

Microgravity Movement



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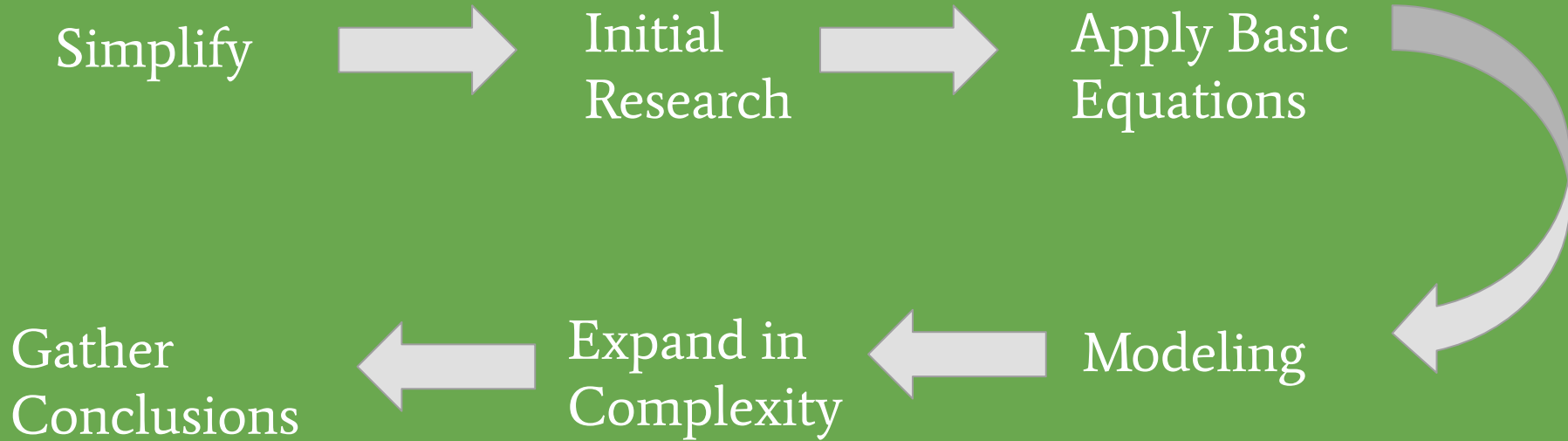
The Problem

- Successfully land a probe on an asteroid in a microgravity environment
- Propel the probe to a predetermined location on the asteroid

Constraints

- Smallest asteroid to successfully land on
- Minimum number of jumps
- Use minimal amount of energy
- Spring only source of force
- Rugged terrain
- Microgravity situations

Our Approach



Simplified Problem

- Prior knowledge

$$v = \frac{mg}{b} + Ce^{-\frac{b}{m}t}$$

- Assumptions:
 - Flat surface
 - Ideal approach
 - Uniform gravitational field
 - Once landed, spring is only mode of movement

$$my'' + by' + ky = F_{ext}$$

Experiment/Modeling

- Constructed crude models
- Incorporated various spring sizes and lengths
- Compared results at different elevations and angles



Expansion of Problem

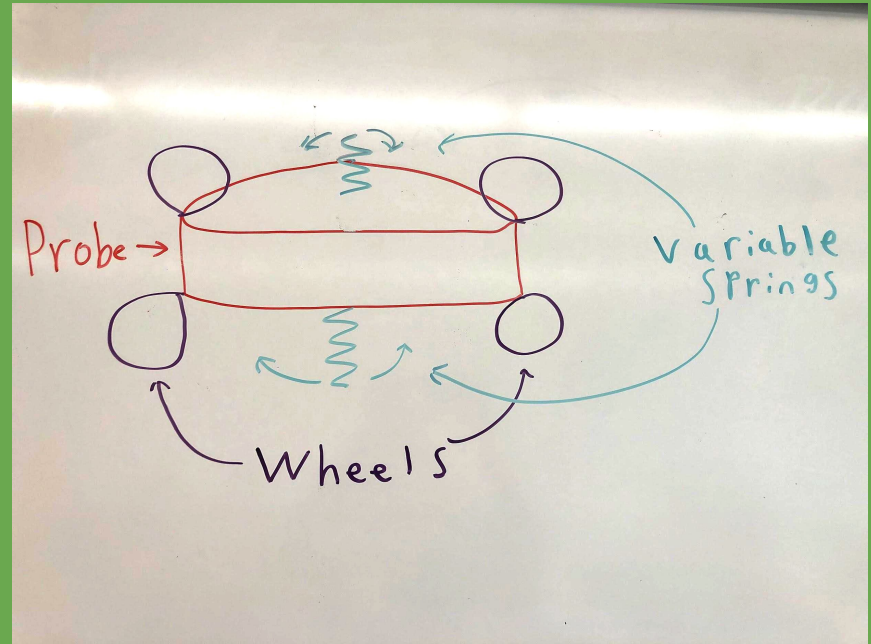
- Probe thrust
- Probe navigation
- Rough surface
- Cliffs and ravines

$$U(r, \theta, \phi) = \frac{u_a}{r} \left\{ 1 + \Delta \left(\frac{R_0}{r} \right)^2 + z \left(\frac{R_0}{r} \right)^4 + O(r^{-5}) \right\}$$

$$m \frac{d^2 y_1}{dt^2} + \lambda \left(\frac{dy_1}{dt} - \frac{dy_2}{dt} \right) + k(y_1 - y_2) = 0$$

Additional Issue

- The probe has the capacity to roll on the asteroid
 - Continue movement in horizontal direction
 - Less chance of damage to the probe
 - Higher percentage of upright landing



Conclusion

What did we find and what's the next step?

References

- Liu, Keping, et al. “Finite-Time Spacecraft's Soft Landing on Asteroids Using PD and Nonsingular Terminal Sliding Mode Control.” *Mathematical Problems in Engineering*, Hindawi, 22 Jan. 2015, www.hindawi.com/journals/mpe/2015/510618/#B20.
- “Differential Equation - Modeling - Spring and Mass.” *ShareTechnote*, www.sharetechnote.com/html/DE_Modeling_Example_SpringMass.html.