

Arizona Space Grant Consortium - Embry- Riddle Aeronautical University Team

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Overview

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Project Description

- Team part of Montana State University's (MSU) Nationwide Eclipse Ballooning Project
- Main objective was to provide NASA a live video source of Moon's shadow on the Earth's surface from the high-altitude perspective
- Initial systems were provided by MSU
- ERAU team made improvements to tracking and payload systems during the year leading up to the eclipse on 21 August 2017
- Team launched balloon from Glendo, WY

Tracking System (1 of 3)

- Original components
 - 900 MHz antennas
 - 5.8 GHz dish
 - Arduino with GPS
 - 9-axis IMU
 - Base tripod
 - Laptop with Intel i3 processor
- Operation
 - Servos to control the elevation and azimuth
 - GPS location of balloon via Iridium network
 - Location packets ranged from 30 sec to 5 min apart

Tracking System (2 of 3)

- Improvements
 - Adaptation and modification of LSU's tracking code
 - Introduction of APRS beacons to system
 - Manual user location input option
 - Improved laptop

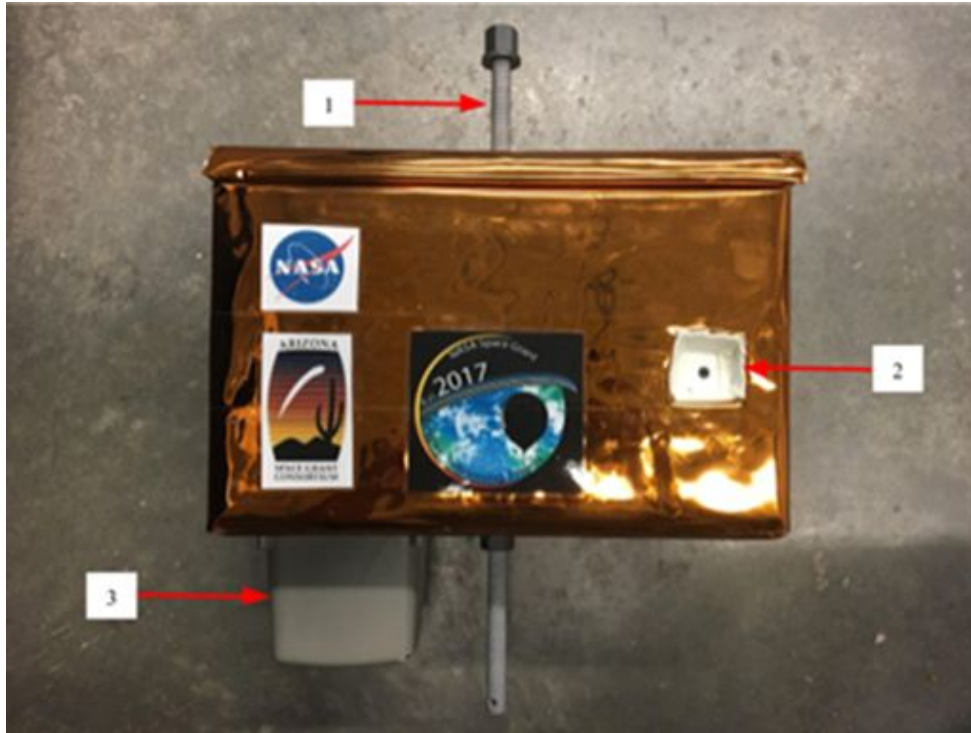
Tracking System (3 of 3)

- Additional Modifications
 - Removal of the 900 MHz antennas
 - Relocation of the Arduino
 - Relocation and mount replacement for servo controller
 - Arizona Near Space Research (ANSR) tracking system was used for Digital Images over 2.4 GHz
 - ANSR provided internet connection

Digital Video Payload (1 of 3)

- Objective
 - Designed to live stream video of Moon's shadow on Earth during the eclipse
- Modifications
 - Use of higher-gain patch antenna
 - Addition of passive stabilizers
- Limitations
 - Higher-gain antenna narrows the main lobe
 - Flight parameters defined to get ground station within main lobe

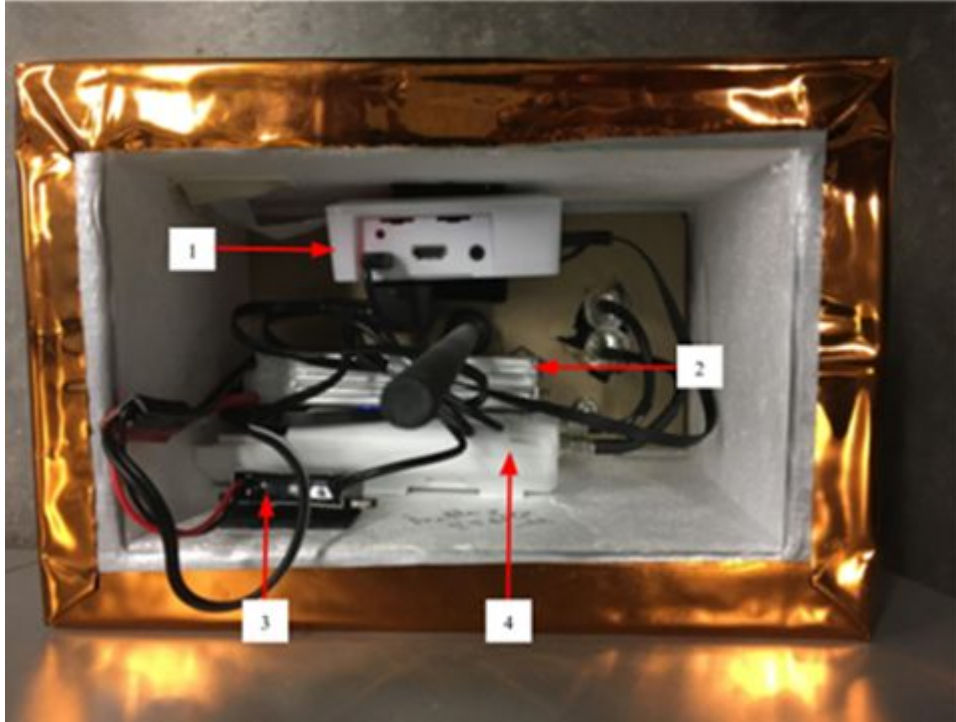
Digital Video Payload (2 of 3)



Side View

- Call-out 1: Carbon-fiber tie rod
- Call-out 2: Pi Camera
- Call-out 3: L-Com patch antenna

Digital Video Payload (3 of 3)



Top View

- Call-out 1: Raspberry Pi 3
- Call-out 2: Lipo battery
- Call-out 3: DC/DC power converter
- Call-out 4: Ubiquiti 5AC 5.8 GHz WiFi Transceiver

Digital Image Payload (1 of 1)

- Objective
 - Capture images of the Moon's shadow on Earth's surface
- Modifications
 - Rotate camera to view the Earth's surface and the horizon
 - Horizontal view provides greater perspective of the event
 - Transmit images on 2.4 GHz rather than 900 MHz
- Limitations
 - Jitter caused by rotating the camera with a servo

360 Video Payload (1 of 1)

- Objective
 - Auxiliary payload use to film Moon's shadow crossing the earth with horizon-to-horizon (i.e., 360 degree) capability
 - Located at the bottom of the payload chain
 - Video only saved locally due to large file sizes

Results (1 of 5)

- Summary
 - Successfully streamed image slideshow (i.e., not video) during eclipse
 - Digital Video Payload and 360 Video Payload media recovered after landing
 - Over 400 images and 100 minutes of video collected during the flight

Results (2 of 5)



Image captured during totality

Results (3 of 5)



Image captured shortly after totality

Results (4 of 5)

- Digital Video Payload failure
 - Damage to stabilizers at launch
 - Unable to stream video during flight because could not connect to payload
 - Possible power failure of WiFi transceiver
 - Unable to connect to payload during flight
- 360 Video Payload
 - Successfully captured Moon's shadow move from horizon to horizon during the eclipse
 - Stabilized (i.e., de-spun) by software developed by Andras and Marton Szep from the University of Arizona
 - <https://www.youtube.com/watch?v=ztNpjVwYEjs>

Results (5 of 5)

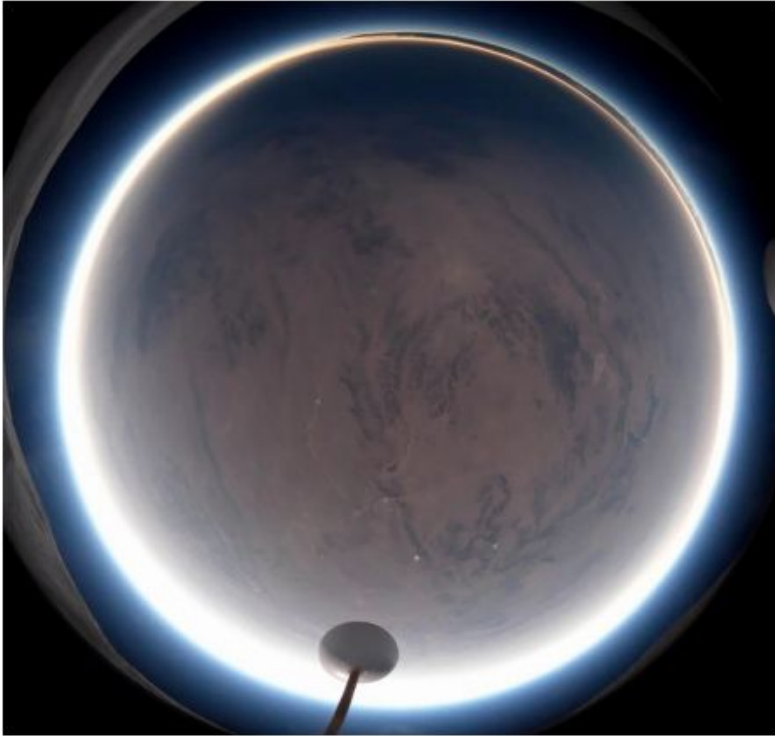


Image snapshot of 360 Video

Conclusion

- ERAU team recommends the following improvements to MSU's original systems:
 - APRS beacons for tracking
 - Multi-position cameras on the DIP
 - Higher-gain antenna on the DIP and DVP
 - Mobile satellite internet at the ground station
 - 360 video capability
 - Laptop with better processor

Acknowledgements

Arizona Near Space Research

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