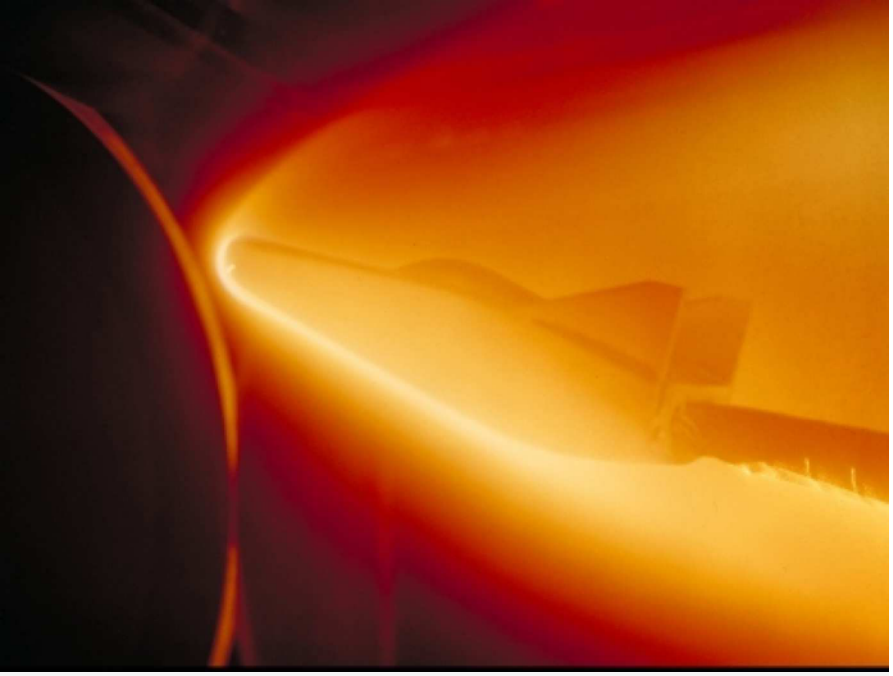

National Aeronautics and
Space Administration

technology solution

Instrumentation

Photogrammetric Recession Measurement

Method to measure the recession of ablative materials

The testing of materials that ablate as a design function requires detailed time history of the ablation process. The rate at which the surface recedes during testing is a critically important measure of the performance of Thermal Protection System (TPS) materials for example, heat shields on aerospace vehicles. Photogrammetric Recession Measurement (PRM) meets the challenge by recording the surface ofthe ablating model during heating in hyper-thermal test facilities (Arc-Jets), using two high-resolution digital cameras capable of recording at 15 frames per second simultaneously. The cameras are calibrated to yield three-dimensional object space measurements for each stereo pair of images, producing surface recession data over the portion of the model for which both cameras share a view. Image cross-correlation is used widely in several imaging applications, but the new technique of de-warping small interrogation areas of the model surface seen by both cameras and cross-correlating the de-warped views from each camera is an innovation. This acts as a highly accurate feature recognition utility, and can be implemented in several applications.

BENEFITS

- Provides time-history data without targets and without modifications to the test article
- Employs novel image cross-correlation techniques
- Low-cost, non-intrusive, and easy-to-implement
- Complements/supplements other recession measuring techniques
- Permits multiple insertion testing
- Works at any magnification, with any imaging spectrum

THE TECHNOLOGY

Two or more synchronized digital cameras image the face of a test article from different directions, either directly or off mirrors, during article testing. The cameras are calibrated using standard photogrammetry methods which result in a Direct Linear Transform (DLT). Recession measurements are made after a test is complete by analyzing the sequence of images from both cameras. The analyst defines selected points on the surface of the test article by constructing, in three dimensional object space (3DOS), a mathematical surface grid that conforms to the original shape of the test article. The density and distribution of measurement points can be arbitrarily chosen, and no fiducial marks are required. The surface texture of the test article must be random for the cross-correlation technique to work. Synchronous images from each camera are analyzed using the local dewarp method for establishing correspondence. The 3DOS coordinates of the points are computed from the 2D image-plane coordinates that match in each camera view using the camera calibration coefficients from the DLT. This yields the instantaneous 3D shape of the surface of the model. Repeating this calculation for each pair of images in the image sequences from the two cameras yields the time-history of the shape of the surface.

orion heat shield

APPLICATIONS

The technology has several potential applications:

- Ablative-type materials with varying density/multi-layer
- Heat shields, aerospace re-entry vehicles
- Insulation coatings
- Arc-Jet systems
- Ceramics and composites
- Cold material sublimation/ melting
- Soil erosion

PUBLICATIONS

Patent No: 8,290,246

More Information

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