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Surveillance Drone

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Abstract - *Surveillance drone is an electronic device which is remote controlled based UAV used to achieve flight with stability using pixhawk 2.4.8 controller. The main aim of this project is patrolling over a specific area and capturing images, performing object detection on them and then sending it to the users telegram bot. The drone consist of frame, motors, Electronic speed controller, Pixhawk flight controller 2.4.8, lipo battery 5200maH 3s ,raspberry pi 3b+, pi camera, transmitter and receiver, GPS M8N, radio telemetry 3DR. Individual components were tested and verified. Tuning and calibrations are done to stabilize the drone and object detection's script was run on Raspberrpi. Now the drone can properly stabilize itself and send object detected pictures to the users telegram bot. The aim of the project has been achieved, resulting in stable hovering and capturing and sending object detected images.*

Key Words: **Pixhawk flight controller 2.4.8, Raspberry pi 3b+, pi camera, Tensorflow based model mobilenet ssd v3, Open cv, Mission planner, Telepot and Remote.it.**

1.INTRODUCTION

A drone has the potential for performing various tasks where humans cannot enter, like high temperature and high altitude surveillance. This drone can be used for stealth operations and for surveillance purposes. Basic working of this drone is divided into two major parts, 1) The patrolling autonomous drone and 2) is the object detection part. The drone or the hexacopter has propellers with motors that generate thrust for lifting the complete aircraft aswell as the payload attached to it. Along with it , it has raspberryPi which functions as a another secondary brain besides pixhawk flight controller and whose functions are solely limited for object detection. The autonomous drone can hover over specific area as it has been pre provided with the mission for doing so. The drone will go to the specifed way points based on the mission assigned to it, using the mission planner software. It can take-off go to the specfied way points and return to it's orignal landing position all on it's own, while doing so it can be commanded for capturing images , performing object detection on the caputred images and sending them to the user's telegram bot. The raspberryPi on the drone is powered by pixhawk and it has a camera mounted on it . Telepot has been pre installed in the Raspberry pi which enables the raspberry pi to communicate with the telegram bot API . User can give commands to the raspberry pi using telegram bot API. In our case the user can send /photo command to the telegram bot API who's bot i'd has been synced with the Rpi. On receiving that command, the Rpi will know it's now time to click picture, perform object detection on them, add labels and square boxes around the objects detected and send that as a picture to the user's telegram bot. After this process is completed the Rpi will wait for further commands from the user. The drone can return back to it's launching position by simply switching to RTL mode (Return to launch position mode) on the remote.

2. LITERATURE SURVEY

The project required extensive research into similar systems. According to others work, we used this insight to develop our system. To this end, research papers from various quad-copter groups were used as guides in the early development of the dynamics and control theory. Ashfaq Ahmad Mian Ahmad developed a non-linear model and nonlinear control strategy for a 6-Degree of Freedom aerial robot. The nonlinear model of this aerial mechanism is predicated on Newton-Euler formalism. The Wallenberg Laboratory for Information Technology and Autonomous Systems is conducting a basic research project on Surveillance Drone at Linkoping University, Sweden. This project is a multi-disciplinary one. It involves integration of autonomy with digital video and cameras, and a communication system. Hexacopter is a remote-controlled aerial vehicle, which might be enforced in numerous applications.

3. BLOCK DIAGRAM/SYSTEM ARCHITECTURE

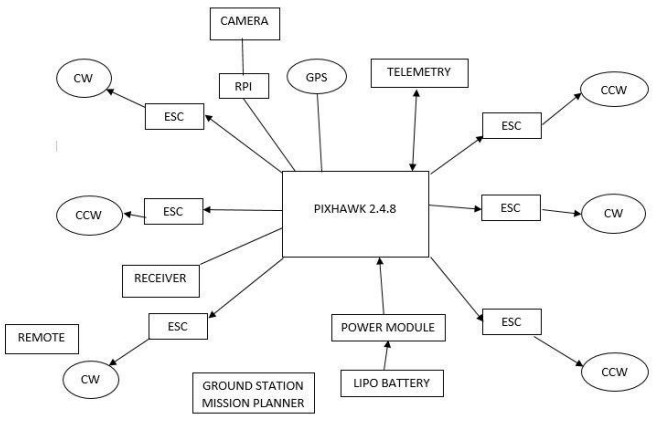


Fig -1: Block diagram.

4. METHODOGY

The hexcopter's hardware has been assembled, M8N Gps module is mounted , 3DR radio telemetry system is attached and Raspberry Pi and it's camera is also connected.

Pixhawk which was powered by the power module connected to the Lipo battery also powers raspberry Pi. The ESC's (electronic speed controller) connected to the BLDC (brushless dc motors) motors cannot flash the firmware, therefore power module is required for providing power to pixhawk. Drone's frame itself acts as power distribution board and provides power to the other peripherals. ESC's receive power from PDB to run motors.

ESC's are electronic speed controllers which manage the rotor speed , which is essential for drone's maneuvering.

The motors combined with the propellors provide essential thrust to the vehicle

Gps is used for accessing guided modes like loitr , rtl and in giving mission.

Telemetry enables communication with user's laptop or mobile.

Pixhawk is the brain which manages all the functions and other peripherals of the drone. It's caliberation is necessary for stable flights.

Caliberation of drone and radio caliberation is done via mission planner software and only after that stable is acheived. Mission planner is also used for assigning missions to the drone which includes auto take off and return to launch position modes. 3 way switch for providing additional 3 modes (3+3 = 6 total) has also been added on the flysky remote by making the switches C and D as master and slave. So now the drone can fly in 6 possible modes.

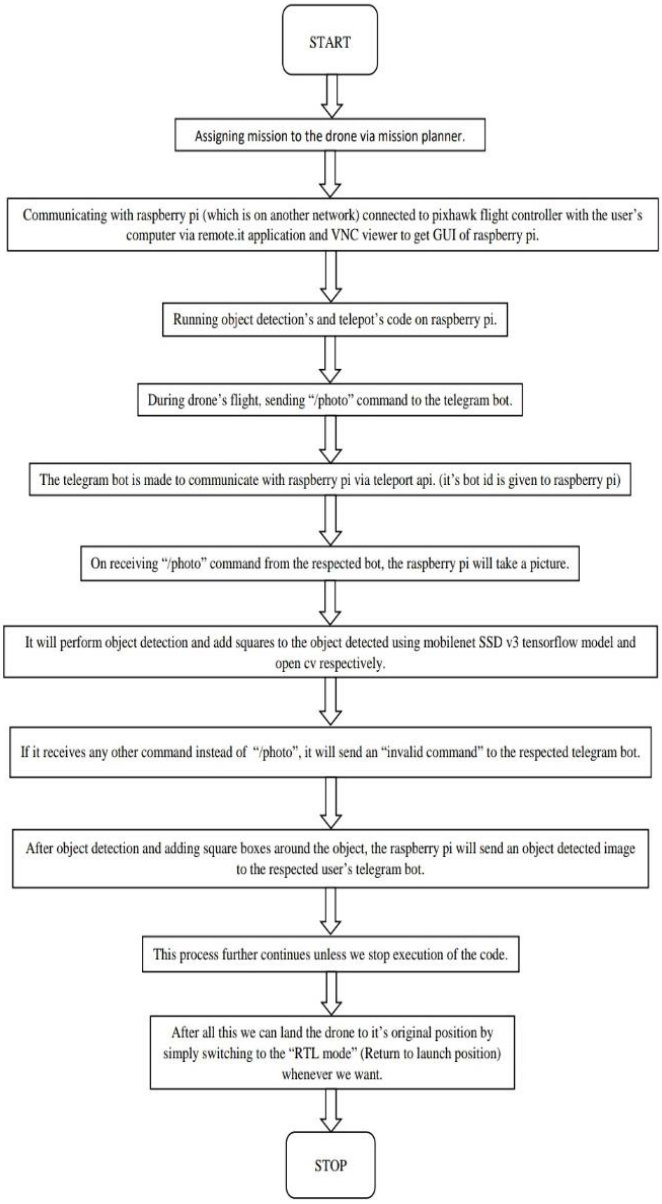
Fig -2.1: Drone's stable flight.

Fig -2.2: Mission assigned to the Drone.

The raspberry Pi connected to the drone functions as another secondary brain.
It's main purpose in our project is object detection and receiving commands from the user's telegram bot.
As raspberry pi on the drone is on another network whereas the user's laptop is on another network, in order to communicate with Rpi remote.it application (which is also installed in our Rpi) is used, which enables communication over the internet and using vnc viewer we get GUI of Rpi. This process is essential for running python script in the rpi for object detection.
Now the only thing left is to send command to click picture, then Rpi will perform object detection on it.
We have used telepot for building telegram bot API which communicates and sends command to the Rpi. User's bot I'd is added to the python script so after receiving the specified command i.e /photo from the user's telegram bot further functions would be carried out.
Telepots and object detection script are combined.
Object detection is a combination of image classification and localization.
For implementation we have used python as a programming language.
Open Cv is used for loading pre trained tensorflow frozen models.
Algorithm used for image classification is ssd mobile net v3.
SSD Mobile net (single shot multibox detector)
It divides the whole image into small patches, combining those patches into the most saliant feature of the corresponding image and it asks the classifier i.e mobilenet or yolo etc to classify that image.
Ssd mobile net is most light weight and faster algorithm which goes hand in hand with the Rpi.
Coco dataset which consists of 80 classes is used.
Deep learning architecture's pre trained models like mobile net ssd v3 is available on the official page of openCv github link, which is based on tensorflow. OpenCv is used to load them. The frozen inference graph and configuration file need to be extracted from the mobilenet ssd v3 config and weights respectively which in turn are gonna be loaded by open cv as a detection model.

All the 80 coco names need to be copied as there are a total of 80 classes in coco data set as labels, which are essential to check if the detection model has provided the correct output or not.
Open Cv and matplotlib are installed.
The python code which loads the detection model (using graph and configuration file), performs object detection on the captured image, cross checks it with the class index's , adds rectangle boxes and adds the corresponding label based on the class index to the captured image , this script is executed every time after receiving the /photo command from respected user's telegram bot.
This object detected image is saved in raspberry pi and sent to the user's telegram bot.

5. FLOW CHART



6. RESULT ANALYSIS

Fig -3.1: Hardware components assembled.

As visible from the figure 3.1 the drone is completely assembled, components used are Hexacopter frame S550, pixhawk 2.4.8 flight controller, propellors, 920 Kv motors, ESC's, M8N Gps module with a stand attached to it, radio telemetry and remote's transmitter and receiver, Raspberry pi 3b+ and it's 12Mp camera.

Figure 2.2 shows the mission assigned to the drone which includes auto take off, visiting way points and then returning to it's launch position. GPS is required for using these three guieded modes. Drone is able to manuever itself while moving to the way points. Return to launch position mode ensures safety in landing to it's original launch position compared to the unguided landing mode. Similarly if the radio connection is lost or the battery threshold is reached, drone will return to it's launching position on priority without following the mission assigned to it, thus making sure there's no crash landing in case of battery failure or connection lost.

However this drone cannot detect obstacles in it's path thus there is always a chance of crash during it's flight.

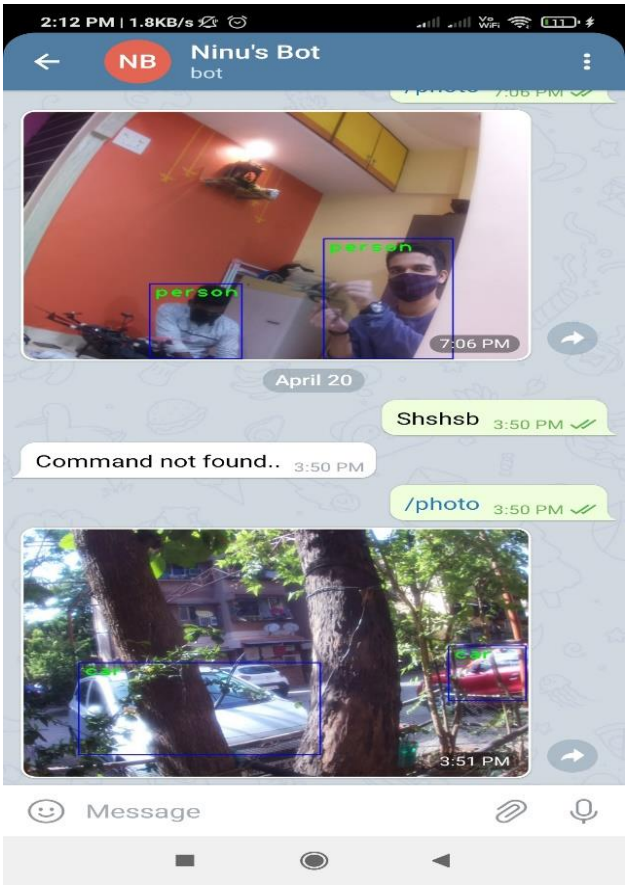


Fig -3.2: Telegram bot API

Figure 3.2 proves the correct working of telepot (telegram bot API) which works as a medium to send commands to the Rpi. Based on those commands the Rpi will respond. As visible, if any other command other than /photo is sent, the Rpi will quickly respond by sending "Command not found" to the user's bot. Only the specified command i.e /photo can be used for receiving object detected images. As seen from the figure 3.2 Raspberry Pi can quickly respond to the user's command in few milliseconds.

Successful detection and classification of objects, results.

Fig -3.3: Successful detection and classification of objects

Fig -3.4: Detection of car and pedestrains.

Fig -3.5: Detection of objects besides various obstructions.

After initiating the /photo command via telegram bot API the script running in Rpi for clicking pictures, performing object detection, saving the object detected image and sending it to respected user's telegram bot is executed. 80 objects can be detected present in coco data set since coco data set contains 80 classes. Figure 3.4 shows the successful detection of car, motorbike and a person standing near the shop who isn't adequately visible still the script has detected it. The accuracy for detection is set to 60% in the code, it can increased further. However increasing the accuracy is not recommended as the script doesn't prove to be much efficient then.

7. CONCLUSION

As per the design specifications, the drone self stabilizes using the pixhawk flight controller. It acheives stable flight and provides surveillance of the terrain through the camera mounted on it. The drone is controlled via remote whereas the communication with the raspberry pi attached to the drone is done via telegram bot API (for send-ing commands to the RPi) and vnc viewer (to get GUI of RPi) . Its purpose is to provide real time object detection on the pictures clicked by camera and send it to the respected user's telegram bot

from areas which are inaccessible to humans. It is easy to maneuvre, thereby providing flexibility in its movement. It can be used to provide surveillance through the usage of cameras. The system can be further enhanced for future prospects.

8. APPLICATION AND FUTURE SCOPE

As the title of this project says, this drone can be used for surveillancing a particular area (upto 800m) which can be used by military and local police authorities to sneak into enemy area for invading information and detecting targets. The police authorities have increased using UAV's for managing crowds during covid 19's lock-down, this drone can prove as a major help to them. Similarly it can be used to carry a limited amount of payload to some other location. This project can be further enhanced by adding real time video detection , adding sensors, deep learning algorithms to prevent obstruction and change it's course automatically. Further it can be also made to detect fire and extinguish it on it's own using deep learning algorithms and powerful processors enabling such tasks.

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