Information Sciences

Update on EMD and Hilbert-Spectra Analysis of Time Series

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U.S. Patent 6,381,559 presents further information about the method described in "Analyzing Time Series Using EMD and Hilbert Spectra" (GSC-13817), *NASA Tech Briefs*, Vol. 24, No. 10 (October 2000), page 63. To recapitulate: The method is especially well suited for analyzing time-series data that represent nonstationary and nonlinear physical phenomena. The method is based principally on the concept of empirical mode decomposition (EMD), according to which any complicated signal (as represented by digital samples) can be decomposed into a finite number of functions, called "intrinsic mode functions" (IMFs), that admit well-behaved Hilbert transforms. The local energies and the instantaneous frequencies derived from the IMFs through Hilbert transforms can be used to construct an energy-frequency-time distribution, denoted a Hilbert spectrum. The patent expands on the description in the cited prior article by explaining underlying mathematical principles and describing details of implementation. The patent also describes, as major elements of the method, the options of (1) filtering the original signal by combining a subset of IMFs and (2) fitting a curve to the filtered signal — something that it may not be possible to do with the original signal.

This work was done by Norden E. Huang of **Goddard Space Flight Center**. *Further information is contained in a TSP (see page 1).*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Goddard Space Flight Center; (301) 286-7351. Refer to GSC-13817-3.

Quad-Tree Visual-Calculus Analysis of Satellite Coverage

The computational burden is less than in a pixel representation.

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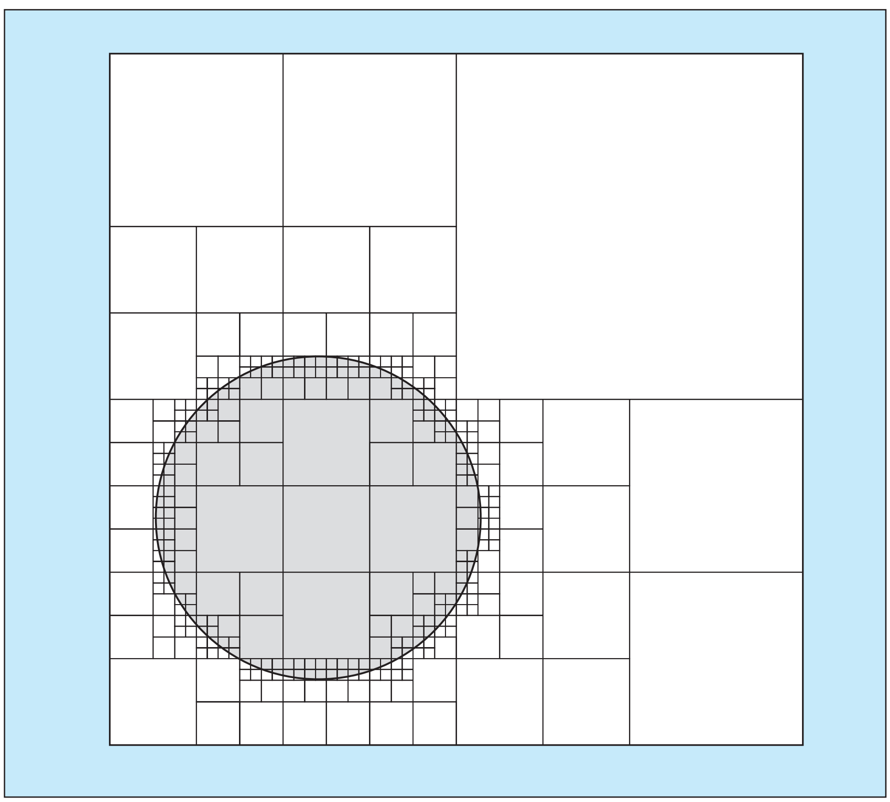
An improved method of analysis of coverage of areas of the Earth by a constellation of radio-communication or scientific-observation satellites has been developed. This method is intended to supplant an older method in which the global-coverage-analysis problem is solved from a ground-to-satellite perspective. The older method is suitable for coarse-grained analysis of coverage of a constellation of a few satellites, but the algorithms of the older method are too slow and cumbersome for the large scope of the problem of analysis of coverage of a modern constellation of many satellites intended to provide global coverage all the time. In contrast, the present method provides for rapid and efficient analysis. This method is derived from a satellite-to-ground perspective and involves a unique combination of two techniques for multiresolution representation of map features on the surface of a sphere.

The first of the two techniques, called "visual calculus," is one that embodies the satellite-to-ground perspective and assists in the visualization of global coverage. In visual calculus, a satellite can be regarded as "painting" its field of view or other coverage field onto the ground



Using a Multiresolution Map to analyze a circular region, it is not necessary to resort to full resolution everywhere. Large areas with the same value can be represented by a few large squares; smaller squares are needed only to resolve details of the boundary.