End user programming technique for remote sensing image analysis using spreadsheet

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Abstract: Spreadsheet is a typical end-user programming tool. The spreadsheet programming paradigm is effective in the raster image analysis. We applied the spreadsheet programming to satellite remote sensing image analysis. In order to achieve for the applications effectively, we have developed image analysis modules. If the operation form in the analysis module is fixed, the end-user could achieve remote sensing investigation easily.
Keywords: Spreadsheets, image analysis module, image operation form

1. Introduction

The spreadsheet is a typical end-user programming tool [1] [2]. The spreadsheet was used for the teaching aid of remote sensing image analysis of end-user students of technical college [3]. Notes of image analysis using the spreadsheet are as follows.

1) Image operation and image data format should be defined.
2) Big image data and complex operation should not be treated.

The end-user will be able to analyze the remote sensing image easily if follow the above notes. This paper shows the image data and operation form, operation panel for end-user, some examples of the analysis and features of remote sensing image analysis using the spreadsheets. This system was developed using Microsoft Excel and VBA (Visual Basic for Applications).

2. Image data form using spreadsheet

Two-dimension image data is a form that is suited to cell array of the spreadsheets. If image data is small size, any image data can locate on the worksheet, and calculate the data using spreadsheet basic function. However, it is necessary to limit end-user's ability to calculate form, or maintenance and the reuse of the calculation program become very difficult. This is a potential problem of the spreadsheets [4]. Fig.1 shows the relation of the reading image data. Fig. 1(2) shows a form of the image of spreadsheet. Fig. 1(3) shows image data of the worksheet is read by the fig. 1(2) with fixed form from fig. 1(1) original image that coordinates axis by geographic map. Fig. 1(3) image data is mapped to fix place of the worksheet with some auxiliary data. When many images are read, many worksheets generated, and an image data read a worksheet one per one. Of course, a worksheet can read many images. However, only one image data should be read a worksheet. This is a technique to avoid potential problems of the spreadsheets. As a result, the end-user will obtain many profits from the spreadsheet.

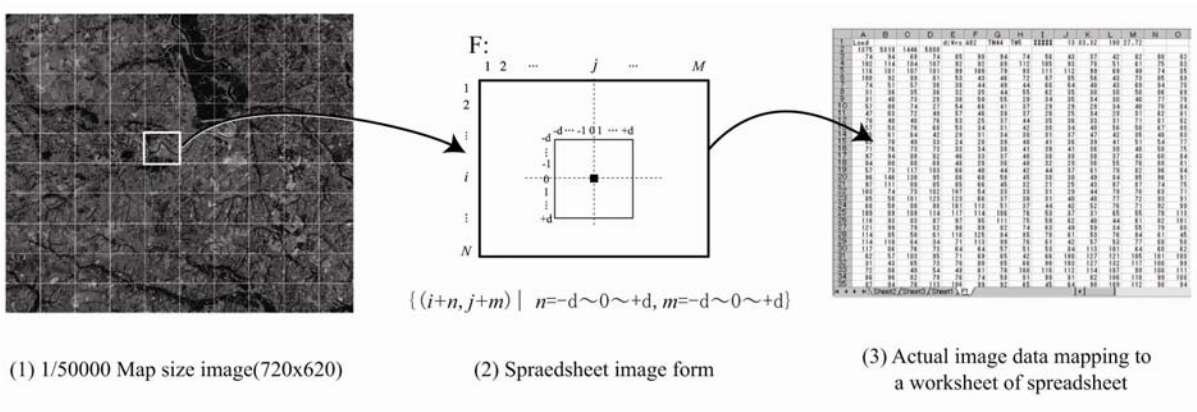

Fig.1 Relation of the reading image data and form of the image of spreadsheet

We have the Landsat TM images, terrain images, and the vegetation maps of the data form of Fig. 1(2). The image data of the worksheet can graphic display by the basic function of the spreadsheets. Fig. 2 shows the typical example of the graphic display using spreadsheet [5] [6] [7].

Fig. 2(1) shows an example of the image display by a conditional format function. The background color of the cell can change according to the value of the cell of the worksheet. This method is simple and fast. This method can show pseudo color image up to four colors. The graphics image is displayed by decreased row and column size for whole observation. Fig. 2(2) also shows an example of the graphic display using change of color allocation table. In the method, the gray level of 56 steps can display by color allocation table re-assignment with VBA [5].

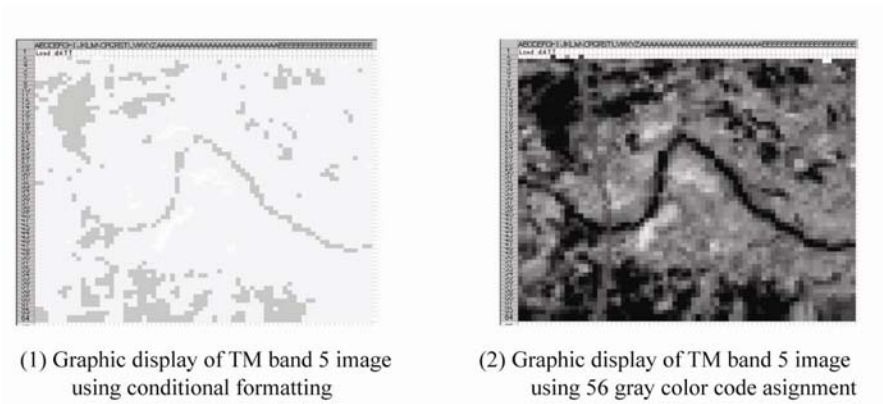

Fig.2 Graphics image display using spreadsheet

3. Image operation form using spreadsheet calculation

It is necessary to fix the form of the image data operation. Otherwise, end-user's profit will decrease because of potential problem of the spreadsheets. Debug and improvement works of spreadsheet programming become easy by using fixed operation form. Fig. 3 shows one of the forms of the fixed image operation that is a multiple-image and neighborhood operation. F_1, F_2, F_k and G are worksheet name. Ψ is spreadsheet cell expression. The operation is a general form of the spreadsheet. Various image operations can derive from the form of Fig. 3. These operation forms are multi-point operation, single-image neighborhood operation and single-image point operation. These operation module forms were built into control panel developed by VBA as described in next section.

Fig. 3 shows the relation of the dataflow graph. The dataflow graph is a spreadsheet programming paradigm [8]. Fig. 4 shows the example of operating NDVI using by dataflow graph. The dataflow graph is composed by the token, arc and actor as shown in fig.4. Three tokens are inputs and an output data. Arcs are cell variables. Actor Ψ is calculation formula of NDVI. Dataflow graph operation structure includes a potential problem. Debug and reuse work of the dataflow graph become difficult in applications that are large scale or complicated image data operation.

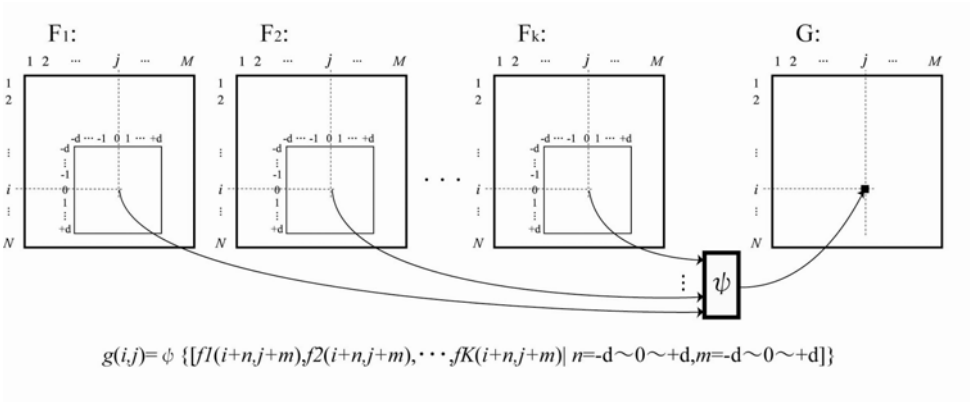

Fig.3 Multiple image and neighborhood operation of the spreadsheet

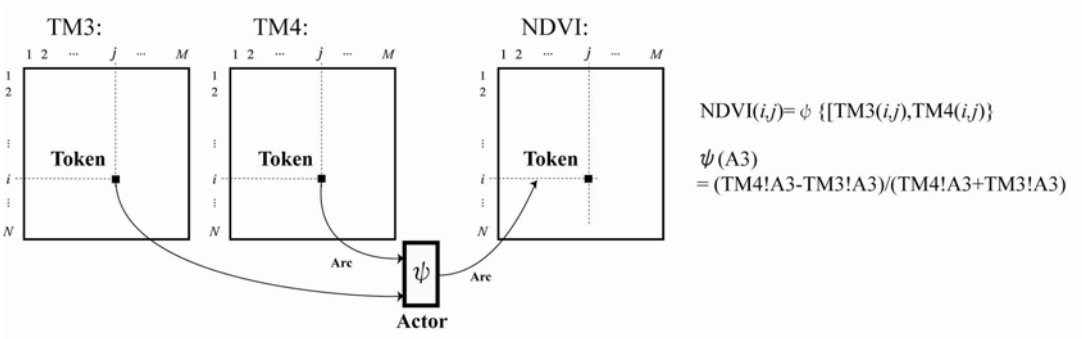

Fig.4 Dataflow graph diagram of NDVI image operation

4. Image operation module using spreadsheet calculation

Fig. 5 shows an image operation control panel that generates fixed image operation module form of spreadsheet. The control panel developed with VBA of Microsoft-EXCEL. Some sub-panels are generated from the operator control panel.

The sub-panels are point operation, a neighborhood operation, and a multiple-image operation as shown in fig. 5. In addition, the control panel can operate image data loading from dataset, graphic display and complex operation module such as NDVI histogram observation. The end-user can easily do the debug work of the image operation by using the control panel.

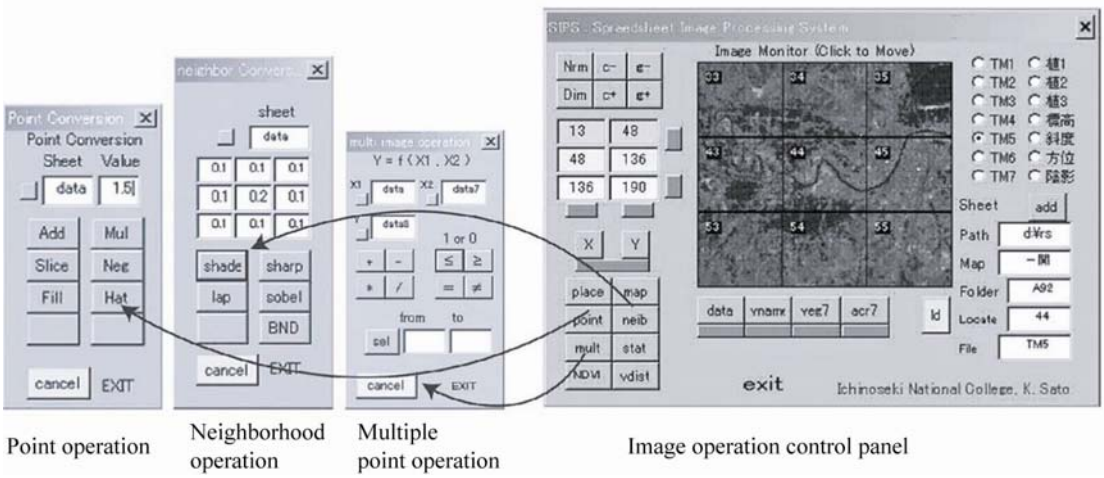

Fig.5 Image operation control panel using VBA of spreadsheet

5. Examples of remote sensing analysis using spreadsheet

Fig.6 shows a typical analysis example of NDVI operation by dataflow graph. VEG, TM3, TM4, NDVI, SNDVI and HIST are worksheet name and Ψ1, Ψ2, Ψ3 are cell calculation formula.

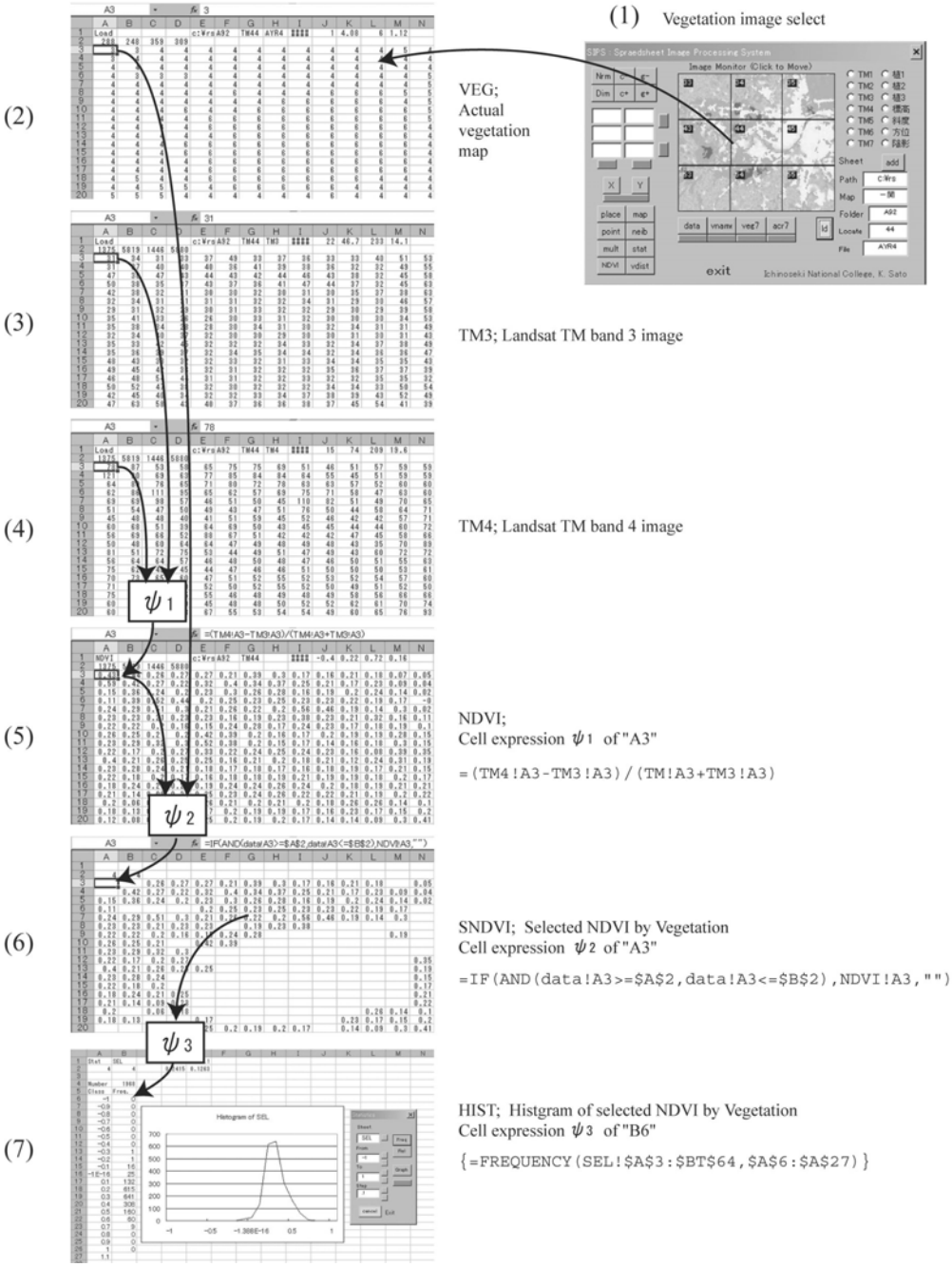

Fig.6 NDVI analysis operation and the histogram display

In this application, a vegetation image of figure (1) is read from dataset to worksheet as shown in figure (2). Then, the NDVI image (5) is generated by the operation between TM band 3 (3) and band 4 (4) images. Next, selected image (6) is generated by AND operation of the vegetation of figure (1) and (6) image. At last, histogram (7) is automatically displayed by operation of the control panel. End-user can quickly accomplish the image analysis with understanding the mechanism of these operations.

6. Features of spreadsheet programming

Fig. 7 shows the features 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. 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.

◎ Excellent ○ Ordinary × Inferior

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

Fig.7 Features of spreadsheet programming compare with specific software

7. Conclusions

We have developed a new method of remote sensing image analysis system using spreadsheet, and introduced a unique form of image operation and data set. The image operation and data set suit to programming paradigm of the spreadsheets. End-user students can be analyzed remote sensing image effectively by the unique form. In this Paper, we have shown the unique image operation form, data set, application example and features of spreadsheet image analysis method.

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