Interim Report

ORSER-SSEL Technical Report 17-73

CANANICAL ANALYSIS APPLIED TO THE INTERPRETATION OF MULTISPECTRAL SCANNER DATA

H. M. Lachowski and F. Y. Borden

ERTS Investigation 082
Contract Number NAS 5-23133

INTERDISCIPLINARY APPLICATION AND INTERPRETATION OF ERTS DATA WITHIN THE SUSQUEHANNA RIVER BASIN

Resource Inventory, Land Use, and Pollution

Office for Remote Sensing of Earth Resources (ORSER)
Space Science and Engineering Laboratory (SSEL)
Room 219 Electrical Engineering West
The Pennsylvania State University
University Park, Pennsylvania 16802

Principal Investigators:

Dr. George J. McMurtry
Dr. Gary W. Petersen

Date: May 1973

CANONICAL ANALYSIS APPLIED TO THE INTERPRETATION OF MULTISPECTRAL SCANNER DATA

H. M. Lachowski and F. Y. Borden

A number of classification methods are known and have been applied to remote sensing data. One method which has the potential of being used as a satisfactory classifier is based on the multivariate statistical technique called canonical analysis, or multiple discriminant analysis. The most useful aspect of canonical analysis for remote sensing studies is its ability to maximize the separability among the categories defined for it. However, because of the great volume of remotely sensed data to be analyzed, and the particular nature of these data, it is necessary to substantially change the existing method. An algorithm for processing remotely sensed data based on the canonical analysis method would enable rapid processing and interpretation of multispectral scanner (MSS) data with digital computers.

Application of canonical analysis to the interpretation and analysis of MSS data was investigated[1]. The existing canonical analysis method was changed substantially to accommodate the great volume of data obtained in the process of remote sensing. The objective of canonical analysis in this application was to obtain the maximum separability among a number of categories. Each MSS observation, identifiable by scan line and element number, consisted of a vector of as many vector elements as there were channels. For each category, the spectral signature (the mean vector) and the covariance matrix were computed on the basis of a number of observations which belonged, by training area definition, to the category. The objective was to derive an orthogonal transformation which would maximize category separability on as few axes as possible. As the result of the transformation, the first canonical axis represented the greatest separability achievable on one axis among all categories, the second axis represented the next greatest separability achievable for remaining axes, and so on. Each unknown

---

[1]Lachowski, H. M. (1973) "Canonical Analysis Applied to the Interpretation of Multispectral Scanner Data," M.S. thesis, The Pennsylvania State University, University Park, Pa.

observation was then classified into one of the categories on the basis of the euclidean distance between the transformed unknown vector and each of the transformed category mean vectors. Classification was made into the category for which the euclidean distance was smallest or into the "other" category if the distance was not less than the specified critical distance.

The canonical analysis program was developed as part of the MSS digital processing and analysis system used in ORSER. The system is capable of processing multispectral scanner data collected by an airborne or spacecraft scanner. Input to the canonical analysis program was obtained in either of two ways: (1) through a supervised method, using a program which computes the basic multivariate statistics for any polygonal training area or (2) through an unsupervised method, using a cluster analysis algorithm. Output from the canonical analysis program consisted of maps and statistical analysis information. The digital maps were converted into line maps to a desired scale and with scanner distortion removed.

Two types of MSS data were used to demonstrate the utility of the method: (1) high resolution aircraft data, and (2) low resolution spacecraft data. The MSS data collected by aircraft (at 3000 ft) were used in conjunction with aerial photographs taken at the same altitude. These photographs, together with a detailed soil map, were the sources of ground truth. Most targets were fairly easy to identify on the aerial photographs and, therefore, the interpretation of the computer generated maps was also simplified. The computer generated maps were of sufficient accuracy to be used to determine the location and extent of major cover types, such as forest stands, pastures, agricultural crops, and various soil types. The only source of ground truth for the MSS data collected from the spacecraft (ERTS-1) was a series of photographs taken from a U2 aircraft flying at 65,000 ft. Target identification was considerably more difficult because of the lower resolution of the MSS data. However, successful delineation of strip-mine spoils and of vegetation associated with them, using a river as reference, was obtained. It is feasible, therefore, to apply canonical analysis in conjunction with other computer algorithms to the interpretation of the MSS data.
