Books & Reports

Surface Modeling to Support Small-Body Spacecraft Exploration and Proximity Operations

In order to simulate physically plausible surfaces that represent geologically evolved surfaces, demonstrating demanding surface-relative guidance navigation and control (GN&C) actions, such surfaces must be made to mimic the geological processes themselves. A report describes how, using software and algorithms to model body surfaces as a series of digital terrain maps, a series of processes was put in place that evolve the surface from some assumed nominal starting condition.

The physical processes modeled in this algorithmic technique include fractal regolith substrate texturing, fractally textured rocks (of empirically derived size and distribution power laws), cratering, and regolith migration under potential energy gradient. Starting with a global model that may be determined observationally or created *ad hoc*, the surface evolution is begun. First, material of some assumed strength is layered on the global model in a fractally random pattern. Then, rocks are distributed according to power laws measured on the Moon. Cratering then takes place in a temporal fashion, including modeling of ejecta blankets and taking into account the gravity of the object (which determines how much of the ejecta blanket falls back to the surface), and causing the observed phenomena of older craters being progressively buried by the ejecta of earlier impacts. Finally, regolith migration occurs which stratifies finer materials from coarser, as the fine material progressively migrates to regions of lower potential energy.

This work was done by Joseph E. Riedel and Nickolaos Mastrodemos of Caltech and Robert W. Gaskell of the Planetary Science Institute for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47233

Achieving Exact and Constant Turnaround Ratio in a DDS-Based Coherent Transponder

A report describes a non-standard direct digital synthesizer (DDS) implementation that can be used as part of a coherent transponder so as to allow any rational turnaround ratio to be exactly achieved and maintained while the received frequency varies. (A coherent transponder is a receiver-transmitter in which the transmitted carrier is locked to a pre-determined multiple of the received carrier's frequency and phase. That multiple is called the turnaround ratio.)

The report also describes a general model for coherent transponders that are partly digital. A partially digital transponder is one in which analog signal processing is used to convert the signals between high frequencies at which they are radiated and relatively low frequencies at which they are converted to or from digital form, with most of the complex processing performed digitally. There is a variety of possible architectures for such a transponder, and different ones can be selected by choosing different parameter values in the general model.

Such a transponder uses a DDS to create a low-frequency quasi-sinusoidal signal that tracks the received carrier's phase, and another DDS to generate an IF or near-baseband version of the transmitted carrier. With conventional DDS implementations, a given turnaround ratio can be achieved only approximately, and the error varies slightly as the received frequency changes. The non-conventional implementation employed here allows any rational turnaround ratio to be exactly maintained.

This work was done by Larry R. D'Addario of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47460