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Skylab Support
Progress Report, March 1975

(E75-10369) [RECOGNITION MAP ANALYSIS AND CROP ACREAGE ESTIMATION USING SKYLAB EREP DATA] Progress Report, Mar. 1975 (Environmental Research Inst. of Michigan) 7 p HC $3.25 CSCL 05B G3/43

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Subcontract #1 Prime NAS9-13332

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Skylab Support
Progress Report, March 1975

The following report serves to report progress for March 1975 on Subcontract #1 of contract NAS9-13332. The financial reports for this contract are being submitted under separate cover.

The objective of this subcontract is to support the Skylab EREP effort of Michigan State University by: 1) performing standard recognition processing and producing recognition maps and area counts, 2) assisting in the analysis and interpretation of the recognition maps and other extracted information, 3) further developing and adapting, for use on Skylab EREP data, methods for estimating proportions of unresolved objects, and 4) applying proportion estimation techniques to one frame of EREP data to determine to what extent the accuracy of crop acreage estimates is improved.

The SKYLAB S-192 data being studied under this contract is the same data set being studied here at ERIM under NASA contract NAS9-13280, Richard F. Nalepka, Principal Investigator. Inasmuch as the same data is being prepared for two different contracts, a monthly report similar in content to this one is also being issued for the other contract.

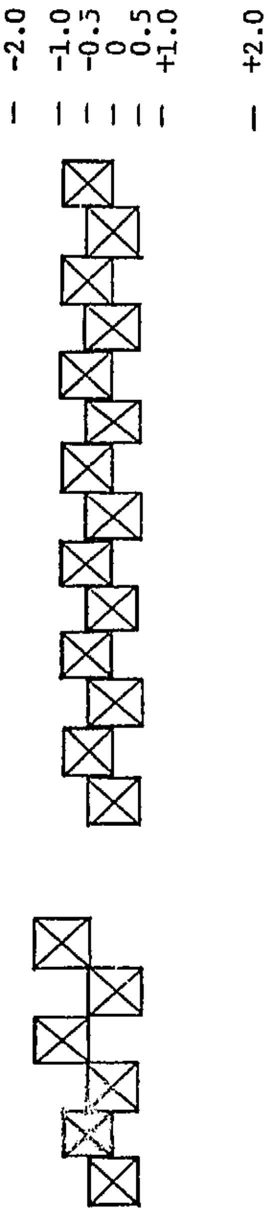
During the reporting period we continued to emphasize the data preparation aspects of the task in an effort to finish entirely this part of the work. The decision to perform most of the processing on the non-scan line straightened, or conic, format data (which is discussed below) caused this process to be drawn out further than had been anticipated. Jobs performed during the month included extending field location to conic scan line and point coordinates, the marking and digitization of field location points from the second U-2 acquired imagery, investigations into SDO to SDO misregistration in the conic and straightened data and measurement of pixel size for the S-192 data for the Michigan EREP test site data.

To begin with, we were concerned over the effects of misregistration of SDOs on processing of S-192 data. A report [1] issued concerning S-192 sensor evaluation called out 4 SDOs which were not perfectly registered. Examining the conic data, we found a sizeable water body where three scan lines made the transition from land to water at the same point. Signals from these scan lines were averaged and the resulting data normalized to the boundary value and plotted. The results, shown in Figure 1, showed the same misregistration problems as reported in the reference. We attempted

FIGURE 1. MISREGISTRATION OF CONIC FORMAT S-192 DATA

(The symbols (☒) indicate the relative projection on the ground for all SDO's for one resolution element.)

SDO	Misregistration (±.25 Resel)
1*	-0.5
2*	0
3	-0.5
4	0
5	-0.5
6	0
7	-0.5
8	0
9	-0.5
10	0
11	-0.5
12	0
13	-0.5
14	0
15	Not Used
16	Not Used
17	-1.0
18*	0
19	-1.0
20	0
21*	-0.5
22*	0



*Indicates Bands where the land water boundary is indistinguishable; reported is the assumed correct registration characteristic.

a similar analysis on the straightened data, however we could not locate lake areas where the boundary occurred at the same point on several consecutive scan lines. An analysis was made using just individual scan lines but this failed because the noise in the data made the individual scan line traces too irregular to analyze. We could reach no conclusion regarding the misregistration of the straightened data.

Under the auspices of NASA contract NAS9-13280 we are pursuing more precise answers to this question using a computer implemented program based on analyzing cross correlation functions for pairs of channels. The information coming from this effort will be used to aid the processing for this contract.

However, it was felt that further processing should not be suspended pending the outcome of the above program. Since we wanted to continue with the processing effort and since we were convinced of the existence of misregistration, it was decided to continue the processing effort on the conic data. We felt that we could correct the conic data for misregistration since the algorithm to correct for misregistration is simple for the conic data and we felt that we had a good estimate of the misregistration of the conic data. We would further mention here that we have experienced very little problem in working with the conic data especially in regard to obtaining line and point numbers of particular pixels. Since the test area is located near the middle of the data swath, we have found that ordinary graymaps are only slightly distorted and are eminently useable for our needs.

Having decided to process the conic data it was next necessary to convert the previously obtained straightened-data line and point numbers for the fields in the ground information area to conic line and point numbers. This was done by using the inverse of the scan line straightening transformation equations as given in the EREP Users Handbook, coupled with regression techniques to accurately calculate the constants in the equations. The equations we used are:

$$\text{CONIC POINT} = A \left[\frac{N}{\theta} \sin^{-1} \left[\frac{P\pi\theta}{180 \cdot N} \right] + \left[\frac{N+2}{2} \right] \right] + B$$

where:

P = [STRAIGHT POINT - 517.8-0.5]

N = 1239 Points/Conic Scan Line

θ = 116.25° Field of Scan

A & B are constants estimated from regression techniques.

Similarly, for scan lines:

$$\text{CONIC LINE} = C + D \cdot \text{STRAIGHT LINE} - E \cdot R \cos\left[\frac{(\text{CONIC POINT} * 2 - 2 - N)\theta}{2\ N}\right]$$

with

R = Radius of the scan circle projected on the Earth

R $\approx$ 608 pixels

and C, D, and E are constants estimated from regression techniques. To perform the regression, 18 points were located on both conic and straightened graymaps. The regression fit was very good and further, all 5 coefficients seemed to be sensible, a reflection of the physical reality.

With the field coordinates converted, the ground information was merged with the conic data. Graymaps of two conic data channels and the ground information channels were overlayed for comparison and the conversion was deemed very satisfactory.

Finally, we ran the data through a deskewing program to reduce the misregistration in the data. With reference to Figure 1, we took the even numbered, high sample rate SDOs, along with all the low sample rate SDOs. Thus there were three channels out of registration with the rest, two of these by a full pixel. The registration algorithm shifted these two channels over by one full pixel. The other SDO was registered by estimating the signal expected midway between the two samples. Initially the estimator used was a simple average of the two adjacent samples.

During the reporting period we completed the marking of fields and other points of interest on the second U-2 acquired photograph, and digitized all these points as we had done for the first photograph. Again following the procedure established while working with the first photo, regression analysis was performed to calculate parameters to convert from photo coordinates to scan line straightened coordinates, and the digitized points were converted. The next step is to convert, again using regression techniques to estimate parameters, to conic line and point numbers and to then merge the ground information with the data. We plan to do this during the next month.

A chief requirement of this study is for determining the costs associated with processing S-192 multispectral data, especially as a function of the amount of ground information used in the training procedure. Classification and false alarm rates as a function of the amount of ground information used are also components of this study. We intend to provide this information by training successively in 40, 20, 8 and 4 sections (one mile squares) and then processing all of the 40 sections to tally the accuracy rates. Selecting a section for training means using all the fields within that section large enough to contain pure field center pixels as training fields.

To select the sections to be used at each stage we have randomly ordered a list of the sections. This was done so that there would be, hopefully, a uniform distribution of the training sections throughout the area and so that there would be no analyst intervention in the selection of training sections.

Other processing requirements include generation of agricultural recognition maps and mapping of forest areas. These will be produced as byproducts of the major analysis.

Other work during the period included the following three items:

1) We received screening film of all SDO's (except for 15 and 16 which are redundant) and examined it thoroughly. We expect this to be a useful tool throughout the analysis of the data.

2) A brief analysis of actual pixel (not RESELM) size was conducted. Pairs of pixels in lakes were located on straightened data graymaps which were either on the same straightened scan line, several hundred points apart, or located at the same scan point, several hundred scan lines apart. Points corresponding to these pixels were also located on USGS maps of Southern Michigan. Distances were accurately measured on the USGS maps and on the graymaps with the result that the pixels were measured to be 69 meters wide along scan direction and 72 meters in the along track direction.

Calculations based on geometrical considerations using only the angle of the scan cone and the altitude at the time of data acquisition yielded measures of 70 x 70 meters. The EREP Users Handbook calls out the pixel size to be 72 x 72 meters. The differences are not felt to be serious. This has an impact in the calculation of acreage from classification results.

3) Crop acreage was totaled for each of the 90 sections in the ground information area and grand totals were also calculated. This showed the predominant ground covers and percentage of total area as:

Corn	30%
Trees	17%
Grasses	25%
Stubbles	9%
Soil	7%

During the next reporting period, in addition to those items already mentioned above, we intend to extract spectral signatures and perform analyses of the signatures, including calculation of optimum bands for training over different numbers of sections. Having trained we will classify the area and assess the results for correct classification and false alarm rates for field center pixels.

Reference:

[1] "ERIM Contributions to the S-192 Sensor Performance Evaluation", John G. Braithwaite and Peter F. Lambeck, ERIM 102800-51-F, January 1975.

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