Image Rendering Using Drone

Rohit Ekka, Sanjana Keluskar, Darryl Lopes, Karan Kachi

Abstract— With the recent development in Drone the applications of the Drone has increased multi-fold. However, the scope of this project addresses the applications particularly in the area of search and rescue, surveillance and monitoring in Archaeology, Architecture, Agriculture, Forestry, Emergency and Traffic Management. To achieve the desired application, we have developed an autonomous Drone which can navigate through a pre-determined GPS co-ordinates programmed into the Raspberry Pi module and executed through the flight controller. We then connected a Pi camera to the Raspberry Pi which takes the images, stores it in the Home directory of Pi and the images are then accessed from Ground Station (Mobile/Laptop) via FTP server enabled on the Pi and Wi-Fi adapter. We then use those images to construct a model using various Image Rendering softwares like Auto Desk Recap 360.

Index Terms—Drone, Flight Controller, Python, AutoDesk, Raspberry Pi, Rendering.

1 INTRODUCTION

We know that it's an impossible task to monitor huge structures from every angle and to do real time monitoring of under construction sites. To solve this problem, we have come up with an autonomous drone. Earlier drones were controlled manually using Radio Controller and thus human involvement was required simultaneously. This project also eliminates this problem

We feed the parameters like Altitude, Co-ordinates from GPS module, etc. through an open source software named Mission Planner. The basic construction of the drone started with calculating the approximate weight of the drone by adding up weights of individual components. Using the estimated weight we calculated the thrust required to take off the drone. For better stability, we selected a frame size of 450mm and propellers of 10 inch (Frame size is directly proportional to propeller size).

The ArduPilot Flight Controller controls the Electronic Speed Controllers (ESC) which in turn controls the brushless motors. The Pi camera is controlled by Raspberry Pi and in Pi we have used Python script which is user defined that means the camera will take images as per the user requirement. After reaching to a particular waypoint, it will toggle a function which will make the GPIO pin high on Raspberry Pi which in turn execute the python script. The images will get stored in home directory of Pi which can be access by the ground station by enabling FTP server on Pi

The captured images received from the drone are then processed in Image Rendering software which creates a model. The images are fed sequentially and each image is 70% over lapped with the previous image. The drone will implement the use of wireless modules like Wi-Fi and 433MHz Telemetry radio set in order to communicate with a base station. The goal of this project is to make the drone to go to a specific location and capture images.

2 HARDWARE DESIGN

2.1 Architecture

The system architecture consists of two main parts, on-board system for collecting data and off-board analysis i.e. rendering of images. The on-board system consists of a Quad Copter, ArduPilot APM 2.8 Flight Controller, Raspberry Pi, and 5MP Raspberry Pi camera, RC Receiver, Telemetry Radio and Wi-Fi Adapter. The Raspberry Pi and the Ground station are connected via Wi-Fi. The APM 2.8 Flight controller and ground station are connected via Telemetry Radio.

As we are monitoring huge structures, the drone has to be stable at high altitudes and should be able to tackle external disturbances like wind, etc. The stability factor of the drone depends on the size of the frames (Size α Stability). We estimated the weigth of the components (4 x motors, ESCs, Propellers, Battery, Raspberry Pi, Flight Controller and Frame) which was approximate 2kg. In order for the drone to take off, we need optimum thrust which is twice of estimated weigth of the drone given by the following formula:

Thrust (kg) = 2 x Estimated weight of the Drone
Thrust (kg) = 2 x 2kg
= 4kg

In order to provide thrust of 4kg, we divided the total thrust by 4 motors to get the individual thrust of the motors that comes down to 1kg.

Frame Size	Prop Size	Motor Size	KV
150mm or smaller	3" or smaller	1306 or smaller	3000KV or higher
180mm	4"	1806	2600KV
210mm	5"	2204-2206	2300KV-2600KV
250mm	6"	2204-2208	2000KV-2300KV
350mm	7"	2208	1600KV
450mm	8", 9", 10"	2212 or larger	1000KV or lower

Figure 1: Reference Chart

Using a standard reference chart as shown above, we selected A2212 940KV Motor which gives a collective thrust of 5kg.

2.2 Technical Data and Costs

The technical key data of the system are:

- Diameter : 450mm
- Net Weight: 2Kg
- Power Supply:2200 mAh, 11.1 V Li-Po Battery
- Drivetrain: 4 Brushless 940KV Motors
- Take-off weight: 2kg
- Flight Time: 20 min
- Maximum Altitude: 100m

The overall cost of the drone system adds up to roughly Rs. 14000.

3 ASSEMBLY OF DRONE

3.1 Block Diagram

The Drone system consists of a ground controller, a flight controller and the communication link between them. Since the motive is to make the drone autonomous, we have used an advanced software called Mission Planner which is installed on a Laptop, which we have named the Ground Station.

An object hovering in air is always dangerous, keeping in mind the possible technical failures, we have kept a RC Transmitter in communication with the Drone, and so in case of any issues, we can manually take back the controls from the autonomous flight.

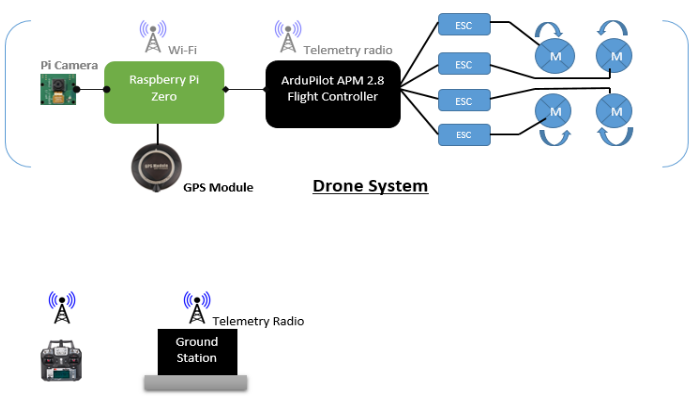

Figure 2: Drone Architecture

The on-board circuit consists of two major components: APM Flight controller and Raspberry Pi. The Flight Controller controls the Electronic Speed controllers which in turn controls the 4 Brushless motors, while the Raspberry Pi handles the Camera department. The GPS module provides the Flight controller with Position co-ordinates. The Ground Station is always in communication with the Drone.

3.2 Rotation of Motors

To achieve stable flight capability, we first focus on the rotation of motors where out of the four brushless motors two motors diagonally opposite to each other rotate in the opposite direction of the remaining two motors. This is done to nullify the angular momentum. The angular momentum depends on how fast the rotor spins. If there is no torque on the system then the total angular momentum must remain constant.

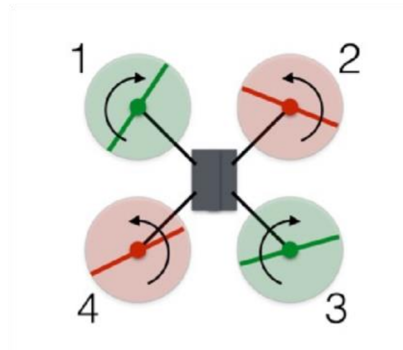

Figure 3: Rotation of Motors

For example: Suppose the red counter-clockwise rotors have positive angular momentum and the green clockwise rotors have negative angular momentum then the effective angular momentum will be zero. If each rotor has an angular momentum of +2 and if we decrease the angular velocity of rotor 1 such that the angular momentum changes to -1, then the total angular momentum would now become +1, which results in the drone rotating in clockwise direction. Thus this principle is used in navigation of drone

3.3 Flight Controller

The ArduPilot APM 2.8 is a flight controller, an open source project. This flight controller allows the user to turn any fixed wing, rotary wing, or multi-rotor vehicle (even boats and cars) into a fully autonomous vehicle, capable of performing a wide range of tasks like setting waypoints on map (around buildings, etc.) and giving appropriate functions to perform at that position like to Loiter, or turn left/right, climb altitude, etc.

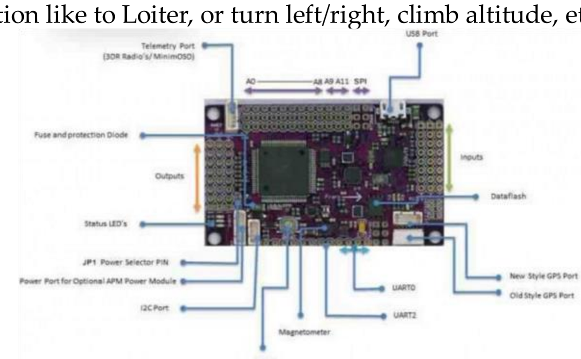

Figure 4: Flight Controller

3.4 Camera

To equip the drone with image capturing ability we make use of Raspberry Pi camera, which is a 5 megapixel fixed focus camera which supports 1080p, 720p and VGA90 video modes. The camera's dimensions are 25 x 20 x 9 mm and it is mounted on the Raspberry Pi. Here we connect GPIO 17 and channel 6 of RC Receiver module. Once the switch is turned on, GPIO pin on Raspberry pi will become high which will inform the Raspberry pi to run a python script.
The Script will either take single image at a time on every toggle or will take continuous images till we toggle the switch depending on user.

Figure 5: Pi Camera

3.5 Software

We have used Mission Planner Software to plan the paths which the drone will follow. It's an open source software through which we give pre-determined co-ordinates on to map integrated in the software. On each particular waypoint we give various parameters such as altitude, co-ordinates (latitudes and longitudes), take-off and landing positions. This helps us make the flight plan for the drone. The advantage of using this software is it results in precise operation of the drone. It also provides live parameters from the drone, which helps us to analysis whether the communication link between the drone and ground station is healthy or whether the drone is facing any technical issues.

Figure 6: Mission Planner Software

4 GENERATION OF MODEL

4.1 Selection of Images

The first step of Image Rendering Process is to select the adequate images without any technical noise i.e. out of focus, over exposure and blur. Since not all the captured images are fully accurate, 20%-40% captured images will be eliminated.

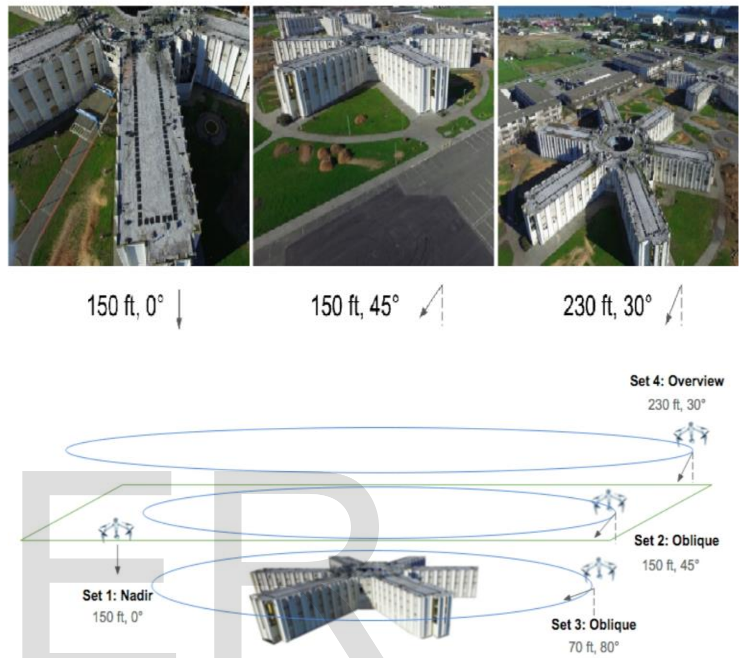

Figure 7: Images from different angles

4.2 Software

After the selection process of images, a sequential stream of images is fed into the AutoDesk Recap 360 software. The Recap in AutoDesk stands for "Reality Capture". The images which are captured are then loaded on to the software, which are displayed in accordance to the sequence captured in a scanning window. Each scan creates numerous points which can be altered according to our needs of desired result. The Autodesk software then merges all the selected images into a model. The model can be then analyse for the civil works.

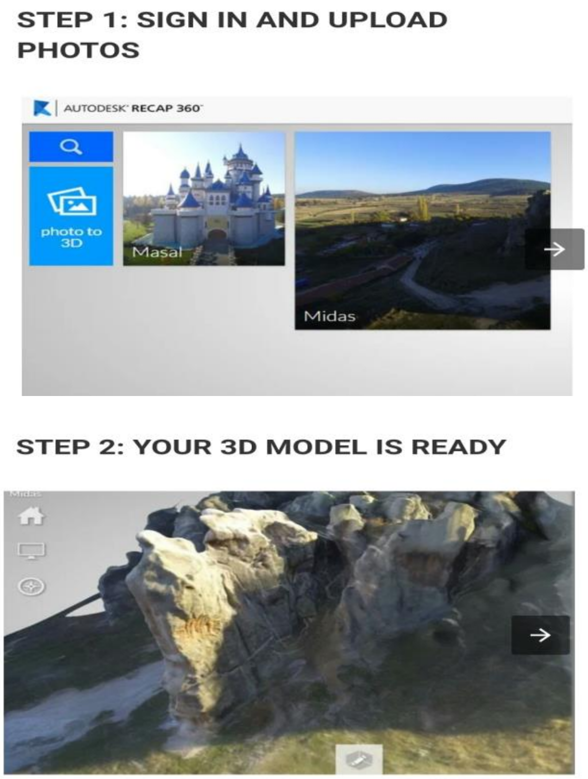

Figure 8: AutoDesk Recap 360 Software

5 CONCLUSION AND FUTURE SCOPE

Using an automated flight system, leaves few room for any error caused due to human intervention while operation of the drone. A flow of developing a model using the images captured with help of camera on-board the autonomous drone was presented.

The basic applications consist of surveillance and monitoring operations of usual structures such as buildings, archaeological sites, Forests and day to day management of civic life. Further development can result into drones being developed of smaller cross-section with better image rendering ability to be used in military and stealth security operations by flying undetected and producing images with better panoramic qualities.

REFERENCES

[1].Open source computer-vision based guidance system for UAVs on-board decision making. In 2016 IEEE Aerospace Conference, 5-12 March 2016, Yellowstone Conference Center, Big Sky, Montana

[2]. Neitzel F, Klonowski J (2011). Mobile 3D mapping with low-cost UAV system. Int. Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, Zurich, Switzerland, 38 (1/C22).

[3]. Bendea H, Boccardo P, Dequal S, Giulio Tonolo F, Marenchino D, Piras M (2008) Low cost UAV for postdisaster assessment. Int. Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, Beijing, China, 37 (B1): 1373-1379.

[4]. Bouabdallah, S., Becker, M. and Siegwart, R. "Autonomous Miniature Flying Robots: Coming Soon!" Accepted for the IEEE, Robotics and Automation Magazine, 200