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Man-machine interactive classification technique for land cover mapping with TM imagery

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ABSTRACT: The conventional classification, for example, the maximum likelihood method for land cover classification has limitations of lower accuracy because of an assumption of normal distribution for respective classes. In order to improve the accuracy of classification, the paper deals with an improved classification technique based on man-machine interactive system to enable to consider the actual distribution and to enable to interactively study between the imagery, histogram and the existing topo-map using a computer system with two color graphic displays and a digitizer. To assist human interpretability, HSI (Hue, Saturation and Intensity) conversion and/or pricipal components can be applied to the conversation with the computer system. The improved technique was tested in the vicinity of Tokyo Area with Themetic Mapper data. As compared with the result of the conventional method, the result of the study was much improved. The man-machine interactive classification technique developed by the authors can be said " a real time and on-line classification ".

1 THE OBJECTIVE OF THE STUDY

In order to improve the following disadvantages of conventional maximum likelihood method;
* misclassification due to the assumption of normal distribution
* lack of consideration with detail information on each pixel in the histogram or each geographic position on a map, and
* lack of adoption of classification order from the reliability or separability,

an interactive man-machine classification technique has been developed to enable a real time or on-line classification with use of image plane, two dimensional histogram plane and map plane located on a digitizer tablet.

2 MAN-MACHINE CLASSIFICATION SYSTEM (MACSYS)

2.1 Hardware system

The following units are utilized.
1) Computer: FACOM M 170 F (8MB memory, 7.6GB Disc)
2) Color Graphic Display: NEXUS (512x480x27bits)
3) Digitizer: Oscon graphic digitizer

The following three planes are registered in order to implement the man-machine classification system as shown in Figure 1.

1) Image plane: generated in graphic display with a work file
2) Histogram plane: generated in graphic display with a work file
3) Map plane: generated on tablet digitizer with a geometric transform to both of image plane and histogram plane

2.2 Software system

The following softwares were developed in menu type.
1) FRQ-IMG: A point or polygon given in a histogram plane is tranformed into the image plane
2) IMG-FRQ: A point or polygon given in an image plane is transformed to the histogram plane
3) IMG-IMG: A point or polygon given in an image plane is classified in a given color code
4) MAP-IMG: A point or polygon given in a map plane is classified in a given color code
5) MAP-FRQ: A point or polygon given in a map plane is tranformed to the histogram plane
6) ON IMG: Classified map is edited in an image plane
7) ON MAP: Classified map is edited in a map plane
8) CATEGORY: A class to be classified can be given
9) DISPLAY: A current work file will be displayed
10) RESET: A work file will be cleared

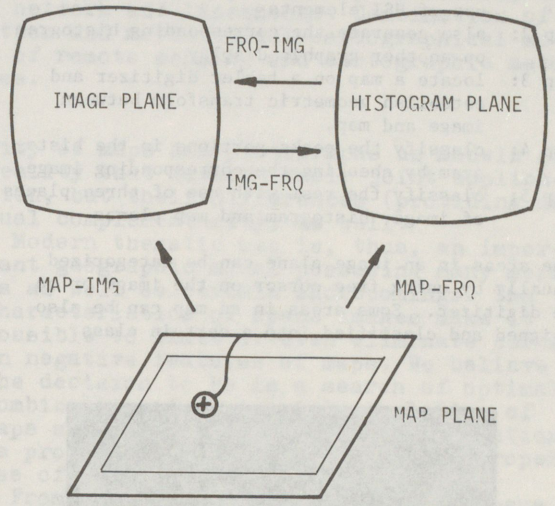


Figure 1 Man-machine interactive system (MACSYS)

Both of image and histogram planes can be zoomed up to 4 times and 8 times. The current results of classification may be stored in a registered work file of image and histogram plane respectively. MACSYS also includes a function to detect which pixels in an image plane or histogram plane are not yet classified.

3 REDUCTION OF DIMENSION FOR THEMATIC MAPPER DATA

Six bands except a thermal band of TM 6 may be used for land cover classification. For visual interpretation of image and histogram planes, the dimension should be reduced to three modes as follows.

1) Selected three bands
   A combination of band 1,4 and 5 was selected because it showed the maximum determinant of variance covariance matrix.
2) Principal components
   First, second and third components were utilized with the cumulative contribution of 95 %.
3) HSI elements
   Hue, saturation and intensity are obtained by a transform of six bands.

Image plane is generated by assigning red, green and blue colors to the above three selected or transformed components. Two dimensional histogram plane can be generated to select two of three. From the result of experiment, HSI elements were the best for visual interpretation.

4 PROCEDURES OF MAN-MACHINE CLASSIFICATION FOR LAND COVER MAPPING

Step 1: generate an image on a graphic display with use of HSI elements
Step 2: also generate the corresponding histogram on another graphic display
Step 3: locate a map on a tablet digitizer and establish geometric transform between image and map.
Step 4: classify the peaks portions in the histogram by checking the corresponding image
Step 5: classify the rest with use of three planes of image, histogram and map planes

Some areas in an image plane can be categorized manually by using free cursor on the image or on the digitizer. Some areas in an map can be also assigned and classified into a certain class.

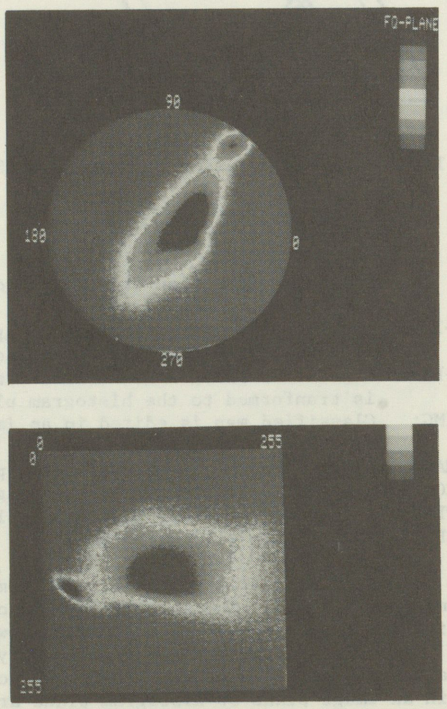
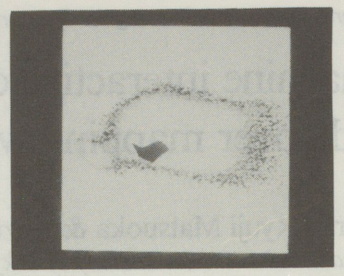
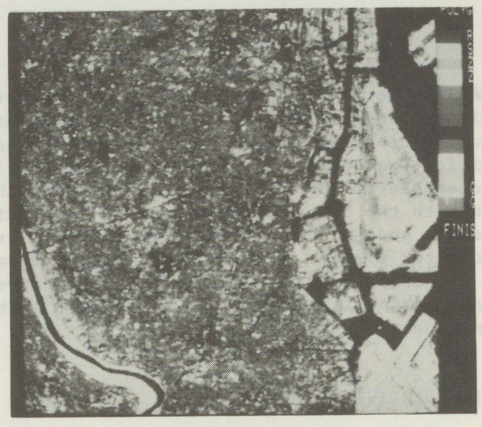


Figure 2 An example of Histogram plane



(a) Assignment of polygon in histogram plane



(b) The corresponding image file

Figure 3 FRO-IMG command

Figure 2 shows a histogram plane and a map plane. Figure 3 shows an example of assignment of polygon in a histogram plane and the corresponding image in red color (original is color).

5 ADVANTAGES OF MAN-MACHINE CLASSIFICATION AS COMPARED WITH MAXIMUM LIKELIHOOD METHOD

Both of man-machine classification technique and the conventional maximum likelihood method were applied to a test area in Tokyo Bay Area with use of TM data taken on January 23, 1985.
As compared with the result from the maximum likelihood method, the following advantages were pointed out.

1) To able to obtain ground truth data in a real time and to train them for classification in a real time,

2) to be able to learn or consider the spectral characteristics by intercorrelating the image and the histogram plane,

3) to be able to set up the priority of classes to be classified

and

4) to be able to give the known geographic information from the existing map.