

SPREADSHEET EDUCATION MATERIAL USING REMOTE SENSING IMAGE AND MAP IMAGE

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Commission VI, WG VI/5

KEY WORDS: Remote Sensing, Environment, Education, Image, Raster, Method

ABSTRACT:

Remote sensing satellite image, topographical map and vegetation map images are helpful education material for environmental studies of college or high school students. Students can research actual information of environment by analysis of these images. However, it was difficult to analyze the images by a conventional programming method. To solve this problem, we have developed new education materials that include CSV formatted image data set and image analysis programming module using Visual Basic for Applications (VBA) scripts of Microsoft-Excel. The spreadsheet is a typical end-user programming tool, and appropriate to the education purpose. The spreadsheet programming is effective in the raster image analysis for students because of the dataflow graphs mapping method. We applied the spreadsheet programming to remote sensing image analysis with topographical map and vegetation map. In order to achieve for the applications effectively, we have developed worksheet image processing system and imagery data set that can access by Web browser.

1. INTRODUCTION

Recently, variety satellite imagery and digital maps have been available. However, the data are not necessarily used actively for education purpose. One of the reasons, there is no adequate data set and calculation techniques. Therefore we developed a new data set for spreadsheet. Spreadsheet is not only a popular tool for end user (Nardi, 1990), but also effective tool of 2D image analysis if the image size is small (Sato, 2006). To enhance the feature of spreadsheet, we have researched image analysis form of spreadsheet, and developed new control panel for various application using remote sensing image and map image. The data set and spreadsheet analysis techniques will promote study of environment for college and high school students. In this paper show the various analysis techniques and features and problems of the education materials.

2. WIPS CONTROL PANEL

Worksheet Image Processing System (WIPS) control panel shows in Figure 1. The image processing module is developed by VBA by scripts of Microsoft-Excel spreadsheet (Sato, 2004). WIPS control panel has some image operation for analysis of remote sensing image. Student can obtain the image to current worksheet by click-button of right-side panel, and analyze by click-button of left-side panel. The 72x62 size CSV image data transfer from the data set to a worksheet. The cells data are calculated by manually or VBA scripts. To analyze data on the cell conveniently, we have developed an image analysis program module. The module has some analysis functions, examples are as follows.

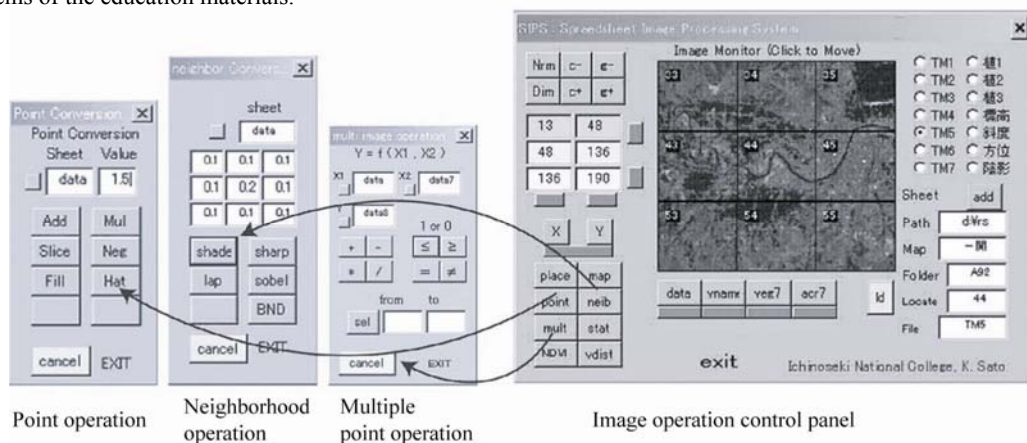


Figure 1. WIPS image operation control panel and sub-panel

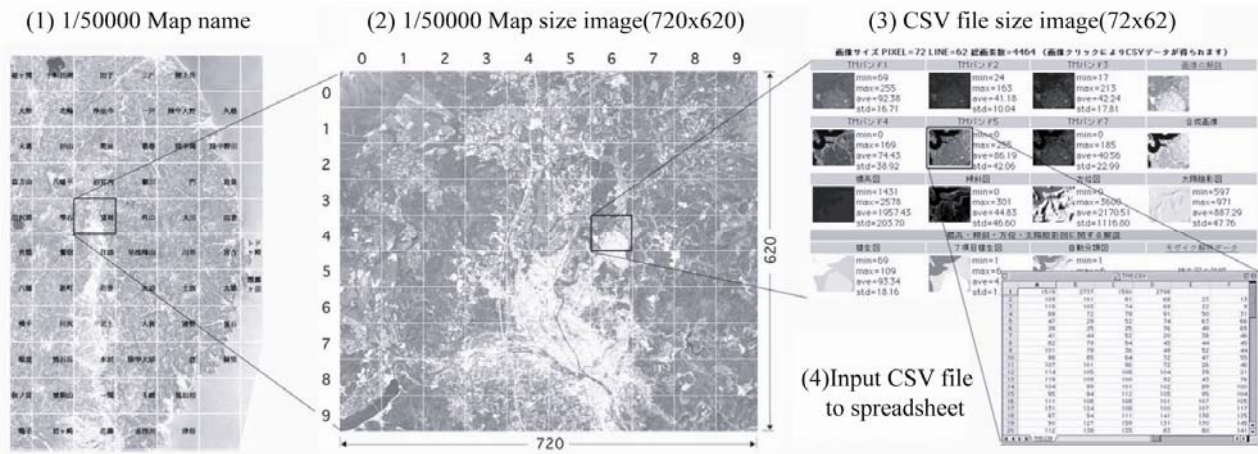


Figure 2. Image data set for spreadsheet image analysis

1. Point image operation
Display using conditional formatting, Addition, Multiplication, Slice operation, etc
2. Neighborhood operation
Filter operation by Shade, Sharpness, Laplacian, Sobel etc
3. Multiple-image operation
Addition, Subtraction, Multiplication and Division, Compare operation etc
4. Statistics image operation
Histogram etc
5. Special purpose operation
NDVI, vegetation distribution etc

3. DATA SET FOR WIPS

Figure 2 shows remote sensing image data set for WIPS. The No.3, CSV (Comma- Separated Values) icons are link to 72x62 size image data for operation of spreadsheet. These CSV images data made from original images that location is Iwate prefecture of Japan. These images are precision geometrical corrected, projected to UTM and 30m resolution. The 17 image data are as follows (Sato,2000).

- 1) Landsat TM images:
Band 1, 2, 3, 4, 5 and 7, 1985.6.16, 9:25:07(JST)
- 2) Topographical maps:
Digital elevation model (DEM) with 0.1m height precision, Slope angle map derived from DEM with 0.1 degree precision, Aspect angle map derived from DEM with 0.1 degree precision, Sunlight incidence angle map derived from above data and incidence and zenith angle
- 3) Vegetation maps:
Actual vegetation map (1978-1985) edited by Japan Environmental Agency, Merged land cover map generated from above vegetation map and Automatic classification land cover map made from TM images and land cover map.

4. PRACTICAL EDUCATION FOR HIGH SCHOOL STUDENTS

Mizusawa senior high school 2nd grade students studied geographical information around their residence area using the WIPS on September 15, 2007. The class can begin to start up of Web browser and spreadsheet. Introduction lecture was various satellite image, topographical image and vegetation image data and it's characteristics as shown in Figure 2 using Web browser. Next lecture was observation pixel value of the imagery on the spreadsheet using WIPS panel. The student understood relationship of the numerical value and image data. Next lecture was observation of their school building using conditional formatting operation and three pseudo coloured map. The image analysis executed by C+ button and the condition adjust button of the WIPS control panel.

Only in the 90 minutes short time explanation, almost students can treat the spreadsheet analysis module. Student learned their living area environment easily using the education materials. By questionnaire, almost student understood the all image data and the characteristics, image analysis operation and results image.

Figure 3 shows typical image operation examples of the practical studies. WIPS analyze the image data set by button click of the control panel. The results are as follows.

- (1) C+ button: Students can observe water, building, grassland, forest area of their residence with pseudo colour map using conditional formatting operation and the condition adjustment using WIPS (Sato, 2001).
- (2) Data button: Students can list up of pixel value of all image data at the cursor potion of specified spreadsheet. Students can see spectrum characteristics of TM images using the list up operation.
- (3) NDVI button: Normalized Difference Vegetation Index map worksheet will appear automatically. The image is calculated by TM band 3 and 4. Students can observe of well known forest area of their residence.
- (4) vdist (Vegetation distribution characteristics) button: A new worksheet shows some histogram graph of vegetation distribution characteristics for topological data. Students can observe land cover distribution characteristics by the elevation, slope and aspects angle of their well known residence area.

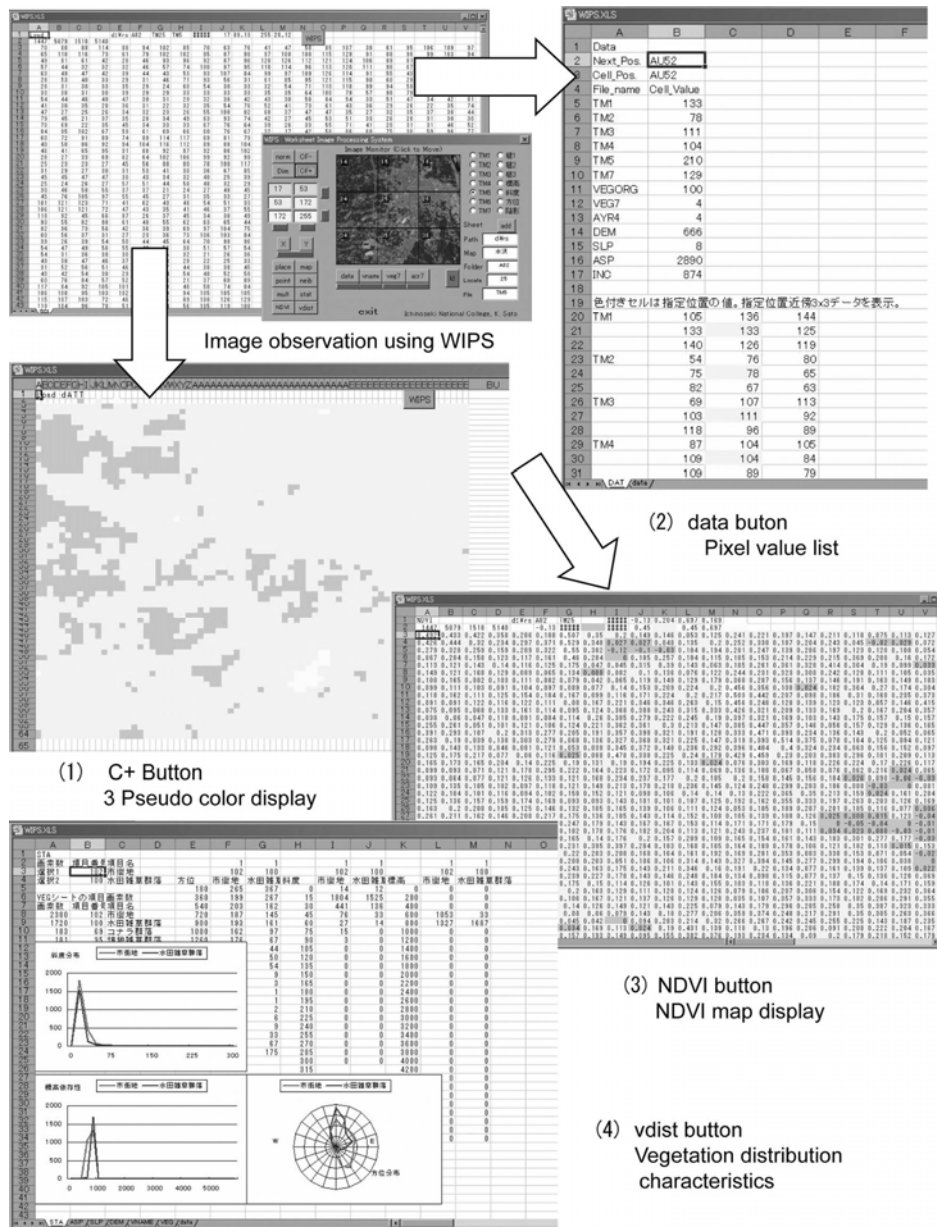


Figure 3. Data observation for senior high school students

5. EDUCATION PROGRAM FOR COLLEGE STUDENTS

The education material is applied to Ichinoseki National College students in their research activities since 2000. The introduction and training class of the image data processing to the college students is the same as it of the high school students as shown in Figure 3. Next, college students learn the spreadsheet programming method. Spreadsheet program is written by the method of dataflow graphs (DFG's) and the graph mapping work (Igarashi, 1998). The programming style is effective in the raster image processing education if the image size is small. For the college students, we applied the tool to analyze satellite remote sensing image and GIS data for research work.

Figure 4 show NDVI operation using DFG's. In this case, a and b are input images, y is operation output image. NDVI value of y image will be calculated as follows.

$$NDVI = y = \frac{b-a}{b+a}$$

Cell K2 expression of the worksheet will be written as follows.

$$=(F2-A2) / (F2+A2)$$

The expression shows DFG's between specified location input tokens of a, b images and output token of y image as shown in Figure 4. The cell K2 expression will be copied from K2 to N5

in square shape. The copy work of the DFG's shows mapping from domains a, b to range y.

In general, a DFG's of spreadsheet is designed to copy in the wide range as shown in Figure 4. In order to maintenance of the mapping work, a DFG's is designed so that the structure may become simple. Domain and range data fields of spreadsheet are designed so that the structure may become simple, too. As a result, template model of spreadsheet for a specific problem is developed as shown in Figure 1. The template models of spreadsheet will have typical DFG set, typical data field forms to reuse by specified end-user (Sato, 2005).

A general purpose DFG's for the raster image operation of spreadsheet is shown in Figure 5. The DFG's forms is multiple neighbourhood image operation. Various DFG's operation form can derive from the general purpose DFG's form.

Students of Ichinoseki National Technical College learn this operation form, and develop the spreadsheet program for their research.

Figure 6 shows NDVI analysis example for training program using the DFG's. In this operation, the result (1) shows a histogram due to logical AND operation between the specific vegetation item area (2) and NDVI value. Changing of the specific vegetation item value will change results, rapidly. These operations are programmed automatically using DFG's generation panel as shown in Figure 1.

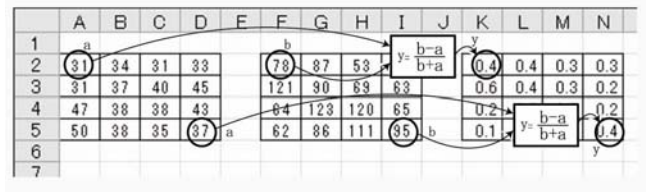


Figure 4. NDVI image operation using dataflow graphs

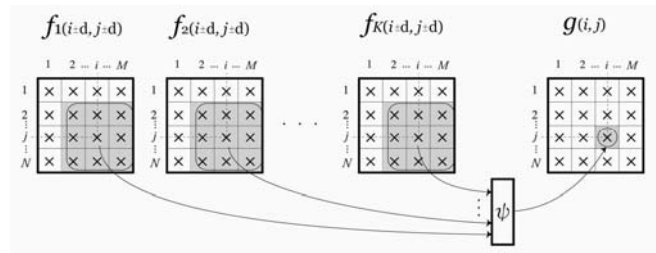


Figure 5. General purpose DFG's for image operation

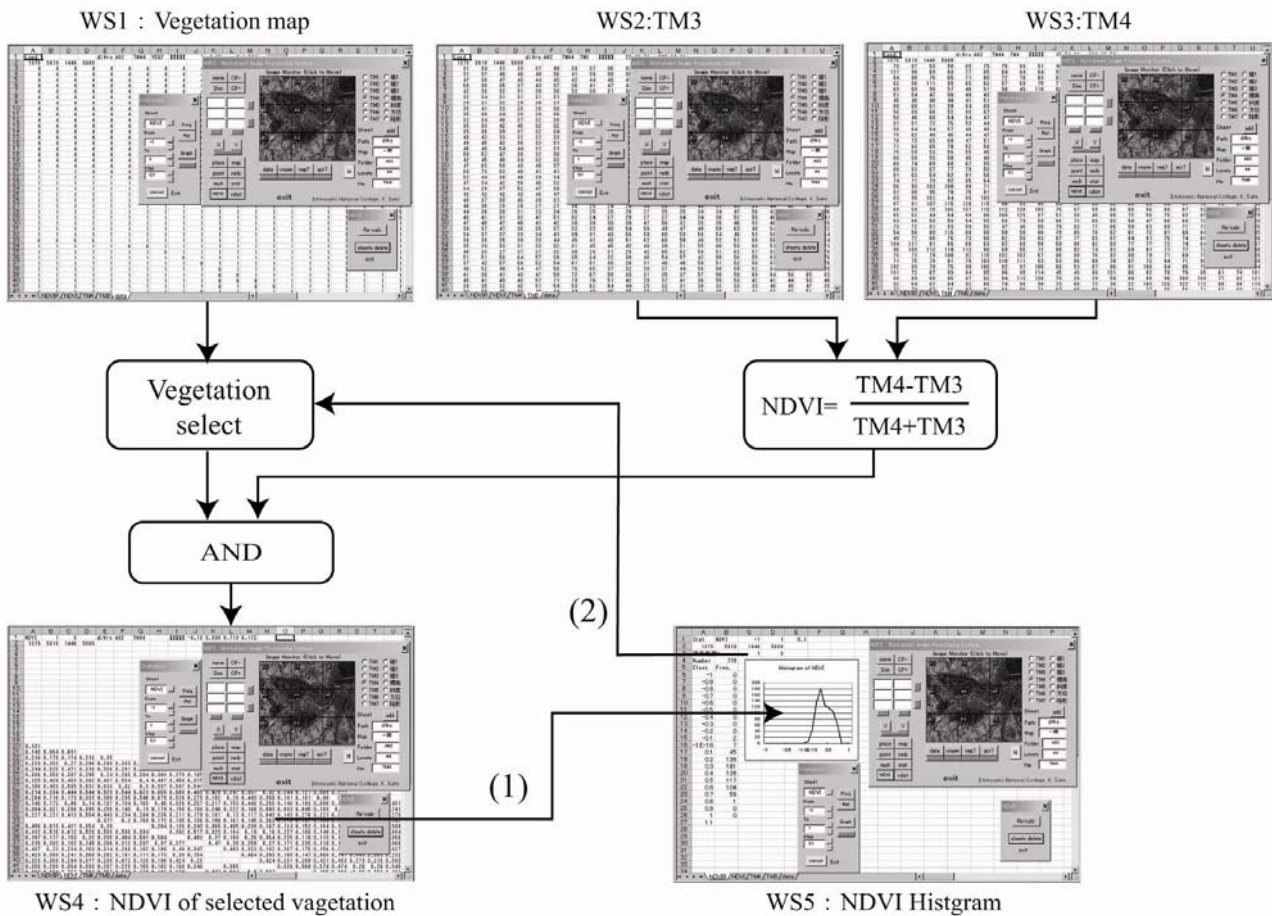


Figure 6. Example of image analysis research work using DFG's. (NDVI distribution characteristics by selected specified vegetation)

6. RESEARCH APPLICATION

More complex remote sensing image processing by using DFG's, Figure 7 show topographic correction of TM images include the Lambert model. Title of the each imagery is worksheet name. The "data" worksheet has digital elevation model with 0.1m height precision data with 72 pixel and 62 line image size. "dx" is slope of x axis and "dy" is slope of y axis, "slope" ground slope angle, "aspect" is aspect (North=0degree), "cosB" is shadow to the sun light by Lanbert model, "TM1" is Landsat band1 image without topographic correction. TM1c is Landsat band1 image by topographic correction. The brightness of the TM1 pixel will rise at a lot of shadows by topographic features.

The ψ_i is spreadsheet cell expression at the location of B4 cell. End user inputs the cell expression, confirms the operation result, and the expression is copied onto the entire image. An image on the way of the operation can be observed by 56 steps gray scale image on the spreadsheet as shown in Figure 7. There were many methods of calculations of slope, and when the calculation type was tried, it was convenient to use the spreadsheet. If the area of the investigation is smaller than that of 72x62 image size, this operation result will be used. When widely image size, end user will develop a programming code using other programming language, C or FORTRAN etc. WIPS is very suitable for testing various expressions. By this fact, we thought that WIPS and spreadsheet is an excellent education material for college students.

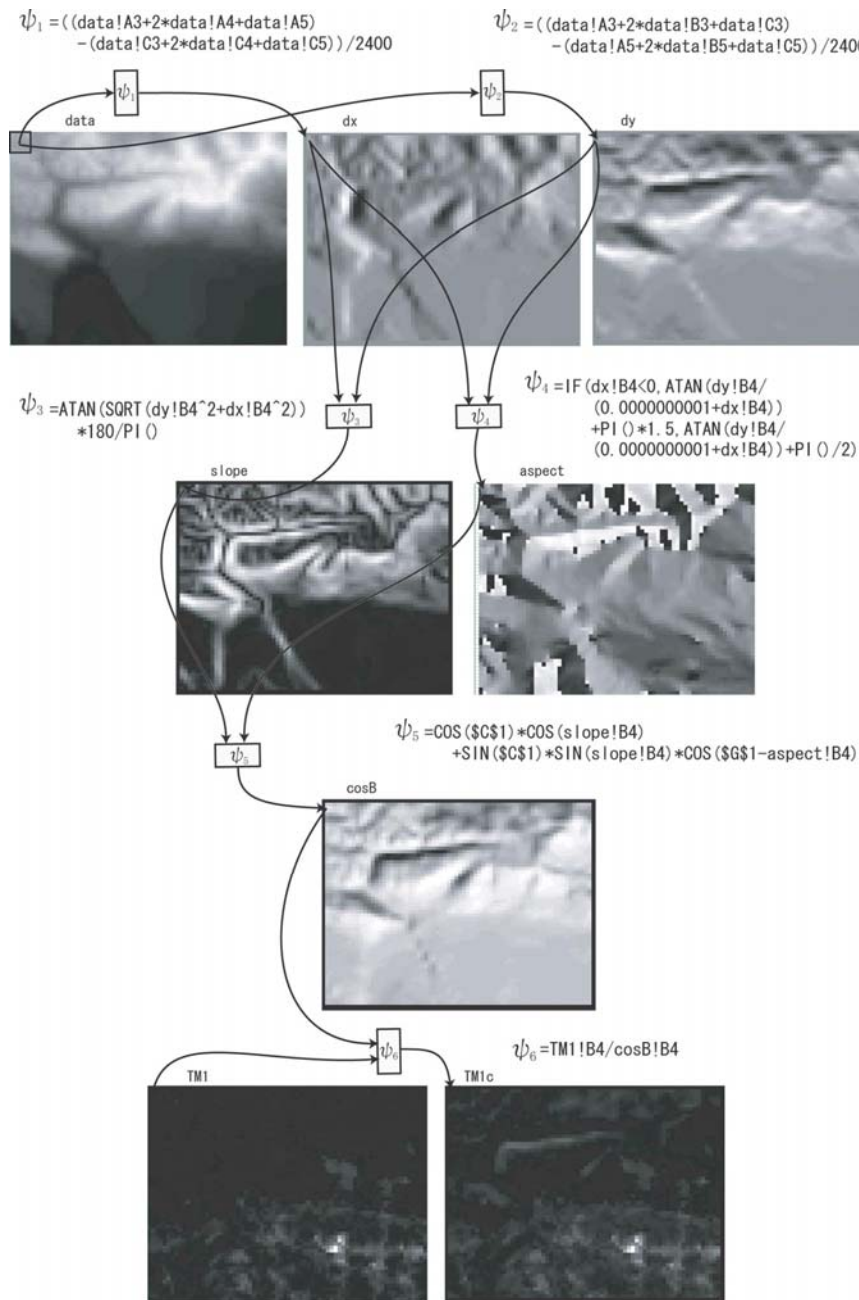


Figure 7. Topographic correction of TM images include the Lambert model

◎ Excellent ○ Ordinary × Inferior

	Spreadsheet	Photoshop	ERDAS-IMAGINE
End user basic training	◎	○	×
Observation of pixel data	◎	○	○
Numerical formula operation	◎	×	○
Histogram, Profile display	◎	○	◎
Image display	○	◎	◎
Data format conversion	×	◎	◎
Geometric transformation	×	○	◎
Highspeed, High productivity	×	×	◎

Figure 8. Features of spreadsheet programming compare with specific software

7. FEATURES AND PROBLEMS OF SPREADSHEET EDUCATION MATERIALS

The spread sheet, WIPS, and the CSV image data set were easy teaching materials in the senior high school student. When the environmental observation classroom for the citizens was executed in Miyagi University of Education in May, 2002, the participant understood this system in a short time. The spreadsheet, WIPS and CSV image data set might be an example of the education material that promotes understanding in short course.

For the college students, Figure 8 shows the features and problems of remote sensing image analysis using spreadsheets. The superior feature of spreadsheet image operation is “shortest elementary education”. The features can be achieved by fixed form operation formula and corresponding to the remote sensing image data set. Moreover, the end-user can do the debug work of a detailed operational expression.

Of course, there are many excellent features in specific software such as ERDAS-Imagine or Adobe Photo-shop. It is suited to apply the specific purpose. The spreadsheets might be appropriate to the school education to which learning time is limit. It is appropriate to the teaching aid that does an environmental observation and a detailed analysis.

Compared with the procedure-oriented language, there are some problems when the spreadsheet is applied to the image analysis. There is a limit of the image size which can be analyzed. The calculation speed is slow. The image data set for the spreadsheet cannot be acquired. When DFG is large-scale, maintenance becomes difficult.

8. CONCLUSIONS

We have developed a new education material for remote sensing image analysis system using spreadsheet and VBA, and introduced a unique form of image operation and CSV data set structure. The image operation and data set suit to programming paradigm of the spreadsheets. End-user students, senior high school and college students can be analyzed remote sensing image effectively by the unique form in a short time class room. The spreadsheet programming paradigm was effective in the raster image processing. However, the paradigm had some potential problems. Especially, it is necessary to note the following two items for maintenance work.

1) When structure of a DFG becomes complex.

For example, Discrete Fourier Transform is simple structure

in the procedure-oriented language, but DFG’s become a complex graph.

2) When mapping size of DFG becomes large-scale.

About 200×200-pixel size, it is not easy to manage DFG’s.

The spreadsheet education material is excellent in the image processing education excluding these problems.

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