LARS Information Note 102067

Research Progress Report 310
February, 1968

Automatic Classification of Green Vegetation, Soil and Water

Introduction

The primary purpose of this report is to provide a brief description of some results from the automatic classification of agricultural cover using multispectral means. The specific problem involves the automatic classification of the areas over-flown into one of four categories. Each category and its symbol which is used on the printout, are as follows:

Bare Soil	-	X
Water	-	I
Green Vegetation	-	G
Other	-	Blank

The "other" category includes such areas as roads, mature wheat fields, and all other types of cover which do not logically fall in the previously listed categories. The flight line was C1 and the data was obtained in late June. Figure 1 is an aerial photograph of this flight line. Three spectral bands (.44-.46, .62-.66, and .80-1.00 microns) were used for the classification.

The results of the classification task are shown on the computer printout in Figure 2. This printout also shows (manually added) field boundaries and ground truth in the form of a letter symbol and two numbers. The letter symbols indicate the primary agricultural cover and are as follows:

A	-	Alfalfa
BS	-	Bare Soil
C	-	Corn
FS	-	Farmstead
O	-	Oats
R	-	Rye
S	-	Soybeans
W	-	Wheat
P	-	Pasture
RC	-	Red Clover
SC	-	Sweet Clover
Tim	-	Timothy

The two numbers indicate the crop height in inches and the estimated per cent ground cover from one or two points near the edges of the fields.

These results are typical and generally very satisfactory. Although there was little water in the flight line to thoroughly test the

1/ See Figure 5 for organization of LARS

Figure 1. A panchromatic air photograph of flight line C1.

The key used on this photograph to designate the primary agricultural cover is A - Alfalfa, C - Corn, O - Oats, R - Rye, S - Soybeans, W - Wheat, P - Pasture, RC - Red Clover, SC - Sweet Clover, TIM - Timothy

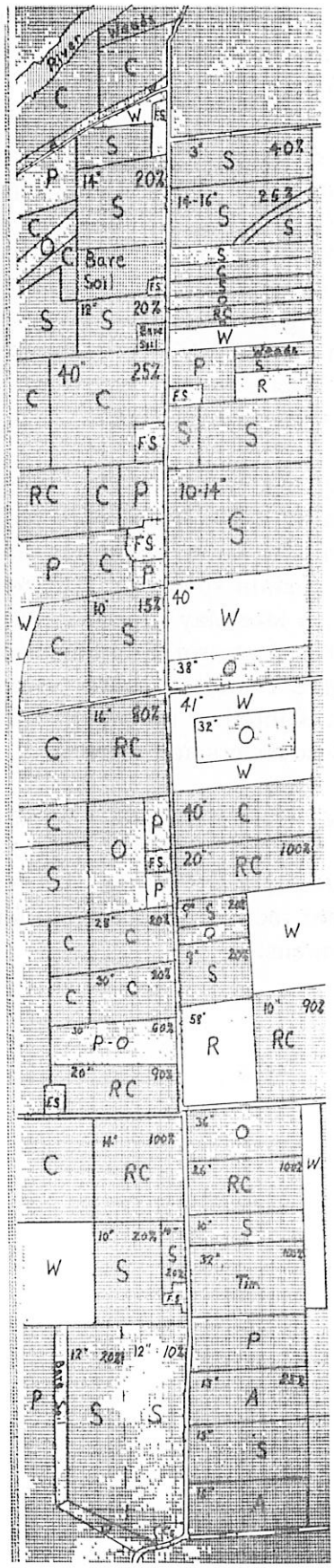


Figure 2. An automatic classification of green vegetation (G), bare soil (X), water (I), and other (blank) of the flight line shown in Fig. 1.

ability to correctly classify water, it appears that there will be no difficulty in distinguishing it from the other categories.

The accuracy obtained in the bare soil classification also appears very good. This flight line contained only two fields of entirely bare soil. They are in the vicinity of scan line 145 and scan line 185 just to the left of the center of the flight line. There were several other fields that had bare areas and have been so classified. For example, the large field just to the left of the center road between lines 745 and 865 was a soybean field, the right half of which was planted later than the left half. The bare soil field located to the left of this soybean field was not classified entirely as bare soil. The new growth of weeds in this field may have caused the classification of primarily "other" since the density of the weeds was not great enough to appear as green vegetation.

A close inspection of the areas classified as green vegetation indicates it may be possible to correctly recognize green vegetation down to less than 20 per cent ground cover. An example illustrating this is given by the soybean field between lines 165 and 193, just left of the center line. It is seen from the ground truth marked on the printout that this field had about 20 per cent ground cover. Figure 3 is a photograph of a portion of this field showing the low percentage ground cover. The photograph was taken from a location equivalent to scan line 169, column 107, and looking west southwest (north is the top).

There is some indication that some day it may be possible not only to map green vegetation but, in addition, to show on the map the per cent of the ground cover. To illustrate this, Figure 4 shows three printouts of the region around the soybean field using different thresholds for green vegetation. The crop in this field itself is relatively uniform; however, the weed condition apparent in the photograph provides variation

in the per cent ground cover. This variation may be correlated with the change in classification of points in the three printouts.

The capability of automatically classifying the primary ground surface conditions of water, green vegetation, and bare soil has very important implications in agriculture development. The automatic mapping and measuring of all surface water immediately after a rain and again several hours later can help to characterize and identify the soil drainage problem areas. The same techniques can be used in surveying inundation under conditions of flooding and in estimating the rate of rise and fall of the water level above flood stage.

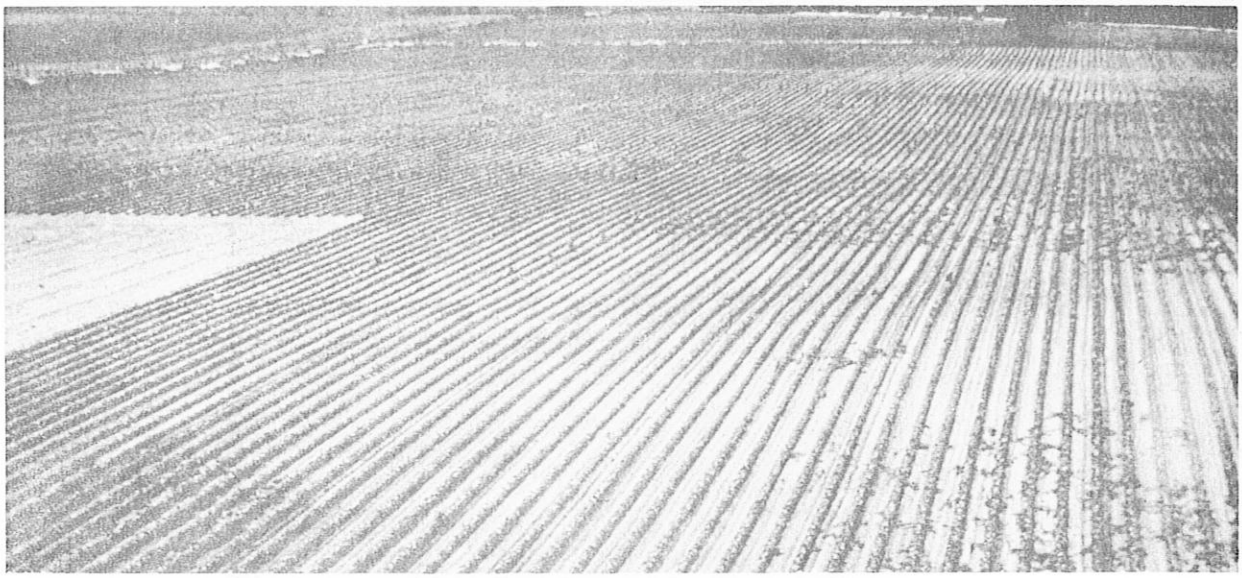
There are many potential applications for the mapping of green vegetation. One example might be in the survey of deciduous forest species. In Indiana, only a few species account for the bulk of forest trees. Because of the differences in dates of leafing out in the spring, several well-timed scanning missions over wooded areas to measure green vegetation might give a good estimate of kinds and amounts of species present.

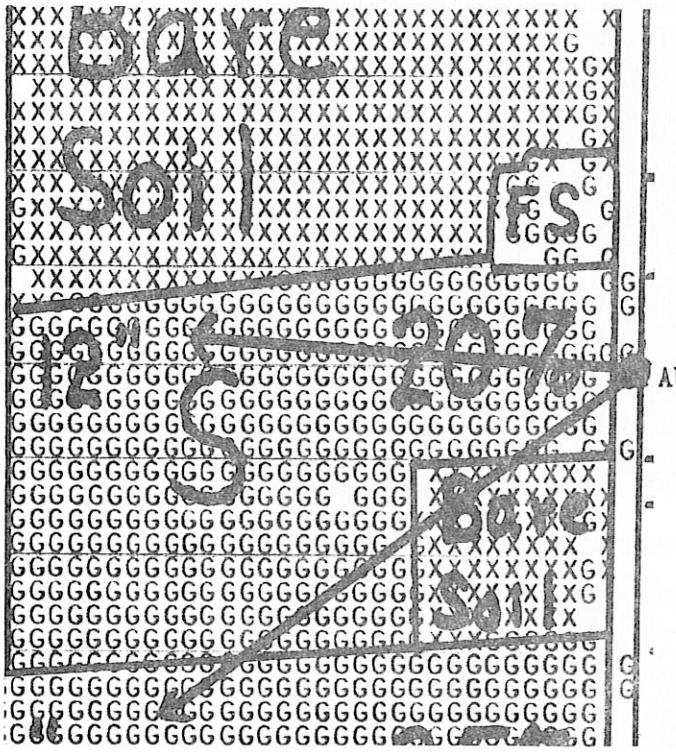
The capability of classifying and measuring acreages of green vegetative cover, even at low per cent ground cover, would make feasible a December winter wheat survey in Indiana.

Flights in March and April might also determine wheat from other crops on the basis of green vegetation. The agriculturist would receive a very good indication of the amount of "winter kill" on winter wheat and acreage figures could be adjusted. Flights taken in the fall which map green vegetation might indicate areas which received yield reductions due to early frost.

Mapping and measuring acreages of bare soil at appropriate seasons of the year might give valuable estimates on intentions to seed certain species. For example, in Indiana, a late May flight for purposes of delineating bare soil from everything else might give a very accurate estimate of the acreage planted or intended for row crops such as soybeans and corn.

These and many other potential applications indicate that automatic classification of agricultural situations can become a very important tool in agricultural planning and development.





Above photograph taken at this point.

Figure 3. A comparison of a photograph with an automatic printout of the same area.

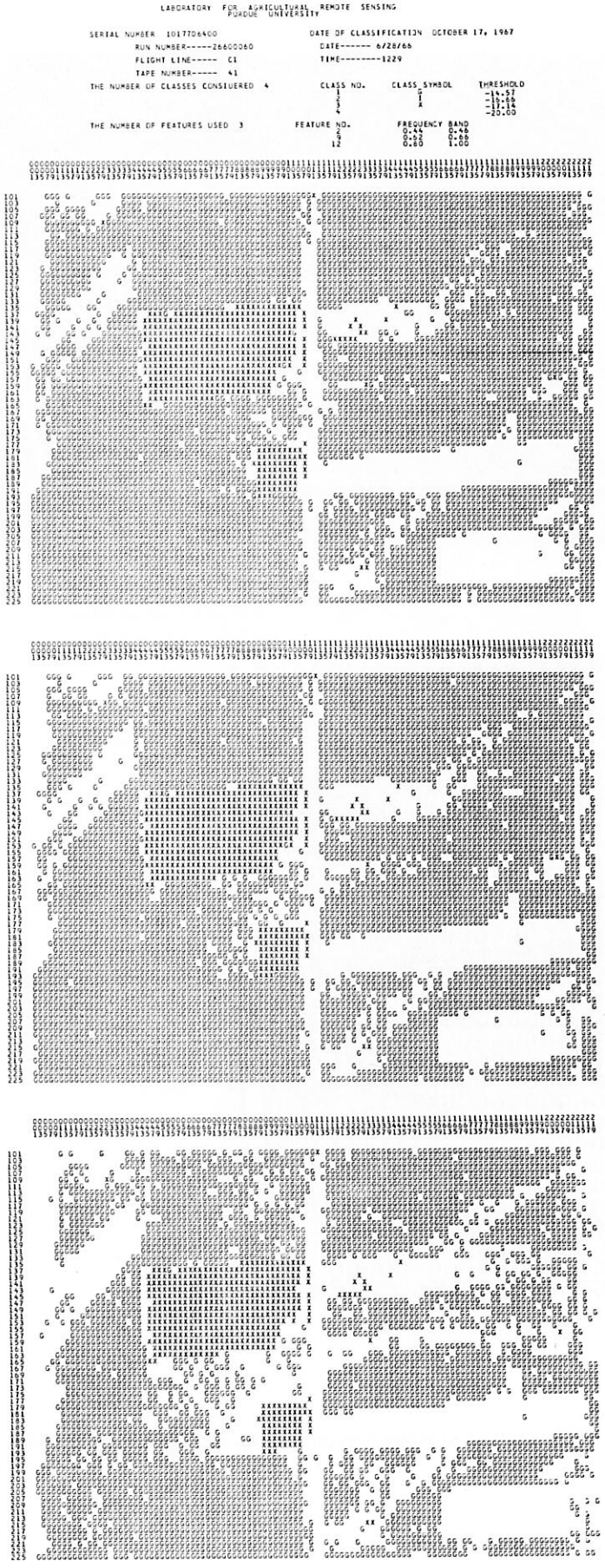


Figure 4. Three automatic printouts of the same area illustrating the ability to vary the threshold of a classification.

LABORATORY FOR AGRICULTURAL REMOTE SENSING
McClure Research Park
1220 Potter Drive
West Lafayette, Indiana 47906
Phone: 92-3532

Administration

Co-Directors
Dr. N. K. Ellis, Associate Director
Agricultural Experiment Station
Dr. J. C. Hancock, Head
School of Electrical Engineering

Technical Director:
R. B. MacDonald

Agricultural Requirements and Applications Programs

Program Leader: Dr. M. F. Baumgardner
Assoc. Prof. of Agronomy

Measurements Programs

Program Leader: Dr. R. A. Holmes
Assoc. Prof. of Elect. Eng.

Data Processing Programs

Program Leader: Dr. D. A. Landgrebe
Assoc. Prof. of Elect. Eng.

Date Handling: T. L. Phillips
Data Analysis: Dr. K. S. Fu

Agricultural Research Programs

Program Leader: Dr. R. M. Hoffer
Research Assoc. in Forestry

Research Agronomist: C. J. Johannsen

Aerospace Agricultural Programs

Program Leader: R. B. MacDonald
(Acting)

Figure 5. The organization of Laboratory for Agricultural Remote Sensing.