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A Design for Use Cargo Dron

Christian Rene Castillo Carvajal[1], Octavio José Salcedo Parra[1, 2] and Miguel J. Espitia R.[1]

[1]*Internet Inteligente Research Group-Faculty of Engineering-Universidad Distrital Francisco José de Caldas, Bogotá D.C., Colombia.*

[2]*Faculty of Engineering - Universidad Nacional de Colombia, Bogotá D.C., Colombia.*

Abstract

This paper contains the simulation of a family dron (quadcopter-cuatrorrotor) with the objective of implementing, through software, an unmanned apparatus for specific use of cargo, with which it can be used for different military, academic, investigative tasks and supplies for areas of low accessibility, where it uses the programs Mavproxy that simulates the dron, which provides the characteristics of this through the protocol MAVLink and the Mission Planner who is in charge of giving instructions of the mission entrusted. Therefore, the simulated unmanned aircraft in MAVLink requires the modification to carry additional load and this is done by means of the promagation to be able to perform an analysis of the behavior of the unmanned airplanes with different loads.

Keywords: Cuatrorrotor, Drone, Mavlink, MAVProxy, QuadCopter, Mission Planner, Simulation, Software.

INTRODUCTIÓN

Unmanned aerial vehicles are not a recent technology, since in the First World War there was a first approach where man did not have to pilot a warship or spy. For the Second World War the drones were used for reconnaissance at high altitudes in enemy control. Therefore the word drone is not current, with time has been reforming that idea with respect to the technology that was appearing.

Drones have now been used for various purposes having as axis the applications to which they can be used. For the particular case of serious military research, since the technology, the development and the advances of these are strongly linked with the military industry.

For this reason a cargo drone would be very useful to carry supplies to the troops in the combat zone without losing human lives due to a possible air attack or also for the transfer of troops from one place to another more quickly; with the development of a drone that can load up to half a ton of weight.

BACKGROUND

In [1] the authors consider that the unstructured and unknown environments for drones through systems or techniques of dynamic planning allow to carry out the mission entrusted in the best way.

In the work of Iglesias, Mario A. Lamborie [2], reference is made to the large number of drones that military forces have been using and with which they have been used in attacks in countries such as Pakistan against the terrorist group AlQaeda. In this type of drones for military attacks you must have considerable capacity to transport a certain number of missiles or artillery and carry out your mission successfully. From this work you can analyze the number of missiles, the weight of each of these and thus determine the carrying capacity of this type of drones.

The authors in [3] start from the usefulness of drones today to operate in dangerous places and thus keep the people who operate them safe from any danger they may encounter. They conclude that the problem of drones is given by weight capacity that can transport from one place to another and assert that the drone quadrotor, or a drone with 4 turbines or 4 helices, is the indicated transport weight.

In the thesis of degree [4] they describe the way in which a C-130 aircraft of the Ecuadorian Air Force can be supplied with more electrical capacity to guarantee the different tasks they use. Therefore it would reduce problems in flight of loss of electric charge. This process can be applied to a drone to increase its flight time.

In [5] the authors of the thesis of degree, try to distribute the load on the plane because the weight affects the center of gravity that initially has this. This way you can estimate the type of load that is carried and how this load is distributed by the aircraft. In the drone a load sheet must be made since this will indicate in the best way the position of this inside the vehicle.

The author of [6] speaks of a drone that has 4 rotors, in which he alludes that they are difficult to maneuver due to the instability that can occur, for which he compares various types of control techniques for these drones. This would be of great use in a cargo drone which has to take off from an area, where there may be a risk of collision or by the situation that is found and also as to what will be transported as cargo, it may be from something vital as water or supplies, as people or even and not disposable volatile material which means having a good control of takeoff to avoid any accident.

In [7] the author mentions one of the most important aspects for aeronautics, pressurization, since a plane at high altitudes must be pressurized by the atmosphere since the pressure of it becomes increasingly low, so that within the airplane must contain oxygen from certain heights. A cargo drone that reaches these altitudes should be prepared for these situations.

The authors in [8] consider that the GPS of the drone has an error of more than 10 meters in the location of the chosen point, for that reason they infer that the use of a camera in the drone can give greater reliability to the location of a drone; with the GPS you can go to a coordinate and depending on the camera you can land in case you require it with much more precision. Therefore, in a cargo drone, it would be useful to have a means to lean on to have the full certainty that the entrusted mission would be carried out with greater probability of success.

On this website [9] is one of the largest projects carried out for commercial transport, or transport of people, which provides information on the largest aircraft that can be used in the implementation of the cargo drone.

Rodríguez, Eugenio in [10] Talks about the 10 largest military cargo planes for the year 2014 (Antonov AN-124 Ruslan, C-5M Super Galaxy, C-17 Globemaster III, Antonov An-22 Antei, A330 MRTT, Xian Y-20, Ilyushin Il-76, Antonov An-70, Airbus A400M Atlas, Kawasaki XC-2) where the military forces of the countries that own those aircraft use them to transport heavy equipment, supplies or troops anywhere of the planet, since these planes have a large fuel tank allows them to fly for a long time, thus achieving long distances between continents.

In [11] they consider a drone developed by Amazon with which they want to make deliveries through them, which has served as a marketing maneuver. To achieve this goal, the company has requested permits from the FAA.

The projects airlander 10 and airlander 50 [12] are zepelins that are born from a past where they were used as transport of people. However, at the beginning of the first world war these are used as weapons since being able to carry cargo inside it becomes an ideal aircraft to carry bombs from one place to another.

According to [13] the idea of creating "drones" was in need of developing "something" that will militarily help the United States in the world war and in order to attack military targets, carrying bombs and being maneuvered to large distances by radio waves.

The drones have evolved, techniques have been applied so that pilots get to have more aptitudes when facing the enemy, with this it was not thought that the drone was going to supplant the man in flight, for the use of the aerodynamics and possible losses that may occur in combat [14].

In [15] it can be observed how a drone is used for the visualization of the terrain by means of taking a photograph and laser point from the air. If a drone becomes a cargo drone, it must carry a camera to take photographs at a considerable distance, it requires a powerful camera plus the laser, so the importance of the drone being used has sufficient capacity to hold this weight with him.

In [16] an author of a cargo drone made by a Mexican in Scotland is mentioned, which due to its low cost allows to reach more people than a drone normally arrived and this one has the purpose of distributing medicines either in a natural disaster in places that are not very accessible.

In [17] they show the public a drone that is capable of transporting medical equipment such as the defibrillator and other devices in case the person is in a bad state of health, for which this drone is capable of carrying more weight than this is already being made useful for society in a very particular and urgent use, given that a person suffers from the heart and requires immediate help from specialized teams.

METHODOLOGY

The methodology to be used will be related to the standards marked by software engineering.

For the methodology, a series of steps will be used consisting of software installation of both the drone simulator (MAVproxy) and the flight simulator (Mission Planner).

For the installation of the MavProxy, a virtual machine is required, either Linux or Windows. [18]

Figure 1. Virtual machine for drone assembly. Source: Authors

This will serve as a connection server where it will work instead of a physical drone, having the same mechanisms, functions.

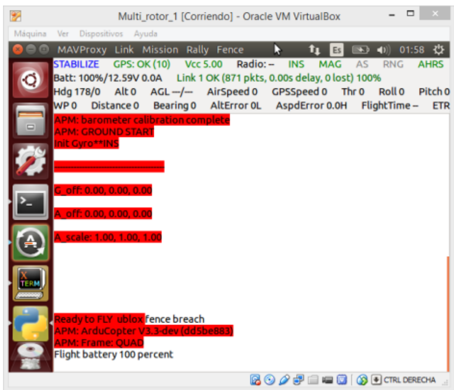

Figure 2. Functions of a drone in the MAVProxy software. Source: Authors

However, it does not have one of the functions that most drones possess: the camera, since this is in real time where the drone is monitoring and does not have the option to load, being a "normal" drone. Since this is a free software where the source code can be modified, it is necessary to determine how the drone simulator can present the load option.

The flight simulator, in this specific case, will be mission planner.

Figure 3. MissionPlanner software. Source: Authors

This software does not require many pc requirements, since this will serve as the connection client to the server. After this, the connection between the two softwares will have to be established, which will be through the MAVLink protocol.

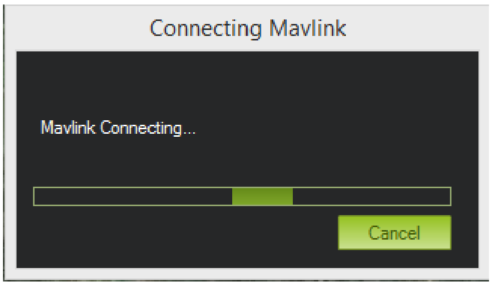

Figure 4. Connection using the Mavlink protocol.

Source: Authors

In this connection the flight simulator receives all the parameters of the drone, with which the drone control would already be in the flight simulator.

With the drone connected to the flight simulator we proceed to give you the instructions required for the desired mission to be performed, starting from the home location (home, place of departure) where the drone was located to start performing the task in charge.

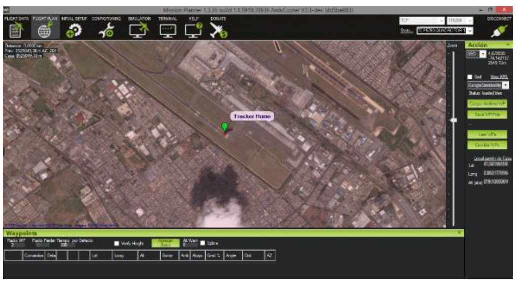

Figure 5. Scheme of the Flight Plan. Source: Authors

IMPLEMENTATION

In the revision made of the mavproxy source code there are two .py files in Python language.

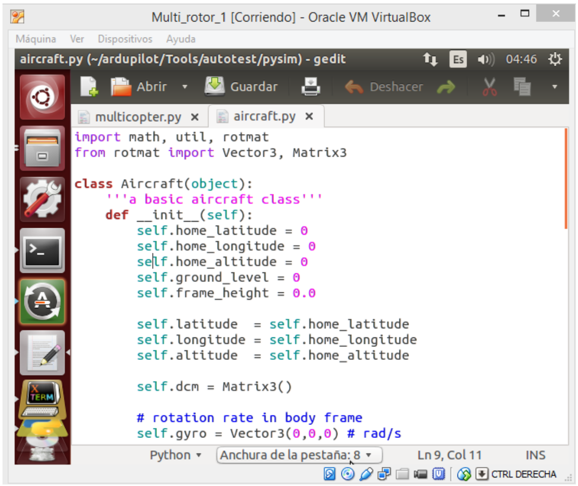

Figure 6. Python language files (Aircraft). Source: Authors

The aircraft that determines an abstract class of which any plane can have, however since it is an abstract class, it can not be modified since only one quadrotor or four engine type drone is required to be modified.

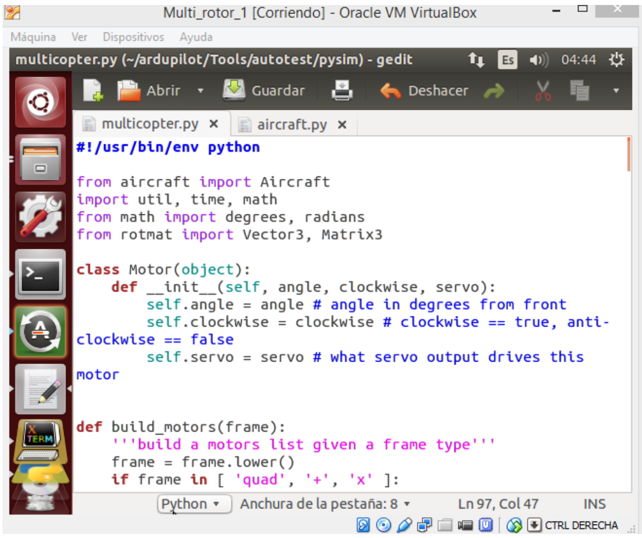

Figure 7. Python language files (Multicopter). Source: Authors

In the previous image it is shown, the code of the quadrotor called multicopter, in this code it can be seen that it is possible to add from 4 to 8 engines, so in the specifications that are given when compiling and running the code for that is a drone is ./copter.sh, this is done in the terminal so that the drone is of 4 motors.

To introduce the load parameter to the drone it is necessary to make an analysis of the source code of the drone drone in order to determine where to insert the load.

```
class MultiCopter(Aircraft):
    '''a MultiCopter'''
    def __init__(self, frame='+',
                 hover_throttle=0.45,
                 terminal_velocity=15.0,
                 frame_height=0.1,
                 mass=1.5):
        Aircraft.__init__(self)
        self.motors = build_motors(frame)
        self.motor_speed = [ 0.0 ] * len(self.motors)
        self.charge = 0.0 # Kg
        self.mass = mass # Kg
        self.hover_throttle = hover_throttle
        self.terminal_velocity = terminal_velocity
        self.terminal_rotation_rate = 4*radians(360.0)
        self.frame_height = frame_height
```

Figure 8. Initial parameters of the drone with load. Source: Authors

```
        # scaling from total motor power to Newtons. Allows
the copter
        # to hover against gravity when each motor is at
hover_throttle
        if self.charge <= 25000.0:
            self.thrust_scale = ((self.mass+self.charge)
* self.gravity) / (len(self.motors) * self.hover_throttle)
        else:
            self.thrust_scale = (self.mass *
self.gravity) / ((len(self.motors) * self.hover_throttle) +
self.charge)
```

Figure 9. Condition for the weight of the drone. Source: Authors

In this fragment of code is where the drone load becomes effective and it can also be observed that in the final part there is a decision making, this in order that if the load of the drone is exceeded it can not take off. However, he may keep trying to get up off the ground but he will not be able to.

RESULTS OF IMPLEMENTATION

For the implementation of the cargo drone in Mavproxy, a revision was made of the code that contains this and it was possible to find the way to introduce in this the loading parameter, since the planner mission does not have a load request, the code will have to be modified to give the local charge to the drone that is desired.
As it is not known what happened when introducing load in the code, it will be tested giving it increasing values to see the behavior and thus be able to determine the maximum load in which the drone can support.
For this, a flight plan will be made for all the drones in which they will look to where they all arrive and start from there for comparison.

Figure 10. Flight plan for drones. Source: Authors

You can visualize the points where the drones will pass, and thus be able to determine what factors each of the drones reach.

Drone 1

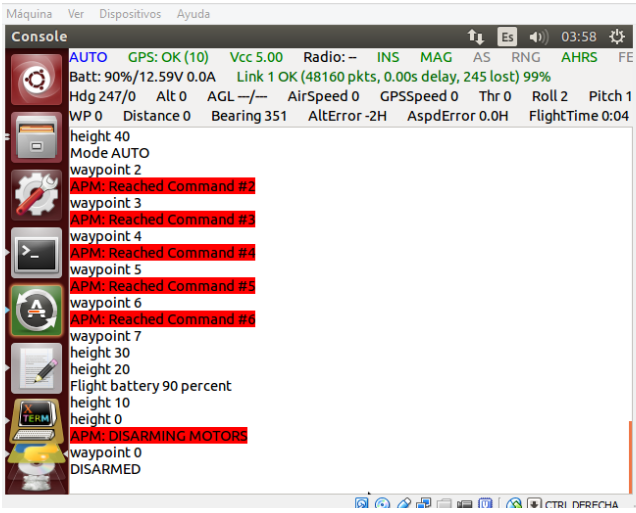

Figure 11. Drone 1. Source: Authors

With the weight of the drone: 1.5 kg, and a load of 0 kg it is obtained that the drone only spends a little more than 10% of battery.

Drone 2

For the second drone with a load of 5000 kg it responds in a good way, and as far as its battery lasts less than the other one since it can be seen that in waypoint 4 it has already worn 90% of the battery.

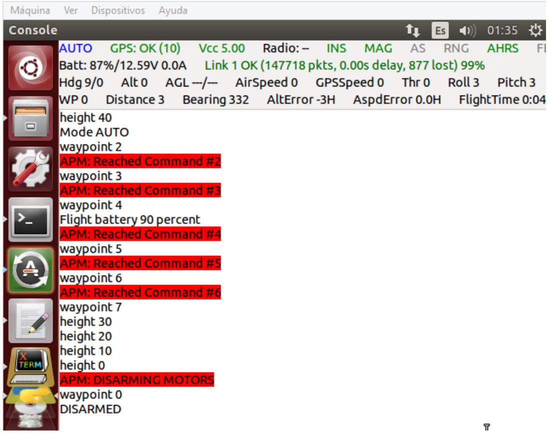

Figure 12. Drone 2. Source: Authors

Drone 3

For the next drone a load of 15000 Kg was used, which shows that the battery lasts less than the Dron2, so the load makes the drone have to use more power to take off and to be in the air. which the battery cycle is quite low.

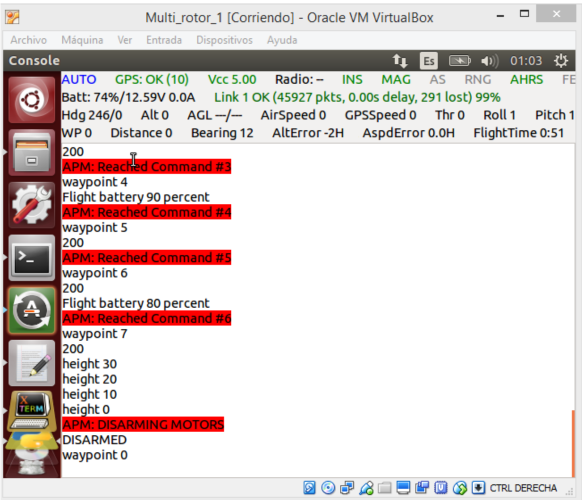

Figure 13. Drone 3. Source: Authors

Drone 4

It was also experimented with a drone where more load (30000 kg) was applied than in code 2 (25000 kg) and thus be able to visualize its behavior with respect to the previous three. However, it should be noted that the simulated drone does not have a real time or variables that could affect its performance, such as rain, intense sun, wear and tear, and even air resistance.

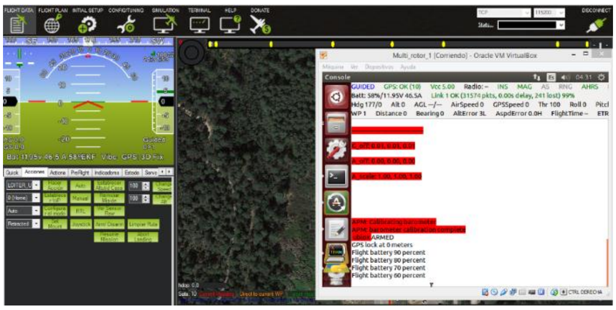

Figure 14. Drone 4. Source: Authors

With the weight of 30000 kg the drone does not have the capacity to take off and reach 50 meters to initialize the proposed flight plan, for which this simulation is limited to 25000 kg of weight for a drone.

DISCUSSION OF RESULTS

As for the visualization, Zhu [10] In Introducing Google Chart Tools and Google Maps API in Data Visualization Courses presents an article that pretends to be a practical guide for the visualization of data and visualization of information through web tools, this guide was Of great utility to the time to be able to connect the application with the API of google maps and to be able to draw the different maps and markers, also had utility at the time of geo locate coordinates, but in none of the related works was found information to be able to draw Heat maps and progress bars which were of paramount importance for users to be able to optimally visualize the results and thus be able to interpret and make decisions.

In the following table (see Table 1) there is evidence of the route that was obtained with the battery percentage of 90% for all drones with their respective weight.

Table 1. Distance by battery to 90%

Charge	Battery	Waypoint
0.0 Kg	90%	7
5000.0 Kg	90%	4
15000.0 Kg	90%	4
30000.0 Kg	90%	1

It can be seen that in the waypoint 4 trajectory the drones with a weight of 5000 kg and 15000 kg coincide, however it is necessary to clarify that at this point the lowest weight drone before the battery reached 90% was about to come out of the waypoint while the highest weight just at the entrance of the waypoint reached 90%.

While in the other two cases it is noted that the first drone without load reaches the end with a battery of 90% while the drone that exceeded 25000 kg load can not take flight (See Figure 15), where it is seen how It is unloading the drone as it tries to take off.

In Table 2 you get the percentage of battery with which the drone already ends its journey, giving rise to the total battery spent on the flight it made and the effort it made to finish.

Table 2. Battery with which the loading drones end

Charge	Battery	Waypoint
0.0 Kg	90%	7
5000.0 Kg	87%	7
15000.0 Kg	74%	7
30000.0 Kg	0%	1

Table 2 shows that the drone with the load of 5000.0 Kg ends with a higher percentage than the next weight, for which it is noted that it makes less effort for what it carries, however the drone that exceeds the load limit is see that it is discharged without being able to reach the desired height and, of course, the route proposed in figure 8.

CONCLUSIONS

The results show that the cargo drone, having more weight than usual, spends more battery for the "effort" it makes, thinking logically that these results were simulated, however applied to a physical drone, force would have to be changed takeoff of these that would be the engines, since this factor greatly influences the takeoff of the drone.

To this is added that not only the takeoff of the drone but also the takeoff must be controlled by a stabilizer proposed by Oscar León Bustos Angarita [6] a method of stabilization for a quadrotorrel drone that is used in this article to perform.

It can be seen how with the passing of time man has looked for ways to transport himself from one place to another, this has led him to give him a current perspective of using the technology available and idealizing an airplane in which he is not manned and instead it is controlled at great distances, for this it requires cameras with which the one who controls it can see in real time what the drone sees and thus act at his disposal.

A drone has many pieces as well as a manned plane, such as GPS, engines, combustion that in this case would be the energy that gives the solar cells or a battery, telemetry, sensors, software already done and previously tested and proven to work in the device, either to perform different activities that the human can not use so easily and thus be able to streamline processes and time, as mentioned in "drones and their applications in civil engineering." [19]

Drones today are seen as toys for young eccentrics that the only thing they see in this is a new way of taking pictures or video, while for others they see them in the future of airplanes, in which drones have already been made of cargo either to be used militarily or to help other people; militarily they are being used as weapons to get faster and stealthier to places that are inaccessible, while to help other people like an ambulance that due to land mobility issues may encounter problems to arrive in time to places where there may be traffic , being a solution the drone since this when flying would not have impediments to arrive at the place, nevertheless one would have to have an extreme precision in the conduction of this so that it did not come to hit with the same people who are in the place or even with homes when landing.

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