Global Roughness Map Algorithm Description Document

Overview

This data product supports the Safety Map requirement SM. ALG.02: "*SPOC shall generate a global roughness input map for each facet in the GSM. The roughness parameter will indicate how smooth (or rough) the sampling area is centered on each of the facets in the GSM*." The tilt of each facet within the sampling site is calculated to determine spacecraft safety for contact dynamics. This map calculates which candidate TAG sampling sites on the global shape model contain sufficiently low tilt facets to satisfy the mission requirement for spacecraft safety during surface contact.

Inputs

- Global Shape Model (GSM)
    - 35cm resolution or beter
- TAG Approach Vector, derived from the Global Tilt Map (GTM)
- r – Contact area radius
- Global Deliverability Map (GDM)
- Sampling site radius (circular)
- G_tilt – parameter for acceptable facet tilt angle
- R_tilt – parameter for unacceptable facet tilt angle

Outputs

- Global Roughness Safety Map
    - Referenced to the GSM

Algorithm

The 'sampling area' centered about each facet in the GSM is defined by the Global Deliverability Map (GDM). Since the GDM is not at the same resolution as the GSM, the size of the sampling area is defined by the semimajor and semiminor axes of the nearest-latitude GDM site. If there are multiple GDM sites with the same latitude, then the nearest longitude GDM site is selected from the remaining options. The semimajor and semiminor axes of the sampling area should be converted 3-sigma values, assuming a Gaussian error distribution (the GDM input is currently 1-sigma). Alternatively, the user can input a single scalar for the sampling site area radius instead of the GDM. The sampling area in this case for every facet is a circle with the specified radius.

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. If the resolution of the shape model data is at most ½ (TBR) of the parameterized contact area radius, a plate is considered within the given radius if any one of its vertices is within the circle defined by the contact radius 'r'.
    b. If the resolution of the shape model data is more than ½ (TBR) of the parameterized contact area radius, only the current plate should be considered.

c. This algorithm requires that the resultion of the shape model data is not greater than the parameterized 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.