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Skylab Support
Progress Report, April 1975

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Skylab Support
Progress Report, April 1975

The following report serves to report progress for April 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.

During this reporting period we began classification processing of the S192 data. Jobs performed during the month included identifying field center pixels, extracting spectral signatures for the field center pixels of fields from the 40 sections of the North half of the test site, performing supervised clustering over field center pixels to obtain a set of spectral signatures, calculating the optimum bands when all 40 sections were used for training purposes, and generating a recognition map for the area using a modified set of the cluster spectral signatures.

Only field center pixels were processed in order to derive spectral signatures representing the pure ground cover distribution. In order to process data using only field center pixels, an inset in terms of pixels had to be calculated to exclude all pixels which were not completely within the field boundaries. For S-192 conic format data the inset equation had to account for several, additive factors. The total inset (I) was calculated as follows (terms are explained below):

$$I = \left(\frac{81}{72}\right) B + R + L_s + L_c$$

If no problems of registration or location exist, the amount of inset required to insure that a pixel is entirely within the established boundaries (B) is .50 since computer processing treats a pixel as if it was a point located at its center. However, data is collected as resolution elements rather than pixels; so the boundary factor is multiplied by the ratio of resolution cell dimension to pixel dimension (81/72) to convert the units to pixels. R is the amount of inset necessary to account for the worst case of misregistration, and was taken as 0.0, assuming that we had corrected for misregistration effects (see March, 1975 monthly report). The standard error of Y given by the regression technique used to transform digitized coordinates from the U-2 acquired imagery to the straightened data (L_s) and from the straightened data to the conic data (L_c) was used to estimate the error in location.

The total amount of inset calculated for the conic data was:

$$I = \left(\frac{81}{72}\right) .50 + 0 + .52 + .40 = 1.48$$

The total inset that should be used with this conic data was 1.48 pixels, but the fields in the ground truth area were small and such an inset would leave very little data to process. Since the errors in location on the straightened data and on the conic probably are not strictly additive, field boundaries were examined further on graymaps. It appeared that .9 was probably an excessive compensation so a value of .5 was used. This gave a total inset of 1.1 for conic data. Even with this inset, there were only 1063 field center pixels from an area with a total of approximately 24,000 pixels.

Initially we obtained spectral signatures for all the fields which had been digitized (see March 1975 Progress Report) from the U-2 acquired imagery corresponding to the Northern portion of the ground truth area. The boundaries were inset a sufficient amount to exclude all boundary pixels and to account for errors in locating the field boundaries. Over half of the fields digitized had no field center pixels. Of the remaining fields, approximately one-fourth contained only one field center pixel. Further training was performed using only fields with more than one field center pixel.

We used one band from each detector giving a total of 13 signal bands representing SDO's 2, 4, 6, 8, 10, 12, 14, 15, 16, 17, 18, 19, 20. The process which generated these signatures discarded pixels which had extreme values in one or more signal bands. Examination of discarded pixels revealed many had been removed because of very large anomalies in SDO band 16. As a result SDO 16 was not included in further analyses done with this data set.

Since we suspected that many of the ground cover classes should be represented by more than one spectral signature, instead of combining the individual field signatures we generated new spectral signatures using a supervised clustering algorithm. Clustering was done for each ground cover type using only field center pixels, and a total of 24 spectral signatures were generated. Three of the signatures were for the village of Williamston. Since these three consist almost entirely of mixture pixels, they were discarded and were not taken into consideration for the rest of the work completed during this reporting period.

We wanted to reduce both the number of spectral signatures (24) and the number of channels to reduce the cost of the classifier. First, the channels were ranked according to a criterion based on the average pairwise probability of misclassification. The best band was selected, then the band which with the one chosen is best, etc. This analysis indicated that SDO's 6, 19, and 20 provided little aid in discriminating between major ground cover types so they were excluded from further study.

The resulting 9 channel signatures were further examined to determine if any of the signatures, although differently named, were spectrally similar. It was found that some of the pasture, weed and grass signatures were spectrally similar. Since these categories are somewhat nebulous in the first place, it was decided to combine groups of signatures from these classes on the basis of spectral similarity. This reduced the signature set to 15 signatures.

Determining the channels to use in classifying the data came next. The tradeoff involved here is that the fewer number of channels used the lower the cost of processing, while increased accuracy comes from using a greater number of channels. The method used here was first, to rank the channels according to the method described above. Then we plotted the calculated probability of misclassification (POM) as a function of the number of channels in the decision rule and chose the best n channels where the decrease in POM between using n and n+1 channels became less than 0.005. For this set of signatures, 7 channels were chosen for use in classification: SDO's 2, 8, 10, 12, 15, 17 and 18.

Table I displays the results of recognition over field center pixels using the 15 spectral signatures derived from clustering. The 15 signatures are divided into seven ground cover classes as follows: 4 corn, 5 grass, 1 soybean, 2 trees, 1 brush, 1 alfalfa, and 1 bare soil. Work on evaluating the associated costs is not yet completed. Recognition maps were generated for the entire ground truth area for five ground cover classes, corn, trees, brush, bare soil and grasses.

TABLE I. ERROR MATRIX FOR CLASSIFICATION OF S-192 DATA

GT-CLASS	PIXELS	GRASS	ALFALF	B-SOIL	CORN	BRUSH	SOY	TREE	UNCL
GRASS	398	82.91	.75	2.51	7.29	2.76	1.26	1.76	.75
ALFALF	23	13.04	56.52	.00	21.74	.00	8.70	.00	.00
B-SOIL	38	7.89	.00	78.95	13.16	.00	.00	.00	.00
CORN	344	6.40	.00	.29	72.97	10.17	1.74	7.85	.58
BRUSH	68	16.18	.00	.00	33.82	33.82	.00	8.82	7.35
SOY	19	5.26	5.26	.00	31.58	.00	57.89	.00	.00
TREES	24	20.83	.00	.00	4.17	8.33	.00	66.67	.00
STUBBL	53	69.81	.00	13.21	15.09	.00	1.89	.00	.00
URBAN	69	30.43	.00	11.59	57.97	.00	.00	.00	.00
TOTAL	1036	41.80	1.64	5.41	35.52	6.85	2.41	5.41	.97

Additionally, a meeting was held with Mr. Clayton Forbes from JSC and Drs. Lester Manderscheid and Gene Safir from MSU. The meeting was held to brief the sponsors on the current status of this task, describing briefly work accomplished to date, and identifying problem areas in the processing of S-192 data.

Also during the reporting period, the digitized coordinates of fields in the south part of the test site were transformed to conic data coordinates, in the manner described in the previous report.

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