The Search for a Suitable Landing Site

NMT Team 4

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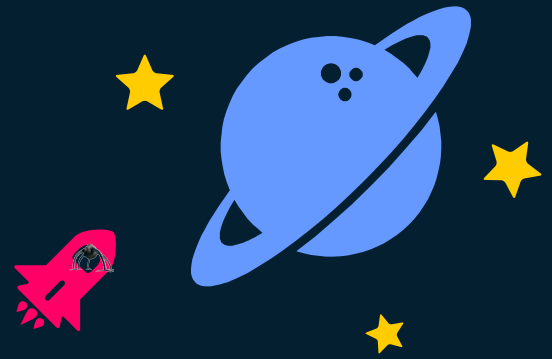
Problem B: Movement of an Object in Microgravity Environments

THE METHOD



We decided to approach this problem as a Mechanical and Electrical Vibrations problem.

Applying the Vibrations Approach

- Variables:
  - Mass
  - Friction
  - Spring Constant
  - External Force
- Equation: $F(t) = mu'' + \gamma u' + ku$
- Equation dampens
- Solve using variation of parameters

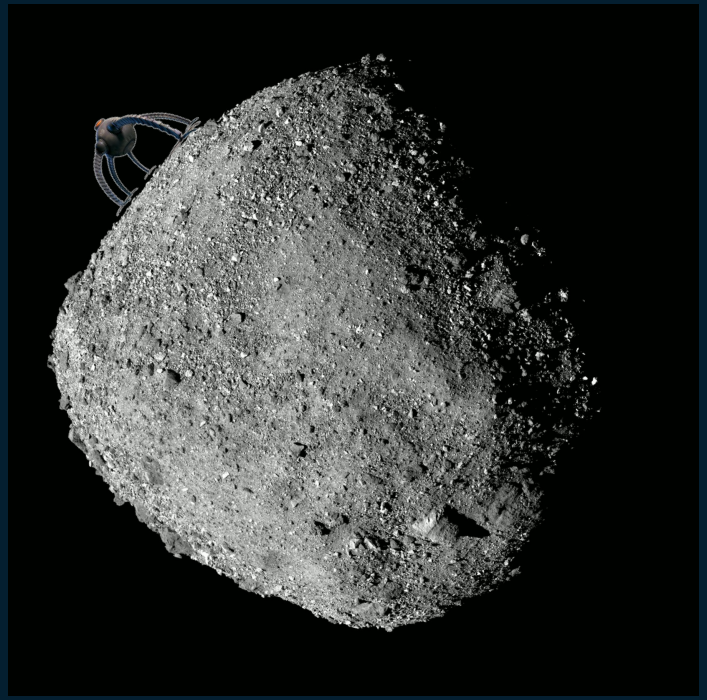


Image source:
https://svs.gsfc.nasa.gov/vis/a010000/a013100/a013154/Asteroid_Bennu_Rotate_20181202_Preview.jpg

Addressing Microgravity

We assume that there is gravity on this asteroid because every object — especially one as large as an asteroid— has a gravitational pull. The problem will be quite difficult to solve if we assume zero gravity or negligible gravity.

Regarding the Other Variables

- Mass
  - $m = w / g$
- Friction
  - Infinite movement
- Spring Constant
  - Probe will need to bounce to prevent damage
  - Shock absorption
- External Force
  - Movement/Stopping

Analyzing Limitations

Distance

The farther away the asteroid is from Earth, the cost and the risk of lost efforts and data increase.

Material

The materials in the probe need to be very specific. They need to absorb enough shock to protect the instrumentation, but also slow down the craft and not send it away.

Speed

If the asteroid is travelling too fast, the risk of crashing or missing the asteroid increase significantly.

Additional Issues

1) If the probe rolls, then we need to take into account an increase in friction to keep the probe at a steady speed and not over shoot the predetermined landing site. Also, the external force would need to be increased as a stopping mechanism for the probe to not crash into the asteroid.

2) The shape doesn't matter as much to our equations unless it is irregular in which finding the circumference of the asteroid will be difficult. The size of the asteroid determines the gravity on our probe, so as the asteroid gets bigger the gravity will increase making the probe land on the asteroid with more force.

3) In order to travel around the circumference of the asteroid, we would utilize rolling and would thus want to have a larger number of bounces. With each bounce, the probe rolls.

THANK YOU!

Any questions?

Image Source: Disney Pixar's *The Incredibles*