Final Year. B. Tech. Capstone Project

Report

On

Land Area Mapping Using Drone and Image Processing

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CERTIFICATE

This is to certify that the Final. Year. B. Tech. Capstone Projectentitled

Land Area Mapping

Using Drone and Image Processing Work is been carried out successfully by

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during the Academic Year 2020 - 2021 in partial fulfillment of their course ofCapstone Project for Final Year Electronics and Communication Engineering as per the syllabus prescribed by the MIT World PeaceUniversity, Pune

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Project Mid-Term Report Contents

Chapter 1

1.1 Introduction

India is well recognized as a Developing Country in the World. Everywhere in the world, technology is booming and every other task which was done manually in earlier days has been replaced by technology today in order to improve on the quality and efficiency of the work to be done. Our project comes from a similar ideology of improving the efficiency of land area measurement, which previously was a labour and time intensive process, but we intend to change this into a one-man task along with making it a lot quicker. Today's process consists of five to ten people on the field with the instruments measuring the distances from different points of the field and then taking the measurements back to the office where the final area can be calculated.

What this project will do is it will not only improve on the time and manpower part of the measurement process with the help of the use of aerial imaging, but also will provide the farmer with a digital map of his field and hence making it possible for him to easily view the current situation of his field with just a short glimpse of the map, this will also facilitate the ease of planning for new development.

The project intends to use a drone which is equipped with a Camera, this setup will be capable of capturing several images, while traversing through the field following the per-planned flight path. These images will be used to form a orthomosaic map upon Geo-Tagging. This map will further facilitate the measurement process.

1.2 Project Objective

1. To Facilitate Fast and accurate Land Area Calculation.

2. To Make Land Area measurement less expensive and time consuming.

3. To Provide farmers with a digital map of their Farm

1.3 Literature Survey

We refereed to various websites for various parts of our projects for knowledge about drone building and parts involved we refereed to rotor drone and this is an overview of the things that we gathered through there: -

1. A general rule is that the motors should be able to provide twice as much thrust as the total weight of the quad copter.

2. KV is the theoretical increase of motor rpm (rotation per minute) when the voltage goes up by 1 volt without load.

3. Higher KV motors would turn the propeller quicker with less torque, and lower KV motors create higher torque with less rotation.

For A Few Calculations we referred to Omni Calculator and we calculated the total thrust required for our drone the applicable trust per motor and the trust to payload ration that we could use. For Fight controller selection, troubleshooting and other flight controller related work we are refereeing Ardu-Pilot which is an open-source platform that provides with expert solution and advice regarding the use of the flight controller in the most optimal way and also provides us with the mission planner software that is the base station control software for the drone.

The paper [1] gave us information about physical modeling and drone structure Mathematical calculation of motor torque and thrust produced by it, as well as the current power calculation was taken into consideration [2]. Controller, remote and the propeller selection was don according to the motor specification [3].

Some Researchers have studied the control system of Drone,Researchers composed a in depth review on Quadcopter Surveillance and Controls as seen in [7], A quadcopter is a multi-rotor aircraft which as the name suggests has 4 motors/Propellers which are controlled by a Flight controller to get the best flight experience compared to any other aircraft., A quadcopter is a perfect solution for a application which needs a versatile mobility. In the Review researchers looked at the various aspects of a drone control system and internal working of the dynamics of a drone.

The most important factor of any flying vehicle is the trust. Maximum thrust generated shall be such that the Drone can easily hover at only 50% of the total thrust as explained in [2]. In other words, thrust to Weight ratio needs to be at least 2:1.

1.3 Literature Survey

There have been researchers using Orthomosaic map for various applications,few Researcher have comprised a Quality Assessment of Photogrammetric Methods [10], they looked into the workflow of reproducible orthomosaic maps, this study also looks into optimizing the Geo-location of UAS orthomosaic time series

Orthomosaic Map is Aerial Images of any location that the creator desires to obtain, this map is made by stitching number of aerial images, this gives us a great top-down view of the desired location.

Researcher also have performed a research targeting the Accuracy of orthomosaic Generated by Different Methods in Example of UAV Platform in [11] where they used an Autonomous, where they explore various methods by which the orthomosaic can be created with a better accuracy in a lesser time improving the accuracy

Chapter 2

2.1 Workflow for obtaining Land area using Drone and Orthomosaic map :-

Fig.1 explains the process carried out to obtaining Land area using Drone and Orthomosaic map.A mission needs to planned before the flight for the drone. Drone refers to the flight paths provided in this mission to traverse the airspace above the land consideration , once the flight mission is uploaded to the drone and the drone is deployed, it captures the necessary images and returns to land.

The images are then collected from the camera module and are Geo-tagged in the Ardu-Pilot software,and a orthomosaic map is created using these Geo-tagged images. This map is then used to find the area of the field under consideration.

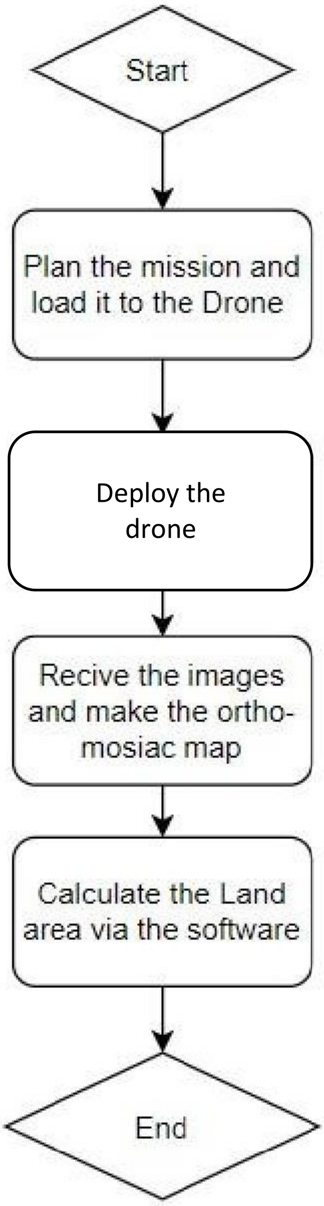


Fig-1 Flow chart of drone and the area mapping algorithm

2.2 Process of Orthomosaic map generation:-

As seen from the Fig.2 ,the images collected are Geo-referenced n-times until the checkpoint error is minimized.These images then are transferred ahead for creation of Meta shape Default and Mesh Alternative, which after further processing ,generate the Orthomosaic map.

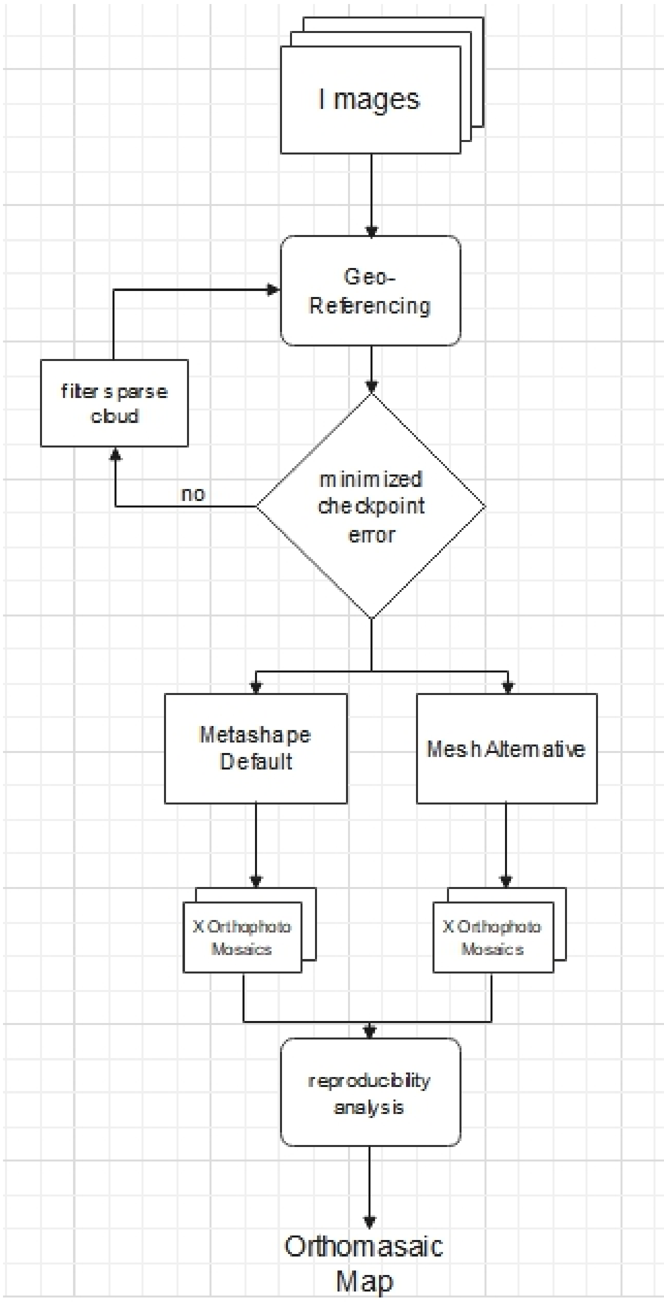


Fig-2 Orthomosaic Map Generatio

2.3 Component connections of the drone

The Fig.3 depicts the hardware Component connections of the drone

The Flight controller as seen in the figure is the center piece of the Drone, The Electronic Speed Controllers are responsible for Proper speed control of the 4 BLDC motors namely-M1,M2,M3,M4.

The First Person View(FPV) camera along with the On-Screen Display(OSD) module is useful for live aerial surveillance .

The camera module consists of a Raaspberry pi 3+ and Raspi cam 2.1

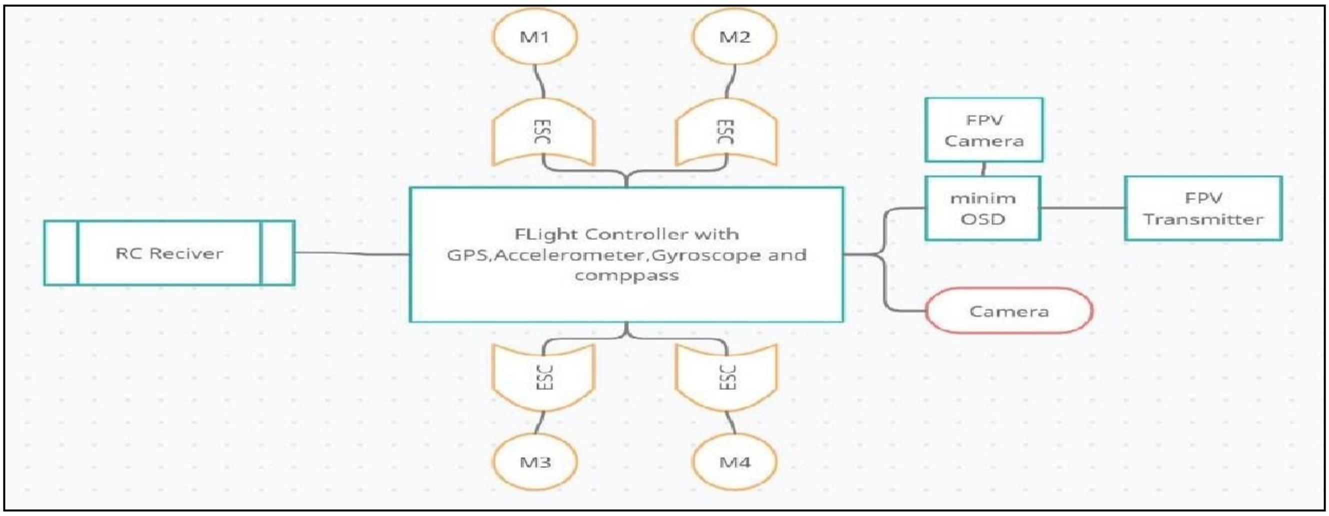


Fig-3 component connections

Chapter 3

3.1 Copter Specifications

1. Dimension of drone [35*35*12] cm The drone is quad copter drone.
2. Its maximum load carrying capacity is around 600gm.
3. The maximum Time of Flight is 20 minutes.
4. Carries a Lightweight Camera for Live Video Transmission.
5. HD camera with remote photo capture capability.
6. Flight Time of 20 minutes.

3.2 Component List

1. Motor - Emax 935 KV BLDC motors-

The motors used in Drones are Brush less DC motors, the advantage of BLDC motors over DC motors with Brushes is that, BLDC motors can run a a higher RPM without much physical wear as there is not essential physical contact between the stater and rotor, resulting in a long lasting motor that can run at a higher RPM ,being lighter and smaller as compared to a brushed DC motor.

The BLDC motors we have selected are Emax 935 KV BLDC motors, these are low RPM ,high torque motors that perform better for weight intensive drones, Each of these motors provide a maximum thrust of 819 g , providing a total trust of 3276 g with 4 of these motors. This provided torque is more than the estimated weight of the drone.

Hence these motors are Ideal for our application.

2. ESC:-Simonk 30A -

Electric Speed Controllers also known as ESC ,are the component necessary for operation of s BLDC motor. A BLDC motor is a 3-phase motor and the flight controllers cant have a 3 phase output for each motor as it would cluster the outputs on the Flight controller. Hence ESC are separate components that act as a bridge between the Flight controller and the BLDC motor.

An ESC has 3 inputs and 3 outputs. The inputs are- 5V DC, GND and Signal . the Signal Input indicates the speed of that particular motor,the ESC then controls the speed of the motor with the 3 outputs that are connected to the BLDC motor.

The order in which these outputs from the ESC are connected to the Motor determine if the motor will rotate clockwise or Anti-clockwise.

The ESC selected is a Simonk 30A ESC ,as the max current draw for Emax 935 KV BLDC motors is 18 A. A 20A ESC would have been fine but considering safety factor , Simonk 30A ESC was selected.

3. Flight Controller - Pixhawk 2.4.8 -

A Flight controller is one of the most important components on a drone.Its the abilities and the features of the flight controller that determine the capabilities of the drone and its performance.

The application demanded a stable flight , along with advanced features life, Failsafe , Return to Launch capability and most importantly the flight controller shall be equipped with a autonomous flight capability

Hence Pixhawk 2.4.8 Flight controller was selected.It is equipped with all the features necessary for the application. It ensures a stable flight ,even in windy conditions ,along with battery and connectivity failsafes, where if the battery reaches a bottom threshold , the drone aborts its mission and returns back to the launch location, similarly if the connectivity with the home station is lost the drone returns to the launch location.

The Flagship feature of Pixhawk is a ability to carryout autonomous flights , the pilot needs to plan a flight beforehand and once the planned mission is uploaded to the flight controller, it takes of on pilots command , completes its mission autonomously and returns to the launch location with out any assistance from the on ground pilot. This feature is important as it ensures consistency and is a better alternative for image collection as compared to a human pilot carrying out the operation.

4. Lipo Battery -

The battery selected will determine the flight time of the drone,hence the battery selected needs to have sufficient capacity to be able to power the drone long enough so as to not be a bottleneck for the drones capabilities.

The Battery selected is Orange 6200 mAh , which provides a flight time of 17 minutes.

5. Avionics Radio Transmitter and Receiver -

The radio connection between the base station and the drone is the most important factor to be considered after the drone reliability itself, as a loss of connection can result in a loss of the drone itself and also a unpleasant crash .

Hence having a reliable Communication setup is important, along with the reliability concerns there is another factor that needs to be considered. The connection between the receiver and the Flight controller, this varies as per the flight controller configuration. The Pixhawk Flight controller supports a SBUS input and hence the receiver needs to have a SBUS output.

Hence Avionics Radio transmitter and receiver was selected as it provided a stable connectivity range of 3 Km along with the receiver having a SBUS output on Pin10, Pin1-9 are PPM outputs which enable us to control many other functionalities.

6. Runcam Swift 3 FPV Camera -

A FPV camera enables the pilot to view the ground or the site he is surveying from the drones perspective , it is important to make sure that the drone is positioned perfectly from where the digital camera can capture the subject and the FPV camera can help the pilot in doing so.The Runcam Swift 3 is a affordable option that provides adequate image quality that is suitable for the application.

7. TS835 Video Transmitter -

The Video transmitter selected is a 600mW TS835 Video Transmitter ,which is capable of transmitting live video feed over 4 Km .

8. Minim OSD -

A Minim OSD is a device that reads important flight and controller data from the flight controller and overlays it on top of the FPV feed , this device is essential for better understanding of the onboard conditions and to be notified with some crucial information like, distance from home and battery voltage.

9. GPS Module -

The GPS module is an essential component of the drone, It is essential for the autonomous flight as the flight controller takes its current location into consideration to continue flying autonomously. Also it is essential for a more stable flight and for failsafe feature like return to launch

Chapter 4

4.1 Methodology:

An advance feature drone for land area mapping and calculating the agricultural or any land under constructions is being developed under this project.

The Drone will be carrying a HD camera that will be capable of clicking photos On Demandand once the photos are clicked, they will be collected and put through the processing.

All the Flight Planning, route mapping and mission planning for the drone will be done using the Ardu-pilot Mission planner software and the Image processing will be done oncethe drone returns to the base station using the images captured by the camera.

These multiple images will then be used to make an integrated Image that will further be used to calculate the area of the land in question.

It will also be having a FPV system to monitor the area and feeding live video to the operator so that the details could be cross checked manually by the user and could also give free hand guidance without getting restricted to software solution.

4.1.1 Theoretical analysis of motor thrust:

The thrust force can be calculated as in the mathematic terms equation (1) :

$$T = A \times \rho \times \upsilon \times \Delta\upsilon \tag{1}$$

Where T represents the thrust in Newton [N], A represents the area of the propeller rotor in meter square (m2), ρ represents the density of air in kilogram per cubic meter (kg/m3), υ represents the velocity of air at the propeller in meter per second (m/s), $\Delta\upsilon$ represents the velocity of air accelerated by propeller in meter per second.

The equation 1 is needed to derive further more according to the type of propeller blade. Consider a full power of motor propeller air flow without the losses. In the air flow diagram above shown P0 and PE are the pressure difference before and after of the propeller. The equation (2) and (3) of the mass flow and the change of the air flow are derive as shown below:

0

$$m = A \times \rho \times \Delta \upsilon \quad (2)$$

$$\text{Momentum conservation, } F = m \times \upsilon \quad (3)$$

Where ṁ represents the mass flow rate in kilogram per second [kg/s], ρ represents the density of air in kilogram per cubic metre (kg/m3), υ represents the velocity of air at the propeller in meter per second (m/s), Δυ represents the velocity of air accelerated by propeller in meter per second. The conservation of energy is given by: Energy spent in one act = Energy gained in the related act (4)

Similarly, the propeller spinning energy available in the air flow is converted to force against the gravity which created the thrust. Suppose a velocity of propeller motor is spanned (rpm) for a particular velocity air accelerated The conservation of energy equation can be written as Energy conservation,

$$F \times \Delta\upsilon = \times 2\ 1\ \dot{m}\ 2 \times \upsilon \quad (5)$$

Substituting equation (2) and (3) into equation (5)

$$\dot{m} \times \upsilon \times \Delta\upsilon\ 2\ 2\ 1 = \times A \times \rho \times \Delta\upsilon \times \upsilon \quad (6)$$

Substituting equation (2) into equation (6), and simplify.

$$A \times \rho \times \Delta\upsilon \times \upsilon \times \Delta\upsilon\ 2\ 2\ 1 = \times A \times \rho \times \Delta\upsilon \times \upsilon \quad (7)$$

$$\upsilon = 2 \times \Delta\upsilon \quad (8)$$

Substituting equation (8) into equation (1)

$$T = 2 \times A \times \rho \times \Delta\upsilon \quad (9)$$

the area of the rotor diameter is:

$$2\ A = \pi \times R \quad (10)$$

Where R represents the propeller radius in meter [m]. Substituting equation (10) into equation (9)

$$2\ 2\ T = 2 \times \pi \times R \times \rho \times \Delta\upsilon \quad (11)$$

4.1.2 Power Calculation analysis :

The power is calculated based on the motor run in load condition RPM (Revolutions per minute). Normally, the specification is given in no load condition of the RPM per volt. The rpm value should be calculated 75% approximately of its no load rpm. The power equation is based on the propeller constant and power factor for the propellers that are used to create thrust

$$\text{P} = \text{Propeller constant} \times \text{rpm power factor} \tag{12}$$

The Propeller constant is calculate by P/D ratios. D is the diameter length of a propeller of N blades while P is the pitch of the blade. Power factor is the ratio of operation power in kilowatts (kW) to apparent total power in kilovolt-amperes (kVA).

4.1.3 RPM analysis of Motor:

The RPM is calculated based on supplied voltage to the motor as shown in equation 13. As the voltage increases, the spin is increases simultaneously.

$$\text{RPM} = \text{Kv} \times \text{Voltage} \tag{13}$$

Where Kv represents the RPM per volt from the specification of the motor. Voltage represents the supplied voltage from the battery to the motor.

4.1.4)Accuracy of the Land Area Mapping

The Accuracy is confirmed by measuring the area under consideration manually. The test are is always a geometric shape usually rectangle ,whose accurate area can easily be deduced. dimension of the rectangle is fixed , 4 indicator objects are placed on each corner, the mission is planned accordingly and the area is calculated manually for the rectangle(13).

Once the on-field work is done , orthomosaic map is generated and area is obtained. Once we have obtained orthomosaic area OA and Actual Area AA. Their ratio gives us he accuracy Percentage(14).

$$\text{Actual Area} = \text{Length} * \text{Breath} \tag{14}$$

$$\text{Accuracy} = \text{OA/AA} \tag{15}$$

4.2 Orthomasaic Map:

An orthomosaic (a digital map) is a geometrically corrected map that is made by stitching all the individual Aerial images captured using drone. It uses the Geo-coordinates of each image because of which the data is more accurate and updated giving us all the information we need at the touch of a button.

The map can be used for various things such as measurements, roof -condition reporting and even volumetric. Drone – Based customers has seen 98% decrease in time spend on the site to get all the data using manual methods and 400% + cost reduction which is a huge amount and resulted in profit. Ultimately by integrating orthomosaic maps and drone data into the workflow.

4.2.1 WEBODM:

A software which helps us with our image processing by performing several operations on the datasets which we form using our drone consisting of aerial images of the ground whose area we wish to calculate. There are certain rules to the aerial photography which our drone must follow while making the datasets to obtain the workable datasets which would be useful to us. Therefore, the rules are as follows:

1. The image captured should be comprised of minimum of 50% and maximum of 80% of t the previous images.
2. The angle made by the camera of the drone and the ground whose image must be captured should make 90 degrees.
3. The images captured should be crisp and clear. There should not be any dampening because of any vibrations.
4. The quality of the image captured should be above 1080 pixels * 720 pixels.
5. The Field view angle of the camera lens used by the drone should not exceed 150 degrees mark.
6. All the images captured should be Geo-tagged before processing.
7. Two consecutive images should have the gap of at least 300 milliseconds.

The WEBODM therefore, process the datasetss taken by us strictly following the rules mentioned above to make the orthomosaic map more accurate, sharp and complete. It follows some basic step to process the datasets and convert it into desirable form. The steps are as following: -

1. Select the new project on the Home-screen of the WEBODM software and label the project.
2. Upload the entire datasets in the mainframe of the software where it can process the data under your newly formed project.
3. There are many options available asking you to process the data in different ways, Choose Fast-Ortho or Custom.
4. After uploading the entire datasets, choose the resolution at which you would want to resize your images.
5. Choose the number of cores you would want your computer to use while processing the datasets.
   [NOTE : Choosing '-1' in number of cores, makes you use all the available cores of the CPU or maximum number of cores]
6. After choosing all the parameters and specifications, the software itself picks up each image of the datasets and retrieve the details such as Latitude, Longitude, Pixel density, Altitude, ISO of the image etc. and order them in the according to their geographical properties.
7. After ordering them by comparing the closest distance between two images using their Latitude and Longitude, the images are stitched together to form one digital image.

Similarly, next image is stitched to the result obtained after stitching first two images and following this entire process continuously to the entire datasets gives brings us the a complete orthomosaic map[a digital geographically corrected map, giving us the parameters we require.

4.2.2 Pix4D:

It stands for Professional photogrametry and Drone Mapping This software is an industry standard to the market and unlike WEBODM it is not a open source software. Anyhow, the trial version is free to try and we have worked on it with our datasets. The software serves the similar purpose of making 3-D maps to perform various operations and get the required output.

4.3 Caparison between WebODM and Pix4D: -

The major difference between the two software in technical point of view is that Pix4d has the ability of Geo-tagging the images, Whereas in WEBODM the images uploaded to the framework should already be Geo-tagged with an external measure. This makes the working with Pix4D little bit easy and efficient.

The Pix4D works on any device with some basic requirements or even on any smartphone because all the processing works is done online on the strong servers which has enough memory and capacity to process any kind of datasets where as in WEBODM the device [Personal Computer] should have the processing capacity and tools to work on the data because the entire work is carried on the device itself instead of any online server.

WEBODM can be used offline, whereas Pix4D uses internet to send the data on servers and receive the output.

Because of strong industry standard servers used by the Pix4D, the output from Pix4D tends to be more accurate and the formed orthomosaic map comes out to be more detailed and crisper.

WEBODM uses an older version of google maps to tune in the Geo-Coordinates whereas the Pix4D uses its own custom map which turns out to be more accurate and user friendly.

If the image quality is not good enough than the processing node in WEBODM throws an error, whereas Pix4D skips those images and give back slightly inaccurate results.

4.4 Challenges and Solutions:

1. Battery Management and specifications:-

As our motors are industrial level and has the specifications of 965 rpm with every volt and our drone requires 4 of it, the amount of current drawn by the motor plays a vital role in managing the battery. Hence, we would require a battery with higher discharge rate, maintained with the minimum potential of 8 Volts and could give us the flight time of minimum 15 min.

Solution:-

These were the problems and after several trials and research and experiments we reached to the LIPO [Lithium Polymer Battery], which had the discharge rate of 40 which was good enough and was not highly expensive. And with the setup of 3 cells, we were able to maintain the minimum voltage of 9 Voltsand the flight time of 17 minutes.

Precautions:-

1. While planning the mission from mission planer software make sure the initial height does not exceed 20 meters, as it draws more current from the battery, getting it discharge more quickly and there by reducing the flight time and the battery life too.
2. Don't place the battery below the drone, as in case of crash landing the battery can get a direct impact leading to dent/ puncher in the battery which can damage the battery.So always place the battery in the middle compartment.
3. Make sure the battery is properly Placed in the drone, in flight time due to vibration and its motion, there is a high chance that the battery may fall from the drone.

4.1. Never charge the battery above 12 volts, and never discharge it below 10 volts, as charging above 12 volts make the battery to catch fire as it is an LIPO battery and discharging the battery bellow 10 volts can completely damage the battery, as it is made up of 3 individual cells connected in series, and the total discharging it below their threshold can lead to damage in a cell.

4.2. Make sure to charge it fully i.e., till 12 volts before keeping the battery in a no use mode more than 7days.

4.3. Always charge the battery by the balance Charger only

Steps for charging with balance charger is given in the below link
https://www.youtube.com/watch?v=nV90KWLptVo

2. Radio Communication Establishment: -

At the early stages of the project when we were building the drone from the scratch. We decided to order the products which are manufactured in INDIA and are cheap but comes with quality. Because of which we ended up on choosing a radio transmitter and receiver which is not used in the market generally because of its usercomplexity. We were unknown with this fact ended up buying it and installing it inour drone. While we tried to connect our remote using the radio transmitter. We ended up trying everything we could, but we were not able to figure out the problem. We also have replaced our most of the component with the new one and yet couldnot figure it out.

Solution: -

After writing down our query to various online Drone Forums and asking several professionals we got to know that the transmitter working is different than the standard market available transmitter and it has to be triggered Manually for the first time to connect to the remote and after that in the end it will stay connected whenever the power is switched on.

3. Accuracy of orthomosaic Map:-

The orthomosaic map being created in early stages were not perfect, they had many errors and incorrect map creation, the circular field would be mapped as an oval and so on.
Also, this affected not only the appearance but also the accuracy of the area under the map

Solution:-

Upon observation we diagnosed 2 major factors that were potential reasons for this, one of them being the distortion in the images captured, these distortions were a result of the vibrations in the drone frame. Solution for this is a Vibration Dampening arrangement, upon instalment the distortions were reduced significant.
The 2nd Factor seems to be on the Geo-tagging side. There seems to be few inaccurate Geo-tags and they are affecting the generation of the map; This issue arose because the number of expected images did not match with the number of images obtained, which was resolved by improving the Camera - Pixhawk interface,by improving the code written for camera in Raspberry Pi.

Chapter 5:

5.1 Project Implementation:

5.1.1 Geo-Tagging Images

To facilitate the Generation of the orthomosaic the Images captured need to be Geo-tagged. This will provide the software with essential data of each image, which is used to align the images together and facilitates a better accuracy of the orthomosaic map.

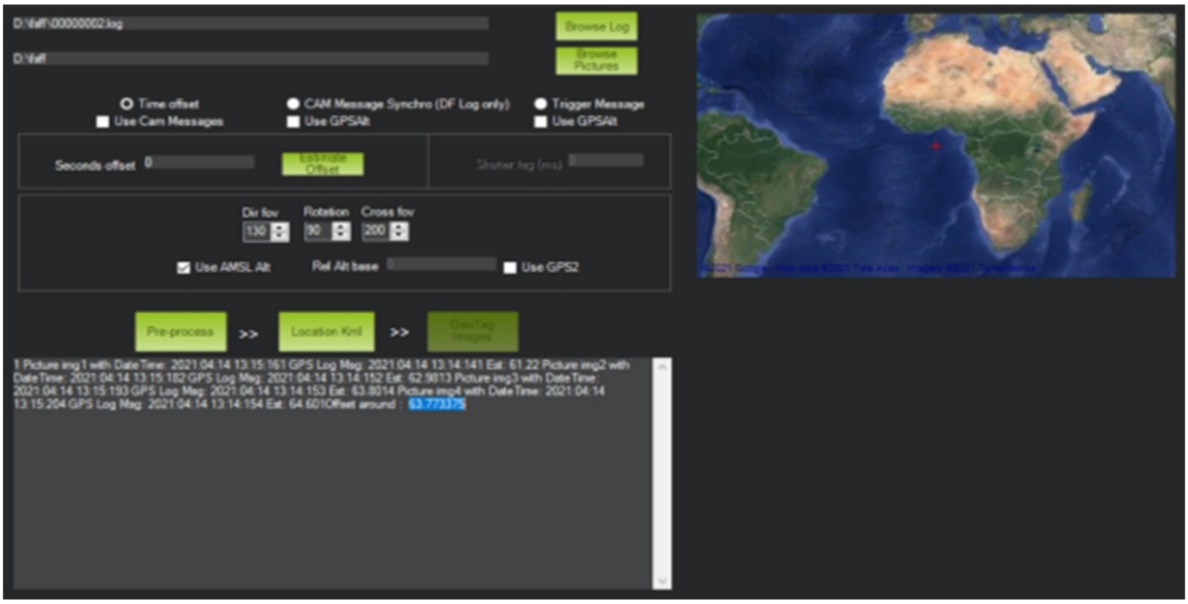


Fig-7 Geo-Tagging and Estimating the Ti Offset me

The process necessary for a successful Geo-Tag starts with the flight itself. The Flight controller records all the flight data in an onboard storage device in the form of a Bin file. This Log file consists of all the data, the speed of the drone at any time, the height and most importantly the time line of the photos clicked, the Height at which each photo was clicked and its Geo location in terms of Latitude and longitude coordinates.

This Bind File needs to be converted into a Log file which is done in the Mission Planner software by ArduPilot. Once the Log file is generated, we can start the process of Geo-Tagging.

As seen in the Fig.7 we need to load the log file along with the images linked to the log file into the Geo-

Tagging software and firstly find the time offset. This is the difference of time of Photo being clicked and the time noted. Once the time offset is noted, it needs to be entered and we can go forward with pre-processing the images for Geo-Tagging as seen in Fig.8

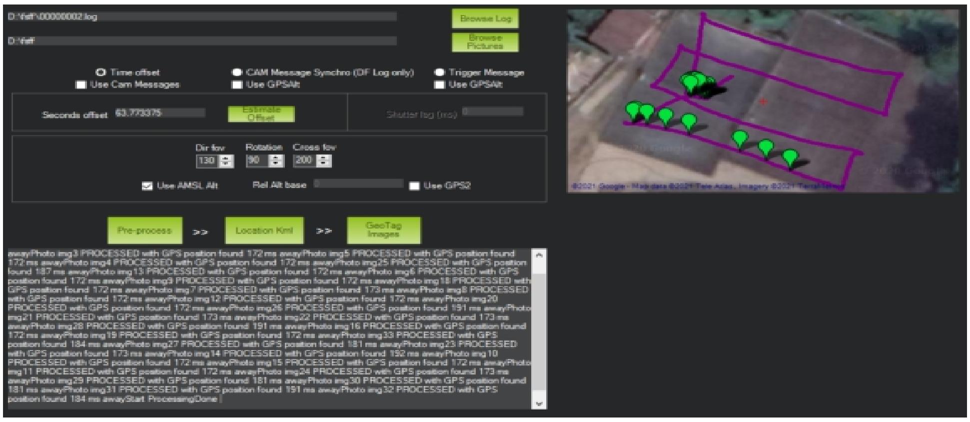


Fig-8 Pre-processing and Geo-tagging

5.1.2 Mission Planning

1. Open the Mission Planner application on your computer.

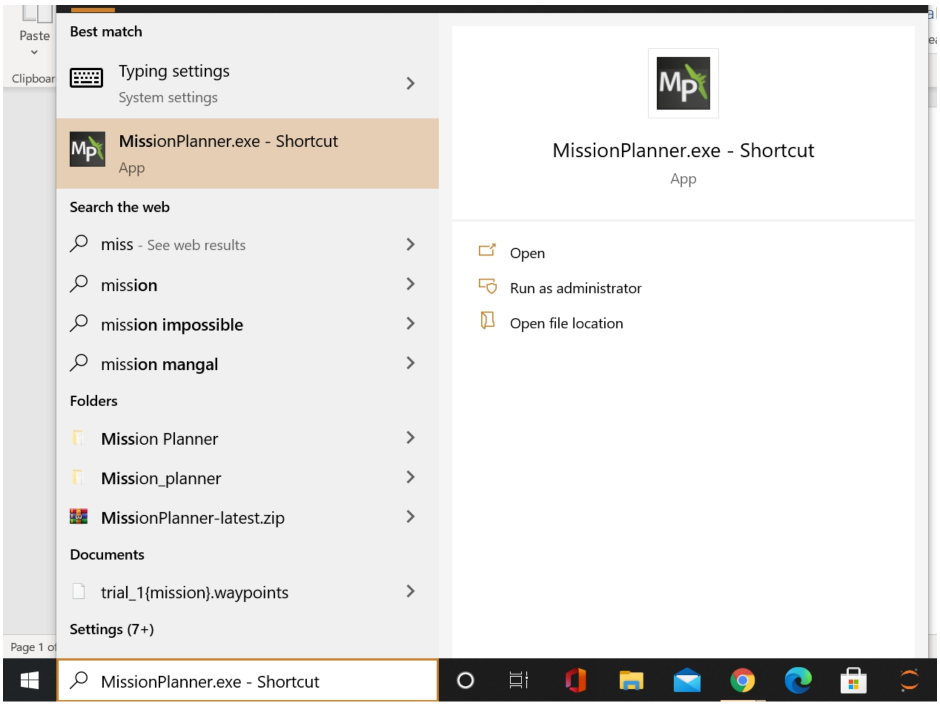


Fig.9 Start the Mission Planner Software

It will direct you to the home-screen of our software(Mission Planner), which will consist of all the important parameters related to our drone.

Fig.10 Home screen of Mission Planer

Home screen shows us the values of the sensors such as GPS, Gyro, Accelerometer etc. It tells us about the status of our drone. As in this image the drone is not connected hence, in the right upper corner we have option of connect.

2. Click on the Plan option present on the left upper portion of your screen. It will direct you to the map simulation place where we can design the route which our drone would follow.

Fig.11 Mission Planing window

In this we have chosen the location of a cricket ground .The screen shows us the exact latitude and longitude value on the lower right portion.

3. Right click on the virtual map to bring out the number of options available for planning a mission route.

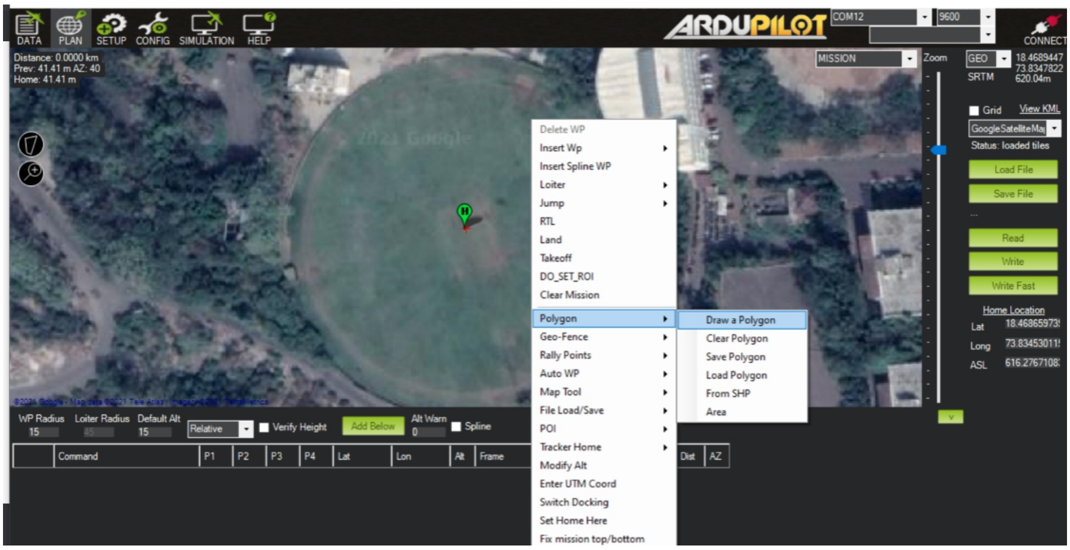


Fig.12 Mission Planing window

4. Choose the “Polygon” option from the drop-down menu and then choose “Draw a Polygon” from the sub-options.

5. Draw a polygon using a cursor making a shape of your own choice. Need not to be regular or irregular.

6. After designing the shape, right click the cursor placing it inside the polygon.

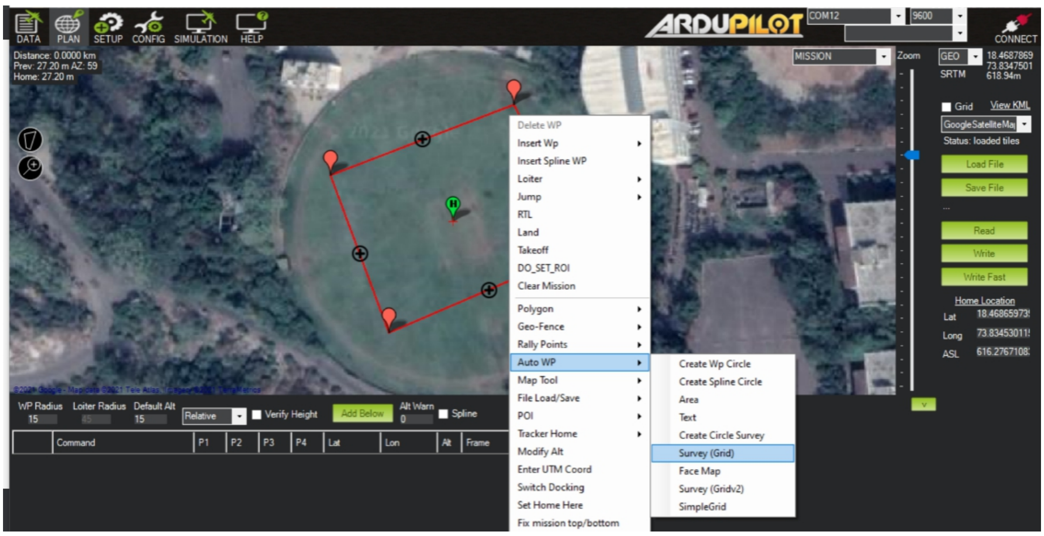


Fig.13 Planing the mission

8. Choose the “Auto WP” option from the drop-down menu and then choose the option “Survey (Grid)” from the sub-option.

9. It will open a dialog-box which will explain about the parameters to choose and how many images will be clicked in the entire duration of the flight and time duration between two images, speed of the drone and at what altitude the drone will fly.

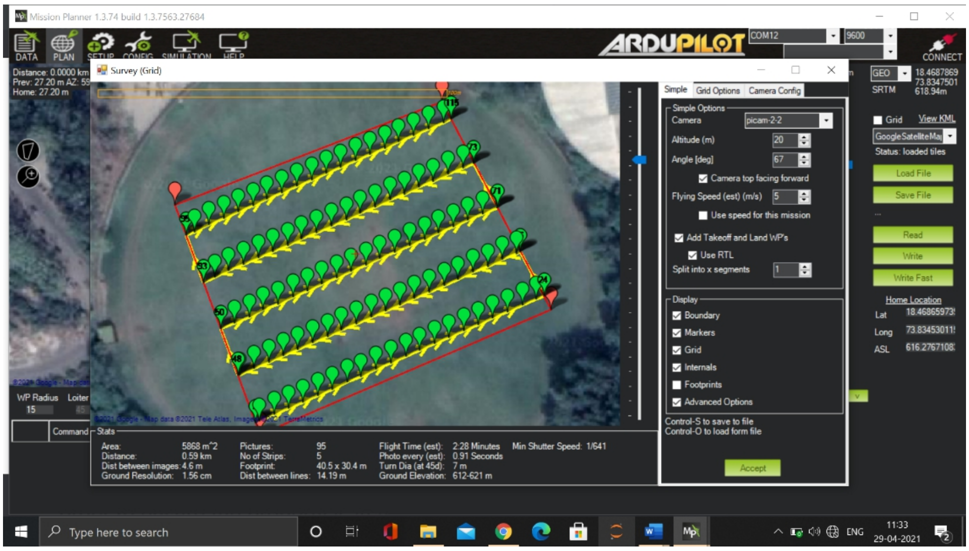


Fig.14 Here we see the flight path

10. From the upper right portion of this dialog-box, click on the “Camera Config” and it will open the entire configuration of the camera which is installed with the drone to click the images.

0

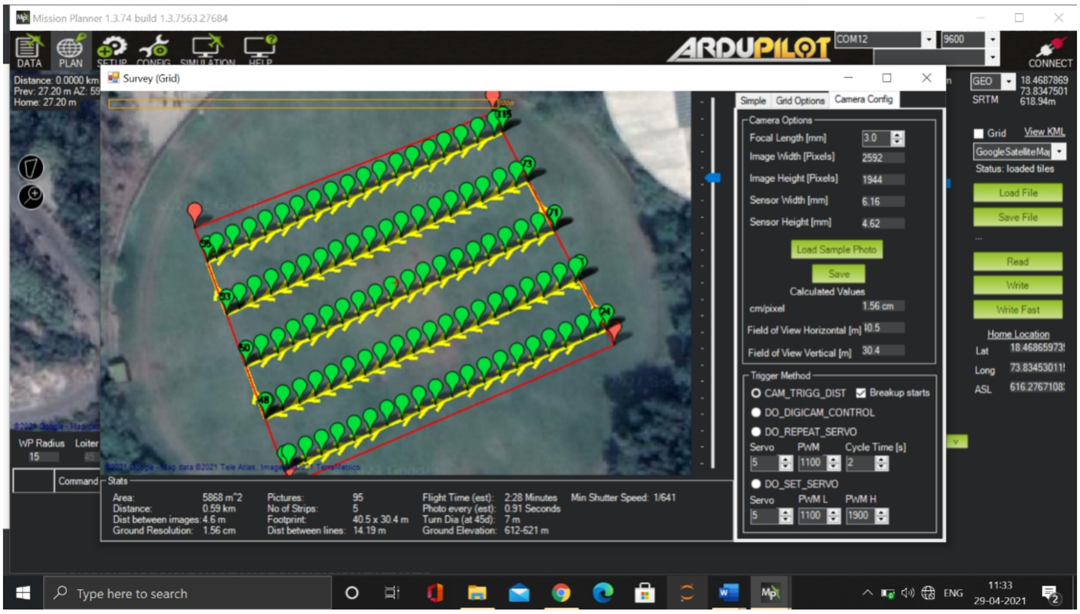


Fig.15 Here one can change flight parameters

Here we have choosen, the Pie-camera(custom designed by uploading the samples of the images clicked by the pi-camera) with the drone altitude to be set at 20m high. And we can see the number of images to be clicked are 96 and the focal length to be set at 3mm.

11. Hit on accept button in the lower right-corner of the dialog box. And after that we reach back to the map simulation, showing us this plan oin which it shows us the route our drone will follow while capturing the images of the land we covered using our polygon.

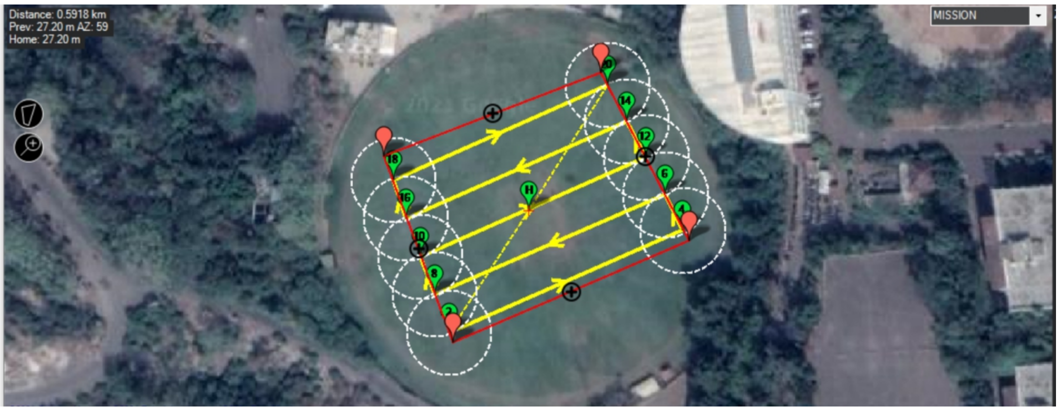
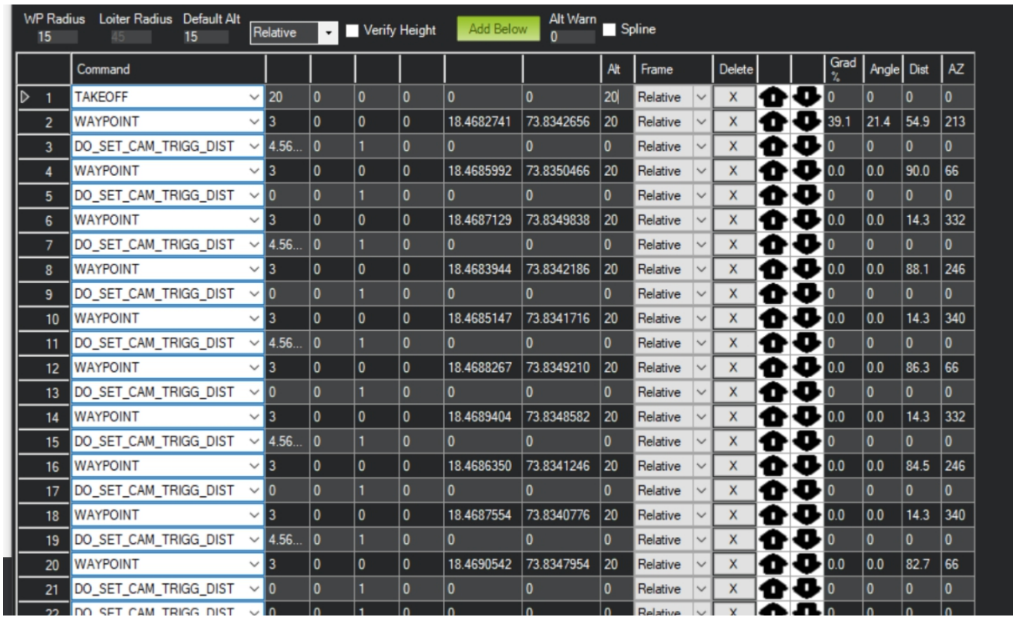


Fig.16 Final Mission

There will lot of instructions stored in the form of .waypoint file extention, which will let us know about the specifications of our drone flight.

0



	Command							Alt	Frame	Delete			Grad %	Angle	Dist	AZ
1	TAKEOFF	20	0	0	0	0	0	20	Relative	X			0	0	0	0
2	WAYPOINT	3	0	0	0	18.4682741	73.8342656	20	Relative	X			39.1	21.4	54.9	213
3	DO_SET_CAM_TRIGG_DIST	4.56...	0	1	0	0	0	0	Relative	X			0	0	0	0
4	WAYPOINT	3	0	0	0	18.4685992	73.8350466	20	Relative	X			0.0	0.0	90.0	66
5	DO_SET_CAM_TRIGG_DIST	0	0	1	0	0	0	0	Relative	X			0	0	0	0
6	WAYPOINT	3	0	0	0	18.4687129	73.8349838	20	Relative	X			0.0	0.0	14.3	332
7	DO_SET_CAM_TRIGG_DIST	4.56...	0	1	0	0	0	0	Relative	X			0	0	0	0
8	WAYPOINT	3	0	0	0	18.4683944	73.8342186	20	Relative	X			0.0	0.0	88.1	246
9	DO_SET_CAM_TRIGG_DIST	0	0	1	0	0	0	0	Relative	X			0	0	0	0
10	WAYPOINT	3	0	0	0	18.4685147	73.8341716	20	Relative	X			0.0	0.0	14.3	340
11	DO_SET_CAM_TRIGG_DIST	4.56...	0	1	0	0	0	0	Relative	X			0	0	0	0
12	WAYPOINT	3	0	0	0	18.4688267	73.8349210	20	Relative	X			0.0	0.0	86.3	66
13	DO_SET_CAM_TRIGG_DIST	0	0	1	0	0	0	0	Relative	X			0	0	0	0
14	WAYPOINT	3	0	0	0	18.4689404	73.8348582	20	Relative	X			0.0	0.0	14.3	332
15	DO_SET_CAM_TRIGG_DIST	4.56...	0	1	0	0	0	0	Relative	X			0	0	0	0
16	WAYPOINT	3	0	0	0	18.4686350	73.8341246	20	Relative	X			0.0	0.0	84.5	246
17	DO_SET_CAM_TRIGG_DIST	0	0	1	0	0	0	0	Relative	X			0	0	0	0
18	WAYPOINT	3	0	0	0	18.4687554	73.8340776	20	Relative	X			0.0	0.0	14.3	340
19	DO_SET_CAM_TRIGG_DIST	4.56...	0	1	0	0	0	0	Relative	X			0	0	0	0
20	WAYPOINT	3	0	0	0	18.4690542	73.8347954	20	Relative	X			0.0	0.0	82.7	66
21	DO_SET_CAM_TRIGG_DIST	0	0	1	0	0	0	0	Relative	X			0	0	0	0
22	DO_SET_CAM_TRIGG_DIST	0	0	1	0	0	0	0	Relative	X			0	0	0	0

Fig.17 Waypoint

Explaining us about the different action taking place at different instance of time.We are alllowed to make changes between the parameters such as height at which the drone will reach while taking off, the altitude of the entire flight etc.

12. Now our Flight Plan is ready for the execution, to save this plan in your local computer storage. Click the “Save File ” option present in the mid- right of the screen. It will save the file , providing the name user provide, with the file extention of .waypoint .

13. To upload the entire plan on the drone flight controller(Pixhawk in our case), connect the pixhawk with the type b data USB connecter to your computer where you are running Mission planner.

14. Hit “Connect” button present on the upper right corner of the screen and give the system around 5-10 seconds to establish the connection between the drone and the computer.

15. After getting connected go the “Plan” section and click on the “Load File” option present in the mid-right, above the “Save File” option. And choose the file which you named earlier and click on it.

16. This will show the last plan you created on te map simulation present on the screen.

17. Click on the “Write” option present below “Save File”.

18. You can click on “Read” option to find out the plan already present in the pixhawk.

19. After “Write” option, give your drone some time to finish uploading the plan. And after that, your drone is ready to get Armed and fly the route which you planned for it.

5.1.3)Creating Orthomosaic map:

1. Switch on the PC where WEBODM is installed.

2. Click on the Docker

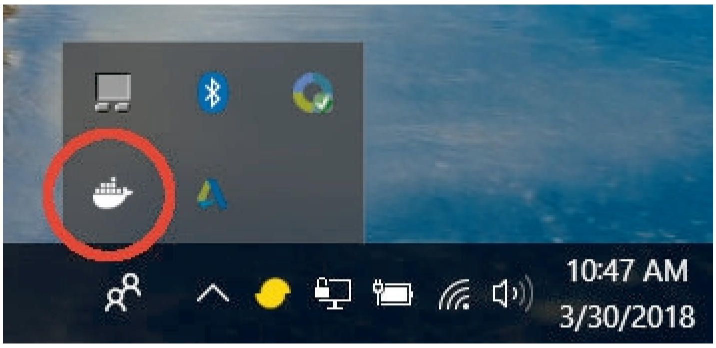


Fig.18 Starting Docker

3. After some time, you will receive the notification of docker started running succesfully. Open any web-browser present on the device and enter the local host ip- address. “https://localhost8000/”

4. It will direct you to the Home-page of the WEBODM platform, which looks like it is given in the image below:

0

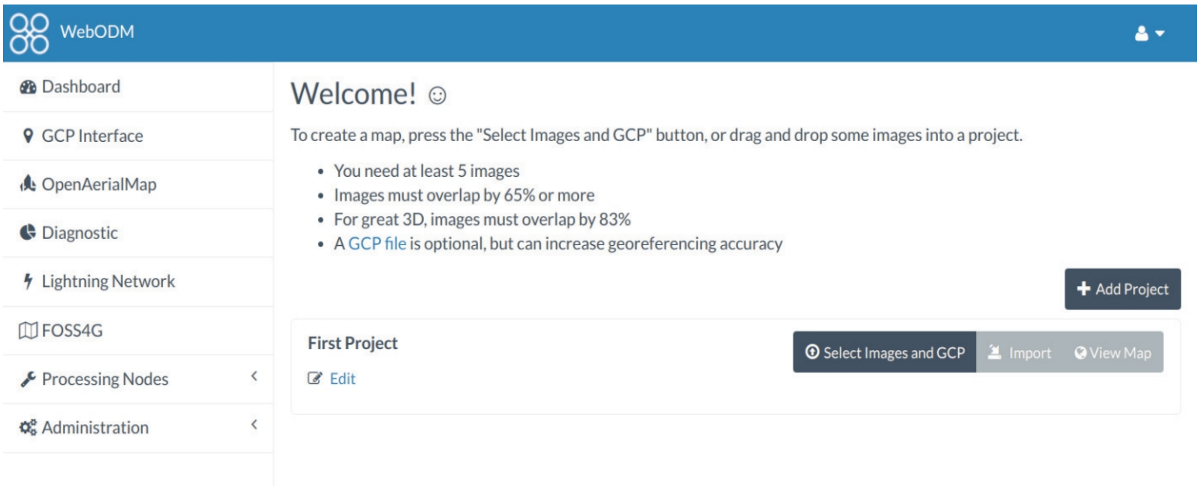


Fig.19 WebODM Homepage

5. Click on the "Select Images and GCP" option present on the home-page or Dashboard on the screen.
   1) It will open a dialog box, searching inside the local memory of the device and you are asked to navigate it to the location where your Geo-tagged images or the data-set is present.

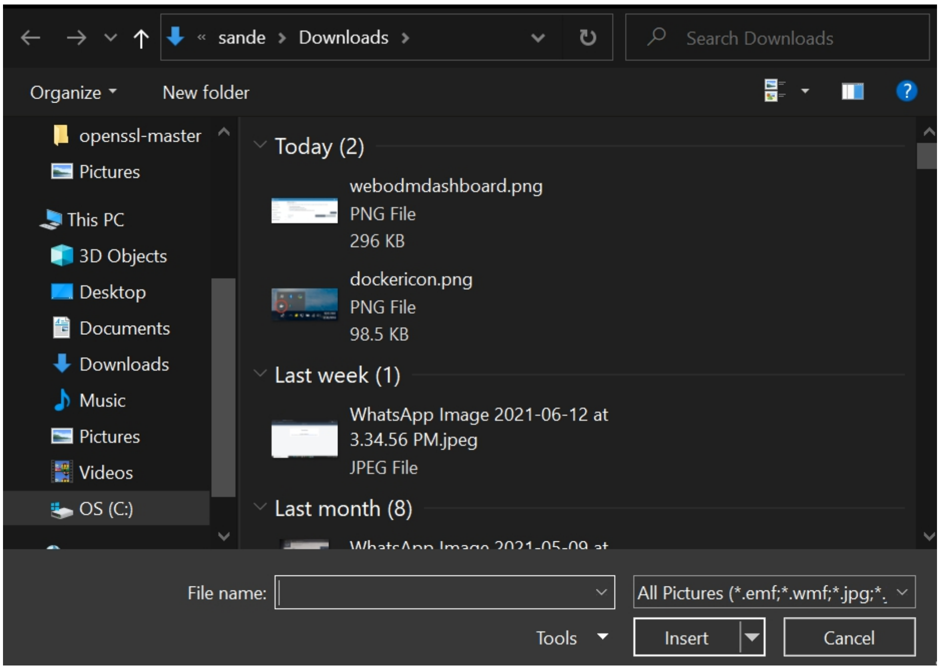


Fig.20 Selecting The Geo-tagged Images

   2) Navigate to the location and select all the images present in your datasets

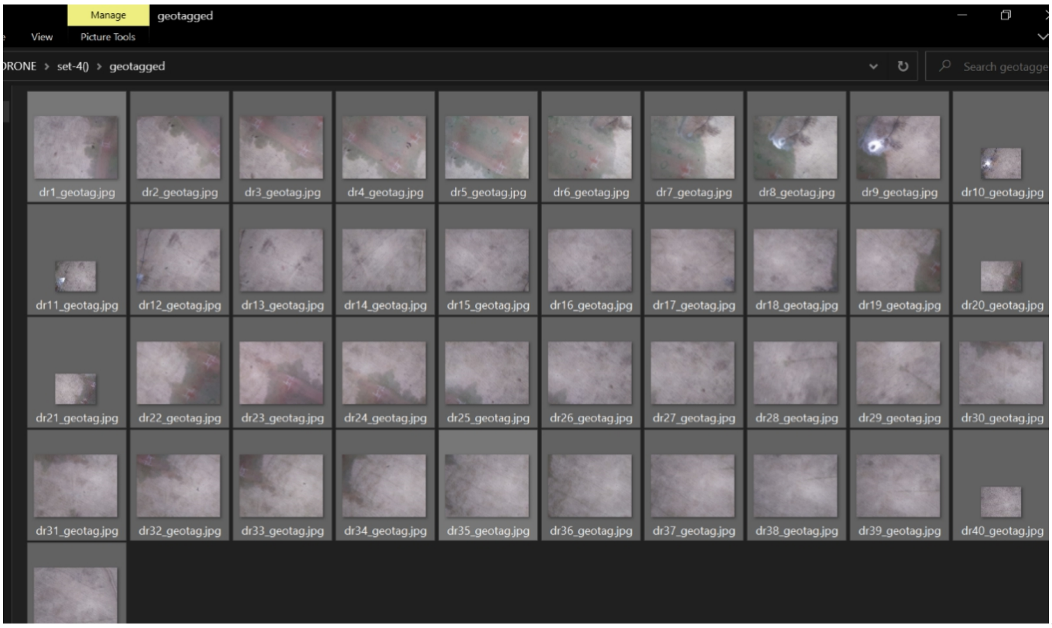


Fig.21 Selecting The Geo-tagged Images

6. Press insert, and all the images will be uploaded to the main-frame of the WEBODM under the name of new project.

7. You can change the name of the project by a single left on the already allocated name of the project.

8. After all images are uploaded, there will be numerous options available which we tune into to get the best ouput from our datasets.

9. Resize the images to 1024 x 720 pix, which will resize the image resolution of all the images to a specific pixels. Through this the processing of all the images as a group becomes easier.

10. Choose the number of cores to be “-1”, which means it will utilize the maximum number of Processing cores present on our machine to bring the result faster than normal.

11. Choose the orthomosaic map , from the drop-down menu because our datasets is designed for the purpose of orthomosaic map and not for other things such as 3-d Model, Vegetation Index etc.

12. After setting all the parameter click on “Start Processing”. [The processing takes few minutes completely based on the size of data. datasets with 73 images and size 221 MB took 17 minutes and 15 seconds to complete.]

13. Once the processing is done , click on “ View Orthomosaic” option, and it will direct you to a different screen loading the orthomosaic map in the free space of the screen with the various options to perform any kind of operation on it.

14. Upper right corner will have the option “Measurement and Area”, Click on that to get a custom cursor which could be used on the orthomosaic map.

15. Click on the map from where you wish to find the area of the bounded region.

16. Using the same cursor, make a dotted boundary around the region whose area you wish to calculate.

    NOTE: More the number of dots covering the boundaries of the region, higher the accuracy of the result we get.

17. After covering the entire region, A floating drop box will display the values such as Length , Area in Sq meters.

18. This is the final output which we receive giving us the area we require.

5.1.4 Radio Controller

The Radio controller selected is Avionic RGB OS10. The reason for selecting this Radio controller ,It has 10 Channels and a inbuilt SBUS output which is necessary for establishing a connection with Pixhawk. The Radio controller comes with 2 joysticks, providing- throttle, yaw,pitch and roll. Along side we have 4 switches and 2 nobs which can be used for any custom use .

The setup and operations of the Radio controller is explained will in these videos:-

https://youtu.be/TIrxowlg7Tc
https://youtu.be/mD2x9Jw2lyU

5.2.1)THE DRONE

Fig.4 shows thecomplete drone setup,including the radio controller on the left hand side of the image and the drone on the right hand side of the photo

Fig 4 Radio control module and the drone in a still position

5.2.2) The Drone flying:

Fig.5 shows the drone hovering still at a particular height during its first flight

Fig.5 – The drone hovers at a particular altitude

5.2.3 Onboard Camera video feed:

In Fig.6 you can see the video feed from the drone , showing all the important flight parameters such as battery voltage, altitude, flight time ,heading, radio connection, GPS strength and many more.

Fig-6 The On Screen display

5.3.1) Advantages:-

1. There is no market available drone which uses land area mapping for the Village areas.

2. The price is significantly cheaper for our drone compared to the market drone available with similar capabilities.

3. Our drone is smaller in size compared to the market drone, which is used for arielphotography.

4. Our product will cut down the manual work and will be highly efficient than the traditionalways used till date for area mapping in rural areas.

5. Easy to upgrade/ replace components design, which makes sure that we can upgrade the drone whenever we want.

6. All the software in use are open- source, which decreases the price of the product and accessibleto everyone.

5.3.2) DRAWBACKS:-

1. Can only carry the load of around 600-800 gm.
2. Battery life is only 15 minutes.
3. FPV camera is not highly reliable.
4. Clicking pictures manually is not possible yet because of high number of micro-vibrations.
5. Do not have the obstacle avoidance capabilities yet.

5.4)Tasks Completed till Date:-

1. Able to fly by controlling through Radio communication.
2. Able to fly with the weight of around 600 – 800 grams.
3. Able to plan the Autonomous flights with the software used.
4. Able to give commands of different flight- modes such as Altitude Control, Return to Land, Return toLocation.
5. Able to install FPV camera and get the video output out of it.
6. Able to understand the battery management system after several failed attempts and tries.
7. Pixhawk Raspberry Pi connection established ,Raspi Camera working as expected.
8. Orthomosaic maps are created.
9. Complete Setup is ready and the results obtained are as expected.

5.6)Key Learning Till Date:-

1. Proper Techniques for battery management and maintenance
2. Mission planning and fail-safe activities.
3. Calculations related to the Drone.
4. Properties and Procedures of Othomosiac Maps.

1) Results:-

Following are the results obtained from WebODM

Fig.22 orthomosaic map of a field

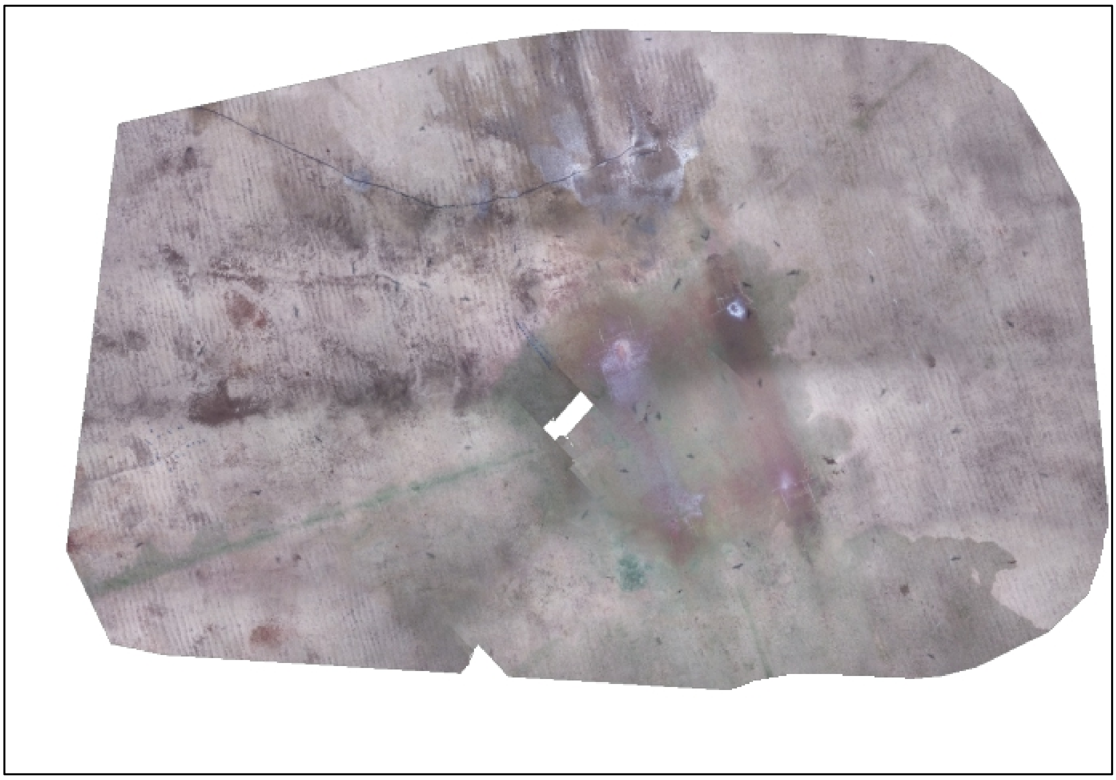


Fig.23 Orthomosaic map of a tennis court

Table 1 Overview of the results acquired from the WebODM software in comparison with the area obtained from Google map and the actual area under consideration

SR. NO	AREA FROM WEB-ODMEM	AREA FROM GOOGLE MAP	ACTUAL AREA	ACCURACY
1	6458.05 Sq. meters	6590.783 Sq. meters	6500. Sq. meters	99.35%
2	10961.89 Sq. meters	10834.56 Sq. meters	11000. Sq. meters	99.65%
3	7653.75 Sq. meters	7600.456 Sq. meters	7650. Sq. meters	99.25%
4	2357.45 Sq. meters	2320.56 Sq. meters	2370. Sq. meters	99.32%
5	3456.30 Sq. meters	3412.30 Sq. meters	3470. Sq. meters	99.67%
6	359.73 Sq. meters	357.89 Sq. meters	350. Sq. meters	99.45%
7	260.52 Sq. meters	260.00 Sq. meters	260. Sq. meters	99.8%

Formula for calculating accuracy:

ERROR = [(ACTUAL AREA) – (AREA CALCUTED FROM WEB ODMEM)] *100/ (ACTUAL AREA)

ACCURACY = (100) - (ERROR)

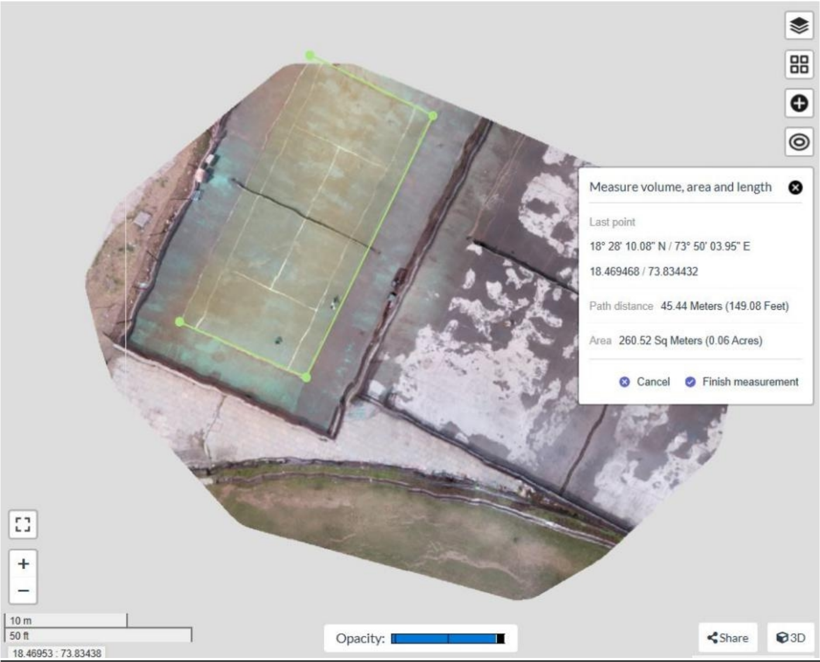


Fig.24 Area calculation in WebODM

As seen in Fig.10 the area calculated for the tennis court is 260.52 Sq. Meters where as the standard court area is 260 Sq. Meters. These results determine a accuracy of 99.8% which is the best accuracy obtained. As observed in Table.1 the accuracy is above 99% throughout.

9.1) Conclusion:

Calculating the area of any field using Quadcopter is very efficient were the time and manual efforts are reduced to generate accurate results in less time, Further the accuracy can be improved by using high-definition camera and improving the software competency.

The Quadcopter used in this project is versatile and can lift a payload of up to 700gm with robust functionality with respect to freedom of motion, which is piloted by the advance flight controller Pixhawk and the base station software Ardu-pilot.

The Quadcopter is compatible with an FPV System i.e., First Person View, which can be used for surveillance purpose. The drone is also equipped with fail safe mode, were the drone returns to the launch location safely, in case of low battery or loss in Radio connection.In cases where immediate return to ground is needed the drone also lands autonomously

Autonomous flight is a flagship feature of the drone and the total flight time the Quadcopter is around 17 minutes.

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Ref: SVR/21/06-5 Date:29th June 2021

CERTIFICATE OF PROJECT COMPLETION

This is to certify that Mr.Aditya Kore, a B.Tech student of Dr. Vishwanath Karad MIT World Peace University has duly completed his project work titled "Land Area Mapping Using Drone and Image processing" for SVR InfoTech.

During his project work, Mr.Aditya has met all the key objectives.

We at SVR InfoTech. appreciate his timely and consistent performance. We additionally thank Prof.Manisha Kumawat, MIT WPU for her guidance during the project.

Thanking You,
For SVR InfoTech,

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Ref: SVR/21/06-6 Date:29th June 2021

CERTIFICATE OF PROJECT COMPLETION

This is to certify that Mr.Rushikesh Shelar, a B.Tech student of Dr. Vishwanath Karad MIT World Peace University has duly completed his project work titled "Land Area Mapping Using Drone and Image processing" for SVR InfoTech.

During his project work, Mr.Rushikesh has met all the key objectives.

We at SVR InfoTech. appreciate his timely and consistent performance. We additionally thank Prof.Manisha Kumawat, MIT WPU for her guidance during the project.

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Ref: SVR/21/06-07 Date:29th June 2021

CERTIFICATE OF PROJECT COMPLETION

This is to certify that Mr.Sandesh Tulsani, a B.Tech student of Dr. Vishwanath Karad MIT World Peace University has duly completed his project work titled "Land Area Mapping Using Drone and Image processing" for SVR InfoTech.

During his project work, Mr.Sandesh has met all the key objectives.

We at SVR InfoTech. appreciate his timely and consistent performance. We additionally thank Prof.Manisha Kumawat, MIT WPU for her guidance during the project.

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Ref: SVR/21/06-08 Date:29th June 2021

To,
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Pune – 411038

SUB: Capstone Project at SVR InfoTech.

Dear Student,

You are hereby informed that you are permitted to work in SVR InfoTech, Pune for your capstone project, under the guidance of Mr. Piyush Tailor, Head of Robotics, electronics and Software departments InfoTech.

The duration of your project is expected to be six months long from 11/2020 to 06/2021.

The components will be completely sponsored by the company.

Kindly find herewith the terms and conditions which are applicable to you during your capstone project at SVR InfoTech.

You are requested to kindly acknowledge the terms and conditions in token of acceptance.

Thanking you,

For SVR Infotech,

Piyush Tailor

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Head of Robotics, Electronics and Software department
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Dear Student,

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Thanking you,
For SVR Infotech.

Piyush Tailor

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