High Altitude Balloon Payload Improvement through Aerodynamics

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Abstract

Austin Peay State University has flown stratospheric balloons for a variety of space-related science experiments. Our development of an integrated flight computer makes our payload an intelligent systems that tracks flights conditions. The flight computer serves as the brains for other scientific experiments. Here, we present our improved payload design. The design criteria were: Ease of construction, strength, and aerodynamic considerations (stabilizing the payload in the wind). This platform can support numerous experiments. We have made successful improvements to the payload in all of the categories. At APSU, we are using this platform to studying the upcoming total solar eclipse that will pass through our area in August of 2017. During the eclipse, it is very important to have the cameras pointing in a specific direction without adding a lot of weight, which will be achieved with this system.

Introduction

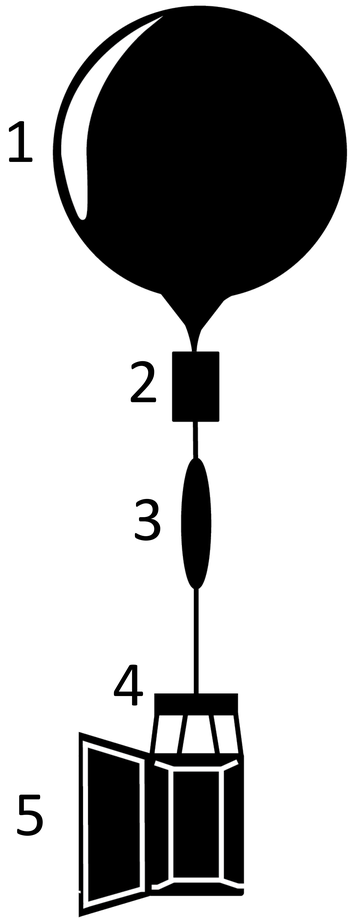

Figure 1: Balloon Launch, Helium Filled Balloon, Parachute, Payload

1. Helium balloon filled to achieve 12-15 lbs of lift.
2. Cut down mechanism.
3. 72” Parachute attached to the balloon and payload.
4. Swivel plate allows the payload to rotate freely
5. Payload containing electronics and tracking system. Fin stabilizes payload housing in one direction.

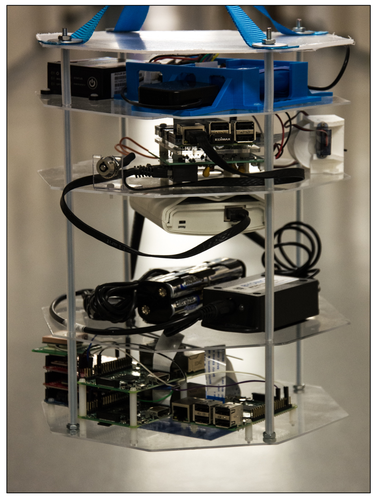

Figure 2: Inside of the payload. Camera system, tracking system, video stream

Payload Models

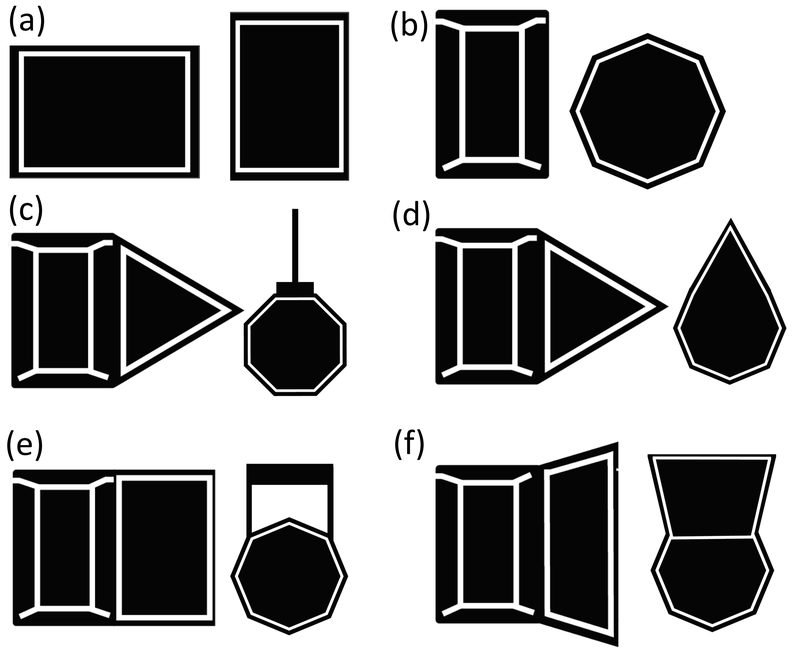

Figure 3: All 6 models on top (right) and side (left) view. (a) Original payload, Rectangular. (b) Octagon shape with no extensions. (c) Octagon with back fin. (d) Octagon with filled fin. (e) Octagon with square open fin. (f) Octogan shape with most optimal fin.

Wind Tunnel

Figure 4: Final payload in wind tunnel prior to experiments.

A wind tunnel was used to analyze the different payload designs. Video of the behavior of each payload was collected and an iterative process was used to created the final design. The final payload is shown in Figure 3f. The shape came from multiple iterations and took inspiration from Figure 3e. The major difference between model 4 and 7 is the top and bottom wind support.

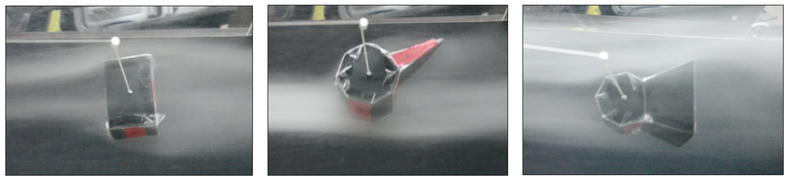

Figure 5: Wind tunnel with smoke to demonstrate airflow around the designs. (a) Payload design 1. (b) Payload design 4. (c) Payload design 7.

In the wind tunnel, further video analysis was done using smoke to detect air patterns around the payloads. This showed that most designs just increased turbulence.

Payload Rotation Solution

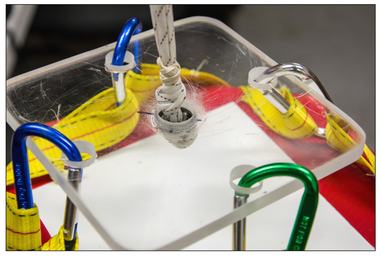

Figure 6: Image of the rotational mount for the payload to strap, hooked up to the current payload.

A rotational platform was developed to allow the payload to rotate freely. With free rotation, payload design 7 should always point in the same direction as the wind. The rotational platform was constructed from a durable piece of acrylic and a skateboard bearing. The payload is attached so that it has 4 mounting points while the parachute is attached through the center of the bearing allowing for the rotation.

Payload Construction

Figure 7: New payload design with the developed harness and rotational plate, attached to the parachute.

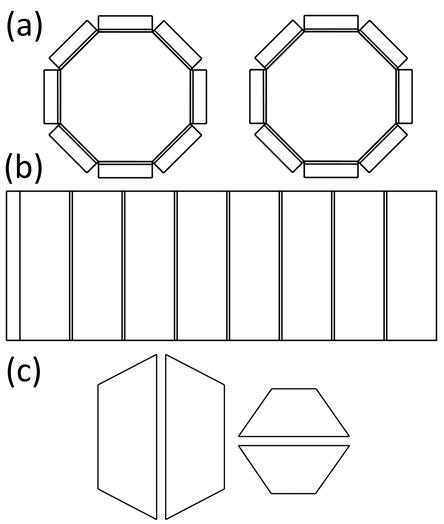

Figure 8: Technical drawing of the construction for the octagonal design of the payload. Three parts are required. Additional the new payload design technical drawing.

For structural strength, an octagon-shaped base is used for the new design. It is constructed out of 3 parts of foam core. The bottom is tapped and fitted to form a box as shown in Figure 8a-b. The shape of the box and the minimal amount of parts it makes this design durable. The harness is designed to support all sides of the box while keeping the bottom center free for downwards pointing cameras. It is constructed from durable car straps.

Acknowledgements

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