Real-Time Detection of Dust Devils From Pressure Readings

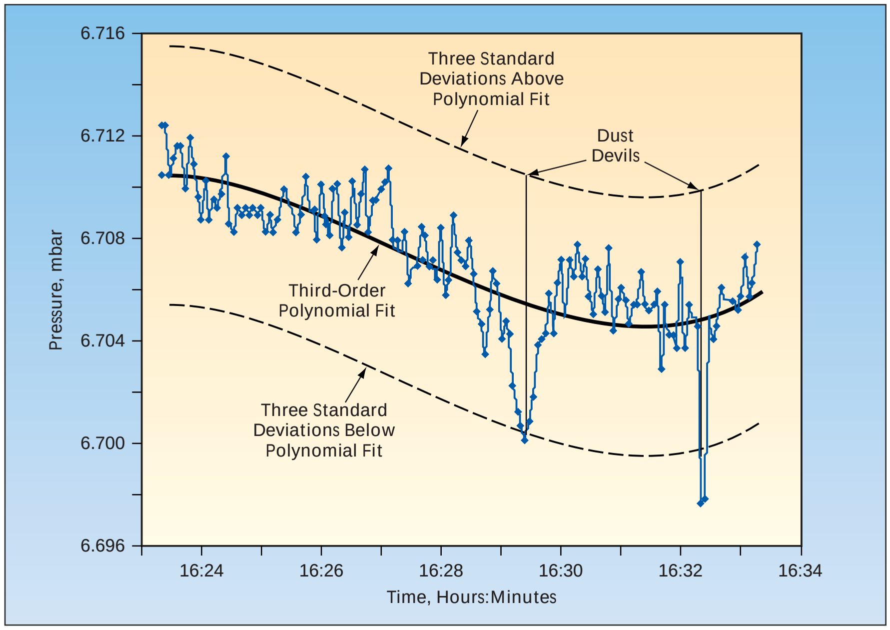
Dust devils are identified as large deviations from a sliding polynomial fit.

NASA's Jet Propulsion Laboratory, Pasadena, California

A method for real-time detection of dust devils at a given location is based on identifying the abrupt, temporary decreases in atmospheric pressure that are characteristic of dust devils as they travel through that location. The method was conceived for use in a study of dust devils on the Martian surface, where bandwidth limitations encourage the transmission of only those blocks of data that are most likely to contain information about features of interest, such as dust devils. The method, which is a form of intelligent data compression, could readily be adapted to use for the same purpose in scientific investigation of dust devils on Earth.

In this method, the readings of an atmospheric-pressure sensor are repeatedly digitized, recorded, and processed by an algorithm that looks for extreme deviations from a continually updated model of the current pressure environment. The question in formulating the algorithm is how to model current "normal" observations and what minimum magnitude deviation can be considered sufficiently anomalous as to indicate the presence of a dust devil. There is no single, simple answer to this question: any answer necessarily entails a compromise between false detections and misses.

For the original Mars application, the answer was sought through analysis of sliding time windows of digitized pressure readings. Windows of 5-, 10-, and 15-minute durations were considered. The windows were advanced in increments of 30 seconds. Increments of other sizes can also be used, but computational cost increases as the increment decreases and analysis is performed more frequently. Pressure models were defined using a polynomial fit to the data within the windows. For example, the figure depicts pressure readings from a 10-minute window wherein the model was defined by a third-degree polynomial fit to the readings and dust devils were identified as negative deviations larger than both 3 standard deviations (from the mean) and 0.05 mbar in magnitude. An algorithm embodying the detection scheme of this example was found to yield a miss rate of just 8 percent and a false-detection rate of 57 percent when evaluated on historical pressure-sensor data collected by the Mars Pathfinder lander. Since dust devils occur infrequently over the course of a mission, prioritizing observations that contain successful detections could greatly conserve bandwidth allocated to a given mission. This technique can be used on future Mars landers and rovers, such as Mars Phoenix and the Mars Science Laboratory.



A **Third-Order Polynomial Fit** with 3-standard-deviation limits was superimposed on a 10-minute sliding time window of Mars atmospheric-pressure readings. Two dust devils were detected as negative deviations of more than 3 standard deviations.

This work was done by Kiri Wagstaff of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-44724

Determining Surface Roughness in Urban Areas Using Lidar Data

An automatic derivation of relevant parameters estimates surface roughness.

Stennis Space Center, Mississippi

An automated procedure has been developed to derive relevant factors, which can increase the ability to produce objective, repeatable methods for determining aerodynamic surface roughness. Aerodynamic surface roughness is used for many applications, like atmospheric dispersive models and wind-damage models. For this technique, existing lidar data was used that was originally collected for terrain analysis, and demonstrated that surface roughness values can be automatically derived, and then subsequently utilized in disaster-management and homeland-security models.

The developed lidar-processing algorithm effectively distinguishes buildings from trees and characterizes their size, density, orientation, and spacing (see figure); all of these variables are param-