Unsupervised Classification and Analysis of 2D Data Using Wavelet Transform Techniques

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Wavelet transforms (WTs) are historically and mathematically analogous to Fourier transforms (FTs). However, while both FTs and WTs approximate complex data as a weighted sum of simple functions obtained from an orthogonal basis function, WTs allow the researcher to consider the behavior on the interval by simply taking the sum of the wavelet indices over the subinterval. Furthermore, WTs allow the user to define the scale of interest. WTs, therefore, are characterized by two major properties: 1) localization in space in the case of images or time in the case of signals, i.e. the ability of wavelets transforms to preserve information on subintervals and 2) scaling, or the ability to define the level of detail desired in the analysis. Thus, WT-based analysis techniques are uniquely suited to many types of geologic data because geologic data tends to be complex, non-stationary (non-repeating) and scale-dependant.

DWT image analysis techniques, such as wavelet texture analysis and wavelet co-occurrence features (WCF) analysis can be used to analyze and classify images and features in images. We present a techique for automatically classifying images of sedimentary fabrics, mineral textures and artifical textures (Fig. 1). This technique can be used to assess the liklihood that geologically interesting textures from Mars are associated with known textures on Earth. Furthermore, DWT techniques can be used to create searchable libraries of 1D and 2D geologic data and their associations, aiding in interdisciplinary earth science research.
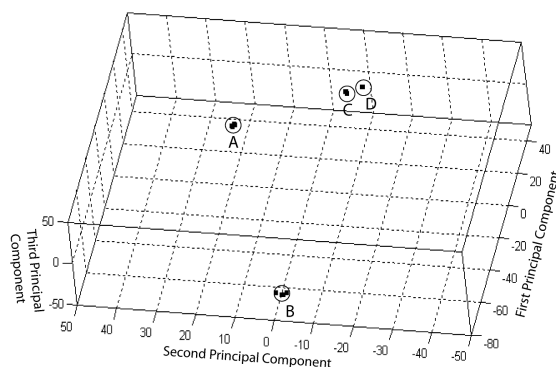

Figure 1: 20 textures classfied into 4 families (A-D) using principal component analysis on the WCF.