NASA NEAR SPACE SATELLITE

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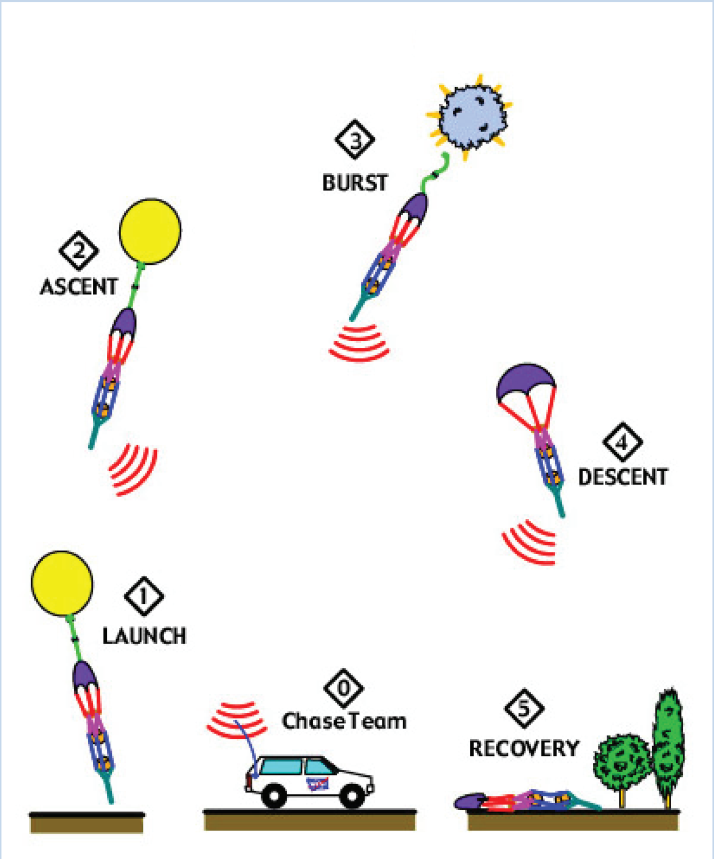
Abstract

The goals of this project were to obtain several realms of atmospheric data including temperature, pressure satellite acceleration, and images up to 100,000 feet. There was an additional objective of transmitting and receiving the GPS coordinates of the satellite location throughout the flight. This data was plotted throughout the flight in order to track and finally locate the package after landing. The digital imaging subsystem consists of the EX-Z50 Casio 5.0 Mega Pixel digital Camera, a 2 GB SD memory card, and a 555 timer actuator. The Sensors subsystem contains a HOBO temperature sensor, a HOBO pressure sensor, and an accelerometer. Team CapHAB will present the NAU/NASA Space Grant with several benefits from this project. First Team CapHAB will present the components and information required to build and launch a payload implementing a wireless GPS tracking system. Further the team will present information regarding the forces and impacts that the payload experiences throughout flight. Further this project will provide numerous high-quality digital images of the atmosphere. Future teams will be able to utilize the design presented by Team CapHAB in order to implement even more complex payload designs.

Problem Statement

The NAU/NASA Space Grant Administration has requested the design, launch, and retrieval of a small payload on a high-altitude weather balloon. The purpose of this project is to promote science education and practice engineering design procedure through hands-on design and implementation of a high altitude satellite.

Balloon Flight Overview



http://spacegrant.montana.edu

Step 0: The chase team should establish a wireless link with the payload before it is launched. The chase team will follow the payload by following the tracking beacon in the location mapping software.

Step 1: A latex weather balloon is filled with a predetermined amount of helium and then launched with all payloads attached.

Step 2: The balloon expands due to the decrease in pressure as the payload ascends. The wireless payload continues to transmit the present location of the payload throughout the entire flight.

Step 3: Finally at the apex the balloon pops and the payloads begin their rapid descent.

Step 4: After a very short period of time the parachute will open and slow down the descent. The period of descent is significantly shorter than the ascent. The payload will continue to transmit GPS location coordinates throughout descent. The chase team will follow this beacon to bring it towards the landing location.

Step 5: Finally the payload lands. The chase team locates the final landing point by traveling to the final location plotted in the mapping software.

System Breakdown Overview

The overall project has been broken up into four major subsystems as listed below:

1. Sensor Subsystem
The sensor subsystem measures internal temperature, atmospheric pressure, and gravity forces in the horizontal and vertical planes.

2. Digital Imagery Subsystem
The digital imagery subsystem is responsible for taking multiple high resolution digital images over the span of the flight.

3. GPS Telemetry Subsystem
The GPS telemetry subsystem consists of a wireless communica tions system that is capable of relaying the balloons GPS coordi nates down to a ground receiver. Received coordinates will be mapped on a mobile laptop computer.

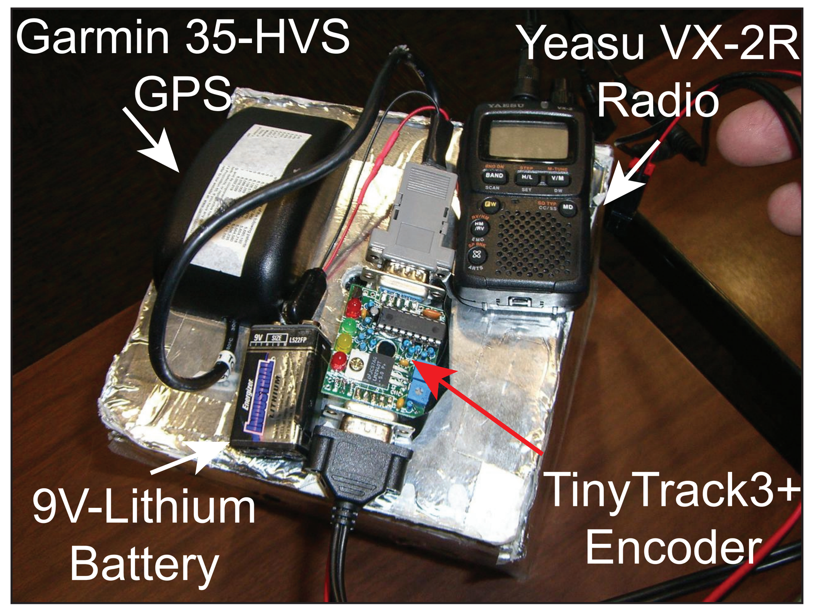
4. Payload Subsystem
The Payload subsystem provides insulation as well as containment for all other subsystems.

GPS Telemetry Subsystem

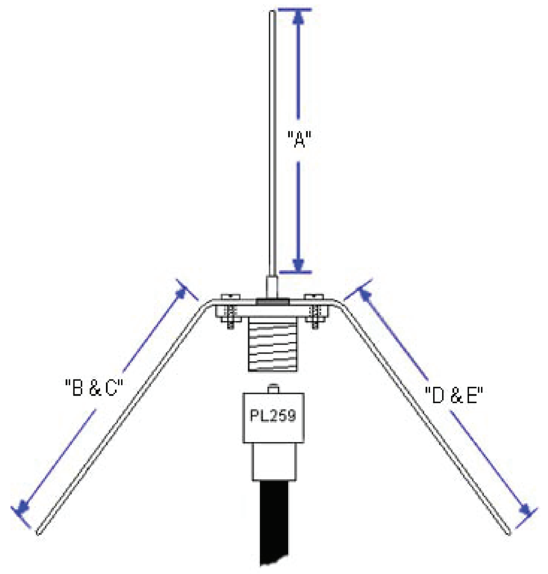
The GPS telemetry subsystem is broken up into the following two parts:
1. Onboard Satellite Telemetry: Transmits the payload GPS defined location.
2. Ground Station Telemetry: Receives and Maps GPS location.

Onboard Satellite Telemetry

The balloon current latitude, longitude, and altitude data is determined by the Garmin GPS 35. This data is encoded and packaged by the Tiny Trak 3 Plus modem.. Encoded packages are then sent to the Yaesu VX-2R radio for transmission, with the modem enabling the radio's transmit mode. The Yaesu VX-2R radio transmits at 144-MHz frequency.

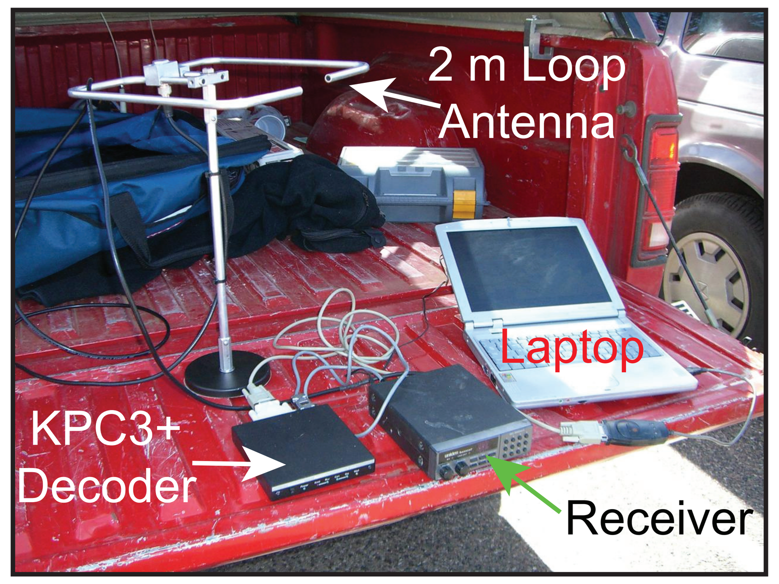


The radio transmitter's antenna has a modified quarter-wave ground plane antenna which is tuned for 144-MHz frequency. This design transmits the signal on one wire and then the signal is reflected in the desired direction by the other two ground plane wires.



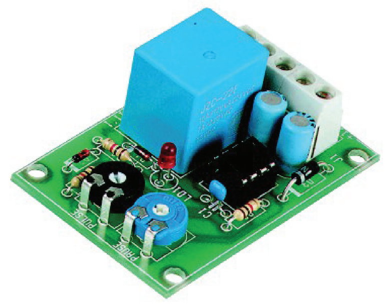
Ground Satellite Telemetry

The transmitted location data is intercepted through a two meter loop antenna and filtered and demodulated on a tri-band receiver. The data will then be routed to a Kantronics KPC-3+ TNC that will be responsible for decoding the data. Decoded data is then sent to a laptop which maps the balloons location.

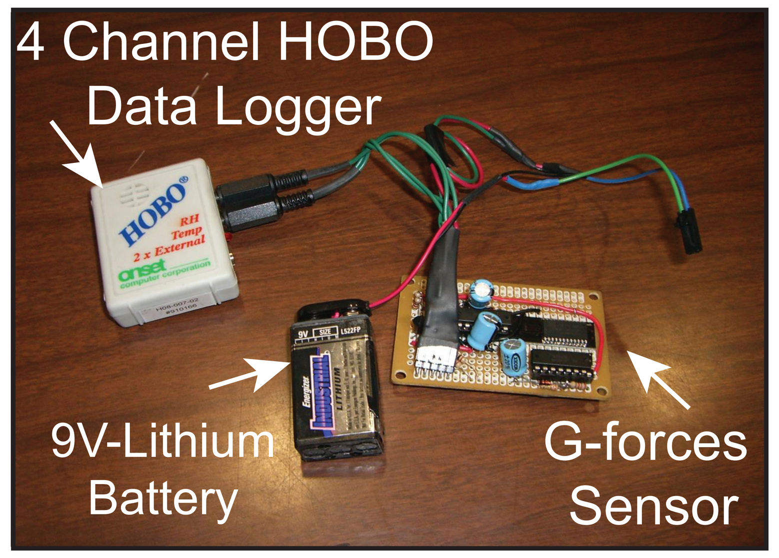


Digital Imagery Subsystem

The digital imagery subsystem consists of a Casio EX-Z50 5.0 Mega Pixel digital camera, a 2 GB SD memory card, and a 555 timer actuator. The 555 timer actuator signals to the camera to take a picture every 15 seconds. The Digital camera is capable of taking up to 458 pictures in one flight.



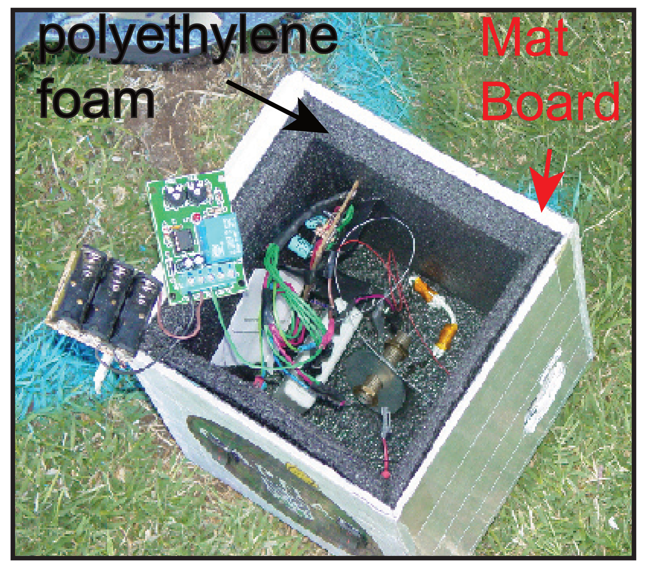
Sensor Subsystem



The sensor subsystem includes a digital thermometer to measure internal temperature variations, a pressure sensor, and vertical and horizontal accelerometers to measure flight G-forces. All sensor output data will be stored on two HOBO data loggers.

Payload Subsystem

Previous data indicates that the atmosphere reaches extremely cold temperatures below –40° C during a typical flight. As such it is imperative that the payload have adequate insulation to protect the sensitive subsystems. The first form of insulation utilized was mat board. This provides a physical structure for the payload as well as medium insulation abilities. The other type of insulation implemented was polyethylene foam. This foam is a very good insulator for its weight.

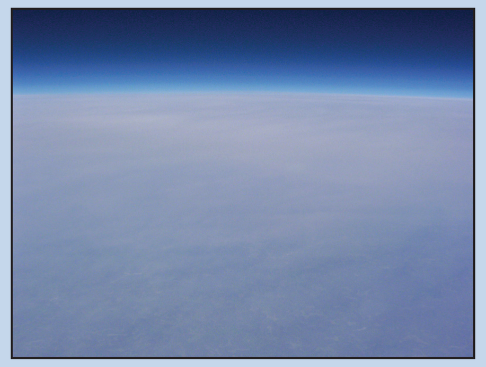


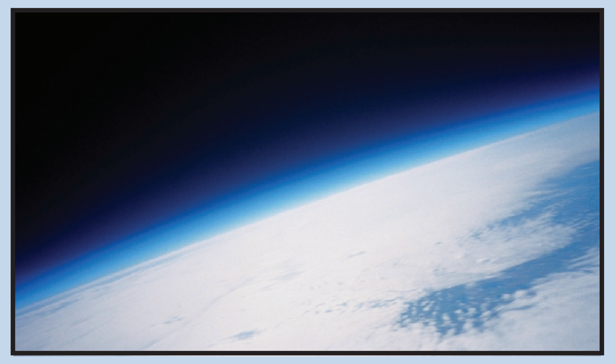
Results

Unfortunately the scheduled balloon flight on 4/22/06 was cancelled due to a balloon failure at launch. On the drive back from Maricopa City to Flagstaff, a complete functionality test was run to prove that each subsystem would function to the desired specifications. The individual subsystem results as well as results from our previous flight are shown below. It should be noted that the individual subsystems were stress-tested prior to the scheduled launch in a simulated environment to ensure proper functionality. The launch of the final payload wil result in the following four features:
1. Atmospheric Temperature/Pressure Data
2. Payload Acceleration Data
3. High Quality Digital Images of the Earth Surface/Curvature
4. Tracked Flight Path Map

Flight Images

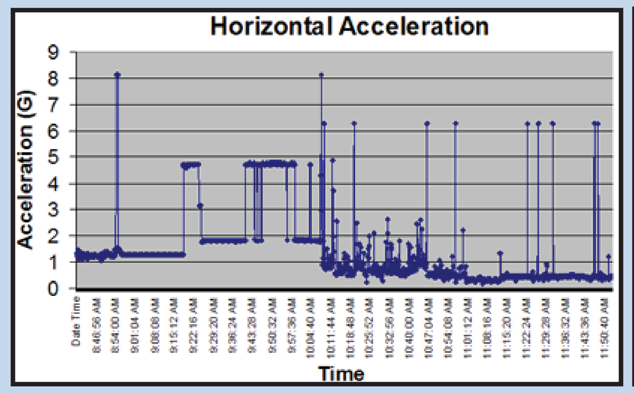
The left image of the earth and atmosphere is from our 35mm camera used in our previous flight. The right image is an example of what we expect from our five megapixels Casio camera. These images are taken at altitudes around 100,000 feet.

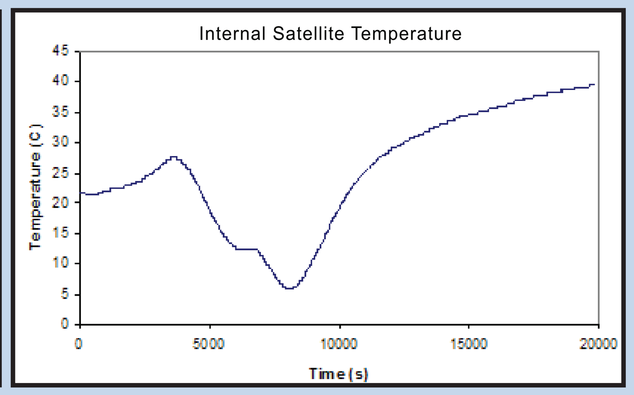




Accelerometer and Temperature Sensors Data

This acceleration graph displays acceleration data in the horizontal direction. The points show the maximum acceleration for a fifteen-second period.
The temperature graph displays how the internal satellite temperature varies throughout the flight.





Recommendations

Recommendations for future projects would the three following:
1. Designing a payload package that is easier to seal and reopen
2. Transmit high resolutiong digital images during the flight
3. Transmit data on the 70cm band (420-450MHz), which reduces the size of the antenna as well as its weight.

Acknowledgements

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Team Webpage

http://www.cet.nau.edu/Academic/Design/D4P/EGR486/EE/05-Projects/NASA/index.htm#