

The results obtained by use of the algorithm depend partly on three parameters: the block size (the number of data samples in a block), the aforementioned threshold value, and the aforementioned number of quantization bits. By adjusting the values of these parameters for different types of data, one can obtain usefully large compression ratios with minimal er-

rors. Higher threshold values always result in greater compression ratios at the expense of quality of reconstructed signals. Increasing numbers of quantization bits generally reduces compression ratios but yields reconstructed signals of higher quality. Increasing block sizes yields more-varied results; in general, larger compression ratios are associated with

larger blocks because fewer block maxima and minima are stored.

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## Σ Onboard Science and Applications Algorithm for Hyperspectral Data Reduction

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An onboard processing mission concept is under development for a possible Direct Broadcast capability for the HypsIRI mission, a Hyperspectral remote sensing mission under consideration for launch in the next decade. The concept would intelligently spectrally and spatially subsample the data as well as generate science products onboard to enable return of key rapid response science and applications information despite limited downlink bandwidth. This rapid data delivery concept focuses on wildfires and volcanoes as primary applications, but also has applications to vegetation, coastal flooding, dust, and snow/ice applications.

Operationally, the HypsIRI team would define a set of spatial regions of interest where specific algorithms would be executed. For example, known

coastal areas would have certain products or bands downlinked, ocean areas might have other bands downlinked, and during fire seasons other areas would be processed for active fire detections. Ground operations would automatically generate the mission plans specifying the highest priority tasks executable within onboard computation, setup, and data downlink constraints.

The spectral bands of the TIR (thermal infrared) instrument can accurately detect the thermal signature of fires and send down alerts, as well as the thermal and VSWIR (visible to short-wave infrared) data corresponding to the active fires. Active volcanism also produces a distinctive thermal signature that can be detected onboard to enable spatial subsampling. Onboard algorithms and ground-based algorithms suitable for on-

board deployment are mature. On HypsIRI, the algorithm would perform a table-driven temperature inversion from several spectral TIR bands, and then trigger downlink of the entire spectrum for each of the hot pixels identified.

Ocean and coastal applications include sea surface temperature (using a small spectral subset of TIR data, but requiring considerable ancillary data), and ocean color applications to track biological activity such as harmful algal blooms. Measuring surface water extent to track flooding is another rapid response product leveraging VSWIR spectral information.

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## Σ Sampling Technique for Robust Odorant Detection Based on MIT RealNose Data

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This technique enhances the detection capability of the autonomous RealNose system from MIT to detect odorants and their concentrations in noisy and transient environments. The low-cost, portable system with low power consumption will operate at high speed and is suited for unmanned and remotely operated long-life applications.

A deterministic mathematical model was developed to detect odorants and calculate their concentration in noisy environments. Real data from MIT's NanoNose was examined, from which a signal conditioning technique was proposed to enable robust odorant detec-

tion for the RealNose system. Its sensitivity can reach to sub-part-per-billion (sub-ppb).

A Space Invariant Independent Component Analysis (SPICA) algorithm was developed to deal with non-linear mixing that is an over-complete case, and it is used as a preprocessing step to recover the original odorant sources for detection. This approach, combined with the Cascade Error Projection (CEP) Neural Network algorithm, was used to perform odorant identification.

Signal conditioning is used to identify potential processing windows to enable robust detection for autonomous systems.

So far, the software has been developed and evaluated with current data sets provided by the MIT team. However, continuous data streams are made available where even the occurrence of a new odorant is unannounced and needs to be noticed by the system autonomously before its unambiguous detection. The challenge for the software is to be able to separate the potential valid signal from the odorant and from the noisy transition region when the odorant is just introduced.

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