EMBRY-RIDDLE
Aeronautical University

High Altitude Balloon Controlled Ascent System (HABCAS)

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OUTLINE

- Purpose
- Objectives
- System
- ASCEND Flights
- Future Plans
- Questions

PURPOSE

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- Maintain altitude of balloon by achieving neutral buoyancy
- Provides window for testing systems or conducting experiments at a specific altitude over a period of time

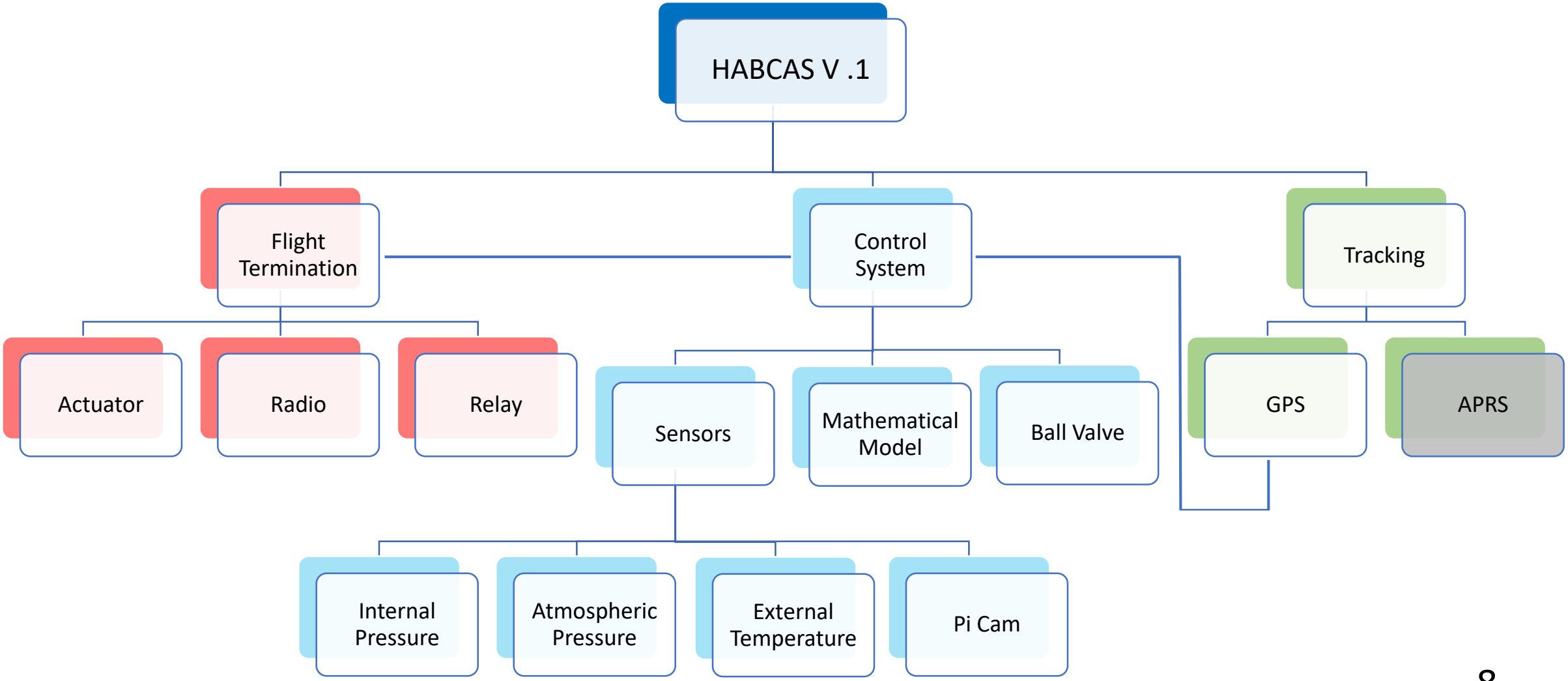
OBJECTIVES

PROJECT OBJECTIVES

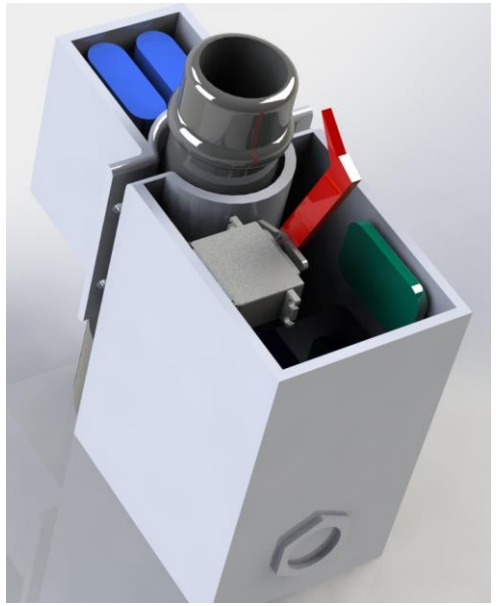
- Create a system that will release gas from high-altitude balloon in a controlled manner to achieve neutral buoyancy
- Terminate flight after specified time once the balloon achieves neutral buoyancy, or at any other point in time
- Create valve stem that is compatible with multiple sizes of balloons to operate system

SYSTEM

PAYLOAD BREAKDOWN

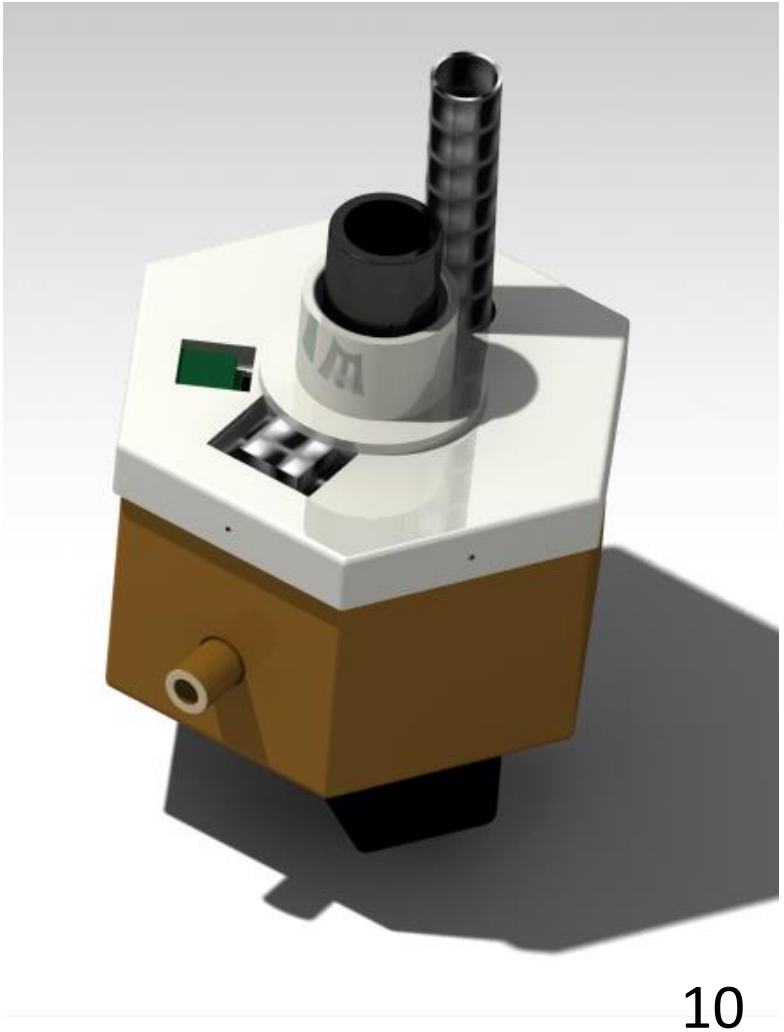


DESIGN ITERATIONS

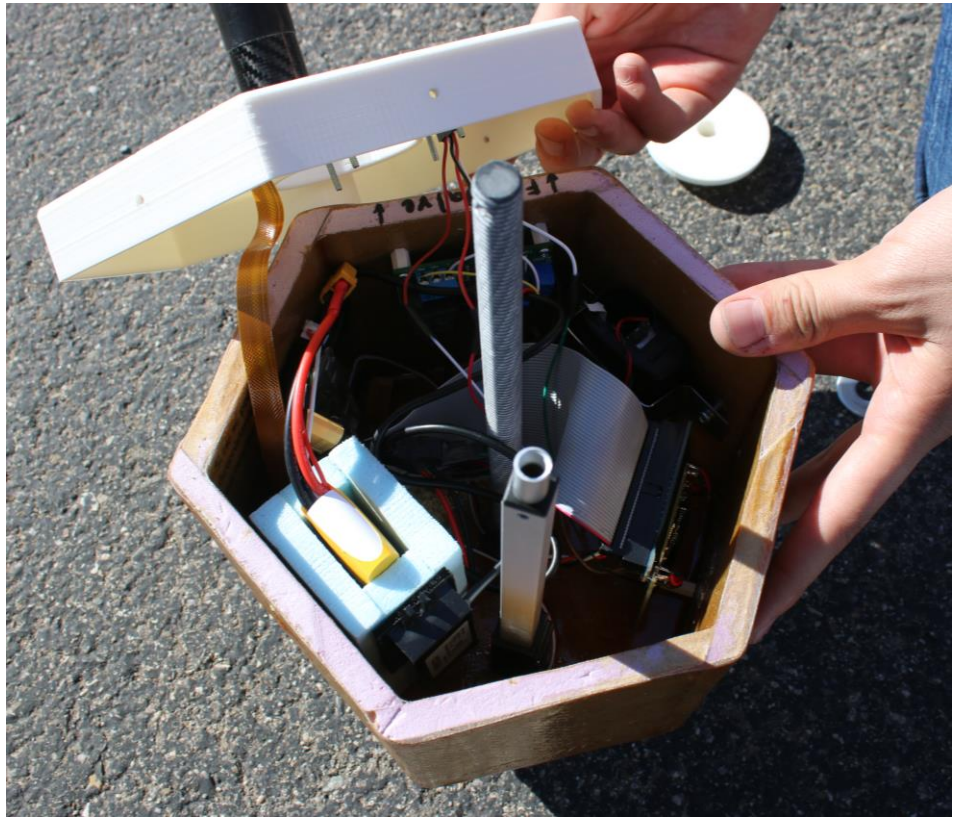


SYSTEM – MECHANICAL DESIGN

- Valve stem of balloon will sit inside fiber-glassed, foam–core payload housing
- Gas fill valve sticks out the side
- Ball valve is attached underneath the housing, into the base of the stem
- Termination actuator is enclosed in a tube for safety

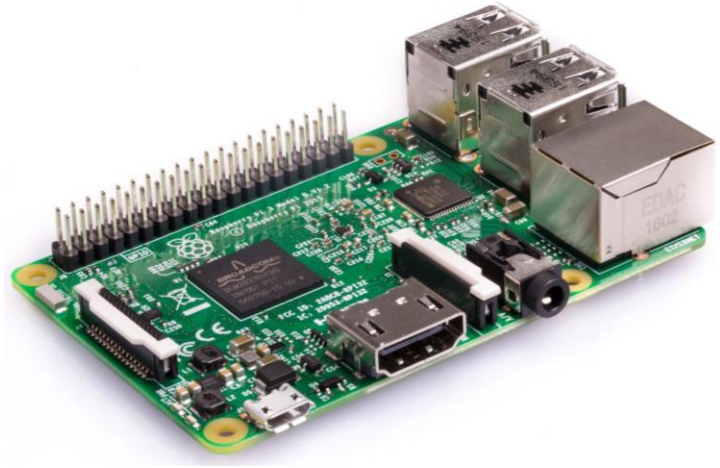


SYSTEM – MECHANICAL DESIGN



SYSTEM – CONTROLLER

- Raspberry Pi 3 microcontroller



- Sensors include atmospheric and internal balloon pressure, along with external temperature
- GPS gathers position and velocity data
- Pi-Cam records video of termination actuator and balloon

SYSTEM – DYNAMICS

- Bouyant lift force L, from Archimedes' principle and ideal gas law:

$$L = P_B \left(\frac{P_A}{R_A * R_{HE} * T^2} * \frac{g}{M_{HE}} \right)$$

- Equation of motion:

$$M_{SYS}\ddot{z} + D + W_{SYS} - L = u(t)$$

Where $u(t) \propto \int_{t0}^{t} \dot{V} dt$, and $\dot{V}$ is the volume flow rate

SYSTEM - TERMINATION

- Actuator extends a blade into the balloon for artificial burst
- Signal sent through radio tone

ASCEND FLIGHTS

11/18/17 FLIGHT OBJECTIVES

- Test equipment in environment (low pressure and temperature) in a payload box (i.e., not on stem)
- Activate ball valve at 60,000 ft
- Close ball valve at 70,000 ft
- Activate test servo 15 s after ball valve closes
- Confirm results with data logger and Raspberry Pi camera

11/18/17 FLIGHT OUTCOME

- All hardware functioned as planned, with a caveat
- Valve opened at 60,000ft
- Balloon burst around 68,000ft
- Valve was still open on the ground
- System still functioning

3/3/18 FLIGHT OBJECTIVES

- Test flight termination sub-system to gain confidence for future flights when the control system is used
- Activate termination actuator via radio command when balloon is at 50k ft, 70k ft and 90k ft during ascent and 25k ft during descent
- Test equipment in environment (low pressure and temperature) in the new payload housing
- Confirm results with data logger and seal over actuator

3/3/18 FLIGHT OUTCOME

- Three of four cut-down commands were received
  - Gives us knowledge of cut-down range
- Software and seal show the cutdown did function
- System and housing performed as they should have

FUTURE PLANS

FUTURE FLIGHTS

- Mid-April:
  - Fly complete system to test cut-down on balloon and collect both external and internal pressure data to compare against model.
  - No control of altitude.
  - Possibly fly test payload from Eagle Space Flight Team.

- Fall 2018:
  - Fly completely integrated system, including gas release and flight termination.
  - Possibly along with EagleSat II test payload.

WHAT'S NEXT?

- Run more comprehensive tests
- Cut down on weight and size
- Design payloads to collect long-duration data

THANK YOU

- Arizona Space Grant Consortium
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- Dr. Douglas Isenberg – Advisor
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- Jeff Hiatt – Machinist

QUESTIONS?

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