Synopsis

Towards Design and Implementation of GIS Based Tools and Techniques for Various Applications

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Synopsis

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1. Introduction

Geographic Information System is the modern technique by which Spatial and non-spatial data can be represented graphically [1, 3, 4,]. User can easily understand the characteristics of the geographic matter by the help of GIS tools. Using modern technology the graphics generation in GIS tools is a challenging work. Many industries and institutions are generating various tools and techniques to include GIS in various fields [9]. The GIS based tools and techniques help people working in this field to easily understand the characteristics of geographic information. The tools may be helpful in making future decisions [2, 6, 7]. To make GIS based system more dears with lesser cost, an attempt has been made for developing GIS based tools.

2. Methodology

Tools are available in the market but these are very costly and processes involved in the software are not so much user friendly. To generate GIS based tools, one has to follow the following tasks.

1. Collecting raster/scanned map
2. Digitization
3. Data Attachments
4. Generating graphics on the digitized map
5. Building of GIS based Decision Support System.

All the tasks are discussed from section 2.1 to 2.5.

2.1 Collecting raster/scanned map

Raster/scanned maps being the computerized picture consist of the pixels. In this map all pixels have some intensity value. Depending on the location wise information, the GIS feature has to generate on the map. So the raster map of the interested region has to be collects. The map may be a satellite image or a scanned map.

2.2 Digitization

Digitization is a process by which all/required objects of a map can be converted as polygon or line or point object. Polygon, line and points are the basic unit components of a vector

map. But in a raster map or scanned map all objects are constructed by pixels and there is no boundary attributes of the objects. In GIS the first task is to convert the raster map to vector map. In case of vector map a database is attached with the unit components of the map. The raster to vector conversion process is called the digitization. In case of vector map each object has the boundary attributes by which all other map related attributes (e.g. area, length etc.) could be derived. Since vector map is a collection of polygons, lines and points and all objects have a database, any type of GIS feature can be generated on it.

2.3 Data Attachments

After generating the vector map from the raster map by the digitization technique information is to be attached with each object of the vector map. Depending upon this information GIS based Decision Support Systems are generated.

2.4 Generating graphics on the digitized map

By using different colors, symbols or shades the information is represented on the map. The variation of attributes may be represented by different colors. Thematic map may be generated depending upon the information. Efficient and proper use of graphical User Interface may be generated.

2.5 Building of GIS based Decision Support System

Depending upon the information associated with each object decision support systems may be generated. Along with the graphical representation the tool provides some decision depending upon the requirements. Some techniques are also present which provide the text base information along with the graphics.

3. Proposed Work

An attempt has been made to develop different tools and techniques of GIS for various applications. Development of various decision support systems using database management system is other intension. Keeping the objective in mind one digitization technique and one thematic map generation technique has been derived and implemented by java swing and oracle 9i. Two decision support systems are also developed. The first one is soil management system of tea garden and the second one is pruning management system of tea garden. Glimpse of the developed tools are given in section 3.1 to 3.4. It is also proposed that some work has to be done on change detection by using Remote Sensing images.

3.1 Digitization tool

Digitization is a process by which all objects of a map can be converted as polygons lines or points. Polygon line and point are the basic unit components of a vector map. Scanned maps are raster map and all objects are constructed by pixels and there is no database corresponding to the map. In case of vector map a database is attached with the unit components. The raster to vector conversion process is called the digitization. In case of vector map each object has the boundary attributes by which all other map based attributes (e.g. area, length etc.) can be derived. Since vector map is a collection of polygons lines and points and all objects have a database, any type of GIS related activity can be performed. The developed digitization technique is implemented by Java swing language and Oracle Database Management System. The technique is based on the mouse click method of java swing. For each polygon the coordinates of some boundary points which are essential to construct the polygonal shape may be obtained by mouse click method and those points are added to that polygon. Similarly the coordinates of required boundary points of each line can also be obtained and added to the line. The coordinates of the boundary points of the polygons and lines can be stored in the database by the JdbcOdbc schema. By a single mouse click the coordinate of a point can be retrieved and stored in the database. In this tool the technique to assign color for each object is also implemented.

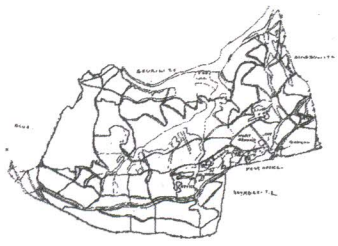

Figure 1: Original map

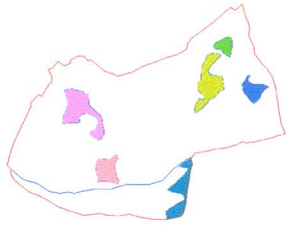

Figure 2: Digitized map

Figure 1 shows the original map. Figure 2 shows the digitized map where the boundary of the map and one river (the blue line) are digitized as line object. In figure 2 six required polygon objects also digitized. All polygon and lines in the digitized map has boundary and color attributes which are stored in the database. If large number of objects has to digitize then the required time will be long. In this case partially completed digitization can also be stored into the database by help of temporary tables. The remaining task can be completed later by fetching information from the temporary tables. After the digitization the user can edit it by

opening the vector map on the actual raster map. This technique has some advantage and some disadvantage which are listed below.

Advantages:

- Since only some boundary points which are essential to construct the absolute shape of the object is stored in the database the size of the tables which stores the coordinates is minimum.
- Temporary storage and editing facility is available.
- In editing page the selected object will be blinked which is more user friendly.
- Color can be assigned to each object.

Disadvantages:

- At the beginning the size of the raster map has to fix to the size depending on which the frames are designed.
- Since zooming facility is not developed, appropriate digitization is difficult.
- At the time of line selection mouse has to click at the absolute end points or at the absolute bending points.

3.2 Thematic map generation tool

A database oriented thematic map generation technique has been developed on a vectorised image for visual interpretation of the attribute values. To vectorise the image/map the polygon based digitization technique proposed in section 2.2 is used. Based on various attribute values, thematic maps can be generated by this technique. A color assignment technique for each sub range of the attribute values is also integrated. In the thematic map the legend also show the sub range of the attribute values and assigning colors for those sub ranges. The technique has been implemented by java swing. Figure 3 is the color selection page. For each sub range of the attribute value one color has to assign by the color chooser buttons at the right side of the color assigning page. In this example the number of color is 5 and polygon number on which the thematic map is generated is 8. The output thematic map is shown in figure 4. The algorithm is given in section 3.2.1.

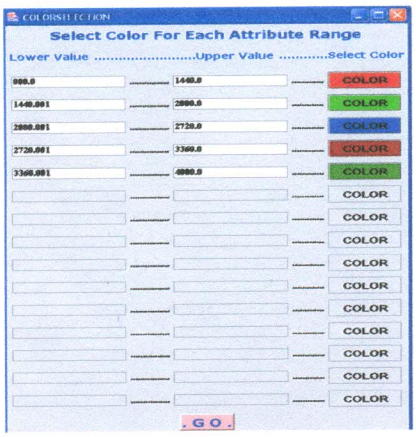

Figure 3: Color assigning page

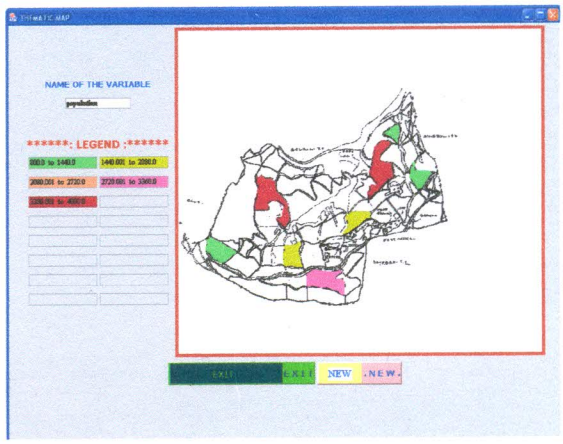

Figure 4: Thematic map eight polygons and five colors

3.2.1 Algorithm

Step1: Fix the image size by using any software depending upon the structure of the designed frames.

Step2: Assign polygon object constructing points' coordinates, name and attribute value to each polygon object.

Step 3: Divide the total range of attribute values into sub-ranges and assign color to each sub-range.

Step 4: Fill the polygon objects with the pre-assigned color which depends upon the attribute value of the polygon/area.

In this tool a temporary storage allocation process is also implemented which helps the user to terminate the digitization process by storing the completed information into the database.

3.3 GIS based Soil Management System of Tea Garden (GISSMS)

The candidate developed a GIS based decision support system on soil management of tea garden. This system store the soil test results in the database, and retrieved them when needed. A polygon based digitization technique has also been integrated in this tool. Depending on the soil test data such as PH value, C%, N%, K_2O, P_2O_5 and available Sulphur in the soil, the technique automates the decision making procedure through generation of GIS features. The technique of thematic map generation upon the tested data is also integrated. The tree view of the implemented scheme is shown in figure 5.

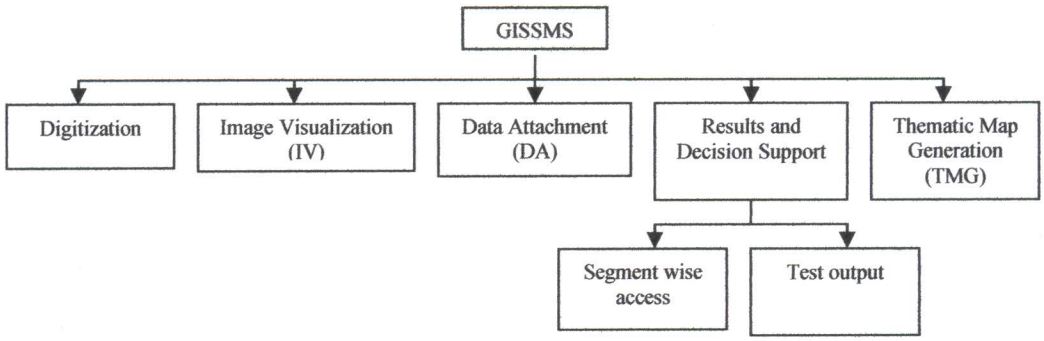

Figure 5: Tree view of the implemented Scheme

The technique is implemented by java swing and oracle 9i by taking data from Puguri Tea Estate Mirik, Darjeeling. Right panel of figure 6 shows a digitized and segmented map of Puguri Tea Estate Mirik, Darjeeling. The arrow shows the zoomed version of the selected segment. The result of mouse click on segment 15 generates the zoomed segment in the left panel of figure 6. This shows the implementation of the main page.

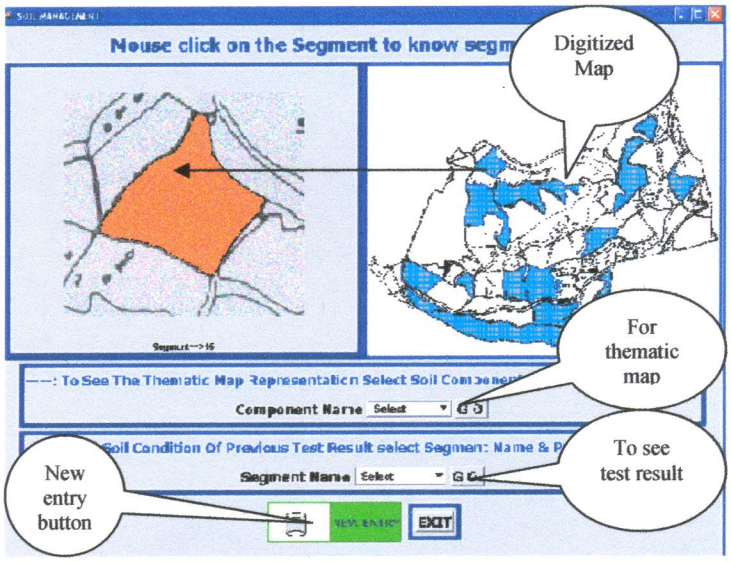

Figure 6: Main page

By selecting the component name from the indicating combo box if 'GO' button is pressed then the thematic map on the component will be generated.

Figure 7 shows a thematic map on the soil component C%. If mouse is clicked on a particular segment of the generated thematic map then that segment's image along with the segment name, soil component value and test date will be visible on a separate window on the left side panel.

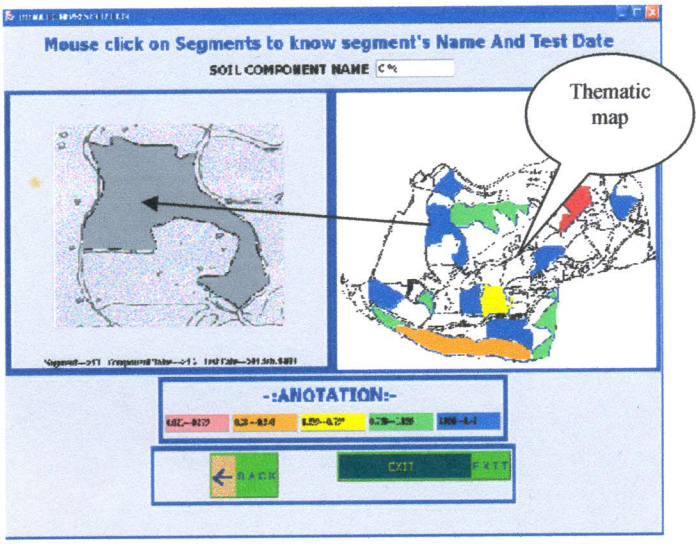

Figure 7: Thematic Representation results of C%

Thematic map of figure 7 is based on C% and zoomed image of segment 13, as selected from the right panel of the garden image, is generated on the left window. This implementation produce the thematic map based on PH value, N%, K_2O, P_2O_5 and available Sulpher. The soil test results stored in the database may be viewed using 'Result view' option of the tool. On selecting the segment if 'GO' button is pressed then the soil test result page will be visible on the screen. The page in figure 8 shows the soil test result of segment 4. To identify a segment properly the image of that segment is attached in this page.

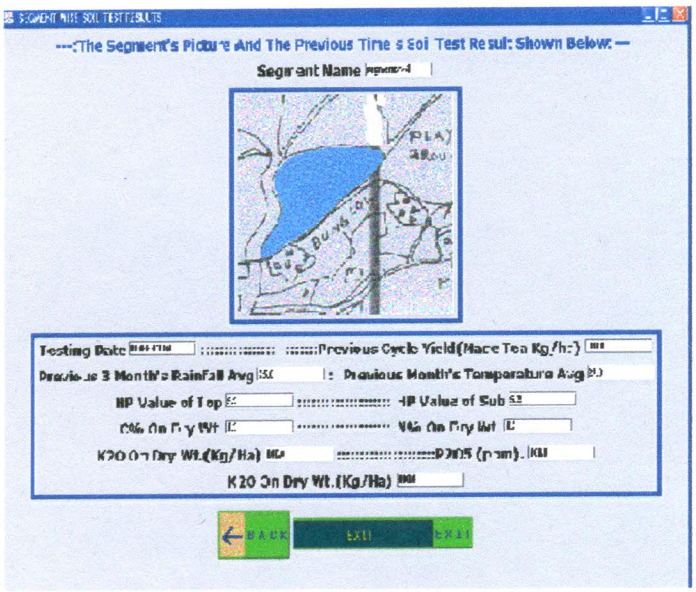

Figure 8: Soil Test Results of segment 4

The Data association is another option of the main menu. There is a 'new entry' button in the main page. If this button is pressed the 'Data Association' page will be visible. This page is

shown in figure 9. The test data may be entered segment wise as input. There is an option to skip any segment during data entry in that page of the tool.

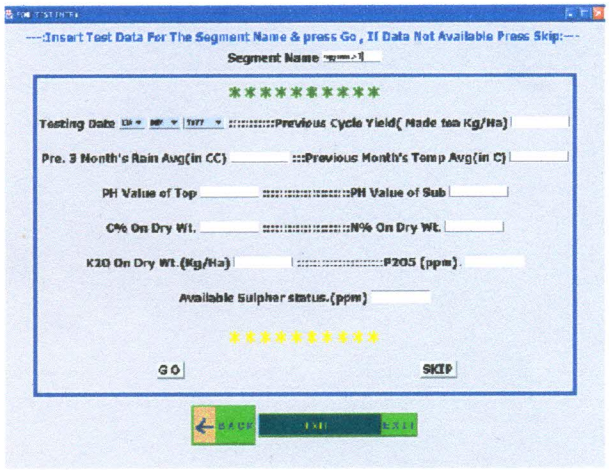

Figure 9: Data Association form

3.4 GIS based Pruning Management System of Tea Garden (GISPMS)

Pruning is an operation of tea garden. Pruning is performed on tea bush to increase the yield of the garden every year. There are different types of pruning, which are LP (light-prune 1), UP1 (un-prune 1), Up2 (un-prune 2), and DS (deep-skiff). Different tea gardens use different name of these pruning types. A cycle is maintained to perform these pruning. Pruning procedure helps to increase the productivity. The management has to maintain all the segment wise records of the pruning. This software will help to easily maintain this procedure as a GIS based information management system. The database stores the previous and current pruning documents. This decision support system generates decision about the next pruning along with the date depending upon the stored data. The data insertion page of the software is shown in figure 10.

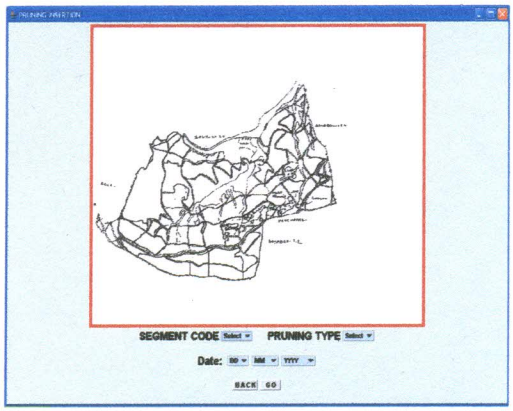

Figure 10: data insertion page

There is an option to get the visualization of all the segments under a particular pruning type. Figure 11 shows the decision support page where the colored segments represent the LP type pruning areas.

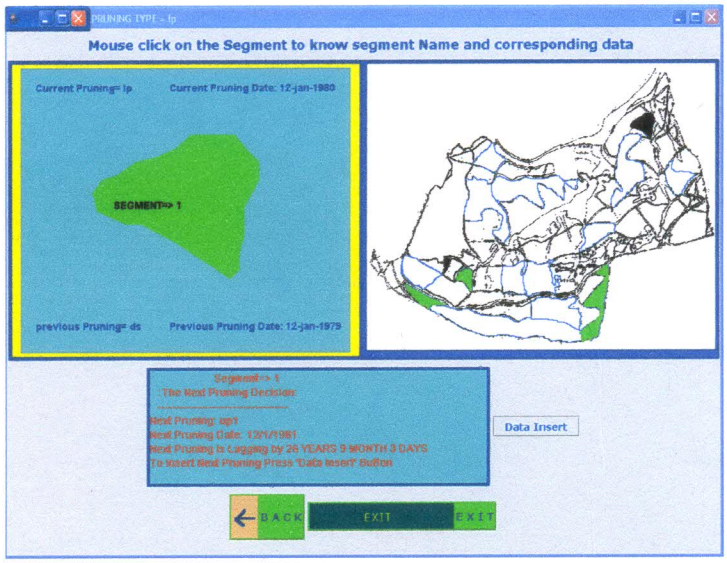

Figure 11: Decision support page shows LP type pruning areas

If any colored segment is selected by clicking the mouse, then that segment will blink (segment 1 in figure 11) and that segments pruning documents will appear on the left side panel of the page. In the left panel, a zoomed view of the selected segment will also be displayed. The lower text box is the decision box which shows the next pruning decisions.

The research has an intension to cover more GIS based applications for rural and urban development.

Comparisons with TNT-mips

The feathers of the developed tools are compared with the TNT-mips, the microimages Remote Sensing and GIS software. Some comparisons are presented here.

1. In case of digitization the developed tool can assign separate color to each digitized objects but it is not possible in TNT-mips.
2. The thematic map is generated on the main map. In case of TNT-mips if some one wants to generate thematic map by taking small number of polygon then the user can not identify each segment/polygon easily without opening the thematic map layer on the main map. But this has been overcome in the developed thematic map generation tool.

3. The blinking of an object is not present in the TNT-mips software but this facility is integrated in the developments. The blinking operation helps the user to easily understand the selection of an object.

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