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Autonomous Unmanned Aerial Vehicle configured with Simulated Drone Environment

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ABSTRACT

Unmanned Aerial Vehicles (UAVs) have gained attention in recent times due to the automation and ease of operation. An Automated UAV called drone, maximises efficiency with its unlimited visibility and data gathering potential. This paper discusses the design and working of a fully autonomous drone system which when fed with Global Positioning System (GPS) could fly without obstacles as desired. A virtually created environment is used for simulation of drone flight. This automated system will be convenient to use with the facilities like halt at the desired location, travel to any distance, and visibility of distance travelled in simulation interface. This simulation when embedded with hardware, data backup, and storage through a virtual cloud could be utilised to its full potential in various industries that require minimal manpower and advanced technology.

1. INTRODUCTION

Unmanned Aerial Vehicle (UAVs), commonly called drones, has their applications on numerous fronts. This paper is to portray the configuration and design of an autonomous flying drone (UAV), particularly a Quadcopter. Using GPS tracking coordinates, the drone is programmed to accomplish automatic flight from source to destination. Developing a drone that could be guided using geographic coordinates has its share of challenges, the chief issue being its flight. The drone is propelled by four motors located at the ends of long arms that extend from a central hub. The flying controller and battery are housed in the hub so that their weight does not destabilize the drone's precise balance.

Additionally, the motors can't influence the pitch of the blades attached to them, consequently, their rotational speed is the only way to control them. Pitch, roll, and yaw are the three key parameters used to determine the orientation of a flying drone. This control system would not operate if the two motors spinning counterclockwise and two spinning clockwise were not present. By interacting with numerous GPS satellites, a GPS receiver on the central hub informs the drone of its present location.

The drone is also capable of flying in moderately windy circumstances. The paper's purpose is to serve as a proof of concept for autonomous flying drones that do not require manual control.

2. LITERATURE REVIEW

UMRao Mogili et al.[1] have discussed the Unmanned aerial vehicle (UAV) which is an automated drone used for agricultural purposes like spraying pesticides, crop monitoring, crop height estimation, soil, and field analysis. The Geographic indicator Normalized Difference Vegetation Index was used to examine data from the multispectral camera via telemetry.Results shown by it are - spraying jobs easy and faster, required pictures taken from a single flight and geographic location of unsprayed plants can be analyzed and reduced wastage of water,chemicals, and skilled labour. However,improving image processing techniques, lower costs and better battery life are not covered.

Bruno Areias et al.[2] proposed how a drone system can be operated without direct drone connectivity with the Ground control station and without any precedent knowledge over the configuration of the drone. Most of the drone flight requirements are automated. The navigation system and internal sensory data are structured as JSON messages and similarly tothe response system. Results shown include user-friendly control of drones and displaying sensor metrics during flight. Although, providing data gathering mechanisms and installation of thermal sensors are not covered.

Andrea Santangeli et al.[3] covered a semi-automated drone system used to identify ground nests of birds using thermal imaging with Artificial intelligence. This resolves the limitations of biodiversity surveys. A drone with a thermal sensor and a deep learning system has been used to spot ground nests of birds effectively and quickly. On training images, the neural network's performance began to consolidate towards significant levels after roughly 600 epochs, with 89.4 percent precision, 95.6 percent recall, 92.4 percent mAP, and 92.4 percent F1 at the penultimate epoch. Although, developing fully automated drones and maintaining the efficiency irrespective of factors such as weather and temperature are not covered.

Tobias Nageli et al.[4]propose a methodology for automated aerial videography using non-linear quadcopter drones for dynamic and cluttered location cinematic shooting. This allows real-time generation of multi drones. Done using virtual rails which adjusted and moved online following a 3d guidance path then formulated a receding horizon nonlinear optimization problem under constraints. Results show that Algorithms work for high-level user goals and physical feasibility providing collision-freepaths. However,control over the depth of field and focus points of the camera is not involved in the work.

Antonio Albanese et al.[5]cover drones being used for finding missing people during natural disasters. This can locate and rescue by approaching locations that are tough to locate while covering large distances in less time using mobile networks users' GNSS information. It employs the pseudo-trilateration approach, which relies on a lone anchor node, such as a UAV flying along a predetermined motion track to pinpoint a target user inside its cellular coverage. Results work for accuracy of victims being a few 10's metres close to the phones and locates and identifies the victims at low battery cost. Though, the installation of thermal sensing to perform image-based localisation is not covered.

Parvathi Sanjana et al.[6]have proposed the idea of using automated drones to deliver First aid kits to patients who do not have immediate access to medical facilities. They set the target latitude and longitude manually and used a basic drone to reach the target.

Gustavo Cedeño Bravo et al.[7]have covered an idea to use a drone to deliver first aid kits to athletes in case of minor health problems during outdoor sports events. The drone is also enabled with real-time audio and video to better understand the athlete's condition.

Raj Mohan et al.[8]have worked on an approach where the user who is under a possible threat can request drone surveillance in a secluded area by sending their GPS location and can be tracked until reaching a secure location. Their experiment where a drone was sent to the location showed the UAV based surveillance is a reliable and safe approach.

Markus Lieret et al.[9] proposed a software and hardware system which will use precise tracking to pick and drop the load in-house. In this, a drone is used to carry a small load from one place to another. For in-flight tracking of the drone a UWB tracking system is used.

Martial Sanfourche et al.[10] defined a system to precisely 3D model an area using video surveillance from a drone and object detection using interactive learning. This can be used for search and rescue purposes. Using an automated drone with a calibrated camera and GPS a model was prepared. In future, the addition of LiDAR can also be considered to improve the quality of the model.

Andri Rahmadhani et al.[11] have covered a drone delivery system using LoRa Wireless physical layer technology which uses LoRaWAN, a de-facto standard protocol for wide area network which provides a long-range communication system and it does also reduce the power consumption and increases the working range of the battery. Results portray the evaluation of limits of LoRaWAN protocol as a secondary communication mode. The results show that the system works fine for up to 8km in an urban area.

K.VV.M ani Sai Kumar et al.12 have developed a crowd monitoring and payload delivery drone that employs a quadcopter with an optimal flight control system that accounts for power consumption, noise, and safety. The suggested framework entails the use of quadcopter-based unmanned aerial vehicles (UAVs). The findings reveal that the Quadcopter was experimentally verified for 6 minutes with a payload of 250gm.

Malik Demirhan et al.13 have presented a Camera-Based Drone Landing System that makes use of a Raspberry Pi 3B+ and a wide-angle camera, as well as PID controls and a pole positioning mechanism for settling. A real-time image processing method is being used to determine landing marks. The study revealed that the landing site was detected accurately using a position control procedure at 20 hertz.

Gang Xiang et.al.[14] have discussed a Life-Ring Drone Delivery System which sends life-rings to casualties rapidly than a lifeguard during rip currents. The utilisation of an octocopter with the right size, power, and endurance enhances the likelihood of a good rescue between 92.3 percent to 99.3 percent. The outcome demonstrates how such an octocopter with a 1000 mm wingspan and an overall mass of 10.2 kg, powered by a 20000 mAh battery, may assist in the predicament.

Jun Shao et al.15 developed an Ant Colony+A* Algorithm-based drone delivery platform that utilizes battery swap stations and servicing waypoints to provide protracted delivery options. To prevent nondirectional searches, the A* algorithm has been used. The outcome demonstrates that the execution was accomplished in a restricted context.

3. METHODOLOGY

The hardware and software components of the drone's design are separated into two major groups. The focus of this research article is on the software component. The software part includes a Linux system running inside the raspberry pi module which will be connected withthe flight controller module of the drone and that will send the control signal to the drone in order to execute the smooth functioning of the drone.The Linux operating system will be running a python script capable of flying the drone in fully autonomous mode including taking off,travelling to and from the desired location,landing and returning back to home(Figure 1).

Here the same python script is run on a virtually created environment that will mimic the real-life scenario of flying a drone. This virtual environment includes repositories from Ardupilot and configuring it with a simulated drone environment (SITL). The SITL receives the controlling signal from a Python script, and it makes the simulated drone do the same.

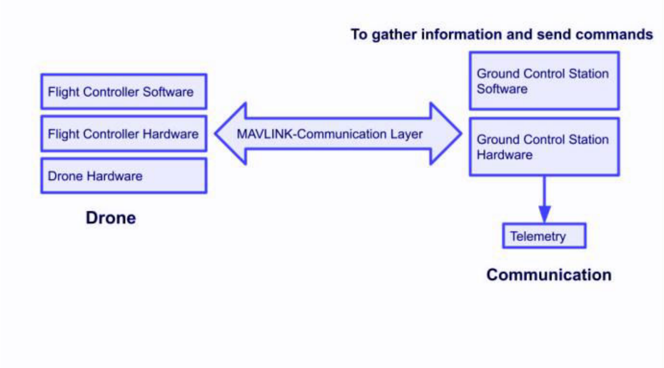

Figure 1: Design

Then the python script communicates with the simulated drone through mavproxy and mavlink protocol on “UDP port” of 5501,5502,5503 and “TCP” port of 5760 and 5763 (Figure 2).

A python file is used for launching the SITL in order to simulate the drone. Since this whole thing is running on Linux, launches the simulation manually (Figure 4) by giving the command "sim_vehicle.py --map --console".

--map to launch the map in order to see the real-time position of the drone

--the console is to come up with a terminal that shows real-time data of the drone-like height,position,battery percentage,velocity,latitude, and longitude.

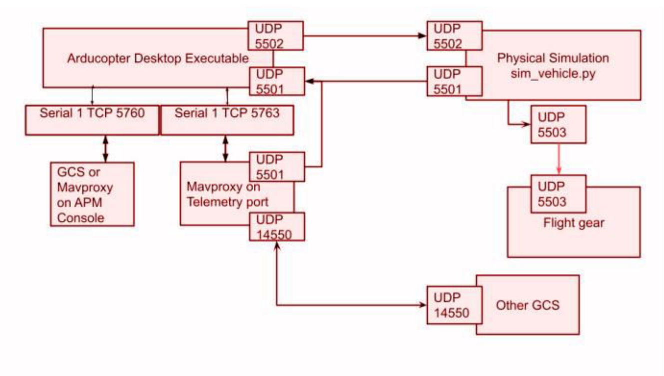

Figure 2: Working of the Automated Drone System

After launching the simulation, the python code can be run which will automatically control the drone by sending the signals to perform a certain action and provide the drone with a path to follow in order to reach its destination and return back to the source. This python script communicates on the “mavlink” protocol as stated above (Figure 2). The flight controller is embedded with a GPSthat helps provide the real-time position of the drone. The coordinate of the drone (Figure 3) is then sent to a python script (Figure 4) running in the background to make a path that has to be followed by the drone.

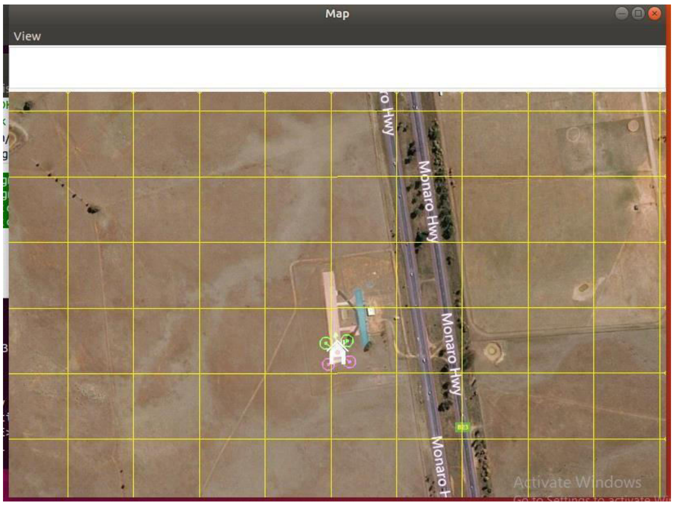

Figure 3: Map

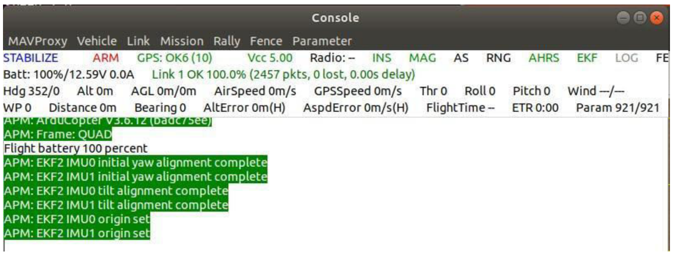

Figure 4: Console- Initiating on MAXPROXY Terminal

4.RESULTS AND DISCUSSIONS

After careful observation and research, above stated discussions reveal a simulated quadcopter capable of receiving a GPS point via a Computer and attempting to navigate to that coordinates using the created programme successfully demonstrated.a simulated quadcopter that is capable of being given a GPS coordinate using a PC and attempts to fly to that coordinate by running through the constructed program successfully demonstrated. This simulation is fully automated, and it can fly up too many kilometres of distance without being manually controlled through radio controllers (Figure 5).

The height given by the script is 100 metres for testing purposes. It can be seen at an altitudeof 99 metres in the console (Figure 5).

Figure 5: Initial position after taking off

The quadcopter can travel from source to destination following the latitude and longitude coordinates given (Figure 6).

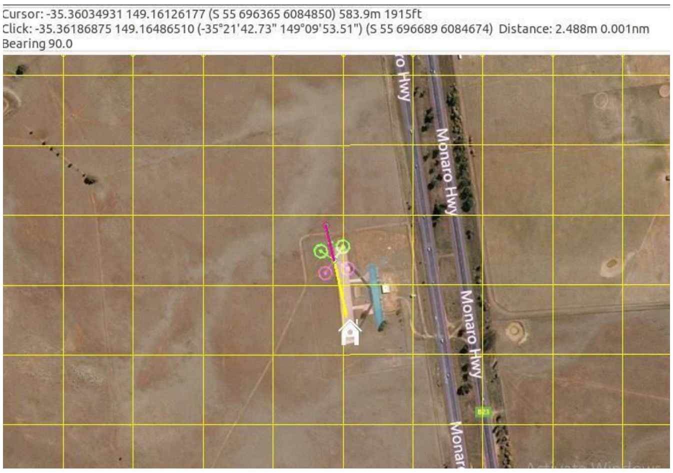

Figure 6: Traveling From source to destination

It can be stopped at the desired location after reaching the geographic coordinates of the destination (Figure 7).

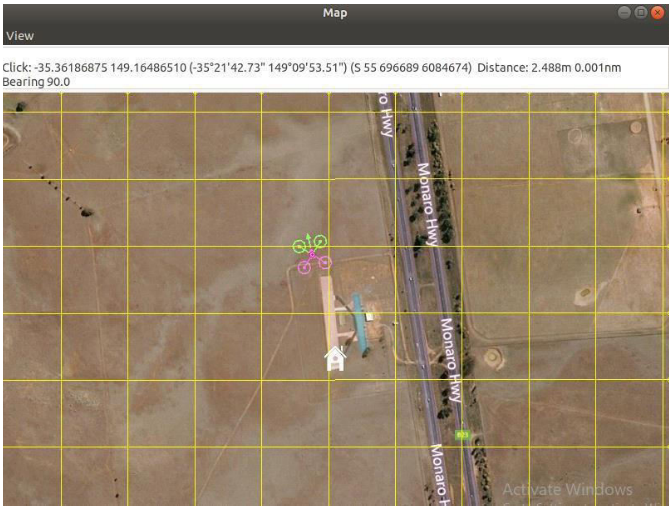

Figure 7: On the desired location

After finishing the task desired the quadcopter can be brought back home using the same method (Figure 8).

Figure 8: Returning from destination to source

Therefore, the following results were seen

- Successfully flying the drone from source to destination
- Flying up to any kilometre of distance without radio controllers
- It should be sent and brought back through the path
- Viewing the distance travelled in the simulation
- Stopping at the desired position

5.CONCLUSION AND FUTURE SCOPE

The work shown here is a design for an automated flying drone (quadcopter) that uses a GPS tracking system to fly from one position to another. The novelty shown through this research paper is how it can be made possible for the drone to be simulated to fly to the GPS coordinate given automatically without manually being controlled. It can be used in medical services as a monitoring system. Although a lot of AIS based drone systems exist, GPS guided drones put forward challenges while the research work tackles those and is unique in its own way being autonomous, that is a fully automated drone system without any manual radio controls, but by using python scripts, arducopter simulator, simulated drone environment. After embedding this whole system into hardware, it can be extremely useful such as in medical services, disaster management and as a monitoring system. After integrating it with the cloud system, this drone can travel more than 50 to 60 km without facing any problems.

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