AUTONOMOUS LONG-RANGE SOLAR PLANE FOR CONNECTIVITY TO REMOTE AREAS AND/OR NATURAL DISASTER

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I. ABSTRACT

AUTONOMOUS LONG-RANGE SOLAR PLANE THAT MAINLY PROVIDES CONNECTIVITY TO REMOTE AREAS AND/OR NATURAL DISASTER AREAS, AS WELL AS THE POSSIBILITY OF SURVEYING THROUGH THE TRANSMISSION OF IMAGES IN REAL TIME, OPENING COMMUNICATION WINDOWS IN AREAS COMPROMISED BY ANY EVENT CLIMATOLOGICAL, DIFFICULT TO ACCESS OR REMOTE DEPENDING ON THE AREA WHERE YOU ARE MOVING ACCORDING TO THE FLIGHT PLAN.

II. INTRODUCTION

Every year, the world is shaken by the passage of phenomena and events of natural origin whose effects change the daily life of human beings. and they often lead to the unpredictable loss of life and property. Various types of natural disasters, such as geophysical (earthquakes, tsunamis, volcanoes, landslides, avalanches), hydrological (flash floods, debris flow, floods), climatological (extreme temperature, drought, forest fires), and meteorological (tropical storm, hurricanes, sand storms, heavy rains), among others, have caused losses of many lives in addition to increasing material losses.

In the face of mobility, transport and communication adversities caused by these natural events, the use of drones is of great importance thanks to its ability to cover large areas, providing WIFI communication and video in real time.

Currently, the most widespread methods are drone surveys and also satellite images for which there are companies that provide services and commercial aerial monitoring equipment.

On the one hand, drones have the advantage of flying at low altitudes, at times and days specified by the client, they can fly on cloudy days, measurements can be repeated, etc. However, the main disadvantage is that their flight time is short and therefore they are used in small areas.

Contrary to drones, satellite images have great coverage, low cost of images, but with the disadvantage that the frequency in which they are taken is not defined by the user and before cloudy day conditions it is not possible to capture information.

Therefore, a platform that has the advantages of a drone and can cover large when the user has it would be the optimal solution (Boyd, 2020). Currently, there are some experimental drones (Atlantiksolar, 2012), and commercial ones (Sunbirds, 2020) that meet these requirements, however, their cost is very high.

In this proposal, a drone plane called “Hawkeye” presented in Fig. 1 is proposed, with autonomous and low-cost flight using solar energy to replenish the charge of its batteries and make long-range flights, with an open source autopilot system necessary for the drone to operate.

Figure 1. Proposed drone aircraft "Hawk Eye" (Ojo de Halcon)

III. SYSTEM DESCRIPTION

The autonomous drone plane mainly uses the energy of the sun to fly, allowing the capacity of flights to be increased to more than 12 hours, improving endurance and helping a drone fly longer without charging more weight on batteries.

Through photovoltaic technology we have an alternative energy available to recharge the batteries during the flight of the drones, added to the possibility that the drone uses energy from the atmosphere to gain altitude (regenerative soaring) and use the same motor as a generator taking advantage of the potential energy of the height gained (Catuogno et al., 2018).

Figure 2. First Prototype LCA-FICA-X03

The controller of the "Hawkeye" consists of the hardware open source controller "Pixhawk 4", which is in charge of carrying out the autopilot with different algorithms that provide guidance, navigation and control of the drone-plane.

In this application, the controller will receive the roadmap previously established on the map and will also receive instructions from the microgrid's energy manager depending on the state of charge of the batteries and available atmospheric conditions as observed in Fig. 3.

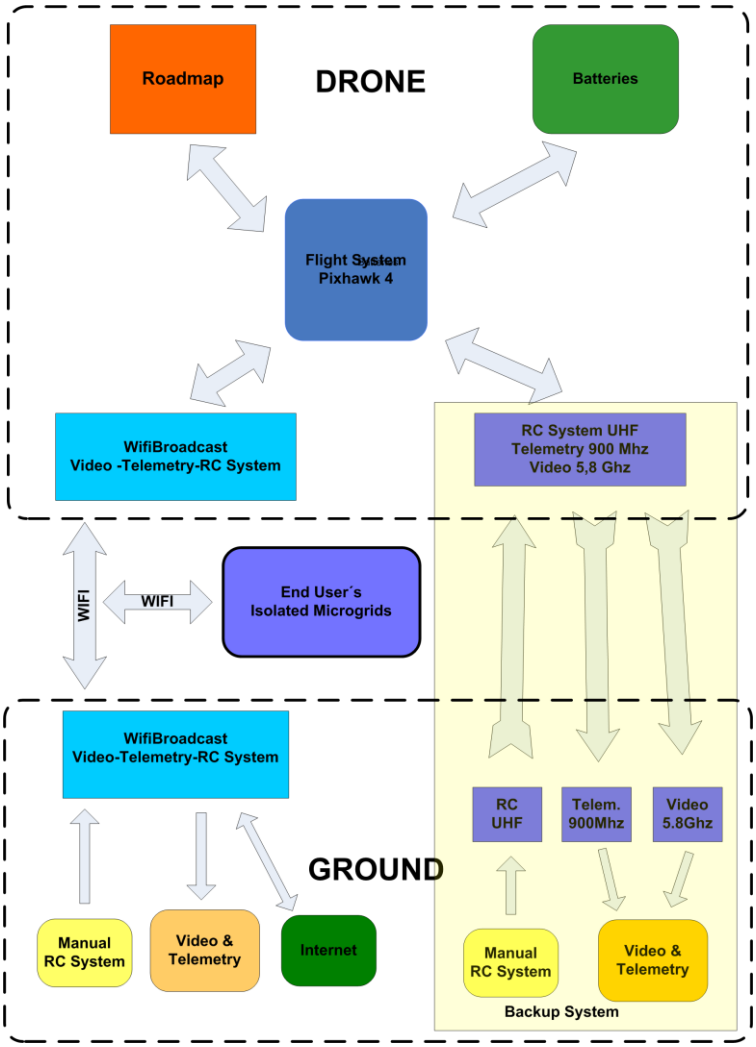

Figure 3. Block diagram of the airplane-drone control.

On the other hand, HD video signals, telemetry and WIFI access point are implemented using opensource wifibroadcast technology, using a raspberry PI. This communication also allows the aircraft-drone to be operated in manual mode, Fig. 4.

Figure 4. Airplane-drone communication system

Finally, as seen in Fig. 3, the drone-airplane has redundancy in the flight control system by means of a traditional RC radio, with long-range telemetry and analog video, allowing to have a backup to control the drone-plane in manual/automatic mode in case the wifibroadcast communication goes down.

IV. APLICATIONS

Throughout history, many natural disasters have happened. On these occasions, a high and disproportionate number of losses are generated, both in property and human lives. Likewise, there is a health problem that increases healthcare needs. The introduction of drones in cases of emergencies would speed up and facilitate assistance. These devices are equipped with high-resolution and infrared cameras, which is an important help for the emergency team in the tasks corresponding to the initial sweep of the area, in order to delimit it and facilitate its beaconing, since they provide a new point of view when analyzing the place from the air. Moving around an area on foot or in a vehicle was often a challenge due to debris. Using an aerial technology will facilitate the response to this type of disaster: automated unmanned vehicles (UAVs), commonly called drones. These affordable and portable aircraft can be quickly used in dangerous situations to locate survivors and send information about their location to ground assistance services.

The power of drones

The benefits of these unmanned spacecraft in an emergency are range, speed, safety, and cost. When there is no electricity, a UAV can fly in the dark and transmit live night vision images to people on the ground; your route is automatically programmed so that you don't miss a single site. A mounted infrared camera can detect thermal body signals and pinpoint survivors' locations so rescuers know where to go.

Unlike unmanned helicopters, drones emit low noise and can be equipped with advanced audio devices to detect sounds difficult to hear. They can enter dangerous situations that would pose a risk to pilots or emergency workers on foot.

Disaster response is just one of the uses that public safety agencies can make of drones, and unmanned aircraft have been created specifically to help fire departments gather information during the wildfire season. Thermal imaging can be used to see through smoke, and UAVs can enter areas that would be too dangerous for manned ships.

A. Initial Aplication

The idea of the development of the aerial platform arose as a necessity for the study of the growing problem of the "New River" in the Morro basin (Province of San Luis - Argentina), Fig. 5, which was declared in environmental emergency by the Province in 2016 (Goñi, 2018), where erosion occurs in the form of “sapping”, an erosive process generated by groundwater, which causes collapses and causes canyons. In the phenomenon, the water does not dig from the top down, but from the bottom up and where the changes in the basin and canyons formed by the water channel are almost daily, it is essential to keep under constant monitoring these changes that are occurring to be able to act preventively in case of overflows, road cuts, etc.

For this, it was necessary to develop a monitoring platform that could cover large areas, and at a low cost, that would allow online photographic and video surveys to be carried out if necessary.

Figure 5. New River in Argentine (Source: The Guardian)

B. New Aplications

The prototype developed was made for a specific purpose, described in the previous subsection, however, as the project progressed and without neglecting the main objective, multiple applications were developed in parallel that can quickly be adapted to the platform for other uses.

a) Natural Disasters

WIFI

When disaster strikes, the most important problem that must be solved is preserving human life. In this context, the first 72 hours after the disaster are the most critical.

Providing Wi-Fi connectivity to remote areas and/or natural disaster areas is vital to keep residents who do not have other types of communication systems in communication.

The drone plane would cover pre-established routes at high altitudes (above the clouds), opening communication windows for the different areas through which it travels.

Figure 6. WIFI service in natural disasters

VIDEO

Possess the ability to make reconnaissance flights with installed cameras that would transmit the information live in real time to users located in the same area where the drone is flying, for monitoring areas of climate disasters, such as floods, fires, etc.,as it can see in Fig. 6 and 7.

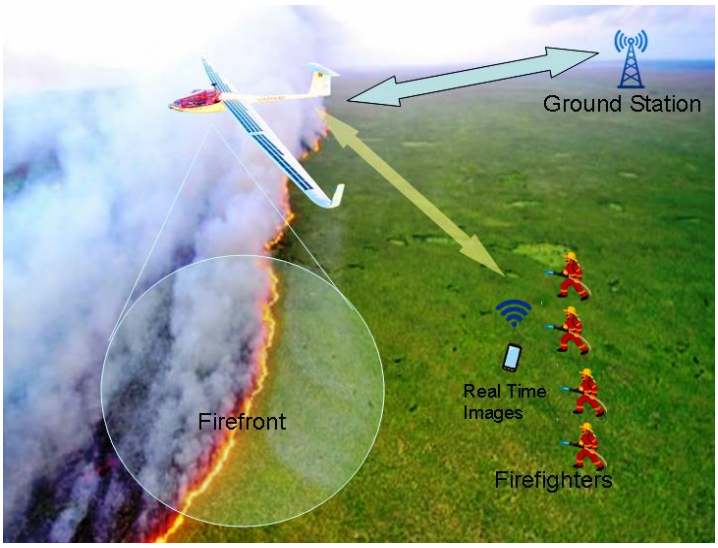

Figure 7. Image and video service in natural disasters

In this case, the drone-plane could descend from the cruising flight height to make flights below the clouds if the situation requires it.

In the specific case and fires, the drones can be equipped with infrared cameras to have a vision through the smoke, as well as sensors to detect the direction of the wind and other climatic variables that influence the spread of forest fires. Their versatility allows them to travel through confined spaces where helicopters or planes cannot fly. Likewise, they move a short distance from the ground, which allows capturing high-resolution images.

Another advantage they provide is the low price per operation. Although we know how expensive drones are, compared to the traditional means used so far, the savings are substantial.

Drones are very useful against incipient fires, since they can help detect other fires in nearby areas early, know the potential of the fire and above all offer information in real time that will allow you to make the best decisions. Thanks to the information and alerts provided by the drones, the emergency services will be able to know what type of operation to send and where to attack the fire. In this way, it reduces the risk of loss of human life.

b) ***Survey of isolated Microgrids***

Use their connectivity to conduct telemetry surveys for isolated microgrids in rural areas with difficult access, as well as for isolated wind generators, Fig. 8.

Figure 8. Service for monitoring and surveying isolated microgrid data

V. CONCLUSIONS

This work presents the advances in the design and implementation of a low-cost drone aircraft with open source technology that provides solutions to current social problems.

The great strength of this communications platform is that when flying at high altitudes and at low speeds, the communication time windows for remote areas is quite large, which would allow users to use WhatsApp or similar communication programs for time. to send and receive messages and offer in the event of natural disasters to users of the Government, Fire, etc., the sending of images in real time at the place of operations transmitting to the cell phones of users who connect to the air platform that fly over the area at that time recording images and video.

Fig. 9 shows an image of the first prototype LCA-FICA-X03 during the first tests.

Figure 9. Hawk Eye

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