Conceptual study of a multiuse and reusable Earth and Space observation platform

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Abstract

Contemporary technology for astrophysical or geophysical observation are expensive, disposable and its launch cots are exorbitant. The main components that make those projects more expensive are its construction, materials, launch and instrumentation. Our group offers as an alternative a carbon fiber lattice structure sustained high pressure balloons that can be equipped with specific instruments for each mission. Reducing drastically its costs by eliminating vertical propulsion engines, fuel and the high complexity manufacture from the project.

Introduction

Our proposal is a low cost and reusable stationary observation vehicle that will be able to replace satellites on short suborbital missions.

As a way to reach greater flight autonomy and altitude at a stratospheric level higher than 30km we thought of a platform supported by two balloons that can be reused multiple times.

This platform is versatile since it can be used to fulfill necessities from multiple different areas such as astrophysical and geophysical observations, region monitoring, telecommunications. Making it's use defined by its user.

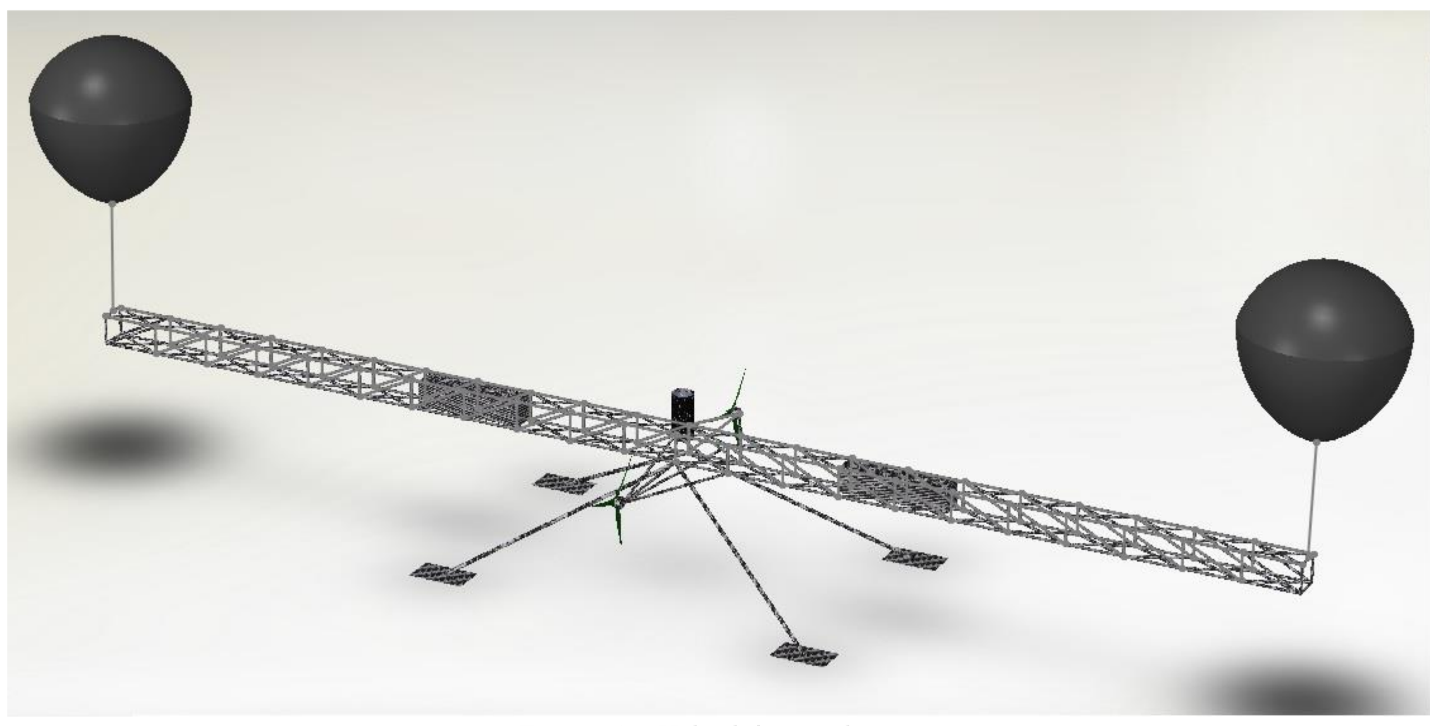

Figure 1 – Vehicle's pre design

Propulsion

The airship's configuration aim to fly at environments with low density atmosphere and at low speeds. For those reasons, there was close to no attention to its aerodynamics and all of its lift is done by balloons. With that in mind, there is no reason to have powerful motors because they will only be used for the airship's stabilization and locomotion. For weight reduction purposes, these motors are electric and rechargeable by solar panels.

To perform movement at it's horizontal axis, there will be two fixed motors at the center of the structure one at each side, facing opposite directions. They will be able to act together in the same rotative direction for translative movement and in opposite direction for rotative motion.

Another pair of electrical motors will be placed at the extremities acting to stabilize the airship.

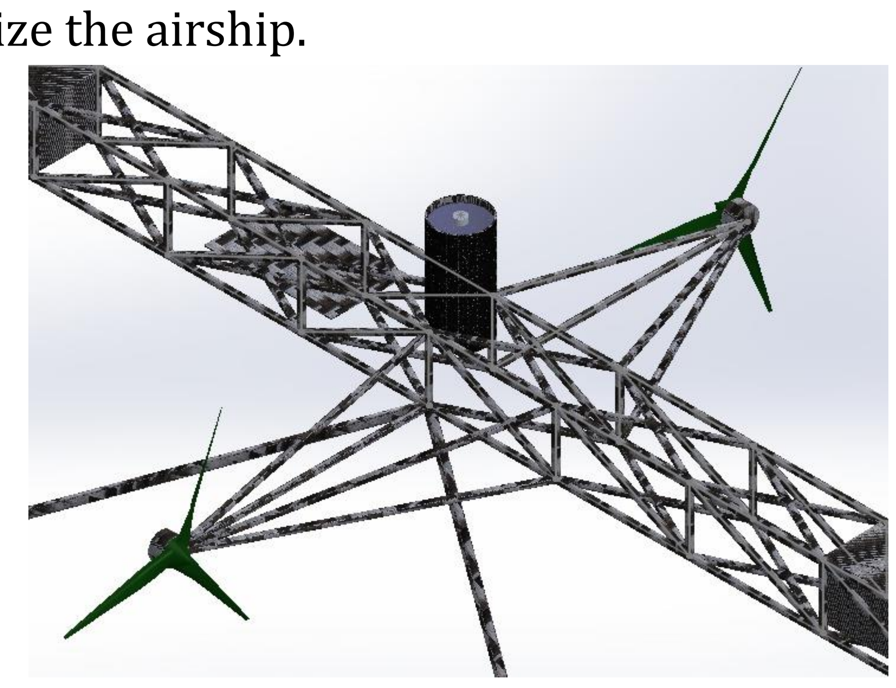

Figure 2 – Central motors and propellers

Structure

Because of its great resistance properties and low weight, we choose a carbon fiber lattice structure. Using this type of structure it's possible to, at the same time, keep it low weight, resistant and with a low contact area to decrease the wind's influence at the flight.

The contour point of it's length is the field of view necessary for the mission to be accomplished. The structure has to be large enough so that the balloons do not interfere.

In the other hand, when it's length increases, the weight also increases, requiring a bigger balloon. So, in other to define it's size it's made an iterative process in witch is increased the total weight of the airship and the size of the balloons until it comes to an acceptable combination.

After this process, we estimated this parameters:

Parameters	Value
Total weight	140 Kg
Maior diâmetro dos balões	5 m
Field of view of Cassegrain(M1xM2)	66 arcmin
Field of view avaliable	5466
Lenght of the structure	25 m

Table 1 – vehicle's characteristics.

Balloon

For the structure's lift it's used a set of balloons in each of its extremities. Each set of balloons is consisted of a zero pressure balloon(ZPB) and a Super pressure balloon(SPB).

The ZPB has a easy manufacture process and is estimated to be filled with, approximately 27m^3 of helium and its diameter will be between 4 and 5 meter long. Otherwise, the SPB has to have a lot more gas to keep the system at super pressure. Bothe balloons are made in a composite material capable of resisting those big pressures.

This specific set of balloons aims to keep the internal volume of the gas constant. For that, it has a compressor and a solenoid valve that helps the gas flow. When the system heats, in other to avoid bursting the balloon the valve pushes air from the ZPB to the SPB and when it gets cold, it does the same thing but the other way around. The system keeps doing that the entire flight, helping the airship to maintain it's altitude constant.

Figure 3 – Structural model of the balloon

Conclusion

The technologies that were planned to be used in its embedded systems as data acquisition, movement, power and stabilization are all accessible. It wasn't proposed any solution with future technology that is not already available.

After evaluating these hypotheses, we conclude that this airship concept is viable and we are already planning the next step, witch is the construction of a small scale prototype to validate our concept and it's configuration.

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