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Wireless Aircraft Design Proposal to Benefit the Search and Rescue of Climbers (SAR)

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Challenge Category: Flight to the Stars
Challenge Chosen: Wireless Ship

Summary
This paper proposes a low-cost wireless aircraft design to assist the search and rescue operations of mountaineers in Aconcagua, making searches more efficient, cheaper and providing assistance through AI (artificial intelligence). This design promises to satisfy this growing demand in this activity. This wireless design does not use cables or connectors for its operation. These characteristics added to the problem of searches and rescues of climbers make the wireless aircraft a disruptive technology, would reduce by 95% the flight hours of a traditional search and rescue operation and by 83% the costs of the same in a year on Aconcagua.

1. Introduction

In recent years there has been an increasing number of deaths of climbers in mountainous areas and interventions by rescuers, such as Aconcagua and Everest. These are mainly caused by altitude sickness and other medical factors (Zavala Tello, 2019; Butcher, 2019). We can reduce these statistics by detecting potential risk cases using predictive algorithms (AI) and achieving efficient rescue through the use of a wireless aircraft.

Currently these search and rescue operations are very expensive and through this innovation will optimize operational time. The wireless aircraft will reduce the number of deaths and also does not require high economic values for operation.

This project is located in the context of Mendoza, Argentina, as the Aconcagua (elevation 6,962 m), the highest mountain peak in America, is located. This aircraft design but with appropriate modifications can be taken globally.

The following section details the proposed design.

2. Development

The description of the design will be specified in the "characteristics" section and the analysis of its convenience and economic viability will be detailed in the "estimation of time and costs in search and rescue operations" section.

A. Characteristics

After studying the problem posed by the challenge (reduce the wiring of the ship) we start by studying all opportunities for new technological options to replace the cables and connectors by another method of information transmission, data connectivity and processing.

We raised the possibility of using an infrared system:
It is a physical standard in the form of transmission and reception of data by these rays, this technology is based on light rays that move in the infrared spectrum. IrDA standards support a wide range of electrical devices and allow two-way communication between two extremes at speeds ranging from 9,600 bps to 4 Mbps.

For the movement of the rudder depth and direction: consists of a narrow angle of 30 degrees operates at a distance of tens of meters.
Point-to-point communication account. The communication of the drone is satellite by means of L band similar to the Iridium technology to be able to handle the telemetric movement.

For the geolocation of people who do not have the bracelet, the drone makes a 360-degree sweep of the area with an infrared and visual thermometer located in the radome, this extracts the image and sends it by satellite to the station.
The visual thermometer identifies the intermittent problem with the temporary monitoring of the person to get alerts when the temperature is out of range, provided with temperature alarms obtained from learning algorithms.
Infrared thermometer: performs precision and accurate, repeatable measurement and associates it with the visual thermometer.

The maximum flight ceiling is 10,000 meters. It is taken by the highest mountain known: Everest with 8,848 m and the minimum is 6,000 meters by the Aconcagua mountain with a height of 6,962 meters.
The design consists of a modular and accessible structure for maintenance and inspection.

The climbers will have a patch and a bracelet with sensors that would allow to obtain data of the vital signs in real time of their location, corporal temperature, arterial pressure, cardiac rhythm and pulsations. This information would be sent to the aircraft and sent to a database on a server (Cloud). Automatic and deep learning algorithms would be applied to this database (machine learning and deep learning respectively). These models would make it possible to predict the evolution of these vital parameters in the coming hours and to evaluate the possibility of the monitored person suffering or not from altitude sickness, cardiac arrest, etc. The robust learning algorithms that will be implemented will be previously well tested and studied to minimize false positives and false negatives. An alert to the rescuers that there is someone, already located, who needs assistance would activate the rescue phase by means of the SAR helicopter (search and rescue).

We have 3 panches. One will be used as a method to get the breath per minute, this would be the duplicate of the bracelet. The other as a means to obtain the data of the location of the person with their respective duplicate.
Both the patch and the bracelet has an autonomy of approximately 60 days thanks to its long battery life, taking into account the time of the longest known expeditions, uses proprietary software to know the status of vital signs, along with triangulation from "Physical Scalars and Plotting Tools in Scala" software provided by NASA, to prevent errors related to physical units in engineering and scientific computing, also along with the thermographic images of the 2 (two) infrared and thermal sensors in the radome of that aircraft.

Fuel:

This aircraft is designed to occupy sustainable aviation fuel (SAF). Currently different organizations are dedicated to the research and development of this. One of the resources being used is sugar cane, the most productive plant in the world, to produce oil that can be converted into bio-jet fuel. In a recent study, it was discovered that the use of this designed sugar cane could produce more than 2,500 liters of bio-jet fuel per acre of land (~0.4 hectares) (Kumar, 2017). Compared to two competing plant sources, soybeans and jatropha, it would produce approximately 15 to 13 times more aircraft fuel per unit of land.
Consequently, the production of this type of biofuel may raise a number of concerns, including possible changes in the use of the biofuel. agricultural land, water use, effect on food prices; and the impact of irrigation, pesticides and fertilizers on local environments. While these raw materials could be used to create jet fuel through different processes, in a variety of ways.
the aviation industry has wanted to avoid using them because of sustainability concerns.
These promote only alternative fuels of sustainable origin. This is why the industry uses the term "sustainable aviation fuel" (SAF).
Current technology allows fuels to be produced from a wide range of raw materials, including: municipal solid waste, waste from households and businesses, among many others.
It has a wind system for its propulsion.
This aircraft uses sustainable fuel only at a certain height range, from take-off to approximately 200 m. It then uses the turboprop wind system up to approximately 6,500 to 10,000 metres, due to pressure conditions.

Design

The design of the aircraft is based on the structure of an insect, specifically a dragonfly. This is due to the fact that the dragonfly has greater stability in wind gusts and its tail allows it to rotate 360° with respect to its vertical axis. We combined the morphology of this insect with the structural design of the Lama helicopter, used in rescues. It was given a modern design and the structure was adapted to the wireless technology, modularized the internal structure (Figure 1).

The material used for the aircraft is Micotectura, flexible, which withstands high impacts and is ecological. The material is lightweight and economical.

The possibility of using the wireless aircraft in other environments and climates, such as jungles, oceans and deserts, is considered. For this, it will be necessary to make a study of structural design and optimal material for such cases.

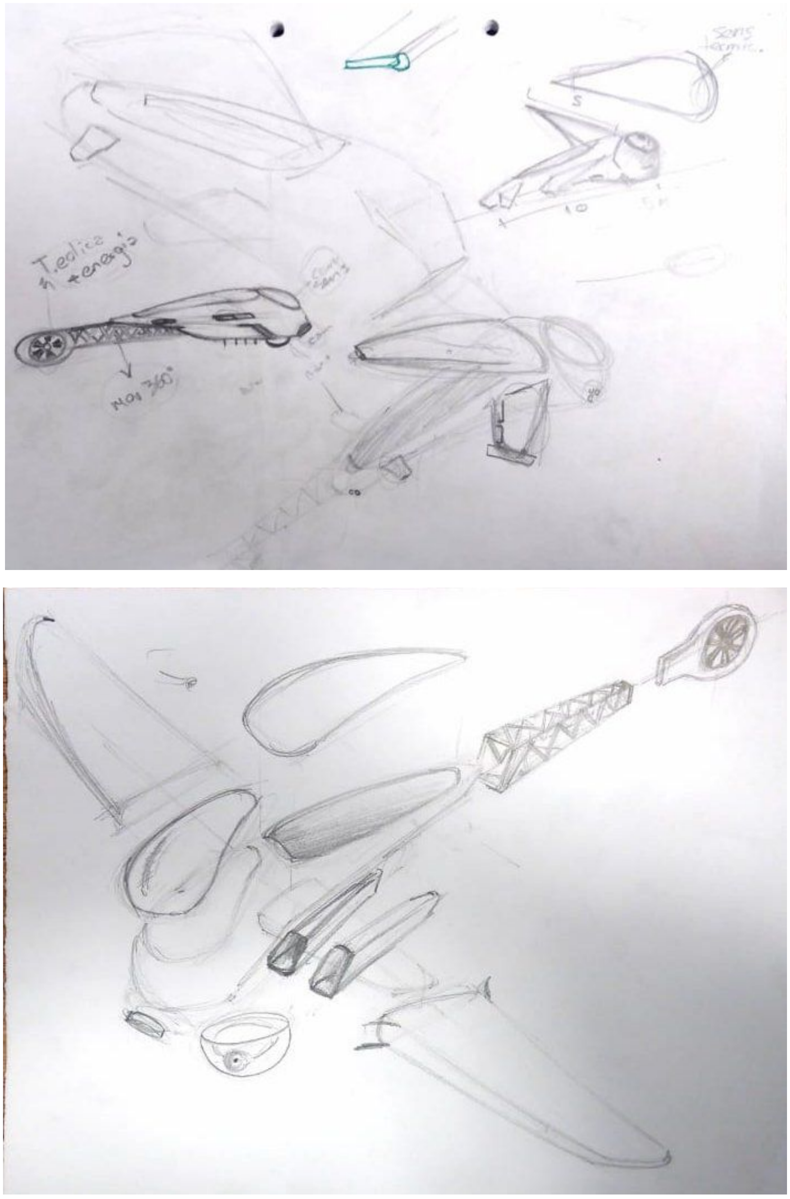

Figure 1. Wireless ship design.

Contingency plan:

List of physical procedure (Bracelet)

1_ In the event that the wristband has a fault of some kind, duplicates of the patches automatically transmit the information from the user to the satellite so that the search and rescue team can access the person.

Aircraft emergency plan

1_ If the infrared system fails, the fiber optic is used with a fiber sensor in the wings, in the plane and in the fuselage, this allows us to have the time to repair the fault later.

2_ If the aircraft has no fuel, it will automatically use the turboprops.

B. Estimation of time and costs in search and rescue operations.

Table 1 estimates the average time and cost of traditional and wireless operations in Cerro Aconcagua, the highest mountain peak in the Americas, located in the Province of Mendoza, Argentina. Table 2 estimates that in one year.

	Operative with Wireless Aircraft	Traditional Operative
Average Time	4 h (helicopter)	24 h (helicopter) + 48 h (preparation and waste time) = 72 h
Average Cost	12.000 dollars	72.000 dollars

Table 1. Estimation of time and average costs of a single operation of traditional type and wireless technology in Aconcagua.

	Operativo con Aeronave Inalámbrica	**Operativo Tradicional**
Tiempo Promedio	312 h (helicopter)	1872 h (helicopter) + 3744 h (preparation and waste time) = 5616 h
Costo Promedio	936.000 dollars	5.616.000 dollars

Table 2. Estimated time and average costs of traditional and wireless operations in Aconcagua annually.

Annually there are an average of 78 search and rescue operations on Aconcagua (Lui, 2017). Likewise, an operation cost approximately 2500 dollars per hour of helicopter in 2016 (CNN Español, 2016). It is estimated that in 2019 this value has risen to 3,000 dollars. The duration of an operation depends on many factors such as the climate, the personnel, the mountain area and each particular case. On average, 8 hours per day (maximum number of flights per day) for three days.

With the wireless aircraft, the helicopter hours would be reduced to only those invested in the rescue of the person already located by that aircraft (~4 h). The aircraft would make 4 daily scans of data acquisition and collection, which is estimated at 15 hours of flight per day. The search and rescue operation costs are reduced to the helicopter hours invested in the rescue phase (not counting the cost of daily maintenance of the aircraft).

The data in Table 1 and Table 2 show how valuable it would be to invest in the technology of a wireless spacecraft. It would reduce the flight hours of a traditional search and rescue operation by 95% and its costs by 83% in one year on Aconcagua (Figure 2). It is worth mentioning that the calculation does not take into account the daily maintenance of the aircraft. However, if this cost were taken into account, the convenience of using the aircraft would not exceed the amount invested in traditional operations.

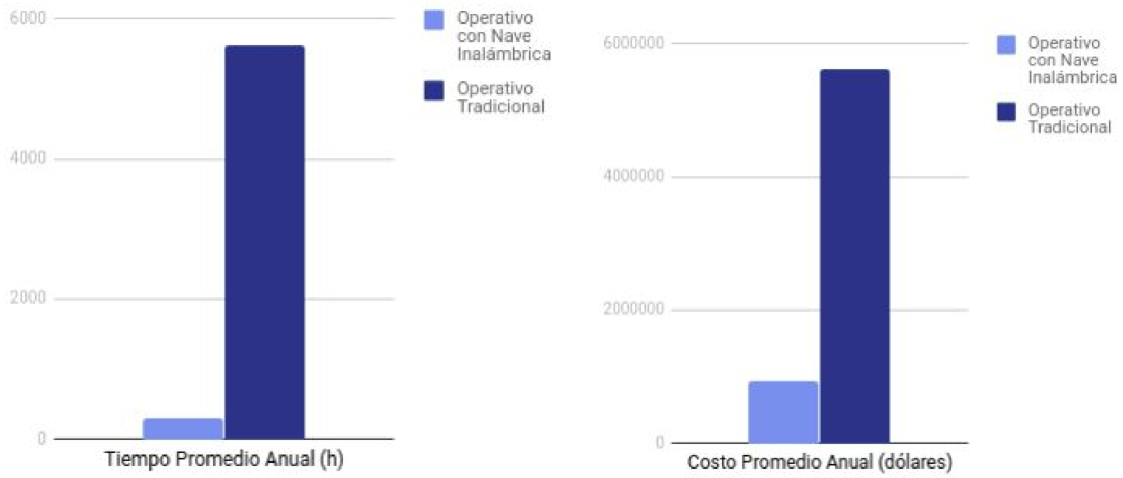

Figure 2. Time bar graphs (in hours) and average annual costs (in dollars) respectively for wireless and traditional spacecraft operations.

Conclusion

This paper proposed an innovative and promising low-cost wireless aircraft design to assist the search and rescue operations of mountaineers on Aconcagua, making searches more efficient, cheaper and providing assistance through AI (artificial intelligence). This wireless design does not use cables or connectors for its operation which solves problems associated with wiring (more weight, failures, costs), having a modularized structure and easy integration. These characteristics added to the problem of searches and rescues of climbers make the wireless aircraft a disruptive technology, would reduce by 95% the flight hours of a traditional search and rescue operation and by 83% the costs of the same in a year in Aconcagua.

Appendix

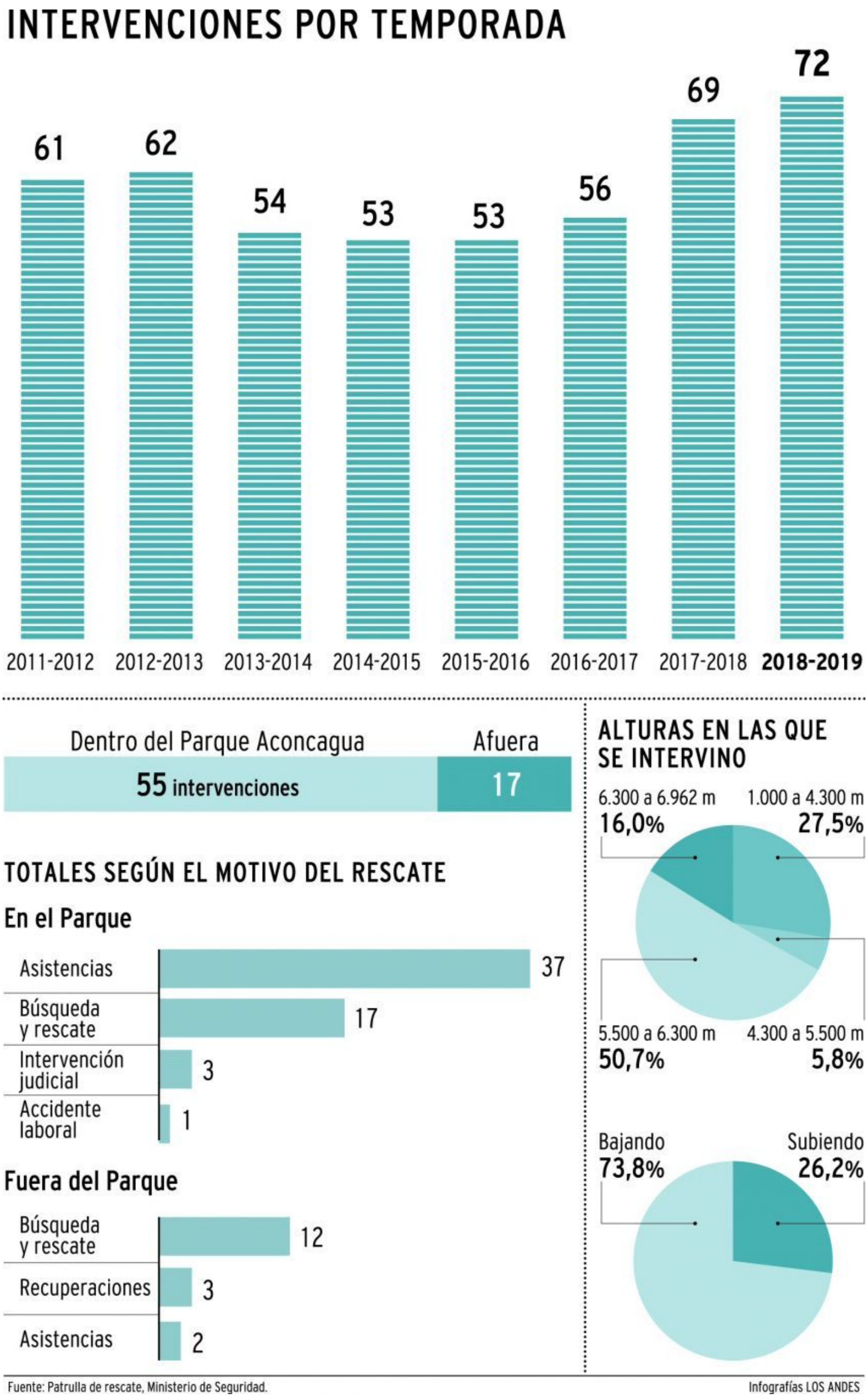

Figure A1. Statistics on the interventions of the Rescue Patrol under the Ministry of Security of the Province of Mendoza as of March 2019 (Zavala Tello, 2019).

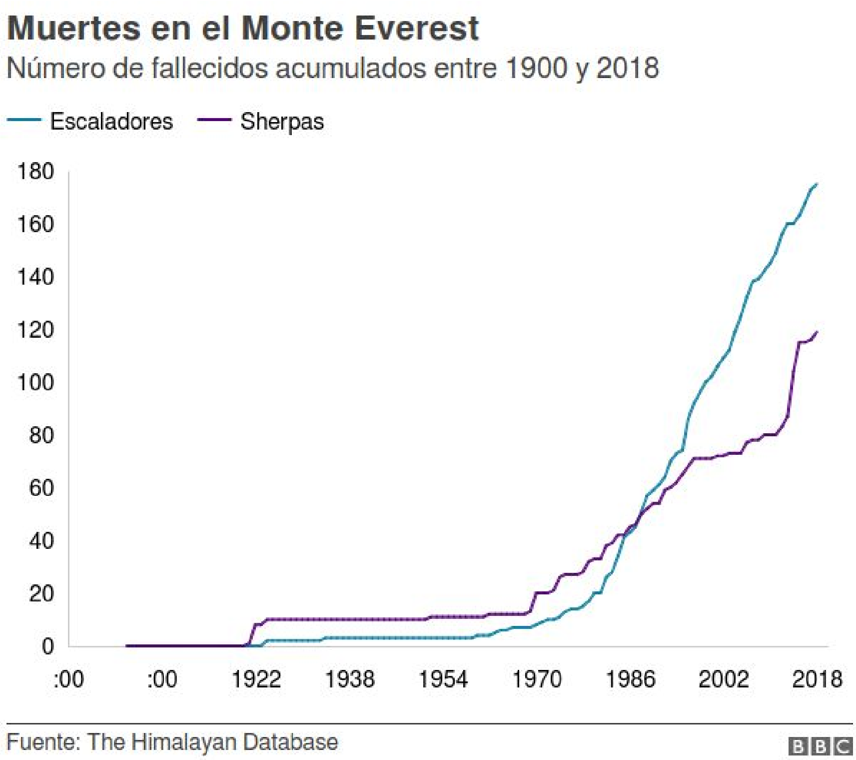

Figure A2. Graph of accumulated deaths on Mount Everest between 1900 and 2018 (Butcher, 2019).

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