USER INTERFACE — A PROCEDURE FOR A RASTER-BASED GIS SOFTWARE

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Abstract

The author developed a program system named TERINFO which has already been used in practical education of the students for two years. This program system will be described in an other article. This study describes how it is possible to form a user interface for a raster-based educational GIS software. It also describes a versatile raster-based operational process that the author has developed. Finally, concludes that ease of use and manipulation, flexible data input and well arranged open building are all very important factors in realization of an educational program package.

Keywords: raster, user interface, education.

Introduction

The user interface (UI) is that part of a computer program which enables the communication and contact between the user and the program (or otherwise between the user and the program developer).The possibilities of computer engineering environment limits the level of realization of this communication which is determined primarily by the developer. An advanced, well designed and structured UI determines to a great extent the usability and success of the complete program. In addition, one can also say that UI development needs more time and efforts than the realization of the technical task itself. The concentration should be directed to the design, the good preparation and application of hardware and software tools which support an effective interaction is also of great importance.

As the number of highly-sophisticated computer programs grows, the demand to ease their use will also increase. (K. TILDSLAY et al., 1988)

Now, let us give a short survey of the development of man – machine relation.

In the beginnings, computers used only punched-tape or punched-card readers and serial printers. In this solution batch processing was used where requirements to run the program were given in advance and then the execution was carried out later by the computer (DOBROVOLNI et al., 1977).

As a result the user had to wait for a long time until he could be aware of a program error, or the result list.Development of alphanumeric terminals and introduction of time sharing operating system led to a row-oriented command processing mode where interaction was replaced by questions and answers. The next phase in development was program control by menus, in this case the system offers a list of processing options to select from by number, an initial or another selecting mechanism. The spread of graphic displays facilitated the appearance of iconized menus where diagrams and drawings make the menu form appear instead of texts. At present graphical user interfaces (GUI) are considered to be most advanced developments. These interfaces make desktop principle realization possible which means that on one graphic display we can open more than one window at a time in which even different applications can run together and their results and charts can be moved between different windows (clipping). One can dispose of resources of computer with using a pointer device and some commands, those resources can be shared among other users or different programs when a workstation is connected to a network. (HERNÁDI et al., 1990).

The basis of standard GUIs is the XWindow System.[1] Knowing that, the system had been developed for running of the graphic applications on a network, it is evident that the XWindow System will have a great influence on many fields of image processing in the future, thanks to its raster-based graphic system. It can be advantageous in an educational laboratory to practice computer-based image processing where the trainer can lead the students to do the work themselves by using the educational program and data base in the central computer of the network. Multimedia, a new born field of computing engineering can be utilized in the teaching processing; it opens up new dimensions for storing and jointly using text, video and audio information. It will probably lead to considerable changes in informatics, education and many other fields of life.

User Interface Construction

Next I want to give a summary of primary elements necessary to construct an application-oriented, raster-based GIS operating software. Firstly, modules capable for supporting data entries from the three basic sources such as maps, analog and digital images, rastered databases (*Fig. 1*). In the course of execution different rastered operational, data management and analysis functions are required, the results are output by various device-dependent processes.

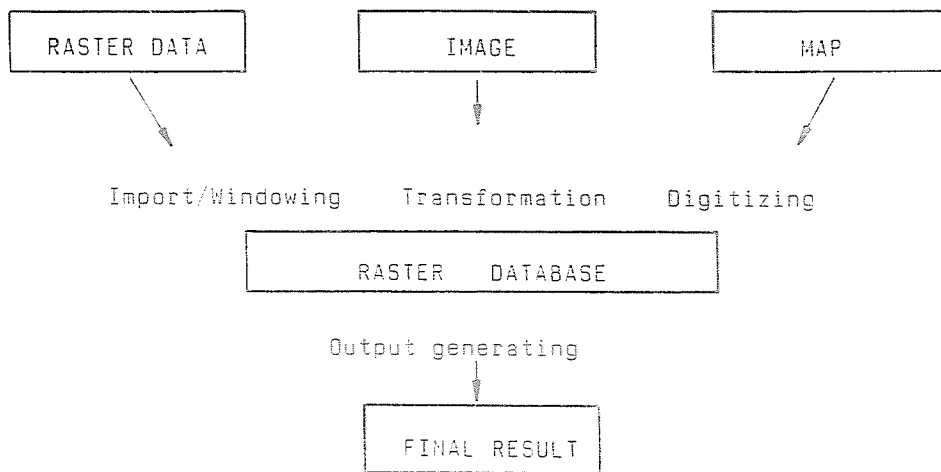[1]XWindow System is a product of Massachusetts Institute of Technology

Fig. 1. Connections of raster database

At every processing level careful development of UI is of vital importance for the effective functioning of the program. In case of well arranged UI, the software practically leads the user through the execution process. The communication between man and machine should be effective including only the necessary questions and answers (branching, status change, etc.). Furthermore, the UI should treat the arisen needs within the course of evaluation and analysis.

Next, let us examine a practical UI necessary for a raster-based GIS software suitable for classroom education. It is practical to make separate modules of groups of functions which can be separated one from another and arranged in a frame system by using a main program . The main program of the frame system should have hierarchically structured menus. The first level should be a selection of module, the selection order may also represent the sequence of data processing. Thus the student can follow a typical execution process.

The second level can be organized including parameters of the selected module. In case the user does not want to change parameters the system should be able to run the module with the defaults.

The map digitizing module can be realized by using a worksheet in a single window and a status display menu. Control can be achieved by selection from the keyboard. When digitizing, it is easy to select functions from the keyboard. In case the number of keys is enough on the cursor of the digitizing board, the selection should concentrate on the keys most

suitable. The selection of a menu with a mouse is not practical because both the mouse and the cursor of the digitizing board are pointer device which should be moved to select a menu item. It is not recommended to create menu areas on small digitizing boards because their areas will reduce the usable digitizing area, on the other hand moving the cursor of the board to the menu area for selection, makes digitizing difficult.

Function load, save and windowing are all menu items in database management. Dataflow between the memory work area and the storage of the system shall be determined by selection of database load and save from menu. If the modules are realizing the independent dataflow of the main program or another module, the registration, updating and management of the file contents would need more attention. Here, windowing means cuts out of bigger raster databases. Assigning numbers to windowing makes window positioning and scaling precise, in graphic mode the same assigning process can be solved only when the values are given by numbers and a high resolution display and a precise pointer device are available for precise positioning.

A double graphic window and a status menu are available for geometric transformation which happens between the different layers of the database or fitting an original image in the geometrical system of database. Control can be achieved by some pointer device. The two windows one near the other are available for simultaneous view of both the source and destination layers. Thus assigning the pairs of link points with known position in both layers by a pointer device or using a cross-hair position in the status menu are numerically feasible.

The group of functions for raster-mode operations and analysis should use a hierarchical menu. As main processing takes place in this phase which cannot be defined during program design and realization stages and need the realization of a highly flexible set of functions. Concerning functions which require a lot of parameters it is practical to use an intermediate data file to write/save data for later processing or change them if needed through repeated sequent processing.

It is practical to create a menu to display the results, the menu function is to activate drivers of different devices (display, raster-plotter and laser printer, etc.). Device selection shall be followed by setting display modes and parameters.

The Multi Function Raster Procedure

Next let us see a simple procedure which is suitable for different raster-mode GIS and image processing operations. These operations are following:

- composite generation of multi band images
- intensity level transformation of digital images
- information code of raster-layers transformation
- algebraic operation of raster-layers (e.g. addition)

This procedure consists of the 5 steps as detailed below. These steps must be done for every raster point:

the position coordinates: $\quad x = 1 \ldots n$ in case $n \ x \ m$
$\quad y = 1 \ldots m$ raster-window

1. Recover information code from the current raster layer:

$IC_i = L_i(x, y)$ $\qquad\qquad$ IC_i: Information code
$\qquad\qquad\qquad\qquad\qquad$ L_i : Mark of layer

2. Index a vector with this value to get the input value:

$IV_i = I(IV_i)$ $\qquad\qquad$ I: Input replacement table
$\qquad\qquad\qquad\qquad\qquad$ IV_i: Input value

3. Multiply IV_i by a multiplier factor relevant to the current layer (F_i) and add the sums multiplication product to the input layers at the current position:

$SV_j = \sum\limits_{i=1}^{l} F_i * iv_i$ $\qquad$ F: Multiplier factor of layer i

$\qquad\qquad\qquad\qquad\qquad$ SV_j: Sum value
$\qquad\qquad\qquad\qquad\qquad$ j: Index of result-layer

4. Index a vector with the result to get to the output value:

$OV_j = O(SV_j)$ $\qquad\qquad$ O: Output replacement table
$\qquad\qquad\qquad\qquad\qquad$ OV_j: Output value

5. Store the 4-step resulting value at the current position in the result layer:

$L_j(x, y) = OV_j$ $\qquad\qquad$ L_j: Mark of result layer

The tables used in this procedure are equivalent to the software-mode lookup tables (LUT's) in image processing. The complete procedure can be carried out by multiplying and adding integer numbers. In order to avoid overflow from the range of figure representation the following condition should be considered. The upper limit of figure representation range must be the square of the maximum value of the information code.

Let us see how the operations above can be realized using this procedure.

- composite generation:
  F_i $\quad$ = component bit shift operator
  IV_i = histogram-transformer$_i$ (IC_i)
  $OV_j = SV_j$
- for transformation of intensity and information code there should be the suitable discrete function loaded in the input replacement table.

$$F_i = 1$$
$$IV = \text{discrete-function } (IC)$$
$$OV_j = SV_j$$
- layers addition
$$F_i = 1$$
$$IV = IC$$
$$OV = SV$$

Summary

Based on our studies and practical experiences, we conclude that an educational system of this structure should include the following properties:
- easy to handle, so enabling quick learning and using which makes it easily applicable in education. Since the description of the software does not take a long time, the user can quickly reach the success of raster-mode data processing via a step by step learning procedure.
- Its flexibility and open structure (data source management, raster-mode analysis, display of results) facilitates access to the raster-mode database from geometrical information point of view. This means that this system is suitable for integrating data of the most common data sources into a homogeneous raster-based system, and for position-dependent analysis.

I hope that, by discussing the theme presented in this paper and the way of explanation where the technical content of the system is treated as a black box and only external connections are concerned; it will interesting for experts too.

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