Design of a Steerable Parachute System for High Altitude Balloon Payload Recovery

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Abstract
High altitude balloon experiments provide incredibly important data about Earth’s atmosphere. Unfortunately, payloads are often lost during descent and the launch team is unable to recover and reuse the equipment. Consistent payload recovery and reusability could have unprecedented impacts on decreased launch costs and better research data collection. A steerable parachute could provide a means to achieve this goal. The high level objective of the project is to design a low cost and reusable system for balloon payload recovery. For the initial launch, the system will be piloted to gather extensive flight data. Work on later iterations will center around automating the flight controls and optimizing performance to handle a range of payloads. Our design features a ram air parachute chosen for its high glide ratio and slow descent rate at lower wing loadings. A ram air design was selected for its high glide ratio and slow descent rate at lower wing loadings.

Canopy
The canopy system will consist of a ram air parachute steered by two brake lines attached to a reeling system. A ram air design was selected for its high glide ratio and relative stability at a variety of wing loadings. A commercially manufactured parachute was chosen over sewing an original to ensure higher quality and more accuracy. Our desired wing loading range is Desired Range: 0.4 to 0.8 lbs/ft². We selected the Opale Paramodels RC parachute with a area of 1.5m².

Motors
There will be two servo motors (with functionality up to 180 degrees) in the interior of the box and connected through to control the motion of spools that reel in the parachute. These motors were selected because their precision should allow us to return the chute to a neutral position.

Electronics
The electronics sub-system is responsible for the collection of flight data, such as compass heading, GPS location, altitude, velocity, and distance from a predetermined target landing location. A pilot on the ground will control the payload by using a radio transceiver and receiver pair, with the receiver inside of the payload attached to the microcontroller and motors. The onboard microcontroller shall collect all flight data as well as radio inputs and log them to a built-in microSD card for post-flight data analysis.

In the future, this system will become autonomous, with the microcontroller calculating and executing movements towards the best heading to land at the designated location. This earlier test and its data will be used in future iterations to create and code better algorithms that calculate the best flight path and determine what degree of motion is created from motor inputs.

Structures
The main structural housing will be a box made of foam core with specific cutouts to house the electronics, motor, and reeling system.

Testing
Structural test will include a drop test and stair test with box structure and spool components to ensure the system can withstand landing.

Various tree (or hanging) tests will be done to verify that the motor and parachute control systems successfully bring in the parachute without harming the structure of the box or throwing it off balance.

The motor will undergo power and range of motion tests to ensure function. Tensioning tests will also be performed with a power gauge to determine if the motors and the spools interface properly.

First Launch
The first launch of our parachute launch will be in the Eastern Colorado plains. The parachute will be attached to a sounding balloon that is tethered to the ground to allow for accessibility and multiple tests for our system. Once the parachute has reached altitude, it will be dropped from the balloon with a release mechanism.

Budget

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Next Steps
Our Budget has been approved and the parachute has been already ordered and received. The one team member who has it will be able to perform tests to ensure that it flies straight when dropped from a height and record opening performance as well as decent rates.

We were unable to order the other parts prior to the lab closing. We look forward to the lab reopening so that we may order the rest of the equipment and proceed with planned assembly and testing. While it is impossible to schedule a launch date at this time, we can report that we have approximately eight weeks of work between reopening and launch.

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