Local Tilt Map Algorithm Description Document

Overview

This data product supports the Safety Map requirement SM. ALG.06: "*SPOC shall generate a site specific tilt input map for each potential sampling sites. The site specific tilt scale map will provide a map for a targeted sampling site and will include the entire area of the targeted site. The local tilt map will provide the average tilt of all facets within the contact area for every facet in the DTM. The contact area is a parameterized value and will be approximately at the scale of the TAGSAM head (TBR).*" The tilt at the scale of the TAGSAM sampling head is correlated to the contact dynamics and ability of the spacecraft to remain safe throughout surface contact. The 'contact area' is the local area of influence to the mechanical contact dynamics and is at the scale of the TAGSAM head. This map calculates the tilt of the contact area for each facet in the site specific Local Topographic Map and assigns a safety rating based on the spacecraft requirements and capability.

Inputs

- Local Topographic Map (LTM)
    - Nominally 2.5 cm resolution
- TAG Approach Vector
- r – Contact area radius
- Local Deliverability Map (LDM)
- Sampling site radius (circular)
- G_tilt – parameter for acceptable contact tilt angle
- R_tilt – parameter for unacceptable contact tilt angle

Outputs

- Local Tilt Safety Map
    - Referenced to the LTM

Algorithm

The sampling site area is a subset of the LTM domain. The sampling area is either defined by the Local Deliverability Map boundaries, or alternatively the user can input a single scalar for the sampling site area radius instead of the LDM.

For each facet within the sampling area:

1. Calculate unit surface normal (ACF) for each facet
2. Search for other plates within given radius 'r' of current plate center. A plate is considered within the given radius if any one of its vertices is within the circle defined by the contact radius 'r'.
3. Calculate average unit vector for all facets within the sampling area, using the following formula

$$Y^j = \sum_{i=1}^{N} x_i^j * A_i * W_i$$

Where: Y^j is the j^{th} component of the average tilt vector
x_i is j^{th} component of the vector normal to the i^{th} facet
A_i is the area of the i^{th} facet
W_i is the optional weighting factor for the facet and is given by the following formula:

$$W_i = 1$$

The weighting scheme is currently TBD. It is possible the final chosen weighting scheme will be a function of radius or other parameters.

4. Normalize the resultant vector **Y** to a value of one. This vector represents the ACF normal vector for the contact area centered on the LTM facet.

Repeat steps 1-4 above for a contact area centered on each facet in the sampling area.

The angle between the contact area ACF normal vector (**Y**) and the TAG approach vector provides an assessment of safety due to contact tilt for each facet. This angle and a color-coded safety rating for the contact area centered about each facet will be output for as part of the Local Tilt Map. The following criteria should be used to color code each facet:

a. The angle between **Y** and the TAG approach vector is less than G_tilt, the facet will be colored Green
b. The angle between **Y** and the TAG approach vector is greater than R_tilt, the facet will be colored Red
c. Else the facet is colored Yellow

The values for G_tilt and R_tilt will be supplied.