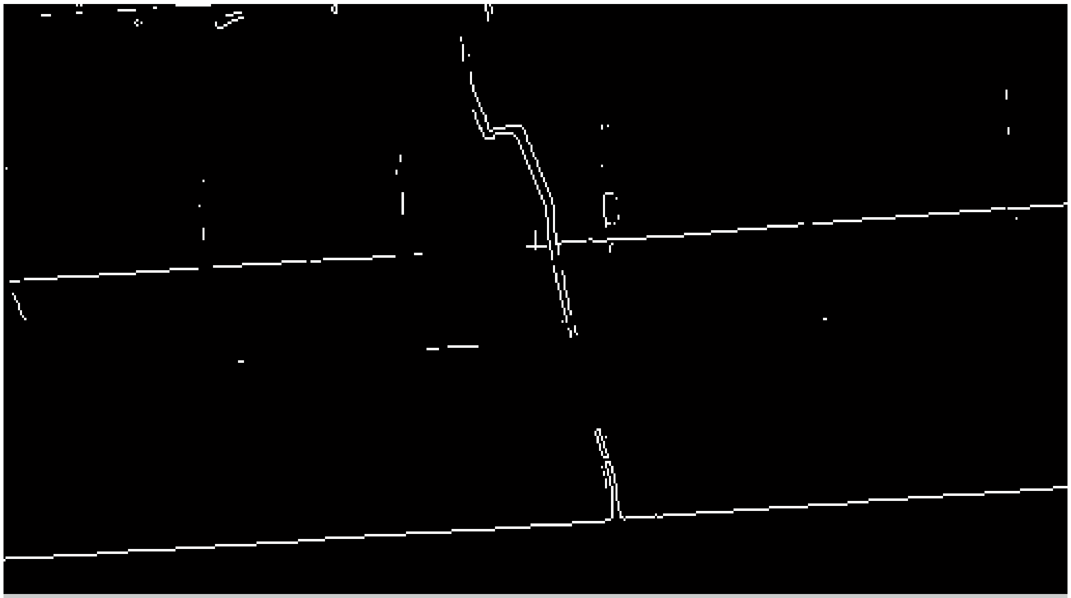


Figure 7.4: Final Crack result

After analysing the noise image MATLAB has produced image which is shown above and illustrating the actual condition of crack on the bridge.

7.4 Discussion:

Our main purpose to find out the cracks on the bridge. We processed one single image through MATLAB and find out the crack by using “canny” method to detect edge. By this, we can find out any major crack on a bridge. By this process, we gather the information what is help us to take proper decision to stop any unwanted event may occur.

7.5 Summary

In this chapter, we briefly discuss and show the result of our experiment. At the last part of this chapter, we mention our website, where we store all the experimental data and the present forest condition and huge data of our country. Finally, we finish this chapter, with the discussion of the project experiment.

Chapter 8

Conclusions and Suggestion for Future Work

8.1 Conclusions

In this investigation, dynamic limited component examination calculation for scaffold brace utilizing MATLAB was created. The calculation has following highlights,

(1) The calculation that figures proportionate flexural solidness of scaffold support,

(2) Limited component investigation technique that ascertains both dynamic and static relocation reactions, and

(3) The calculation that computes Impact Factor dependent on both examination results. Furthermore, utilizing the created MATLAB calculation, the connection between the length of range, firmness conveyance, or vehicle speed and Impact Factor esteem is examined. From the investigations results, the accompanying outcomes could be acquired.

(1) The normal solidness estimations of extension supports is definitely not an essentially influencing parameter for the Impact Factor esteem;

The new research has been selected by an international scientific committee to be given the Atlas award.

However, using unmanned aerial vehicles or drones to replace manual monitoring under certain conditions could save considerable costs, making the monitoring process more feasible for scientists. Using drones to replace manual labour can reduce the costs associated with monitoring conservation projects. This could result in more people monitoring their land in the tropics, giving us better information about what works and what doesn't. An alternative to manual monitoring is LiDAR

– remote sensing technology that analyses reflected light. However, a single LiDAR flight to monitor forest recovery remotely can cost upwards of $20,000. In the new study, Dr. Zahawi and the team, including researchers from the University of Maryland and the University of California-Santa Cruz, USA, tested a new automated approach to monitoring that doesn't involve manual intervention

The drones were fitted with a simple 10 megapixel point-and-shoot digital camera and use open-source software to process these overlapping images. The camera takes thousands of photos and the "Ecosynth" methodology then creates 3D images called point clouds that represent the vegetation. In total, the drone and camera cost is less than a tenth the cost of some equivalent flights.

8.2 Limitations of the Work

Drone use could lead to conflict and accusations of spying. Government officials have few reasons to trust organizations that express a desire to survey their land, and some cultures could view drone technology as an external imposition.

There could be risks that partner organizations could see drones as a mapping shortcut to replace participatory mapping and monitoring processes, which typically include in-depth discussions with various sections of the community, and face-to- face conversations during surveys. This could lose the many benefits associated with these processes.

There are also ethical issues relating to privacy and gender, if one group has the technology to observe another (whether one village able to fly drones over a neighbour, or men having greater access to surveillance technology and images than women).

Drones are by no means a panacea, and may not be effective in monitoring very large areas. The technology is not designed to monitor the same issues as ground surveys (such as soil carbon, or the impacts of illegal hunting on biodiversity).

8.3 Future Scopes of the Work

In our project, we used Go-Pro Hero 4 camera. Actually, this camera is not perfect for aerial mapping. If we use thermal camera instead of Go-Pro camera, image quality will be high. Without it, we can also determine height of the drone or object that we want to measure.

For image processing, we need to calculate air speed of the drone. But, do not use any air flow sensor. We determine the air speed by calculate web point distance with flying time. Therefore, we will use air flow sensor to make our calculation more easy and accurate.

Now, we use only one GPS module. If we use double GPS module, it will give us more accurate location point. Therefore, we will use two GPS module in our project.

REFERENCES

[1] Jose A. J. Berni , Student Member, IEEE, Pablo J. Zarco-Tejada, Lola Suárez, and Elias Fereres "Thermal and Narrowband Multispectral Remote Sensing for Vegetation Monitoring From an Unmanned Aerial Vehicle" IEEE Transactions on GEO-Science and Remote sensing, VOL. 47, NO. 3, MARCH 2009

[2] Ludovic Apvrille, Yves Roudier, Tullio Joseph Tanzi "Autonomous drones for disasters management: Safety and security verifications", IEEE Radio Science Conference (URSI AT -RASC), 2015 1st URSI Atlantic, 1–2 INSPEC Accession Number:15556498, 16-24 May 2015

[3] Catur Aries Rokhmana*, "The potential of UAV-based remote sensing for supporting precision agriculture in Indonesia", Department of Geodetic Engineering, Gadjah Mada University, Jl. Grafika No. 2, Yogyakarta 55281, Indonesia, The 1st International Symposiumon LAPAN-IPB Satellite for Food Security and Environmental Monitoring, 24 (2015)

[4] I. Colomina , P. Molina "Unmanned aerial systems for photogrammetry and remote sensing: A review", ISPRS Journal of Photogrammetry and Remote Sensing, Volume 92, Pages 79–97,June 2014,

[5] Lillesand, TM & Kiefer, R.W. 1994, "Remote Sensing and Image Interpretation", 3rd ed, xvi+750pp. New York, Chichester, Brisbane, Toronto, Singapore: John Wiley & Sons.

[6] Mongkhun Qetkeaw A/L Vechian, "Wireless Control Quad-Copter with Stereo Camera and Self-Balancing System", ISPRS Journal of Photogrammetry and Remote Sensing Volume 92, Pages 79– 97, June 2014

[7] Raghendra Panchal, Unmanned Aerial Vehicle RC quadcopter, International Journal of Students Research in Technology and Management, Vol 1(13), , ISBN 978-93-83004-01-4, Pg3) 9-341, May 2013

[8] Gray A. Shaw and Hsiao-hua K. Burke, "Spectral Imaging for Remote Sensing", Lincoln Laboratory Journal, volume 14, November 1, 2003.

[10] John D. Bossler, John R. Jensen, Robert B. McMaster, Chris Rizos**, "**Manual of Geospatial Science and Technology**"**, Taylor and Francis, **London and New York,** 1998.

[11] H.Rahman and G. Dedieu, SMAC: a simplified method for the atmospheric correction of satellite

measurements in the solar spectrum, International Journal Of Remote Sensing, Vol. 15, Iss. 1,1994

[12]http://ardupilot.org/planner/docs/mission-planner-overview.html retirved on 9th November 2016.

[13] http://forestcompass.org/drones-pros-and-cons-community-based-monitoring retirved 9th November 2016.