Customization Of Bio-Geographical Information System

V.N. Neelakandan,
Centre for Earth Science Studies, P.B. No. 7250,
Akkulam, P.O., Thuruvickal,
E-mail: neelakandan@eth.net
Phone: EPABX: 442454, Fax: 0471-442280.

Manu M Nair
'Karthika', Library Lane,
Nalanchira, P.O,
Trivandrum – 695 031, Kerala, India.
Trivandrum – 695 015, Kerala.
E-mail: manu_mn@rediffmail.com
Phone: 0471-530494

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Abstract

This paper deals with the design and development of a customized Bio-Geographical Information System using MapBasic and MapInfo Professional GIS software. The system, implemented on Windows NT platform, has menus and user interfaces tailored for managing and monitoring spatial relationships of species distribution pattern, plant associations, and bio-geo-climatic variables. It supports customized query processing facilities for retrieving the required information with ease. It also provides layer automation facility using which layer-by-layer information about thematic maps can be easily obtained. The system is useful for bio-diversity related studies as well as for implementing national biodiversity action plans. Naive users, in particular, will find it easy to use the system for obtaining spatially referenced bio-resources information.

Overview

1. Introduction

Geographic Information Systems (GIS) find a variety of applications in the areas of map processing, information retrieval, and spatial analysis. They are widely used for creating, accessing and maintaining geographic databases for resources management, facilities and utilities management, planning, and decision-making. Although, Windows based GIS packages such as Arc Info, MapInfo, and Geomedia, have friendly interface; users generally require specialized training, without which they find it difficult to use them, particularly for query processing and information retrieval. If customized information system is made available for a specific application, with relevant menu and user interface, users will find it easy to make use of such a system for decision-making. This paper deals with the design and development of a customized Bio-Geographical Information System (BGIS) for managing the bio-resources of a region using MapBasic 5.5 and MapInfo Professional 5.5 software on Windows NT platform. A BGIS has been already developed in Centre for Earth Science Studies (CESS), Trivandrum, using MapInfo GIS (Neelakandan, et al, 2001).

MapInfo GIS has several menu items and functions, which can be used to manipulate spatial data. Naive users can get confused with default menus, which are apparently not related to the task at hand. It can be made more application-specific and friendly by using programs written in Visual Basic, Visual C++, Delphi, PowerBuilder, etc., where elements of MapInfo are integrated into another Windows application. This type of application development, where most of the programming is done using a host language, is known as integrated mapping. Instead of using integrated mapping technique to control MapInfo, another approach is to customize it using MapBasic, the proprietary programming language provided with MapInfo GIS package. MapBasic enables us to use MapInfo functions in a customized environment. Customizing MapInfo menu and user interface, using MapBasic to meet specific requirements, is relatively easier than integrated mapping (MapInfo Corporation, MapBasic 5.5 User's Guide, 1999).

For managing the bio-resources and their environment, both spatial and aspatial data are used in BGIS. Spatial data, which are modeled using geometric entities namely, points, lines and polygons, have physical dimensions and relate to geographic locations on the earth's surface. These are supplemented by attribute data in the form of relational tables. Attribute data, which qualify the spatial data, are expressed as names, numbers, data values etc. Data on flora and fauna mainly constitute the bio-resources data. Based on taxonomical classification, the bio-resources data are organized as Oracle relational tables, which are linked with the base map of the region in MapInfo GIS environment. The BGIS developed in CESS has more than twenty layers of different map themes integrated in GIS core with spatially indexed bio-resources data (Neelakandan, et al, 2001). It is a tool to manage and monitor the spatial relationships of species distribution pattern, plant associations, bio-geo-climatic variables, etc. If the end-user is not well versed with data manipulation in MapInfo GIS, he can find it difficult to get information associated with a particular species or on specific task related to different map layers. In such situations customized MapInfo GIS software will be useful.

2. Design Methodology

Design of customized BGIS involves integration of database management, computer graphics, data modeling, and information management. The methodology adopted here is to invoke MapInfo GIS interface through MapBasic program for customizing MapInfo by adding or deleting menus and submenus as well as dialog boxes according to the requirements. There are a variety of features for editing and viewing map graphics and attributes in MapInfo GIS. MapBasic supports all the MapInfo functions and data access tools (MapInfo Corporation, MapInfo Professional 5.5 Users Guide, 1999). Some of them are for creating and modifying thematic maps, opening multiple tables, finding information associated with a map layer, controlling individual layer properties like display and labeling, manipulating map window view, controlling map units and projection. Appropriate user interfaces for query processing and support for multimedia features are to be incorporated. Similarly there is necessity for giving provision to access data from the Oracle database and retrieving them.

In BGIS, a number of digital map layers depicting different themes on geology, soil, landform, drainage, relief, communication networks, land use, vegetation, rainfall, temperature, administrative and forest boundaries, etc. are integrated in the GIS core. It is cumbersome for users to view various map layers manually and retrieve information related to species and their environment. Facility for viewing map layers at the click of a mouse-button will be a welcome feature, which has to be included in the design. Another requirement is to have customized search facility for different types of species and their characteristics. Here both spatial and aspatial search methods are required. Multimedia features are also necessary for incorporating species photograph and sound, wherever applicable. In addition, a few selected features of MapInfo and corresponding menu for window zooming, saving map windows, map object manipulations, creating and modifying points and thematic maps, printing etc. are required in the customized system.

The Oracle 8 is employed for the bio-resources database design (Oracle Corporation, 1998). The database consists of five relational tables viz., Taxonmaster, Species, Family, Climate and Locality. Taxonmaster is the master table with fields such as, Scientific_name, Location, Altitude, Landform, Geology, Soil, Longitude and Latitude associated with the species in the region as well as Accession_ID, Species_code, Family_code, Location_code, and Bioclimate_code. The Species table contains Species_code, Family_code, Scientific_name, Synonyms, English_name, Local_name, Status, Habitat, Economic_ importance, Remarks, Photograph, and Sound. The fields used in the Family table are Family_code, Species_kingdom, Species_division, Species_class, Species_order, Family, and Genus. The Locality table contains Location_code, Ecosystem, Forest_circle, Forest_division, Forest_range, River_basin, District, Taluk, Block, Panchayat, Location, Longitude, and Latitude. The fields in the Climate table are Bioclimate_code, Vegetation_type, Climate_type, Rainfall, Temperature, and Humidity. The required information about species such as environment, location, taxonomy, literature, importance, etc. is retrieved from the Oracle database.

The design of customized BGIS is based on rigourous requirements specifications. The structural decomposition is used to minimize the complexity of system design. Using structured approach, BGIS is partitioned into smaller and independent modules. Modules are organized in a top-down hierarchy that approximates the functional model of the system with each module having a single entry and single exit subroutine. The main modules used here are Customization Module, Layer Automation Module, BGIS Search Module, and Multimedia Features Module. *Fig.1* depicts a simplified data flow diagram of the customized BGIS.

3. System Implementation

Implementation of the main modules and sub-modules of the system is described below. The program coding has been done in MapBasic. MapBasic IDE (MapInfo Corporation, MapBasic 5.5 Reference Guide, 1999) helps to edit and compile the source code. It also creates compiled program (*.MBX) as MapBasic application that runs in MapInfo environment. The MapInfo workspace comprising different map layers and attribute tables are automatically invoked wile running the application.

Customization Module

This module contains MapBasic codes for adding, deleting or modifying the menus in the MapInfo software for customizing BGIS. Menu items that are not directly related to the application are removed from the MapInfo menu bar. The standard menus are then recreated so that the menu bar contains only relevant menu items. The MapBasic program invokes ‘Create Menu’ and ‘Remove Menu’ commands for implementing this feature. Other additional features are added as menu items and submenu items in such a way that naive users will find them easy to use. In order to edit or delete a particular menu item from the menu, the whole menu and menu items have to be re-created. *Fig. 2* shows the customized screen of BGIS with digital map layers and bio-resources data in tabular form. The map layers in the figure correspond to frame, place names, administrative boundaries, forest boundaries, river basin boundaries, land forms, etc., while ‘*’ indicates the location of species.

Layer Automation Module

Displaying all the map layers, one overlaying the other, in GIS environment alone cannot yield proper information related to various maps. Provision to display map layers one after another, keeping a few selected layers fixed, is

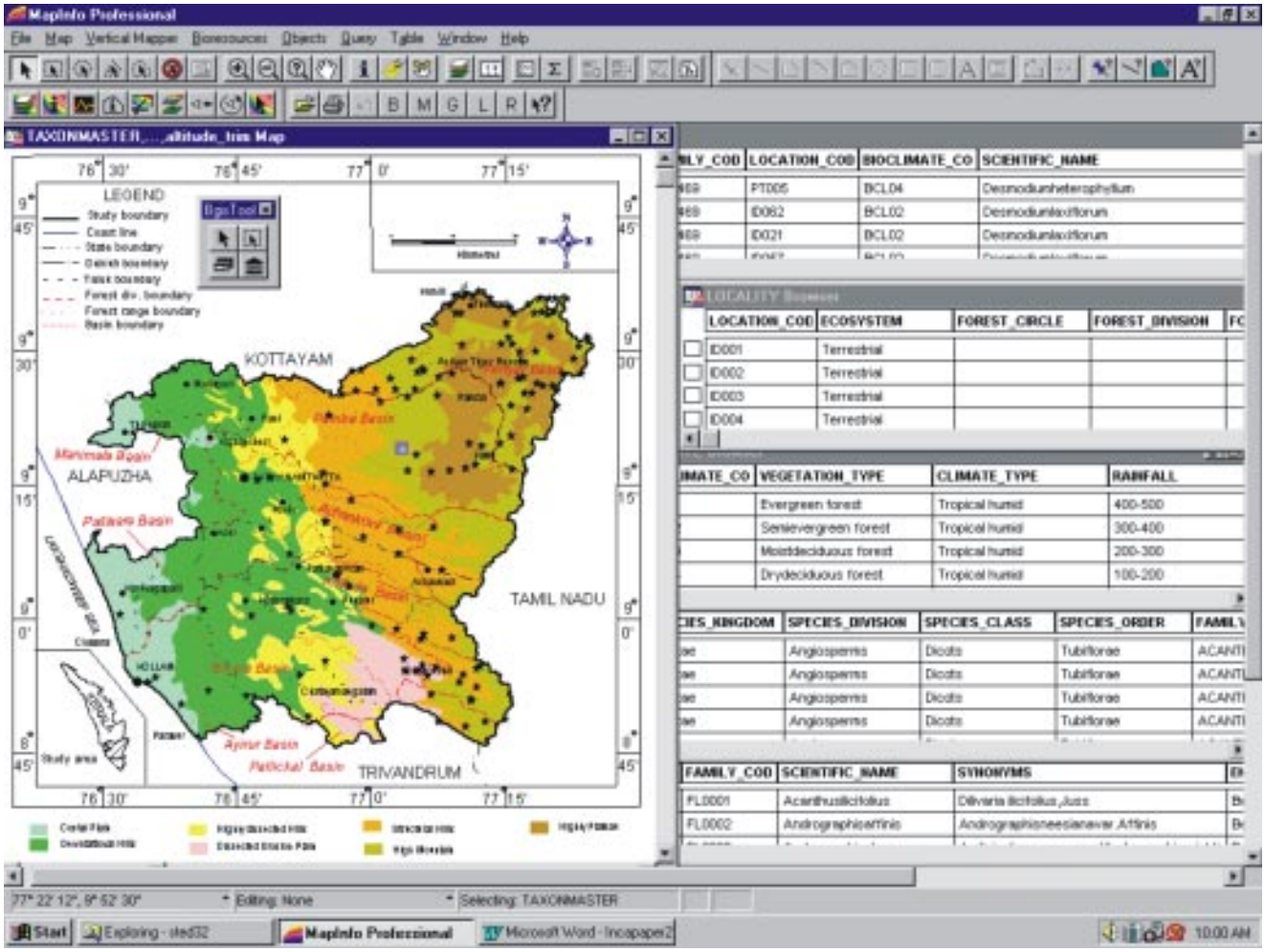

Fig.2. Customized BGIS screen with data bio-resources data and relevant maps

necessary for users to get information about the species and the corresponding geo-environmental factors. The Layer Automation Module contains codes to create a menu 'Display Layers' as well as menu item 'Next Layer'. User will be able to browse through the map layers by clicking on the menu item 'Next Layer'. Using MapBasic, custom tools are also created for viewing map layers easily with the click of mouse-button. The user can then click on the 'BGIS Tool' to add additional layers on to this window and browse through the entire layers one after another. This helps user to view both the windows and compare them layer-by-layer. The module is implemented in such a way that it will create new map window adjacent to the existing one with all map layers. *Fig. 3* shows a screen shot of digital thematic maps integrated in GIS core along with map layers on rainfall, administrative boundaries, place names, and species distribution. Other map layers such as temperature, land use, water bodies, drainage, relief, communication networks, geology, soil, etc. can be displayed one by one by clicking on 'Next Layer' menu item or using the 'BGIS Tool'.

BGIS Search Module

BGIS Search module is one of the important modules implemented in the system. It has three sub modules, viz. spatial search, aspatial search, and query-based search. The spatial search contains two types of search tools, viz, point search and rectangle search. User can select the point search tool from the custom tools created in MapInfo and click on any arbitrary point in the map to get the bio-resource's information at that particular point. The rectangle search tool from the custom tools is used to click and drag a rectangle in the map to get information on the bio-resources available inside that area. In both cases a pop-up a menu will be displayed with the species present at that particular point or region. The user can then select species from the list and retrieve detailed information about them.

Aspatial search contains four functions viz. display species, display plants, display animals, display microbes. Display species menu is used for displaying list of all the species including animals, plants, and microbes in the region. These will be displayed in a combo box.

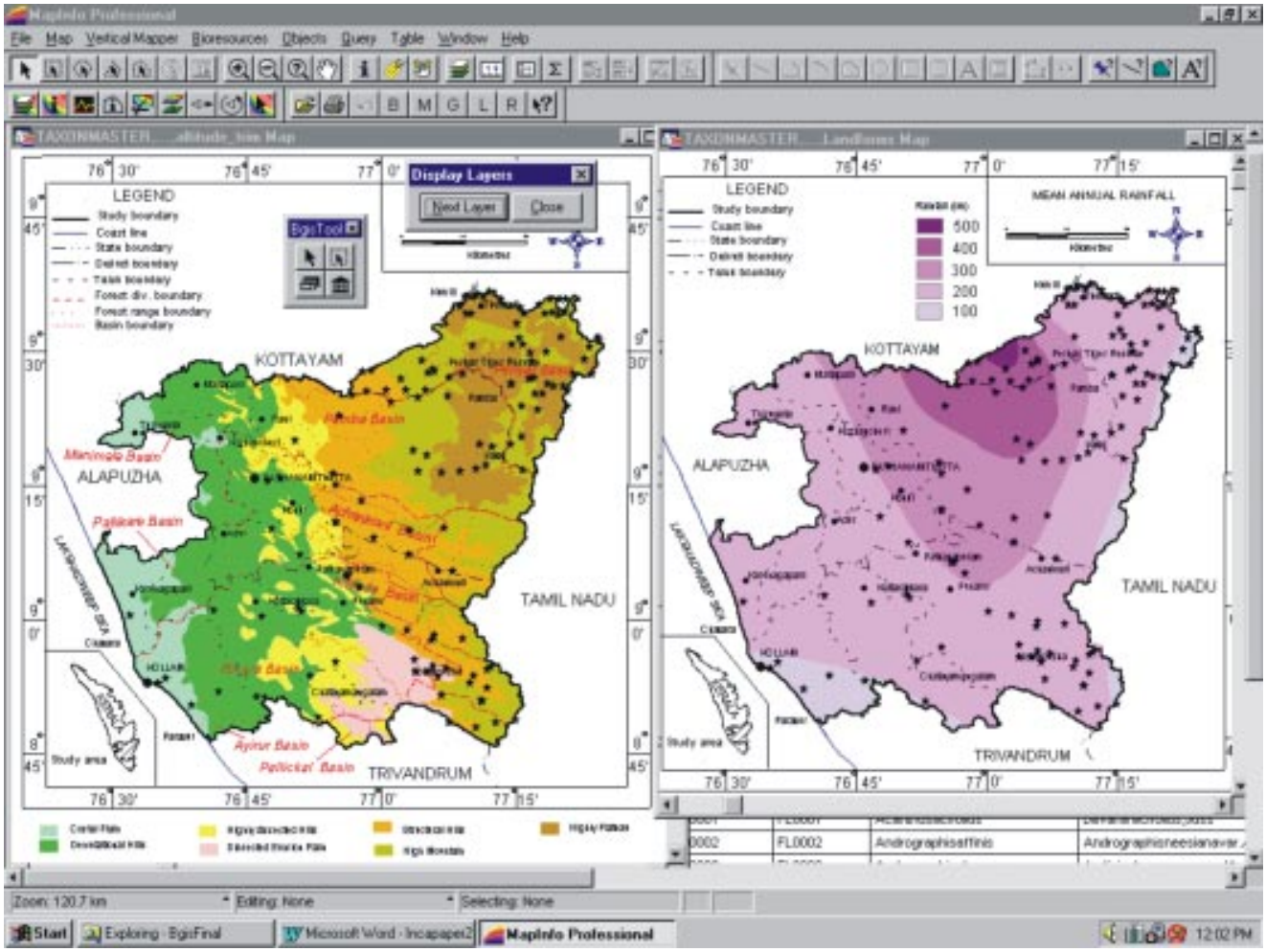

Fig. 3 Maps integrated in GIS core along with individual map layers.

Fig. 4(a)

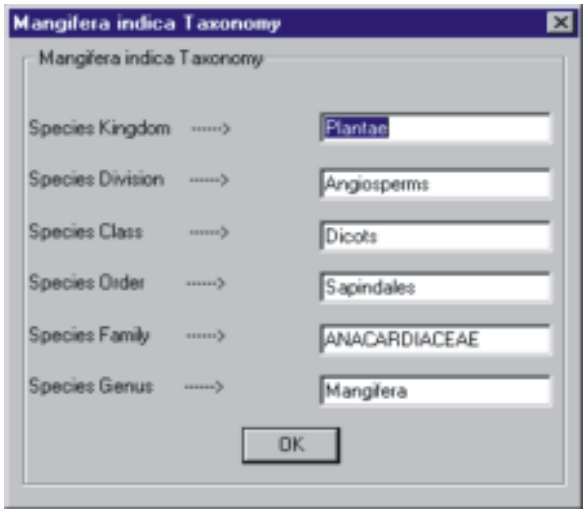

Fig. 4(b)

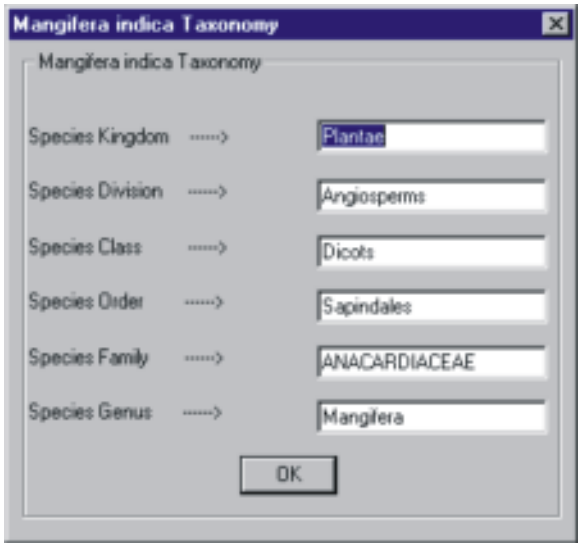

Fig. 4(c)

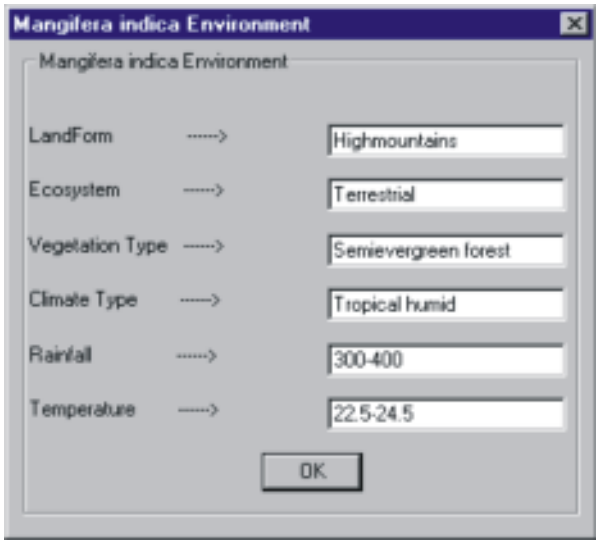

Fig. 4(d)

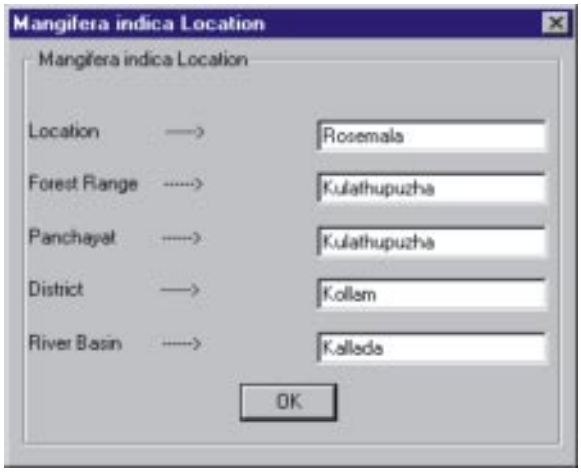

Fig. 4(e)

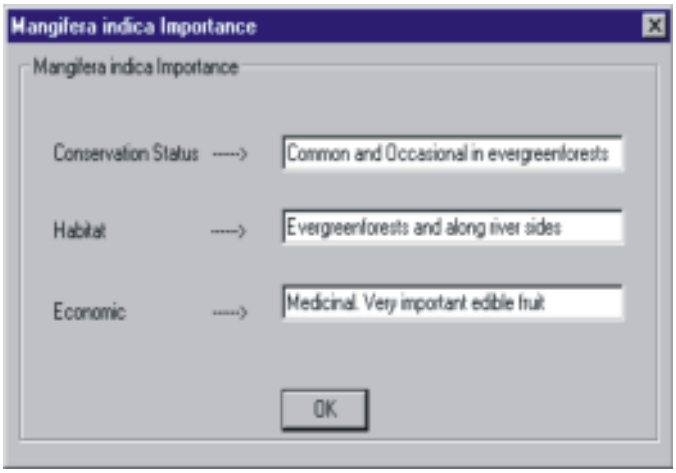

Fig. 4(f)

Fig. 4(g)

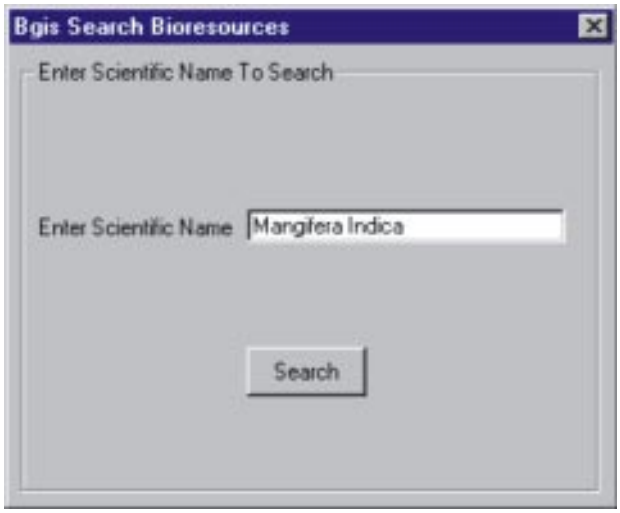

Fig. 4(h)

The user has to select one species from the list and click on any of the command buttons viz, Taxonomy, Literature, Importance, Environment, Picture and Location to get appropriate information. Except for displaying literature and picture

MapBasic codes are epmloyed. In the case of literature, text data can be larger than a page-size. Since MapBasic has limitations in supporting larger fields, Visual Basic application is invoked to access the Oracle table and retrieve the contents of literature field. In the case of display plants, all the plants in the region are listed out in the combo box. Both local name and scientific name of the species are listed in the combo box. A user can also type the first letter of the species name in the combo box itself to make species selection easier. Similarly display animals and display microbes respectively show list of animals and microbes in the region in the combo box.

Query-based search is provided for user to search species database for any species in the region by entering its name in the appropriate box. If the species is present, the exact location of the species will be shown in the map by highlighting its position. Detailed information about it can be obtained by clicking appropriate command buttons. Different user interfaces used in search operation and the results are shown in *Fig. 4(a) to 4(h)*

Multimedia Features Module

This module is for displaying species picture and sound according to users request while clicking the Picture command button. The Picture command can show picture, play sound and display any movie for the current species selected by the user (if any). MapInfo supports picture display as map; but it does not support playing sound and video files directly. Hence another program code in Visual Basic is used to invoke the same as the user clicks on the 'Play video/sound' button. The program can be invoked in MapInfo by using MapBasic.

4. Conclusion

A Customized BGIS has been developed and successfully implemented on Windows NT 4.0 workstation. The main advantage of this system is that it is very simple and user-friendly so that layman can use the system with limited training. It supports multimedia features and customized query processing facilities for retrieving the required information with ease. The system has been tested using different types of queries for retrieval of information pertaining to various layers of maps and found to be working satisfactorily. The layer automation facility is a boon to naïve users. Users, in general, will find this system very useful for retrieving spatially referenced bio-resources information. The Customized BGIS is found to be useful for bio-diversity related studies as well as for implementing national biodiversity action plans.

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