Modeling Micro Gravity Movement

Richard Bradley, Jonathan Perry, and Timothy Taylor; Coached by Timothy Clayton

Lincoln Memorial University School of Math and Sciences

6965 Cumberland Gap Parkway,

Harrogate, TN, 37752

Nov. 9, 2019

Abstract

The problem that we chose was problem B: Micro Gravity Movement. When examining the three problems, we chose this one because each of us had at least some physics work done in the past. We successfully modeled (we believe) how to get the probe off of the planet, into orbit, and through space to the asteroid. We were unsure of how the orbit equation worked around asteroids and this was a weak point in our model. Once there, we dropped the probe down and used dampeners to prevent damage to the probe. Our equation modeling the drop onto the asteroid also successfully models how the probe could move around with just a spring.

Process

When examining the problem, we split it into four different stages. Stage 1 was the launch of the rocket, which we were able to model using a project that Richard Bradley had worked on previously on his own. It utilized lagrangian multipliers to find the minimum wait of the rocket stages and the fuel that would need to be utilized to deliver a certain size payload. The second, the travel of the rocket through space, was modeled using a straight line. We would have liked to have utilized the orbit of planets on the way to the asteroid but were unable to do so given our inability to model orbit well. Once to the asteroid, we used a complex equation found in a paper on the topic at first. Unable to crack that, we moved on to a simpler equation. In orbit, a smaller probe is allowed to drop and fall towards the asteroid following free-fall motion, which is our third stage. A gyroscopic mechanism and the low air resistance keeps the probe in an upright position, and four shocks and a spring are used to keep the probe from being destroyed. Once on the asteroid, an equation that incorporates all forces on the object; friction, elastic, damping from shocks, and weight of probe is used to model how the probe will become stationary and how it will be launched. The fourth stage is projectile motion using conservation of energy.

Our equation modeling the initial descent and movement on the asteroid was developed in such a manner that we are able to use it to model both processes quite well.

Our model is not without its limitations, however. The rocket going up assumes no outside forces interacting on it, so that it maintains momentum. This would obviously not be the case. Because of the way we modeled gravity, our application works well for spherical asteroids but is not able to account for those with high aspect ratios. It does not accurately predict orbit around asteroids. The radius of our asteroid must be much larger than our probe radius. We have a linear path to the asteroid, which limits the range of the probe and is somewhat unlikely (there could be debris in the path of the probe). The asteroid must have microgravity, or our model fails to accurately explain what is happening.

Conclusion

There were multiple equations that were involved in each stage, so due to space constraints we couldn’t include those here. We will submit a separate file with our equations and work if deemed necessary or there is interest displayed for that.

Citations