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.

This work was done by Richard Brown, Science Systems and Applications, Inc., Andrew Navard of Computer Sciences Corp., and Joseph Spruce of Science Systems and Applications, Inc. for Stennis Space Center.

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.

John H. Glenn Research Center, Cleveland, Ohio

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 for simulating triboelectric charging. Adhesive image-charge forces acting on charged particles touching conducting surfaces can be up to 50 times stronger if the charge is located in discrete spots on the particle surface instead of being distributed uniformly over the surface of the particle, as is assumed by most other models.

Besides being useful in modeling particulates in space and distant objects, this modeling technique is useful for electrophotography (used in copiers) and in simulating the effects of static charge in the pulmonary delivery of fine dry powders.

This work was done by Otis R. Walton and Scott M. Johnson of Grainflow Dynamics, Inc. for Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18403-1.

Hidden Statistics Approach to Quantum Simulations

This dynamic system could help in building quantum computers.

NASA's Jet Propulsion Laboratory, Pasadena, California

Recent advances in quantum information theory have inspired an explosion of interest in new quantum algorithms for solving hard computational (quantum and non-quantum) problems. The basic principle of quantum computation is that the quantum properties can be used to represent structure data, and that quantum mechanisms can be devised and built to perform operations with this data. Three basic "non-classical" properties of quantum mechanics — superposition, entanglement, and direct-product decomposability — were main reasons for optimism about capabilities of quantum computers that promised simultaneous processing of large massifs of highly correlated data. Unfortunately, these advantages of quantum mechanics came with a high price. One major problem is keeping the components of the computer in a coherent state, as the slightest interaction with the external world would cause the system to decohere. That is why the hardware implementation of a quantum computer is still unsolved.

The basic idea of this work is to create a new kind of dynamical system that would preserve the main three properties of quantum physics — superposition, entanglement, and direct-product decomposability — while allowing one to measure its state variables using classical methods. In other words, such a system would reinforce the advantages and minimize limitations of both quantum and classical aspects.

Based upon a concept of hidden statistics, a new kind of dynamical system for simulation of Schrödinger equation is proposed. The system represents a modified Madelung version of Schrödinger equation. It preserves superposition, entanglement, and direct-product decomposability while allowing one to measure its state variables using classical methods. Such an optimal combination of characteristics is a perfect match for simulating quantum systems. The model includes a transitional component of quantum potential (that has been overlooked in previous treatment of the Madelung equation). The role of the transitional potential is to provide a jump from a deterministic state to a random state with prescribed probability density. This jump is triggered by blowup instability due to violation of Lipschitz condition generated by the quantum potential. As a result, the dynamics attains quantum properties on a classical scale. The model can be implemented physically as an analog VLSI-based (very-large-scale integration-based) computer, or numerically on a digital computer.

This work opens a way of developing fundamentally new algorithms for quantum simulations of exponentially complex problems that expand NASA capabilities in conducting space activities. It has been illustrated that the complexity of simulations of particle interaction can be reduced from an exponential one to a polynomial one.

This work was done by Michail Zak of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-47158

Reconstituted Three-Dimensional Interactive Imaging

Lyndon B. Johnson Space Center, Houston, Texas

A method combines two-dimensional images, enhancing the images as well as rendering a 3D, enhanced, interactive computer image or visual model. Any advanced compiler can be used in conjunction with any graphics library package for this method, which is intended to take digitized images and virtually stack them so that they can be interactively viewed as a set of slices. This innovation can take multiple image sources (film or digital) and create a "transparent" image with higher densities in the image being less transparent. The images are then stacked such that an apparent 3D object is created in virtual space for interactive review of the set of images.

This innovation can be used with any application where 3D images are taken as slices of a larger object. These could include machines, materials for inspection, geological objects, or human scanning.

Illuminous values were stacked into planes with different transparency levels of tissues. These transparency levels can use multiple energy levels, such as density of CT scans or radioactive density. A desktop computer with enough video memory to produce the image is capable of this work. The memory changes with the size and resolution of the desired images to be stacked and viewed.

This work was done by Joseph Hamilton, Theodore Foley, and Thomas Duncavage of Johnson Space Center and Terrence Mayes of Barrios Technology. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-23860-1