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INTERACTIVE TRAINING SYSTEM USING A PERSONAL COMPUTER

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Abstract

An interactive training system using a personal computer has been developed. This system allows beginners to understand the basic ideas and methods of remote sensing technology focused on digital image processing.
Through the interactive operation of the system, like computer games, the beginners can learn basic ideas of remotely sensed data processing and improve their technique. The menu includes level slicing, multi-band color composite, classification and geometric correction.

1. Introduction

According to the progress of computer technology, these days, digital image processing can easily be performed by using personal computers. In RESTEC, we have developed personal computer image processing system called ENDIPS(End-users Image Processing System) in 1984. ENDIPS has been used for training courses in RESTEC for several years and has been welcomed by the trainees. The software of ENDIPS has been modified and released by NEC Aerospace Systems, Ltd. in the name of LODIA (Low-cost Digital Image Analyzer).
Nowadays this kind of system has become so popular in the remote sensing community that it is almost difficult to find people who are not using personal computers for remote sensing. However, this does not mean that digital image processing itself has become easy. In general, image processing algorithms used in the personal computer systems are almost same as those of conventional computer systems. Even though each beginner has become able to use a personal computer for his training, the effort he has to make for learning has not changed so much from which of conventional computer systems.
However, if the graphic functions and interactivity in which personal computers have priority to conventional computers are effectively used in the training and learning process, a very

effective education system can be realized with a personal computer. Through the experiences of using ENDIPS in training courses, the author have developed the interactive training system called ENDIPS-T (ENDIPS-Trainer) by revising ENDIPS. This paper describes about the ENDIPS-T. The system enables beginners to gradually learn the basic ideas of digital image processing focused on remote sensing.

2. System Construction

The hardware of ENDIPS-T consists of a 16bit personal computer, a key board, a color image display (640 pixel X 400 lines X 8 colors) and two floppy disk drives(8 inches or 5 inches). Fig.1 shows the hardware block diagram of ENDIPS-T.
BASIC and Assembler language are used for software programming. In principle, the floppy in the first drive contains software and the floppy in the second drive contains data.

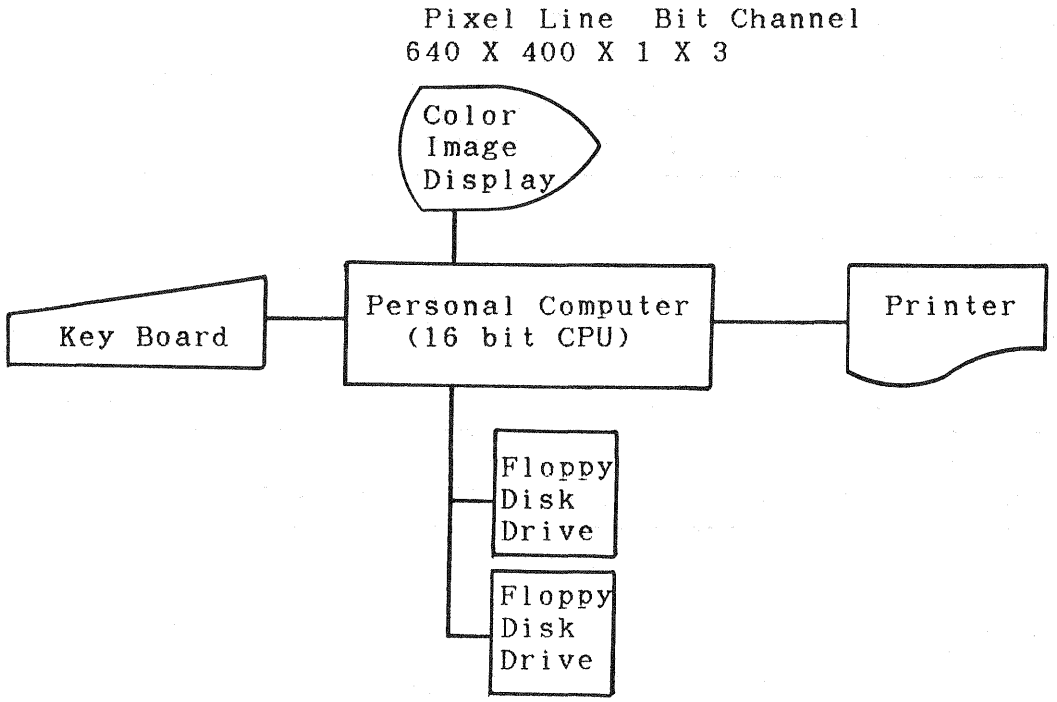


Fig. 1 ENDIPS-T Block Diagram

3. Data

Typical remotely sensed data, such as Landsat MSS data, are usually used for training. One cannot deny the advantage of using real remotely sensed data for training from the very beginning. However, any real remotely sensed data has its particular place, time, sensor characteristics etc. In many cases, the beginners are apt to confuse the generality of basic ideas of digital image processing and the particularity of the remotely sensed data.

Most of the beginners are not only beginners of remote sensing but also beginners of digital image processing.
In order to avoid the confusion, two types of data are used in this training system. One is the artificial test pattern type data used for understanding the basic ideas of image processing, and the other is the remotely sensed data (Landsat MSS data, MOS-1 MESSR data etc.) used for understanding the practical techniques for application of remote sensing.
As the remotely sensed data, Landsat floppy disk data distributed from RESTEC is used. The format of Landsat floppy disk is shown on Table 1 and 2.

Table 1. Disk Format of Landsat Floppy Disk

Item	Contents
Physical format	IBM Part 1766872
Logical format	IBM(256-2D)
Floppy size	8 inches / 5 inches
Recording form	Two-sided, double-density
Memory capacity	1 M Byte
Cylinder No.	77 cylinders
Track No.	154 tracks (2 tracks/cylinder)
Sector No.	26 sectors/track
Sector length	256 byte/sector

Table 2. Data Format of Landsat Floppy Disk

Logical format	File constitution	
BIL (1 file)	Header 512 byte	Data 512pixels X 400lines X 1byte X 4bands
BSQ (4 files)	Header 512 byte	Data 512pixels X 400lines X 1byte X 1band

4. Curriculum

The curriculum of ENDIPS-T are consists of the Fundamental Training and the Application Training.

4.1 Fundamental Training

The Fundamental Training is planned to train beginners to understand basic ideas of digital image processing which are fundamental for remotely sensed data analysis. In order to simplify the problem, the data used in this training are the artificial data.

1) Column/Line Identification

In order to make trainee understand the digital image structure consist of pixels, the column/line identification test is performed. In this exercise, trainees have to identify the value

of the pixel in the test pattern data specified by the computer(see Fig. 2).

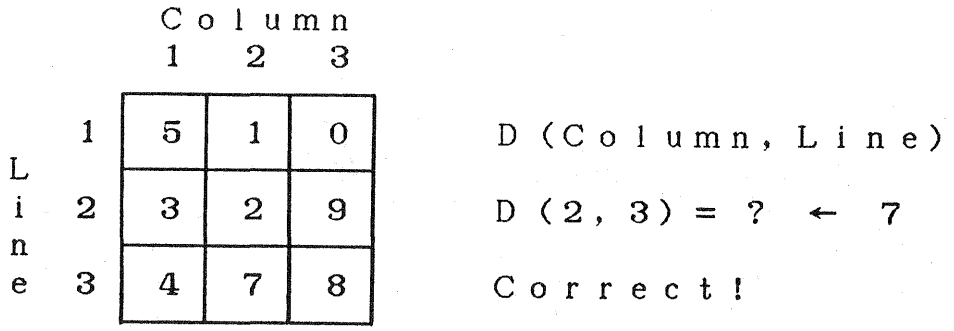


Fig. 2 Column/Line Identification

2) Gradation

The value of remotely sensed data contains information such as reflectance or radiance of the earth surface etc. If the value deference are displayed in the density difference, the data appears in gradation imagery. The imagery changes according to the assignment of graduation.
This exercise enable trainees to understand the basic idea of image gradation.

3) Multi-spectral Information

Any object on the earth surface has its own spectral reflectance. Through this multi-spectral information exercise, trainees can understand the basic idea of multi-spectral information processing in remote sensing. According to the movement of the spectral axis along the spectral reflectance curve shown on the Fig. 3(a) operated by the trainees, the spectral reflectance of the woods and the soil change as shown on Fig.3(b) and (c). This exercise enables trainees to understand the multi spectral characteristics and optimal spectral selection for discrimination of different objects.

4) Pseudo Color

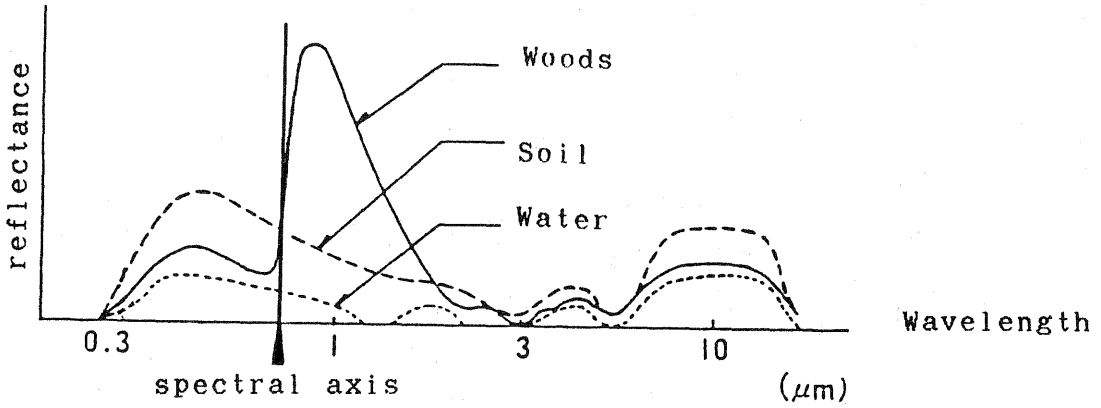
Using test pattern data, trainees understand the basic idea of density slicing and making of pseudo color.

5) False color

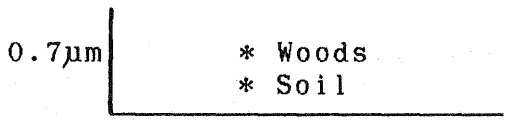
This exercise enable trainees to under stand the basic idea of false color composite.

6) Geometric Correction

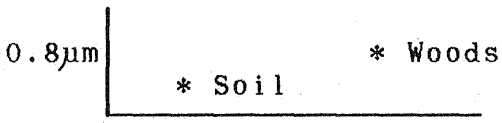
Two different grid pattern, the one is geometrically modified from the other, are displayed on the display as shown on Fig. 4. Trainees have to designate the corresponding grid pair(GCP : Ground Control Point) in the both grid pattern. After designation, geometric correction is automatically performed, and the correctness of the selection of the GCP will be evaluated.
Through this exercise, trainee can understand the characteristics of geometric correction.



a) Spectral Reflectance Curve



b) Spectral Characteristics at 0.7 μm



c) Spectral Characteristics at 0.8μm

Fig. 3 Multi Spectral Information

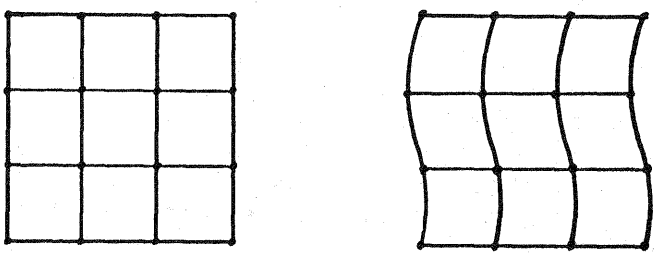


Fig. 4 Grid Pattern Pair for Geometric Correction

4.2 Application Training

The software described in this section are all application software which can be applied for practical remote sensing analysis. Real remotely sensed data, such as Landsat MSS and MOS-1 MESSR, are used in this section.

1) Pseudo color

Themes are given to trainees. Trainees are required to make thematic maps by choosing the appropriate band and applying pseudo color level slicing to the remotely sensed data. The example of themes are as follows.

a) Sea surface pattern
b) Water boundary (See Fig. 5)
c) General land cover pattern

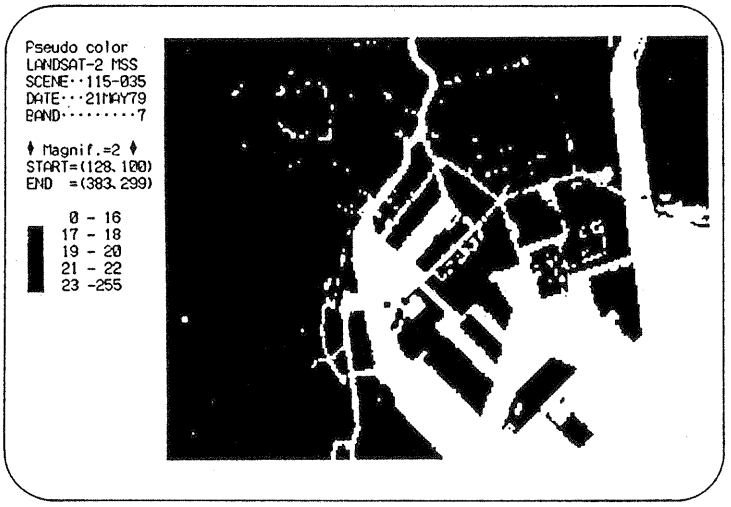


Fig. 5 Water Boundary Extraction

2) False Color

Trainees are required to select band combination and gradation to show the various pattern of the remotely sensed data imagery. Trainees has to compare his product with the fine imagery prepared by ENDIPS-T.

3) Multi-spectral Classification

Based on the multi-spectral characteristics of the remotely sensed data, trainees perform the land cover classification using the remotely sensed data.

a) Training area selection

By using the false color produced by the trainee, he has to select training area of specified items for classification (see Fig.6). The items include urban area, residential area, woods, glass, bare soil and water.

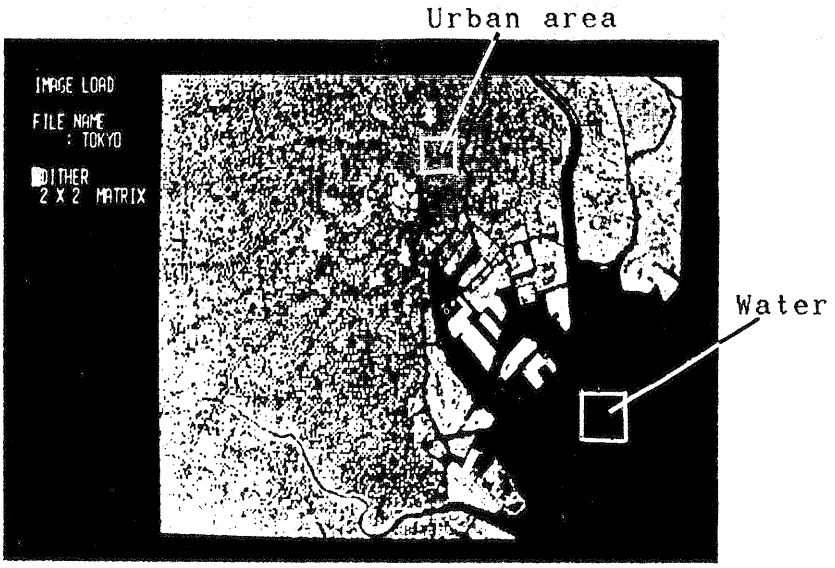


Fig. 6 Training Area Selection

b) Training area evaluation

The multi-spectral information of each training area will be displayed as shown on Fig.7. Trainees can check the separability of each items at each spectral band. If the separability of each items are not clear, trainees have to select better training area again.

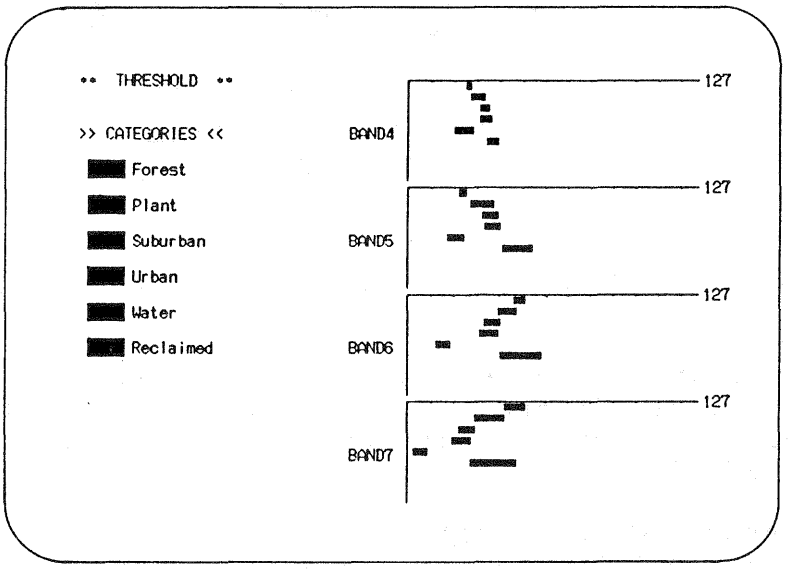


Fig.7 Spectral Characteristics of Training Area

c) Classification

Based on the training data selected by the trainee, the multi spectral classification(minimum distance classification) will be performed. The trainee can compare his classification result with the optimal classification result already prepared by ENDIPS-T, and can repeat classification procedure. Through this try and error process, the trainee can understand the technique of classification.

4) Geometric Correction

Trainees are required to select GCP by comparing the ground pattern of the two remotely sensed data taken at different time. Geometric correction is automatically applied to the data by using the GCP data. Trainees can compare and check the registration accuracy of original image and geometric corrected image by flickering the both image on the display.

5. Conclusion

As described above, ENDIPS-T allow beginners to understand basic ideas of digital image processing and smoothly forward them to the training of real remotely sensed data analysis. The characteristics of ENDIPS-T can be summarized as follows.

1) Two steps training
   1. Fundamental training using artificial data.
   2. Application training using remotely sensed data.

2) Graphic and interactive operation
   Trainees can check their understanding level and improvement through try and error procedure using graphic and interactive operation.

3) Game type exercise
   The exercises are constructed like computer games so trainees can learn remote sensing with fun.

Acknowledgment

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Reference

1) Cho, K., et al., Landsat Floppy Disk Distribution and Data Processing Using a Micro-Computer, Proceedings of the ESCAP Regional Conference on Recent Development in Remote Sensing Equipment and Technology, Republic of Singapore, 1985.

2) NEC Aerospace Systems, Ltd., LODIA USER'S GUIDE, 1986.