VRSE
VIRTUAL REALITY SPACE EXPERIENCE
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Community Colleges of Colorado

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Introduction: Background & Overview

- Primary
  - Virtual reality is an exciting presentation format that can be used by NASA Goddard Space Flight Center for student and consumer outreach.
  - 360° cameras have been used on-board the ISS
  - Our understanding is that this payload will be the first sounding rocket payload to record 360° VR footage

- Secondary
  - Machine Learning: Convolutional Neural Networks (CNN) can be trained to accurately isolate image features.
Mission Success Criteria

● Minimum Success Criteria
  ○ Record interior payload footage to review failures.
  ○ Receipt of telemetry data to ensure events are properly executed.
  ○ Recovery of lower-quality virtual reality video

● Comprehensive Success Criteria
  ○ Full extension and retraction of arm.
  ○ Recovery of primary camera and high-quality footage
Design Overview: Payload Layout

- Electrical Box
- Primary Camera Housing
- Secondary Camera Housing
- Arm Assembly
Scissor Arm Design

- Best design with applied constraints
  - Longest extension
  - Compact when not deployed
- Weight Reduction
- Stepper motor powered
- Base was designed to be as compact and sturdy as possible
- Tests showed need for real to help arm retrieve
Electrical Housing

Housing
- Card for components
- Mounting to base plate
- Waterproof lid
- O-ring sealed
- Environmentally durable 6061 aluminium casing
- D subs for power and data transfer
- Designed for easy access

Components (no custom PCBs)
- Voltage regulators
- Raspberry Pis
- RS-232/TTL transceiver
Primary Camera Specifications

- MADV Madventure 360
  - Resolution: 4k
  - Battery: ~1.5 hours
  - Dimensions: 3.07" x 2.65" x .95"
  - Weight: 0.24 lbs
  - Storage: Micro SD, file transfer over USB 2.0

- Pros:
  - Waterproof depth rating of 3ft
  - Internal lithium ion battery
  - Power & recording states can be toggled with electrical contacts

- Cons:
  - No stereoscopic recording
  - Can’t transfer high quality video files while recording
Primary Camera Housing

- Survivability Needs
  - Re-Entry
  - Ocean Recovery
- O-Ring and compression sealed, including lens cover
- Quartz glass lens cover
- Screws provide compression for seal and also attach camera to arm mount
- Will include 4mm of foam on each side to absorb vibrations between housing and camera
- Room for electrical components and d-subss
Secondary Camera Housing

- Immediate recording
- Compact as possible
- Clear 170° FOV of payload
- Housing fits all components and protect them
- No need for rigorous waterproofing or heat resistance

USB Connection
Pi Zero
Modified Pi Cam
Arm Prototyping and Testing

- **Completed testing**
  - On 2/21/2020 first extension with motor and code on 3D printed prototype → the mount broke during the test.
  - The newest 3D printed arm components have been tested with the motor and code, but no data was recorded. The new components do move more smoothly both with and without the motor power.

- **Incomplete testing**
  - Machined parts
  - Extension post vibration test
  - Heat test
  - Impact test

Test results showed a need for the implementation of a reel to aid full retraction of the arm.
Electrical Testing

- Testing completed
  - Voltage regulator testing
  - Motor testing
  - Sensor testing
  - Power testing (for acquired components)
  - Fit test on payload plate (using prototype)

- Needs to be tested
  - Direct Heat Tolerance
  - Direct Cold Tolerance
  - Vertical Acceleration
  - Centripetal Acceleration
  - Impact
  - Vibration
  - Vacuum
  - Waterproofing
Primary Camera

- **Completed Testing**
  - Field of View was completed on 3/12/2020
  - In 360° mode the view is fairly consistent. The direct field of view towards the rocket is pictured below, as well as the side by side of the base video.
  - The current 3D print of the housing prototype is a little loose and has been adjusted in CAD. We will re-run FOV with an adjusted print.
  - Video Transfer test (High resolution takes too long for in-flight transfer, low resolution video can be transferred before payload power-off)
  - Automated video transfer tests have been successful in a simulated environment.

- **Incomplete testing**
  - Vibration test
  - Vacuum Test
  - Heat Resistance test
  - Waterproof test
  - Impact testing
  - Power testing
  - Camera control via exposed pins
  - USB data/power toggle
Secondary Camera Testing

- Completed tests (using prototype assembly)
  - Component fit test
  - Payload fit test
  - Initial recording test
  - Camera mounting

- Tests to be completed
  - Vibration
  - Vacuum
  - Ambient heat tolerance
  - Direct heat tolerance
  - Cold tolerance
  - Centripetal acceleration
  - Vertical acceleration
  - Impact
  - Long-term operation test (save multiple videos over a recording session longer than the flight)
Full System Testing (Mission Simulation)

- Tests will run on full assembly with machined 6061 aluminium parts
- Simulation of In-Flight Environment
  - Vibration testing
  - Vacuum chamber
  - Recording/Video Transfer
  - Heat testing
  - Impact testing
  - Waterproof testing
- Testing everything at the same time is optimal for guaranteeing tests’ similarity to the actual mission
Conclusions

- The mechanical design of the arm system balances size, weight, and cost, while maintaining smooth extension and retraction functionality.
- The electrical system utilizes pre-manufactured boards and components, which allows the system design to be simple and cost-effective.
- Prototyping through rapid manufacturing makes the evolution of the design process cost-effective and accessible.
- VRSE is currently in its Integrated Systems Testing Phase and is set to launch in August 2020.
- This project demonstrates the value of providing engineering and design opportunities to students in preparation for careers in the STEM workforce.
- This and similar projects can foster outreach efforts to make aerospace media immersive and accessible to the general public.
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