Precision Control Autonomous Systems for NEO Mission Design

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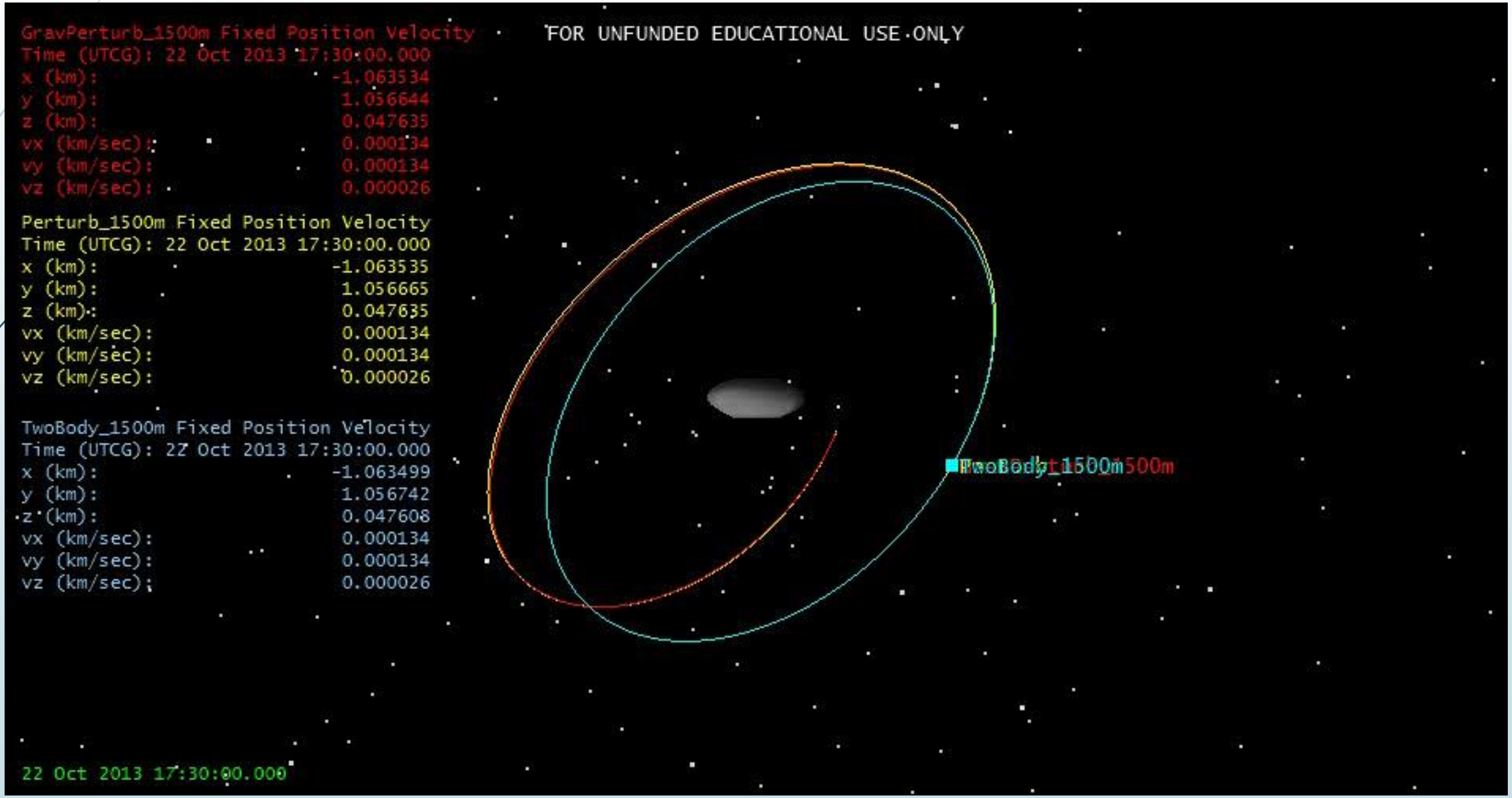
Project Basis / Motivation

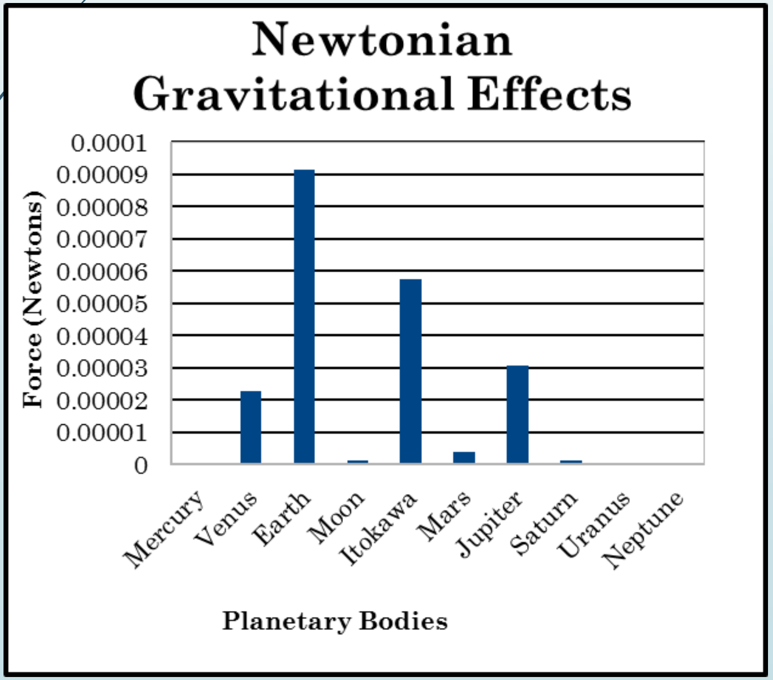
- Asteroid mission has received a lot of attention in recent years
  - Defense, economic and exploration purposes
- Current missions
  - DAWN and HAYABUSA II (2014-15 Launch)
- Orbital control as not been demonstrated around objects of small diameters
  - 500 meter in diameter scale

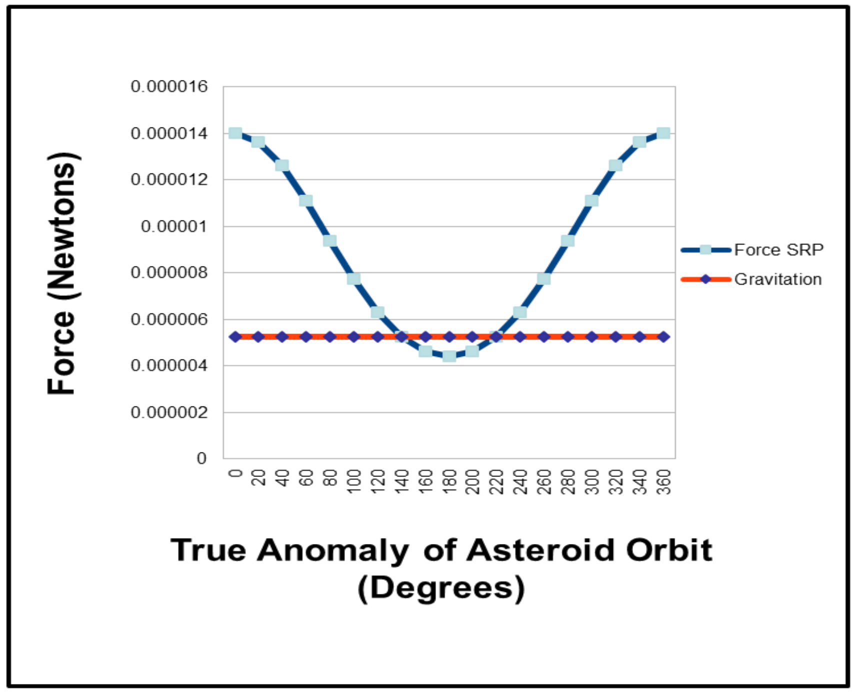
Let’s Look at an Example.



Classifying the Problem

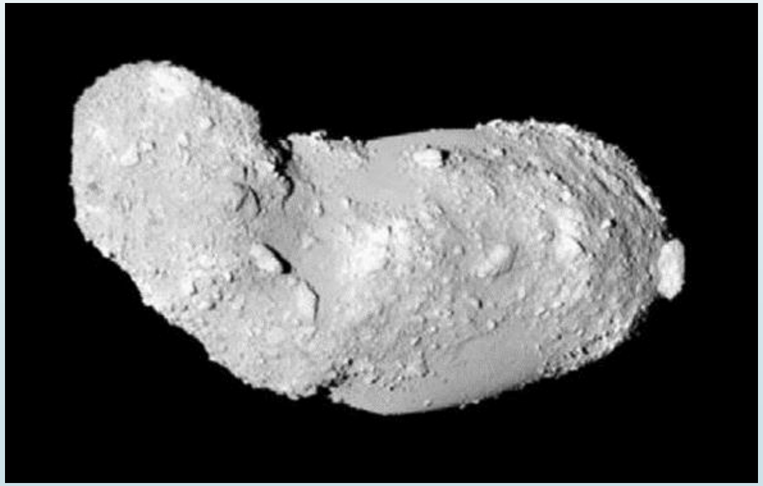
- Need to determine regions of natural stability
  - Balance between complex gravitation, solar radiation pressure and third body perturbations
- Which orbital parameters are needed such that our spacecraft stays in orbit for a longer duration of time disregarding external control





Standardizing the Model

- Running multiple simulations on different computers
  - Prone to error due to changing initial conditions
- Asteroid characteristics
  - Epoch
  - Rotation
  - Gravity Model
- Create a standard satellite model
  - Surface Area
  - Dry Mass
  - Fuel mass



25143 Itokawa (JAXA – 2005)

Standardizing the Model

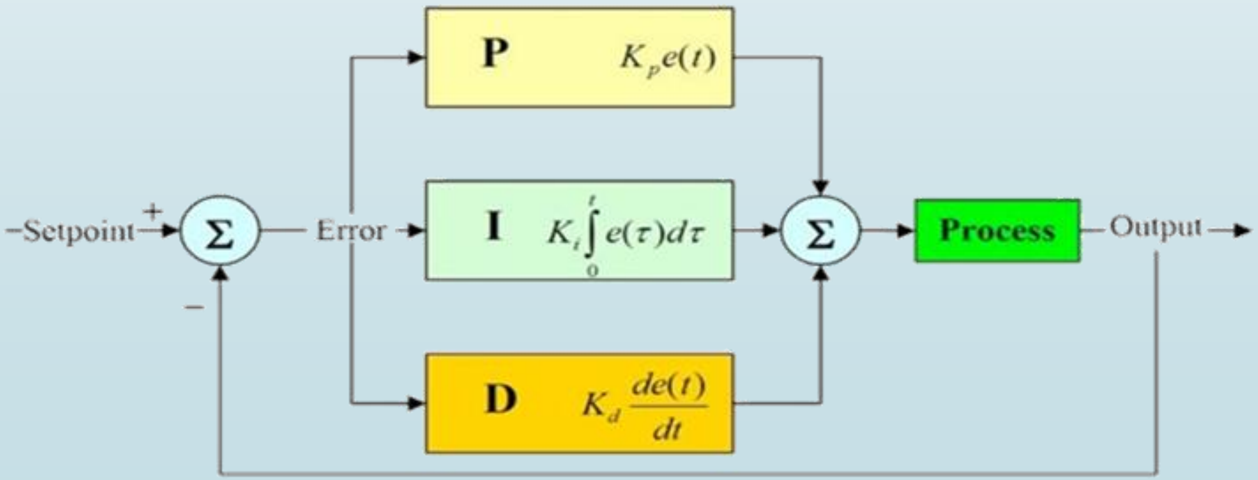
- Custom Ion Engine Model
  - Maximum & Minimum Power
  - Specific Impulse
  - Mass Flow Rate

- Based on existing 8 cm Ion Engine*

*L3 Communications

PID Control

- Proportional, Integral, Derivative Control
  - Error Function: Current altitude vs desired altitude
- Execution
  - Proportional – push based on error
  - Integral – constant summation (plus correction) of the error over the simulation
  - Derivative – monitors the position's rate of change and helps to eliminate rapid fluctuations leading to overshoot

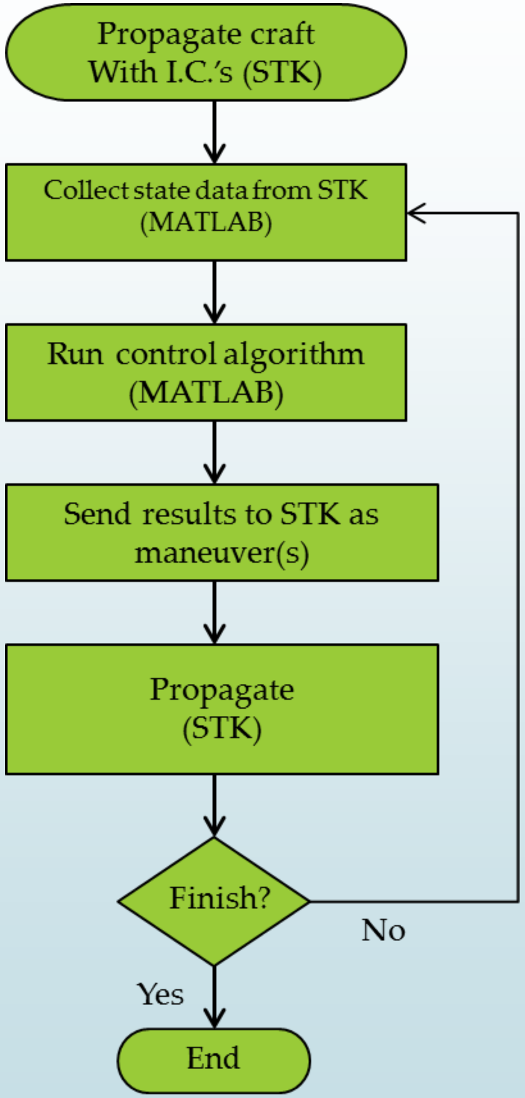


Simulations

- Interface Matlab and STK

- Orbital Mechanics vs PID Control
  - Hohmann Transfer is useful for direct control
  - PID is useful for indirect control

- Multiple simulations ran
  - Impulsive burns
  - Finite burns



Questions?

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