Reprinted from

Tenth International Symposium

Machine Processing of

Remotely Sensed Data

with special emphasis on

Thematic Mapper Data and

Geographic Information Systems

June 12 - 14, 1984

Proceedings

Purdue University
The Laboratory for Applications of Remote Sensing
West Lafayette, Indiana 47907 USA

AUTOMATED SPECTRAL CLASS LABELING

L.R. TINNEY

EG&G Energy Measurements, Inc.
Las Vegas, Nevada

J.E. ESTES

University of California
Remote Sensing Unit
Santa Barbara, California

ABSTRACT

Accurate and repeatable labeling procedures are necessary for the operational use of remote sensing classification products. This paper discusses ths use of digital land use maps, change detection techniques, and geographic information systems as a basis for automated spectral class labeling and performance evaluation. These procedures were initially developed as part of a study directed towards the use of Landsat digital imagery for inventorying and monitoring prime agricultural land. One of the most useful characteristics of automated labeling is that it is completely repeatable.

I. BACKGROUND

In California, as in many agriculturally oriented areas, there is an increasing concern about the amount and rate of conversion of prime agricultural land to non-agricultural uses (Tinney et al., 1979). Many investigators have proposed the use of Landsat imagery for detecting and identifying land use change, but results are very dependent upon the location, available imagery, procedures used, and even the analyst(s) involved. The research discussed here has examined the use of accurate land use maps in conjunction with change detection and geographic information system processing techniques to automate a statistically optimal spectral class labeling procedure (also see Hallada et al., 1981). This procedure eliminates analyst variability from the labeling process once an adequate land use map base is established.

Proper image selection, classification scheme, and change detection procedures all require significant amounts of analyst intervention. The automated labeling procedure, however, eliminates one of the most difficult problems encountered when attempting to optimize classifications; namely, the variance introduced by different analysts or even the same analyst as he or she becomes familiar with an area.

II. APPROACH

The major objective of this project involved both detection and identification of land use change. The ability to locate and measure the amount of change is relatively easy given the image and geobased processing techniques used.

The goal of the project was to develop a capability for annual or some other appropriate multiple year update of land use. Because of the monitoring emphasis, the amount of available data to accomplish the task is more than that usually available to inventory projects.

The test site used for this project was the area defined by two 7½ minute USGS topographic quadrangles. These quadrangles, Oxnard and Camarillo, are situated on the coastal Oxnard Plain near Ventura, California.

Available data included near-anniversary Landsat imagery (August 1976 and 1979) and a detailed land use map of the 1976 base year. The detailed land use map was based upon a photo-interpretation of high quality aerial photography. The imagery and a digitized version of the base map were all registered to one another.

For evaluation purposes, aerial photography for the base year and the update year and a detailed land use map for the update year were also used. The land use map data allowed an automated approach to accuracy assessment while the aerial photography assisted our analysis of errors.

An unsupervised approach was used for most of the analysis because of it's suitability for the automated labeling procedure. Unsupervised or clustering procedures can be considered in terms of their measurement vector space partitioning and cluster labeling components. The partitioning and labeling stages were handled as distinct modules to allow independent improvements in the two stages (such as the "SPICE" partitioning procedure discussed in a separate paper by Tinney and Brewster).

The second Landsat acquisition was clustered into 100 spectral classes. A registered "change" image was created by differencing the base and second date of Landsat imagery. Areas that did not appear to have spectrally changed were assumed to be of the base date land use. The cluster image and the non-changed base date land use were cross-tabulated and used as a basis for the labeling procedure.

A plurality decision rule was used to determine optimal cluster labels. The non-changed areas also provided an estimate of classification accuracy, based on the assumption that the changed areas were properly represented, in a spectral sense, by the non-changed regions. Subsequent processing was used to remove illogical land use changes, such as urban to agricultural classes.

For analysis purposes, the detailed land use map of the second date was used to verify classification performance. The aerial photography allowed close examination of classification problem areas, much of which could be explained in terms of the poor resolution of the Landsat multispectral sensors for discriminating high spatial frequency urban land use patterns.

A comparison between conventional classification procedures based on both supervised and unsupervised algorithms showed the automated labeling procedure slightly superior (83%, 81%, and 85%, respectively). The analyst labeling versus the automated labeling difference (81% and 85%) is most interesting because both used the same set of 100 spectral clusters. The slight edge of the automated procedure over the supervised procedure is considered statistically insignificant but encouraging; it appears that the automated procedure performs at a comparable level to an expert analyst (for this data set). In contrast to an analyst, the automated procedure can be used to test the impact of numerous variables (e.g. date selection, band combinations, clustering algorithms and amount of training data) without "learning" about the area and becoming biased.

III. SUMMARY

An automated spectral class labeling procedure has been successfully demonstrated. Several attributes of the procedure make it attractive for evaluating multispectral classification techniques. By using modular components for change detection, measurement space partitioning, and spectral class labeling, the procedure will allow these steps to be individually evaluated and improved. Integral to this process is the combined use of image processing and geographic information system techniques.

IV. REFERENCES

Hallada, W., F. Mertz, L. Tinney, M. Cosentino, and J. Estes, 1981. "Flexible Processing of Remote Sensing Data Through Integration of Image Processing and Geobased Information Systems", Proceedings of the 15th International Symposium on Remote Sensing of Environment.

Tinney, L., D. Stow, and J. Estes, 1979. "Conceptual Design and Preliminary Demonstration of a Prime Agricultural Land Component of an Integrated Remote Sensing System", University of California at Santa Barbara, Final Report.

BIOGRAPHICAL REVIEW

Larry R. Tinney is a Remote Sensing Specialist with the Aerial Measurement Operations of EG&G Energy Measurements, Inc. His primary interests are the integration of image processing and geographic information systems and the development of advanced information extraction techniques. Mr. Tinney received his B.A. and M.A. degrees from the University of California at Santa Barbara, where he was previously employed by the Geography Remote Sensing Unit.

John E. Estes is a Professor of Geography at the University of California at Santa Barbara. Dr. Estes is also Director of the Remote Sensing Unit at UCSB. He received his Ph.D. in Geography from UCLA. Dr. Estes has written extensively in the remote sensing field and was Co-Editor of the second edition of the Manual of Remote Sensing.