MQP Meeting #1
8.31.2021

Overview:
We would like to focus on primarily mechanical and electrical improvements to the existing salamander robot such that we can create a robot with the following specifications capable of performing the below demonstrations. Additionally, we would like to tailor the improvements and constraints in order to qualify the robot for the NASA Big Idea Challenge, and work with another MQP team as necessary in order to meet the mechanical, electrical, and controls requirements of the challenge.

Areas of Interest:
- Improved suspension system. Want to use either a passively or actively deformable suspension system to make the robot capable of traversing multiple sized tubes
- Improved PCB design. Want a new PCB design that is smaller overall (whether that be through enhanced PCB space allocation or a foldable/flexible board) and allows us to scale down the size of the body
- Viability of smaller body with either the Yoshimura pattern or another folding pattern still capable of deforming linearly while maintaining the present level of torsional stiffness
- Integrating usage of robot with vine soft robot for deployment purposes as well as making the salamander usable in wet/humid environments
- Making robot usable in both vacuum and pressurized environments

Specifications:
- Size
    - Robot should be able to be used within a 3” SCH STD pipe
        - Due to schedule piping, the ID of a 2” ND pipe would be below 2” and the 3” ND pipe will be >2”.
    - Robot is usable in pipes up to 6” nominal for vertical climbs
- Speed
    - Robot is able to travel at a reasonable pace (this will be hardware dependant)
- Mobility
    - Robot should meet a 90 degree minimum turning radius
    - Robot should be able to traverse a 90 degree incline in a pipe
    - Robot should be able to climb at least a 30 degree slope.
    - Robot should be able to traverse pipe with constrictions/expansion
        - This would be doable with an active suspension, not so much with a passive unless we have enough force to really push the robot forward to where the suspension system buckles inward
- Sensing
    - Robot should be, at minimum, able to integrate a camera at the robot head for navigation/inspection/sample collection purposes
    - We’re gonna need other sensing? Temperature and Pressure sensors might be good and easy, if we care about mapping the space this gets more complex
- Other
    - Robot should be able to deploy a small scientific payload (idk what size that really means here)

            - This might mean we have to have a modular design of the robot, so that we can have a scoop or something to collect regolith

Demonstrations:

- Within clear pipe
    - General locomotion
        - Forwards, turning, etc.
    - Passage through a t-split
        - Choose which direction to take instead of following flow
    - Locomotion through varying inclines (45, 60, 90?)
        - Within pipes and potentially up stairs
    - Traverse a constriction
    - Bridge a gap
        - To deploy the robot into a pipe inlet without human assistance
- Deployment with vine robot
    - Can we actually get our hands on one? It may be hard to really demonstrate this otherwise
- Payload deployment

Questions

- Budget
    - If our budget is low, do you have any recommendations for receiving funding?
- Lab space/equipment
    - Do we have a dedicated lab space (Soft Robotics Lab), if so can we get Kate access?
- Start to set calendar/Gantt chart with major deadlines that we currently know of

A Term Goals

By end of A term we have:

- Made it through rapid prototyping phase of suspension mechanism - pursued at least 3 designs and tested physical models
    - Gives us an outline for the overall maximum size and flexibility of the robot
- Have landed on a solution/have a solid plan for the smaller PCB. Doesn’t have to be completed, but we must land on a path forward
    - Talk to Dan Moyer - get a consultation on the feasibility of a foldable/flexible PCB and what connections may be subtracted
    - Will give minimum size
- Have a viable solution to the smaller body. Have either produced a smaller body with the current folding pattern or have found another solution.
    - This will outline the minimum size

Other notes:
With regards to NASA challenge

- Market and sell robot as being good in steep and rugged slopes and for subterranean features (especially caves and lava tubes)
- Required:
    - Needs to be able to manage intrusion of dust
    - Be cost effective
    - Low barrier to adoption. (i.e. low mass, small, low power, reliable)
- Desired
    - Able to autonomously navigate through hazardous environments
    - Able to transport objects with larger mass than it’s own