3D GeoWall Analysis System for Shuttle External Tank Foreign Object Debris Events

This new system augments and optimizes existing 2D monitoring capabilities.

Stennis Space Center, Mississippi

An analytical, advanced imaging method has been developed for the initial monitoring and identification of foam debris and similar anomalies that occur post-launch in reference to the space shuttle's external tank (ET). Remote sensing technologies have been used to perform image enhancement and analysis on high-resolution, true-color images collected with the DCS 760 Kodak digital camera located in the right umbilical well of the space shuttle. Improvements to the camera, using filters, have added sharpness / definition to the image sets; however, image review / analysis of the ET has been limited by the fact that the images acquired by umbilical cameras during launch are two-dimensional, and are usually non-referenceable between frames due to rotation translation of the ET as it falls away from the space shuttle. Use of stereo pairs of these images can enable strong visual indicators that can immediately portray depth perception of damaged areas or movement of fragments between frames is not perceivable in two-dimensional images.

A stereoscopic image visualization system has been developed to allow 3D depth perception of stereo-aligned image pairs taken from in-flight umbilical and handheld digital shuttle cameras. This new system has been developed to augment and optimize existing 2D monitoring capabilities. Using this system, candidate sequential image pairs are identified for transformation into stereo viewing pairs. Image orientation is corrected using control points (similar points) between frames to place the two images in proper X–Y viewing perspective. The images are then imported into the WallView stereo viewing software package. The collected control points are used to generate a transformation equation that is used to re-project one image and effectively co-register it to the other image. The co-registered, oriented image pairs are imported into a WallView image set and are used as a 3D stereo analysis slide show. Multiple sequential image pairs can be used to allow forensic review of temporal phenomena between pairs. The observer, while wearing linear polarized glasses, is able to review image pairs in passive 3D stereo.

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Inquiries concerning rights for the commercial use of this invention should be addressed to the Intellectual Property Manager at Stennis Space Center (228) 688-1929. SSC-00331

Charge-Spot Model for Electrostatic Forces in Simulation of Fine Particulates

More accurate results are obtained by assigning multiple charge spots to dust particles instead of one.

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The charge-spot technique for modeling the static electric forces acting between charged fine particles entails treating electric charges on individual particles as small sets of discrete point charges, located near their surfaces. This is in contrast to existing models, which assume a single charge per particle. The charge-spot technique more accurately describes the forces, torques, and moments that act on triboelectrically charged particles, especially image-charge forces acting near conducting surfaces.

The discrete element method (DEM) simulation uses a truncation range to limit the number of near-neighbor charge spots via a shifted and truncated potential Coulomb interaction. The model can be readily adapted to account for induced dipoles in uncharged particles (and thus dielectrophoretic forces) by allowing two charge spots of opposite signs to be "created" in response to an external electric field. To account for virtual overlap during contacts, the model can be set to automatically scale down the effective charge in proportion to the amount of virtual overlap of the charge spots. This can be accomplished by mimicking the behavior of two real overlapping spherical charge clouds, or with other approximate forms.

The charge-spot method much more closely resembles real non-uniform surface charge distributions that result from tribocharging than simpler approaches, which just assign a single total charge to a particle. With the charge-spot model, a single particle may have a zero net charge, but still have both positive and negative charge spots, which could produce substantial forces on the particle when it is close to other charges, when it is in an external electric field, or when near a conducting surface. Since the charge-spot model can contain any number of charges per particle, can be used with only one or two charge spots per particle for simulating charging from solar wind bombardment, or with several charge spots