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QUARTERLY REPORT

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Research in Remote Sensing of Agriculture, Earth Resources, and Man's Environment

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INTRODUCTION

Following is a summary of the major activity and technical problems encountered in each of the task areas of Contract NAS9-14016 for the period June 1 through September 30, 1974.

I. LACIP Crop Identification

Major Activity. The primary activity during the first quarter was initiation of research on the identification of crops by analysis of multitemporal MSS data. Initially, data sets acquired for CITARS are being used. This data set has good ground observation data and the ERTS data from three to five dates has already been registered. The techniques being researched are: the use of feature selection and the use and interpretation of clustering with multitemporal data. Classification results for single date and multitemporal data will be compared. These techniques will later be applied to ERTS data from the LACIP intensive study sites.

Technical Problems Encountered. To date no ERTS data or ground truth acquired for the LACIP intensive study sites over wheat growing areas has been received. Research on stratification of the ERTS scene and identification of wheat without *in situ* ground observations for training will be delayed until these data sets are made available.

Proposed Solutions to Problems. NASA supplied to LARS the ERTS and ground truth data for LACIP intensive study sites as soon as possible.

II. LACIP Spectral Class Definition

Major Activity. Activity in this area continued to focus on the implementation and effective utilization of clustering for spectral class definition. A new method for determining initial cluster centers was developed, and the effect of the placement of initial clusters centers on the resulting cluster analysis was investigated.

It had been noted that when the data to be analyzed had a significant negative channel-to-channel correlation, the initial cluster centers tended to fall outside of the range of data. As a result during the first iteration of the clustering algorithm some initial cluster centers may not have had any data points assigned to them. When this occurred, the algorithm was unable to successfully resolve the data into the requested number of classes.

The new method developed calculates the principal eigenvalue and eigenvector of the data and assigns the initial cluster centers along the direction of the principal eigenvector. This substantially improves the probability that the cluster centers will lie within the data range and, therefore, that the clustering will be successful.

The new method has been implemented in an experimental version of LARSYS and is currently being exercised by many users at LARS.

Technical Problems Encountered and Proposed Solutions. In some of the examples run to test the new cluster initialization process it has appeared that there is some tendency to fail to isolate natural clusters in the data which lie off the axis along which the cluster centers are assigned. This is particularly true when the number of clusters requested is small relative to the number of actual cover types or natural data clusters. The likelihood of isolating such clusters can be increased, however, by requesting a sufficiently large number of clusters. Additional study is needed to better understand how many initial cluster centers should be requested.

Progress with Problems from Previous Periods. The principal outstanding problem with the LARSYS cluster processor is the limitation in the quantity of data which can be clustered. This problem cannot be dealt with until justification is found to devote sufficient resources to reprogramming the processor.

III. LACIP Crop Acreage Estimation

Major Activity. During this period the major activity has been to review the techniques being used by other investigators. To date most investigators have simply tabulated the number of pixels classified into each crop or category and multiplied by the acres or hectares per pixel to obtain an area estimate. Very little has been done either in sampling ERTS data or unbiasing classifications.

A program for unbiasing classifications has been developed and used on ERTS data classifications of a three county area in Illinois and 12 counties in Indiana. The technique involves multiplying the classification results by the inverse of test field classification performance matrices. First results indicate that the technique works satisfactorily when test field performances are 80 percent or greater, but may not be of much aid if the performance is less than 80 percent.

Technical Problems Encountered. No serious technical problems were encountered. The level of work in this area will increase during the next quarter as the CITARS task is completed.

IV. LACIP-CITARS

Major Activity. The major activity during the June-August quarter has been the classifications of ERTS data. This task has been completed and the results are now being summarized. The results data have been transmitted to EOD. Evaluation of the classification results has been initiated. This effort will consist of a study to determine the cause of the low classification performances (commonly 40 to 70 percent correct classification) obtained and to determine if a less restricted analysis procedure would give better results.

Other activities include documentation of the tasks for which LARS was responsible, i.e. ERTS data preparation including reformatting, geometric correction, multitemporal registration and section and field coordinate location and tests of the effect of registration on classification performance.

Technical Problems Encountered. No major problems were encountered during the first quarter.

V. LACIP Yield Prediction

Major Activity. Major activities on this project during the first quarter revolved around the Exotech spectroradiometer system. The system was available throughout the summer. New calibration procedures were implemented and used. Two documents describing the system and its use were prepared. The first is a paper entitled "A Visible and Infrared Field Spectroradiometer System for Remote Sensing Field Research". The second is a "Exotech User's Handbook".

Improvements in the Exotech data collection system included the construction of a device to simulate Exotech signals to enable evaluation of analog and digital data processing systems and development of new systems without taking the instrument out of service. Considerations of a field digital data collection system was begun.

Data were collected for a study of the effect percent ground cover, leaf area index, plant height, and maturity of corn and soybeans on two types. This was the second summer of data collection on this experiment and the data from the two years is now being analyzed.

Measurements of the directional reflectance of mature wheat and harvested wheat (stubble) were also obtained and are being analyzed along with detailed data describing the crop (planting density, row width, plant height, stem diameter, direction of stem tilt, spectral curves obtained with DK-2 of stems and leaves, and illustrative photos).

A computer program for implementing Suit's canopy reflectance model was begun and a study of theoretical aspects and experimental techniques for measuring and modeling the thermal radiative properties of wheat canopies was initiated.

A second activity has been to begin a study of how meteorological data, primarily temperature and precipitation, can be used in conjunction with ERTS data to predict wheat yield. The literature describing previous results in modeling the effect of weather on wheat yield has been reviewed. We are now in the process of defining specific objectives and test sites for the study. A graduate student has been selected to work on the project.

Finally, a sizeable portion of our effort during August and September has been devoted to planning a coordinated field measurement project for remote sensing of wheat. This effort was requested by NASA/EOD. Two preliminary drafts of a project plan have been prepared and two meetings held - one with Mr. MacDonald and Dr. Potter to discuss objectives and approach for the project and a second with representatives of NASA, USDA, ERIM, TAMU, and LARS to finalize an initial project plan. Briefly, the plan calls for collection of reflectance data over test plots and farmers' fields at sites in Kansas and North Dakota with the NASA Helicopter S-191, Purdue Exotech spectroradiometer, and NASA-TAMU interferometer. The objectives call for work on: spectral-temporal signature of wheat, optimum time for wheat identification, effect of crop variables, differentiation of harvested and unharvested wheat and identification of the factors affecting signature extension.

Technical Problems Encountered. The lack of ERTS and ground observation from the LACIP intensive study sites has prevented progress on the study of the feasibility of obtaining wheat yield information from ERTS data.

VI. LACIP Image Registration

Major Activity. The image registration task is subdivided into three subtasks: A) Temporal registration algorithm development for LACIP sites, B) Data base registration algorithm development for registering ERTS data with an earth grid, C) Aggregation of ERTS data and ground truth data. Work was primarily concentrated on subtask A as was desired by the technical monitor.

A. Registration Algorithm Development.

The main goal of task A is to investigate registration algorithms which may be used to accurately and efficiently register ERTS data taken on different passes over LACIP wheat sites throughout the world. Many registration algorithms have been proposed and information is required in order to select the most suitable one.

Several candidate approaches are being studied and test implementations of certain of them was begun during the period. The existing LARS product correlation and bi-quadratic checkpoint interpolation system is one of the methods being tested. The second candidate is the Computer Sciences Corporation approach which uses a thresholded normalized image gradient edge enhancement and binary logical correlation. This approach was proposed for carrying out all LACIP registration and is being evaluated by LARS under special request by JSC. This algorithm was implemented during the period and is being tested. Several other approaches are being studied, the leading candidates being conversion to binary images before crosscorrelating, a classification edge enhancement scheme and various gradient edge enhancement schemes. Most approaches involve some method of edge enhancement of the images before correlation.

The test data being used is ERTS data from Hill County, Montana and Greeley County, Kansas. Six passes of data are available from Hill County and from Greeley County. Preliminary results indicate that the data from the different times is rather highly correlated and thus the registration task may not be as difficult as for Midwest agricultural areas for example. The CSC normalized gradient for Hill County was computed and compared to the standard gradient. Visual comparison indicated that the standard gradient had more consistent agreement with edges in the original image compared to the CSC gradient. This was a subjective test however, and further evaluation must be performed. No comparative correlation results were obtained from which to judge the capability of the various methods. Such results are expected in the second quarter.

An information note was completed that presents an analysis of the theoretical accuracy that can be obtained in registering two images taken at different times. In the analysis it is shown that the variance in the registration obtainable is inversely proportional to the signal-to-noise ratio of the data and to the spatial bandwidth of the data. For ERTS data it is estimated that registration variance of less than one pixel is theoretically possible whenever the signal-to-noise ratio exceeds unity.

B. Data Base Registration

During the period work was concentrated on defining appropriate image geometric correction functions for ERTS subframes. The presently used bi-quadratic function is believed to be non-optimum for describing ERTS geometric distortion and this work is directed toward defining more efficient and accurate functions. A collinearity and a fractional function were tested and results indicate that comparable accuracy can be obtained with simpler functions than the bi-quadratic. A summary report is being prepared describing these tests.

C. Aggregation of Ancillary Ground Data

Preliminary studies of methods and candidate data types for ancillary ground aggregation were conducted. The data type of greatest interest among applications researchers was digitized topographic map contours. Digitized topographic map data for several areas is available at LARS and registration of this data with ERTS data of the same area is planned for the next period. A grid cell size close to the ERTS cell size is the most likely choice. Overlayed topographic data will allow classification analysis using height, slope, direction of slope, shadow as derived from slope and known sun azimuth and elevation in addition to the spectral and temporal dimensions.

VII. Forestry Applications Project

Major Activity. FAP efforts in Indiana and Colorado during the past three months have been channeled into three primary areas, including:

- .Modified cluster analysis techniques;
- .Statistical evaluation of classification performance;
- .Development of data sets and milestone plan for future research.

As opposed to a strictly supervised or non-supervised data analysis procedure, a modified cluster approach has been evolving as an optimal technique for analyzing ERTS MSS data. This has been tested on ERTS data collected over forested areas in Colorado and Indiana. Following this procedure, the analyst: 1) defines several training areas (each of which includes most or all major cover types); 2) divides each training field's data set into spectral classes through the *CLUSTER algorithm; 3) assigns informational value to the spectral classes by correlation with airphotos or other reference data; and 4) subsequently combines the spectral-informational classes from each clustered training area, compromising between desired informational classes to be mapped and their spectral separability as indicated by the *SEPARABILITY algorithm. In this manner, the high number of spectrally separable classes in the data are first detected and then simplified to a training set which adequately represents desired cover types without using unimportant spectral classes, thus shortening classification time. This procedure also allows the analysis sequence to be more repeatable and more accurate classifications can be obtained than had previously been possible. This technique will be used on the Sam Houston National Forest data set.

Quantitative evaluations of computer classification performance to date have had a possibility of being biased by the manner in which test fields were selected; namely, delineation of test fields of varying sizes, according to the availability of support data and the integrity of the analyst. An evaluation technique currently being tested employs equal sample size (i.e., all test fields have the same number of data points), thereby permitting analysis-of-variance and designation of confidence intervals around the performance means. Randomly-selected test fields of 4 x 4 ERTS data points are accepted if they represent one cover type, and only the inner 9 resolution elements are tallied to avoid misclassification caused by "edge" spectral classes (data points located at the transition between cover types). In addition to testing of this procedure using the Indiana data set, the procedure will be used to evaluate classification performance during the Sam Houston analysis.

The third phase of forestry-related activities performed under the FAP contract deals with preparation of the basic data sets to be used in subsequent analyses. Several ERTS frames have been selected and reformatted which cover the established forest test sites, in the Hoosier National Forest and simulated CIR images produced on the LARS digital display were used to screen the ERTS frames for optimal dates to be included in the temporal overlays. Additionally, a milestone plan has been prepared which details the specific phases of FAP research to be performed on these data sets as well as their chronological order (Figure 1). Various procedures and classification approaches developed while analyzing the Indiana data sets will be further tested within the Sam Houston National Forest test site.

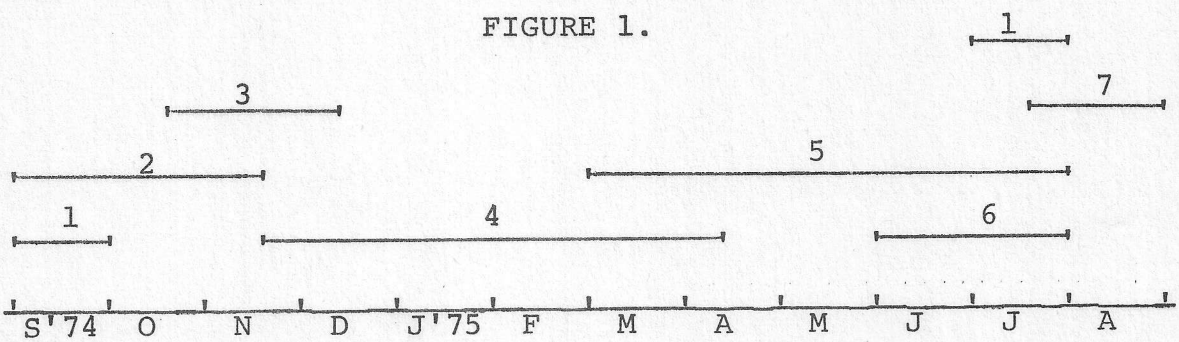
Work on the analysis of the Sam Houston National Forest is scheduled to begin September 1, 1974. A meeting between the LARS and Lockheed personnel was held in July at the Johnson Space Center to discuss the objectives for the project. At this meeting the aircraft scanner data and some ground information was received from the Lockheed group. The aircraft scanner data have been converted to LARSYS format and are ready for use. Since the ERTS data set for the test site has not yet arrived at LARS, the analysis work will be started with the aircraft data September 1, and ERTS data will be phased into the work plan as soon as it becomes available.

The primary emphasis will be the use of the modified cluster analysis technique to define and evaluate training sets for the types and condition classes defined by FAP personnel working on the SHNF test site.

Technical Problems Encountered. No technical problems have been encountered to date.

Proposed Solutions to Problems. Research in this project will follow the general sequence indicated in the Milestone Plan (Figure 1, below). More detailed description of each phase will follow in subsequent Quarterly Reports.

FIGURE 1.



Various phases of the Milestone Plan are as follows: 1) statistical evaluation of classification results, 2) preparation and evaluation of data sets, 3) wavelength region study (single data), 4) analysis of spectral characteristics of materials including spectral/temporal interactions, 5) development of analysis procedures for temporal overlays, 6) wavelength region study (multi-date), and 7) signature extension study.

VIII. Regional Applications Project

Major Activity. Activity during this reporting period consisted of 1) assigning LARS' staff members to the RAP team and 2) meeting with RAP management in Houston and West Lafayette to discuss objectives of the project and capabilities of the personnel and institutions involved, and 3) in addition Matagorda Bay was selected as the test site and B.E.G. maps were ordered.

Technical Problems Encountered. This project is still in the planning phase and no technical problems have been encountered.

Proposed Solutions to Problems. To expedite the research on this project, Mr. S. G. Luther will meet with Dr. Edward A. Weisblatt in early September to finalize a Milestone Plan for FY75 and initiate a Milestone Plan for FY76. Also during this meeting specific ERTS data sets will be selected for analysis.

IX. Remote Terminal and Technology Transfer

Major Activities. The remote terminal and technology transfer project conducted activities in several major areas: support of the Houston, Goddard, and Wallops terminal sites, support of the Texas terminal project, new terminal development, revisions of the LARSYS Education Package, and development of the Technology Transfer concept. A brief summary of these activity areas are included in the following paragraphs.

The Houston, Goddard and Wallops terminals continue to be supported for their evaluation of the LARS system. Fourteen data runs were reformatted and inserted into the LARS library for these three terminals. During June, the Goddard and Wallops terminal connections were changed so that each site now has its own phone line to Purdue and use Paradyne modems. Users of the Houston terminal are beginning to investigate the availability and usage of computer programs such as routines in the scientific sub-routine package on the LARS network. Assistance was also given in interpreting algorithms used to obtain the cluster results table produced by a new clustering processor being planned for LARSYS release. This support to the remote terminals has become a matter of routine.

After initial planning of the Texas terminal project, several of the personnel in Houston felt that a LARS person stationed at the Texas terminal site during the initial training periods for Texas personnel would be critical to the success of the project. During this past quarter, Carl Walker of LARS has been assigned in Austin, Texas for this purpose. Carl returned to LARS August 1, 1974, and reported extensive interaction with the Texas personnel and beneficial tailoring of the training materials to their needs. It is felt that his presence in Austin greatly enhanced the potential success of training personnel from the major state agencies and the probability for their success in using remote sensing techniques in their future activities.

The major activities during this reporting period in the new terminal development area were: 1) review of the current LARS terminal hardware and communications network equipment, 2) distribution of questionnaires to remote terminal users on equipment utility, 3) preparation of a presentation on requirements on the LARS remote terminal equipment, 4) preparation for evaluation of a CRT terminal with imaging capabilities, and 5) generation of a request for information on remote terminal equipment. These activities were pursued to report on a family of terminals which have different levels of effectiveness so that the potential terminal users can determine an optimum cost-effective system to meet their needs. Since these activities are primarily of an information gathering nature, no results are available for reporting at this time.

An ERTS case study is under development for inclusion in the LARSYS Educational Package. The area chosen for analysis is part of Monroe County, Indiana and includes the city of Bloomington, surrounding agricultural areas, forest areas, and a portion of the Monroe Reservoir. The LARSYS Education Package has been in use at remote terminals since October, 1973 and student evaluations have been collected from a number of sites. With the technical content fairly well established, the education package is being examined from a pedigogical standpoint. Student comments are providing a valuable input to this evaluation. Revised versions of units one and two have been drafted.

A technology transfer concept designed to meet the unique and individual needs of students of remote sensing is in the formulation stage. Basically, the concept tries to recognize the wide diversity of background of individuals making use of remote sensing technology by providing pictorial materials at several depth levels ranging from single concept overviews to specialized case studies. Training packages designed to take the students with specific backgrounds to a specific educational goal would be synthesized from this spectrum of tutorial materials. A variety of formats and media are under construction and trial including printed materials, slide tape lectures, and video tapes.

Technical Problems. During the month of June 1974, the LARS computer system became saturated. Users at LARS and at remote terminal sites were questioned about their needs and how they might better share the system during times of saturation. These inputs were then analyzed and memorandums were sent to representatives at each remote terminal sites explaining the computer saturation problem, its causes, new rules, and suggestions for minimizing the problem. The result of this activity was improved response from the system for all users and a satisfactory temporary solution to the current saturation problem.

X. Soil Moisture Measurements

Major Activity. A report entitled "Electrical Methods of Determining Soil Moisture Content", is currently under preparation. This report is divided into two parts; Part One is entitled "The Relationship Between Soil Moisture and

Electrical Permittivity". This portion of the report is complete and ready for publication. Part Two of the report is entitled "Electrical Methods for the Determination of Soil Permittivity Profiles". Part Two consists of two chapters, the first of which is complete and the second chapter of which is undergoing considerable technical revision. The work described in Part Two will lead to the accurate profile without actually disturbing the soil itself. Part Two of the report should be essentially complete by the next reporting period.

A graduate student who will be working on the design of this instrument has been hired and is currently involved in the final phases of the preparation of this report. His activity on the design of the instrument will begin upon completion of the above mentioned report.

XI. Soil Inventory Project

Major Activity. The major activities for the Soil Inventory Project included analysis of ERTS data for White County, Indiana; Barton County, Kansas; and Hidalgo County, Texas. The data were collected June 9, 1973 for White County, June 17, 1973 for Barton County and January 21, 1973 for the Hidalgo County study area.

Field visits with SCS personnel have been made in White County and Barton County. These checks included the comparisons of ERTS imagery, from the Digital Display Unit and also from the line printer, with features observed in the field. These features included relief, sandiness and salt deposits, to name a few.

Comparisons are also being made between detailed soil maps produced in the conventional manner and ERTS data. The ERTS data are also being compared with the black and white aerial photography which the soil mapper uses in the field to help decide where soil boundaries are. The sensitivity of ERTS is thus being considered and thus may be used in aiding future mapping.

There are, along with the previously mentioned activities, two studies in progress which involve field spectroradiometer data. These studies are to measure what the spectral characteristics of the interactions of soil moisture, organic carbon and texture (% sand, % silt, % clay); and further, to quantify the relationships between spectral responses and the characteristics of typical soils from soil orders from across the United States.

Technical Problems Encountered. Problems encountered in these various projects include programming problems with the system used in analyzing field spectroradiometer data; these problems, however, have not been prohibitive and are being corrected. Another problem encountered while using ERTS data in the field is a problem of locating exactly where features are in the imagery as compared to the spatial relationships observed in the field. To solve this problem, digitized county highway maps will be employed. This process will enable easier location of areas in the field by having roads displayed on the same image as the ERTS data.

XII. Preprocessing Algorithms

Major Activity. The preprocessing algorithms task is a non-LACIP research task directed toward methods of improving remote sensor imagery quality and utility. The major effort during the period was the completion of research on an algorithm for optimally correcting the effect of the finite instantaneous field of view (IFOV) in scanning sensors such as the aircraft and ERTS multispectral scanners. The algorithm design procedure was completed and correction functions for several types of apertures were computed. These correction functions were then applied to several images including ERTS MSS images. Image resolution is apparently improved by a factor of 1.5 to 2 for the ERTS data. A final technical report on this work is expected in the next reporting period.

Research was initiated and preliminary results were obtained on methods of enhancing ERTS imagery for geological interpretation. The approach is to use spatial and spatial frequency filtering to enhance portions of the spatial frequency spectrum of the scene. The techniques were applied to lineament enhancement task as an example problem. In the spatial domain, the gradient and Laplacian transforms were tested. A disk buffered fast Fourier transform program to compute 512 X 512 point transforms was completed during the period. Filter design was begun to utilize frequency domain techniques for image enhancement. Several enhanced images were produced and they are being evaluated by a geologist knowledgeable of the areas in the data.

XIII. Effective Utilization of Data Dimensionality

A. Layered Classifiers

Extensive experimental work has been done on the multistage decision tree classifier (layered classifier). This experimental work was divided into two parts, each with a different objective.

The objective of the first portion of the experimental work was to maximize the classification accuracy of the multistage decision tree classifier. The classifier used in this part was designed with a binary tree structure: each pair of classes was classified with their optimal feature subset. Experimental results indicate that this binary tree decision procedure (a class elimination procedure) does have the potential for improving the classification accuracy in the presence of the dimensionality problem* which prevents the full utilization of the available features in classifying a pair of classes.

The objective of the second part of the experimental work on layered classifiers was to maximize the overall performance (a measure of the trade off between the efficiency and the accuracy) of a multistage decision tree classifier. The classifier used here was of a general type of tree structure.

This decision tree classifier was applied to both aircraft and ERTS multispectral scanner data. The results indicate that this type of classifier (designed by a heuristic search approach) has a better overall performance than the conventional one stage classifier. In many cases, both classification accuracy and efficiency have been improved.

B. Error Rates & Bounds

The probability of error in deciding between multivariate normal classes was estimated using Monte Carlo simulation techniques for different numbers of features.

In both the five-class and the two-class cases the percent error was lowest when three features were used for classification. The percent error then increased slightly as features were added. However, the theoretical error bounds computed for the two class case decreased as the number of features increased.

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*The dimensionality problem occurs when the addition of features degrades rather than improves the classification accuracy of a classifier.

The estimated error rates and the theoretical error bounds were found for two classes and sample sizes ranging from 40 to 10,000 data points. As the number of samples was increased, the estimated error rates more closely followed the theoretical values.

The error rates for two sample classifiers (maximum likelihood and minimum distance) were also evaluated by Monte Carlo methods. The maximum likelihood sample classifier was consistently slightly better for all but the smallest sample sizes. At small sample sizes the two sample classifiers cannot be compared as the minimum distance classifier cannot be used due to singular covariance matrices. Thus the main advantage of the maximum likelihood sample classifier appears to be its considerably faster speed.

XIV. Extraction and Analysis of Spatial Information

A. Boundary Finding

The present boundary-finding algorithm was expanded to do more comparisons per cell before deciding in which field to place a cell. Preliminary tests indicate that classification accuracy is not significantly increased and that much more computation time is required.

The boundary finding algorithm has been applied to several data sets. In the analysis of an ERTS data set, the boundary finder improved upon the point classifier accuracy by 3.2% to bring the accuracy to 92.8%. Two classes improved about 5%, and no class decreased in performance. Study of this data set is continuing. Another ERTS data set was examined with inconclusive results. The sample classifier results are just under four percent more accurate than results from the point classifier; and the boundary finder, even if working perfectly, could not improve the results much more. It also was discovered that some of the problems encountered in this data set may be due to mislabelled ground observations.

Several analyses were performed on an aircraft data set. The boundary finder greatly improved classification accuracy for classes "Oats" and "Other" while "Corn" and "Soy" accuracy was essentially unchanged. However, the data was taken in June, and soil patterns were the dominant feature in the corn and soybean fields of the data set. So these results are not surprising.

B. Spatial Correlation

Experimental results from the computation of spatial correlation coefficients (vs. displacement) for test fields of each class in a data image indicate that correlation in the direction of scan (horizontal direction) is much greater than in the vertical direction, as might be expected from the horizontal pixel overlap present in ERTS data. A data set was corrected for the horizontal pixel overlap, and then analyzed. The spatial correlation coefficients for this corrected data set showed that the correlation in both directions was about the same after the horizontal pixel overlap was removed. Analysis of the corrected data image produced only a slight improvement in classification accuracy over the analysis of the uncorrected data.

Next, an attempt was made to remove all second order spatial correlation from a multispectral data image, assuming that such correlation could be modeled by convolving a positive semi-definite window function with a data image having no second order correlation. The spatial correlation was removed in this attempt, but classification accuracy remained about the same. Further investigation revealed that the good effects of decorrelation had been offset by a marked decrease in the separability of the classes.

XV. EROS Data Center Remote Terminal

Major Activity. Since a remote terminal attached to the Purdue/LARS computer is scheduled to be installed at the EROS Data Center, Sioux Falls in early October, orders were placed for the IBM 2741 and 2780 terminals, two Codex 7200 Data Modems and phone lines connecting LARS to the EROS Data Center. The LARSYS Analysis for Instructors Course is scheduled for Fred Waltz and David Greenlee for the period September 9 thru 20, 1974.

Work has begun on the development of the demonstration package which EDC personnel would be able to use in conjunction with the 2780 remote terminal to demonstrate the potentials of numerical processing of remotely sensed data. John Lindenlaub is coordinating this effort and has been in contact with Bill Todd of EDC. They have agreed to do a land use analysis of the Sioux Falls area for the demonstration.

Technical Problems. A problem regarding the installation of LARSYS on the EDC computer within the contractural period appears to be developing due to slipage in the selection and installation of the EDC computer. Another problem encountered in connection with the selection of the EDC computer is the analysis of the benchmarks designed to evaluate the effectiveness of various computers for data preprocessing and analysis.

Proposed Solutions. These problems were discussed with Dr. Waltz and it was agreed that LARS would help analyze the benchmark output to gain experience on potential EDC computer systems. It was also agreed that some rearrangement of the schedule for implementing LARSYS would be required when a selection of the computer is made.