Books & Reports

⧉ Process To Produce Iron Nanoparticle Lunar Dust Simulant Composite

A document discusses a method for producing nanophase iron lunar dust composite simulant by heating a mixture of carbon black and current lunar simulant types (mixed oxide including iron oxide) at a high temperature to reduce ionic iron into elemental iron. The product is a chemically modified lunar simulant that can be attracted by a magnet, and has a surface layer with an iron concentration that is increased during the reaction. The iron was found to be α-iron and Fe_3O_4 nanoparticles. The simulant produced with this method contains iron nanoparticles not available previously, and they are stable in ambient air. These nanoparticles can be mass-produced simply.

This work was done by Ching-cheh Hung and Jeremiah McNatt of Glenn Research Center.

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-18496-1.

∑ Inversion Method for Early Detection of ARES-1 Case Breach Failure

A document describes research into the problem of detecting a case breach formation at an early stage of a rocket flight. An inversion algorithm for case breach allocation is proposed and analyzed. It is shown how the case breach can be allocated at an early stage of its development by using the rocket sensor data and the output data from the control block of the rocket navigation system. The results are simulated with MATLAB/Simulink software. The efficiency of an inversion algorithm for a case breach location is discussed.

The research was devoted to the analysis of the ARES-l flight during the first 120 seconds after the launch and early prediction of case breach failure. During this time, the rocket is propelled by its first-stage Solid Rocket Booster (SRB). If a breach appears in SRB case, the gases escaping through it will produce the (side) thrust directed perpendicular to the rocket axis. The side thrust creates a

torque influencing the rocket attitude. The ARES-l control system will compensate for the side thrust until it reaches some critical value, after which the flight will be uncontrollable. The objective of this work was to obtain the start time of case breach development and its location using the rocket inertial navigation sensors and GNC data.

The algorithm was effective for the detection and location of a breach in an SRB field joint at an early stage of its development.

This work was done by Ryan M. Mackey and Igor K. Kulikov of Caltech and Anupa Bajwa, Peter Berg, and Vadim Smelyanskiy of Ames Research Center for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

The software used in this innovation is available for commercial licensing. Please contact Daniel Broderick of the California Institute of Technology at danielb@caltech.edu. Refer to NPO-47285.

⚙ Use of ILTV Control Laws for LaNCETS Flight Research

A report discusses the Lift and Nozzle Change Effects on Tail Shock (LaNCETS) test to investigate the effects of lift distribution and nozzle-area ratio changes on tail shock strength of an F-15 aircraft. Specific research objectives are to obtain in-flight shock strength for multiple combinations of nozzle-area ratio and lift distribution; compare results with pre-flight prediction tools; and update predictive tools with flight results. The objectives from a stability and control perspective are to ensure adequate aircraft stability for the changes in lift distribution and plume shape, and ensure manageable transient from engaging and disengaging the ILTV research control laws. In order to change the lift distribution and plume shape of the F-15 aircraft, a decade-old Inner Loop Thrust Vectoring (ILTV) research control law was used. Flight envelope expansion was performed for the test configuration and flight conditions prior to the probing test points.

The approach for achieving the research objectives was to utilize the unique capabilities of NASA's NF-15B-837 aircraft to allow the adjustment of the nozzle-area ratio and/or canard positions by engaging the ILTV research

control laws. The ILTV control laws provide the ability to add trim command biases to canard positions, nozzle area ratios, and thrust vectoring through the use of datasets. Datasets consist of programmed test inputs (PTIs) that define "trims" to change the nozzle-area ratio and/or canard positions. The trims are applied as increments to the normally commanded positions.

A LaNCETS non-linear, six-degrees-of-freedom simulation capable of real-time pilot-in-the-loop, hardware-in-the-loop, and non-real-time batch support was developed and validated. Prior to first flight, extensive simulation analyses were performed to show adequate stability margins with the changes in lift distribution and plume shape. Additionally, engagement/disengagement transient analysis was also performed to show manageable transients.

This work was done by Cheng Moua of Dryden Flight Research Center. Further information is contained in a TSP (see page 1). DRC-009-039

∑ Evaluating Descent and Ascent Trajectories Near Non-Spherical Bodies

Spacecraft landing on small bodies pass through regions where conventional gravitation formulations using exterior spherical harmonics are inaccurate. An investigation shows that a formulation using interior solid spherical harmonics might be satisfactory. Interior spherical harmonic expansions are usable inside an imaginary, empty sphere. For this application, such a sphere could be positioned in empty space above the intended landing site and rotating with the body. When the spacecraft is inside this sphere, the interior harmonic expansion would be used instead of the conventional, exterior harmonic expansion.

Coefficients can be determined by a least-squares fit to gravitation measurements synthesized from conventional formulations. Due to their unfamiliarity, recurrences for interior, as well as exterior, expansions are derived. Hotine's technique for partial derivatives of exterior spherical harmonics is extended to interior harmonics.

This work was done by Robert A. Werner of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-46697