Design and construction of an autonomous paragliding system

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1. Introduction

With recent climate change and global warming, record-breaking amounts of hurricanes, tornadoes and waterspouts have appeared in the Mediterranean [1] and hurricanes Irma and Friederike have shown us that natural catastrophes can have devastatingly high body counts. In such situations, reaching the survivors can cost a lot of precious time, so supplies -food, medicine, radio devices etc. - being delivered directly to them can save lives. A flight system that can land autonomously in a predetermined area and has the capability to be mass produced is key to achieving that. Influenced by this idea, we decided to take part in the CanSat in Greece competition creating an autonomous landing system. In this competition, a can-sized satellite is launched 1000m into the air and then completes a mission chosen by the team, the satellite being 350g heavy, 115mm tall and 66mm in diameter at most, as well as able to withstand a maximum acceleration of 196.133 m/s^2 (20g).

2. Research Methods

Through the process of elimination, we concluded that the ideal aviatic system would be a paraglider -as it is light, durable and steerable- steered by a servomechanism that is given coordinates by a GPS device. In order to ensure maximum accuracy for the coordinates, an accelerometer-gyroscope-magnetometer is also placed on the payload, as well as an MCU (microcontroller unit) coded in C++ to process the data and give subsequent orders to the servomechanism. For an easier and more precise construction of the payload, we chose to 3D print it.

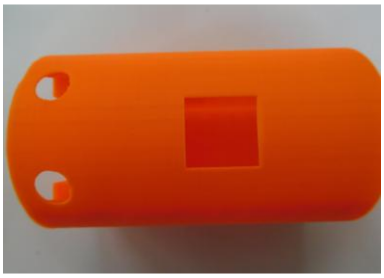

Image 1 - The 3D printed payload

The modus operandi is, as the absolute position of the paragliding system is determined, the system's coordinates are compared to those of a predetermined landing area. The MCU calculates the amount of degrees the paraglider has to turn towards the target's direction, as well as the distance from the target area. The servomechanism then pulls the steering lines of the paraglider accordingly.

The experimental part of the research included three stages: Firstly, the construction of a rough paraglider prototype and testing of its stability during free fall. From it, we concluded it had excellent stability, but poor horizontal displacement. Secondly, the testing of the prototype's steerability using the servomechanism. Finally, the reconstruction of the paraglider with different sizes and its testing with different angles of attack, in order to achieve further displacement and thus better controlled flight.

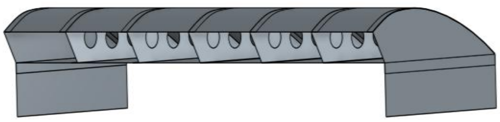

Image 2 – Design of the paraglider

3. Results

Though the experimental process is not fully over and the final details are still undergoing changes, flight tests we performed during our trial and error process gave us an estimated distance deviation from the target of about 250 m. All in all, those are amazing results, considering the fact that success of this level has been reached only by aeronautical university teams in the Japanese "Comeback competition" [2] and never by a CanSat in Europe team.

4. Conclusion

The above described paragliding system would be an ideal solution for a natural disaster survivors' supplier because of its ability to land in a specific predetermined area. Its design is also fairly simple, making it easily and inexpensively mass produced. A mass airdrop could cover a large area of predetermined landing areas.

5. References

[1] Groenemeijer, P. et al, "Present and future probability of meteorological and hydrological hazards in Europe" (2016).

[2] Nakasuka, S. et al, "Autonomous Parafoil Control Experiment as 'Comeback Competition' for Effective First Step Training Towards Satellite Development", IFAC Proceedings Volumes, Volume 37, Issue 6 (2004).