Characterizing Rotation of Satellites (CRoS)

Reducing Point Cloud to Rotation

Getting accelerations

For a given point cloud P, create a set of vectors A from the acceleration ($\frac{d^2}{dt^2}p$) of P. Each acceleration will be the sum of gravity, centripetal, tangential, and error ($a = a_g + a_c + a_t + a_e$). Tangential and error are assumed to be zero, and gravity should only take effect in large arcs of an orbit but can be calculated from estimating position.

Identifying Rotational Axis Tangent

For every pair of vectors in A identify the normal vector n ($a_1 \times a_2$). If the dot product of one n to another n is negative, invert one normal vector until all vectors point in the same general direction. Average all n to the vector n_a. n_a is the tangent for the rotational axis. On clean data, n will equal n_a

Identifying Rotational Axis Point

Map all P onto the plane L corresponds to the normal vector n_a. The point at which all acceleration vectors intersect in the rotational axis point R.

The rotational axis can be described by

$$\vec{r} = R + \vec{v}\vec{n}_a$$

Where $\vec{v} = \begin{pmatrix} x \\ y \\ z \end{pmatrix}$

Rotational Speed of Object

Take the distance r of point cloud P on plain L from point R. Get the velocity v of P on L relative to R. The rotational speed should be $\omega = \frac{\mathrm{v}}{\mathrm{r}}$.