MULTI-DIMENSIONAL MAPS THROUGH DIGITAL IMAGE PROCESSING

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The synoptic, multispectral view of the Earth provided by LANDSAT images has proved extremely useful to geologists studying regional trends for small-scale geologic mapping. These digital images lend themselves to a wide variety of computer manipulation to improve their interpretability.

Application of digital image processing to geologic investigation requires a different approach than its application to most land-use problems. The distribution of geologic formations, rock and soil types, and surface structures is so complex that pattern recognition and automatic mapping routines rarely produce output useful to a geologist (Soderblom, 1975). The philosophical approach to these problems is therefore one of presenting the "cleanest" image possible to a human image interpreter, and displaying the largest amount of data possible in such a way that they can be visually discriminated in a single-image, multi-dimensional map.

The use of color in the presentation of multispectral data is a common way to increase the information content in an image. In a LANDSAT image different bands of the visible and infrared spectrum are routinely composited as color images. However, any set of data in which points are defined by their magnitude and coordinate positions can be treated as an image. The data set need not have been an image initially. Multiple data sets with overlapping coordinate positions but with magnitude variations between sets can be treated as multispectral images. Correlations between data sets can then be evaluated on the basis of color variations. For example, a wide variety of data was taken from Lunar orbit by remote sensing techniques during the Apollo program. These data are arranged in terms of latitude, longitude, and intensity and can therefore be placed in an image array, with intermediate positions filled by interpolation if necessary. Such parameters as gravitational variation, magnetic field intensity variation, and surface brightness in some given wavelength of visible light can therefore be presented as a single color image with each parameter considered to be a different spectral band of the image. Complex correlation patterns become readily visible by their color in such a presentation.

Some data, traditionally presented as contour maps, can be clarified by presenting them as images. For example, digital terrain data sets like those prepared by the Defense Mapping Agency consist of rows and columns of terrain elevations of 63-metre intervals. They can be displayed as images by computing the reflected brightness of each slope segment using an idealized illumination model (Batson, Edwards, and Eliason, 1975a). The image thus formed is a synthetic image of a three-dimensional model. Synthetic stereoscopic pairs can be generated by introducing parallax into such an image by displacing a picture element as a function of its value. The obvious application of this technique is in the shaded relief image discussed above. When an image with introduced parallax is viewed with an image without parallax a strong stereoscopic illusion is produced. When merged with a

LANDSAT image, a stereoscopic pair can be made that greatly enhances the interpretability of the scene (Batson, Edwards, and Eliason, 1975b). Although digital terrain data are the most obvious data type to which the relief and stereoscopic techniques can be applied any data that can be contoured can be presented, and commonly clarified, by this kind of presentation.

The digital processing algorithms used for this work are designed to operate very rapidly on small computer systems such as the DEC PDP 11/45. The time required to make a shaded relief image of a data set consisting of 1400 lines by 1800 samples (2.5×10^6 values) is about 30 minutes on such a machine. It commonly is economically feasible, therefore, to make a composite map displaying five parameters or dimensions (three in color, one in shaded relief, and one stereoscopically) through image processing methods.

REFERENCES

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