INCREDIBLE INDIA – GIS BASED APPLICATION TOOL

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DEDICATION

I would like to dedicate this thesis to my mother, father, sister and brother-in-law and friends who always supported, encouraged and stood by me for accomplishing my work. I also want to dedicate this thesis to my Professor Dr. Carl Eckberg.
ABSTRACT OF THE THESIS

Incredible India – GIS Based Application Tool
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The emphasis of the thesis is to build an intuitive and robust GIS (Geographic Information systems) Tool which gives an outlook into Indian culture and heritage. The GIS tool also incorporates the latest Census Data of 2011 to help the user understand the diversity of India and its people. The census data includes some of the key statistics like literacy rate, sex ratio, population and religion. The user has the option to select these key statistics by clicking on any of the states on the Indian map.

The Indian Map also incorporates key physical features of India like the vast mountain ranges, deserts and rivers. The user can know more about these features simply by clicking on each of them. The primary focus of the tool is to give the user a unique insight into India; for this the tool has several HTML (hypertext markup language) pages which the user can select. These HTML pages give information on various topics like the Indian government, Indian armed forces and judicial system.

The tool has been developed in JAVA. For the Indian map MOJO (Map Objects Java Objects) is used. MOJO is developed by ESRI (Environmental Science Research Institute). The major features shown on the Indian map was designed using MOJO. MOJO made it easy to incorporate the statistical data with these features.

The user interface was intentionally kept simple and easy to use. To keep the user engaged, key aspects are explained using videos and HTML pages. The idea is that pictures and videos will help the user garner interest in the rich heritage and diverse culture India has to offer.

Being from this culture rich nation I hope this tool does justice in giving people an insight into India and its people.
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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

India is a vast country with diverse culture and tradition. The Republic of India shares its boundaries with China, Pakistan, Burma, and Bangladesh. The intention behind developing this tool is to encourage people to know more about a different culture. Being an Indian I chose to learn more about India culture and wish to share the same knowledge with students. This tool holds information of Indian Census data which will give us clear statistics about the population, population density, sex ratio, literacy rate, and decadal growth from 2001. The census in India is carried out every 10 years in the entire country giving comprehensive statistics about the above-mentioned aspects. The tool displays a table with the accurate statistics about the earlier mentioned fields. These statistics are incorporated in the map as well. The tool displays different color shades depending on the field’s value.

Research was done on the census data of India for years 2001 and 2011 to analyze the difference in numbers and the decadal growth of the country. The application tool has features to provide extensive knowledge of the culture which includes dance forms, festivals, holidays, army, judicial system, important faces, and facts of India.

The GIS (Geographic Information Systems) tool is developed using JAVA and MOJO (Map Objects and Java Objects) which is a product of ESRI (Environmental Science Research Institute). This provides flexibility to display different layers in the map. This tool shows the physiography of India which includes the layers like States, Capitals, Rivers, Deserts, Vast mountain Ranges of the Country. The important aspect of using GIS tool is to analyze the data pattern in a more effective way through mapped data. This allows the user to view and understand the data and patterns through maps, charts, statistical tables [1]. People map quantities, like where the minimum and maximum of the quantities explained above, to find places that meet their criteria and take action to see the concentrations by mapping the features [1].
Chapter 2 tells about the requirements the tool should meet and is explained in detail. Chapter 3 discusses the technology used for developing this application. Java, MOJO, Html, DBF Explorer, CDBF-viewer editor are explained. Chapter 4 shows more about India. This explains the tools provided by the application to know about Indian culture, festivals, holidays, politics, armed forces, agriculture and industries. Chapter 5 discusses the software prototype which is a draft of the application. Chapter 6 shows the architecture of the application and the main components of this application development. Chapter 7 tells how to set the up the java environment by importing MOJO. Chapter 8 explains the toolbars available in this application and their significance. Chapter 9 tells about the important menus available like legend editor, how to do labeling using legend editor, how does hotlink tool works, etc.

1.2 ABOUT THE APPLICATION

This is a learning tool developed using the JAVA programming language in accordance with ESRI Map Objects Java Edition to develop the mapping application tools. The advantages of using MOJO software are, it allows users to display maps dynamically, it provides built in tools which can be customized to zoom into the map, query information of the map, etc. Map Objects provides the API which is used to draw various features on the map. The IDE used is Eclipse 3.6.1 which is a flexible Java developer’s environments to develop applications. It helps to develop customized tools to perform user defined functions. The HTML (hypertext markup language) pages are developed and linked to the respective map layers to provide more information about the layer. The image files used for this application are JPG, PNG and BMP since they are supported by MOJO. MOJO helps display shape files of the maps, create different layers and shape files.

The application displays the physiographic information of India with rivers, deserts, mountain ranges, and capitals and also gives the clear statistics of the census held in 2001 and 2011. The user will look at the description of the technologies, application and tools used and the working of the application in a detailed manner in the later chapters.
CHAPTER 2

SPECIFICATIONS

This thesis features an application tool which has an interactive interface with the user, to learn about Indian culture, tradition, Census data and physiography of India. This tool is developed for students in the guidance of Professor Dr. Carl Eckberg, San Diego State University. The main aim is to know more about different countries and their cultures. In this case it is about India. There are a set of requirements for this tool to be effective. Following is the list of specifications and requirements:

- The tool should cover most of the physiographic information about the country and the census data of the country.
- The physiographic information is represented in the form of geography of India which makes it easier to understand the geographic information.
- The census data of all the states of the country should be presented to the user for the modern era.
- The census data should be collected for the year 2001 and 2011 and decadal change in the data like population. Population density, literacy rate and HDI (Human Development Index) for each state are to be displayed.
- The hotlink tool should be provided in order to provide brief information of the layer clicked.
- The tool should be designed in such a way that it provides collective information with pictures about the culture of different regions of the country.
- The tool will show the important facts of India, and its national symbols.
- Printer tool, so that the user can print the information displayed.
- All necessary tools should be provided to the user to interact with the application and gain enough knowledge.
- Tool should be flexible enough to add any additional layers when required.
- The tool is to provide sufficient information about the Indian culture, dance forms, holidays, festivals, armed forces of India and Judiciary system, agriculture and industries.
- The tool should be flexible and simple enough for the users. It should provide enough knowledge about India to students.
• It was recommended to develop using JAVA with MOJO (Map Objects Java Objects) since JAVA is platform independent.

There have been four other master thesis about Indian history [2], Maurya dynasty [3], ancient Harappan civilization [4], Mughal empire which motivated to develop a tool to know more about India. This tool is not on history but on physiography and about the culture of modern India. The books motivated to know more about Indian culture are mentioned in references [5], [6].

The intended audience is young Americans, high school or college. India is a very large country in both area and population. It is democratic and technologically advanced. It is part of the BRIC mnemonic for emerging major economic powers: Brazil, Russia, India, China. As such it is important to have a pleasant but informative multimedia introduction to this extremely important country. Many India students are in United States for advanced degree programs and end up with US jobs is growing and as it does, Indian restaurants and temples and stores are rapidly in US culture.
CHAPTER 3

TECHNOLOGIES

This chapter introduces the technologies and platform used to develop the application tool. It describes why the respective technologies are used to develop this thesis project and their advantages. JAVA Swing is used to develop the GUI, it is a very powerful Java GUI package. Platform independence and easily deployment were the reason why JAVA was chosen for programming. The other technologies used are MOJO, HTML and these are explained in detail later.

3.1 JAVA

A platform is the hardware or software environment in which a program runs. The Java platform differs from most other platforms in that it’s a software-only platform that runs on top of other, hardware-based platforms. JAVA platform has two components:

- The Java Virtual Machine (Java VM)
- The Java Application Programming Interface (Java API)

As a platform-independent environment, Java can be a bit slower than native code. However, smart compilers, well-tuned interpreters, and just-in-time byte code compilers can bring Java’s performance close to that of native code without threatening portability. Java is a general-purpose, high-level programming language and a powerful software platform. Using the Java API, we can write many types of programs. SunMicroSystems releases licensed Java Edition platform for Linux, Macintosh OS and Windows [7]. The programs written in Java usually occupy more memory and are a bit slower.

Java Swing is used to develop the GUI of this Thesis Project. Swing was developed to provide a more sophisticated set of GUI components than the earlier Abstract Window Toolkit. Java is simple, object oriented, distributed, interpreted, robust, secure, portable and dynamic [8]. Java Swing possess the following traits: The advantages are referred from [8]:

- **Simple**: Java is easy to use compared to other programming languages like C++. Pointers are not used in JAVA. It has overcome the multiple inheritance complexity which is there in C++ and developed Interfaces in place of it.
• One of the important advantages in Java is the automatic memory allocation and garbage collection.
• Java code is easy to read.
• **Object Oriented**: Java has helped object oriented programming to enter the mainstream with its simplicity in structure and understanding.
• **Java is Distributed**: It is of greater use in distributed computing where different networks work together and integrate.
• **Platform Independent**: This is the most compelling feature for which programmers choose Java. It runs on major hardware and software platforms like Windows 95, Macintosh and UNIX. Although C and C++ also support these platforms, moving between OS requires recompilation, significant redesign [8].
• **Java is Interpreted**: An interpreter used to compile Java programs. Usually the java programs are converted to byte code and then are runnable on machines. Java code is compiled only once unlike C or C++, then the byte code is portable to run on different machines [8].
• **Security**: The interpreter and compiler are designed with security in mind. In contrast to C++; Java shows likely error sources at compile time by insisting checked exceptions b dealt with.
• Java Virtual machine plays an important role in security policy. JVM converts the program into byte code instead of assembly language where only a VM machine can interpret. The byte code can be converted to machine language using JIT (Just In Time Compiler).

Thus there are many advantages and reviews about Java the platform, and it makes sense to the developers to use Java platform for many projects.

### 3.2 MapObjects - Java Edition

Map Objects for Java Edition whose acronym is MOJO, is a product of ESRI. This product is for Java developers, which helps to build mapping applications and can be integrated with one another or with internet apps. There are two main components in Map Objects with Java Edition, client side and server side. Map Objects with Java, known here as MOJO, is a product of ESRI. Map Objects Java Edition is a collection of client and server side components provided by ESRI for creating GIS based Java applications. It has over more than 900 Java developer components that can be used to build custom applications that incorporate GIS and customized mapping capabilities. MOJO helps you build applications that perform geography-based display, query and data retrieval activities at the client and server side. The client side helps the developers to create the customized user interface as
required and server side is useful for integrating the GIS applications [9]. This software
provides a set of Java tools and APIs for developers to develop GIS applications where you
can display dynamic maps, query and get the results on maps. The book written by Professor
Dr. Carl Eckberg, San Diego State University is a great resource for developers for
developing GIS applications using MOJO. This book provides components usage details of
MOJO.

MOJO offers [10]:

- It helps to display GIS functionality through maps.
- It provides a set of built in tool bars, which are used are zooming, panning, selecting, etc.
- The applications written using MOJO can be deployed on to Web as well.
- The Swing used along with MOJO helps to develop applications faster.
- In different coordinate system the layer data can be projected and also data can be
displayed dynamically on the maps.
- There are tutorials and sample examples available to the developers.

Map Objects –Java Edition has an architectural view. See Figure 3.1 [10]. Thus,
MOJO provides a great source for developing GIS based mapping applications.

**Figure 3.1. Architecture of user interface. Source: Ron Li. GS 634 Digital Mapping Systems, 2011. [Link](http://shoreline.eng.ohiostate.edu/ron/teaching/634/Lecture4/Lecture4.pdf)*
3.3 Eclipse IDE

Eclipse is a Software Development Environment and a plug in for Java programs. Different languages use different IDE. This was initially developed by the source community for Java and Android and is one of the leading development environment [11]. Eclipse provides views, perspective and editors. There is a debug perspective which helps in debugging the code while giving break points. This Thesis project is developed using Eclipse IDE since Java is the programming language used. The ESRI MOJO jar files are imported easily to the project. Eclipse generates the code for the developer which saves significant time; it overrides the super class and also generates getters and setters. The JVM in Eclipse is faster. It provides the flexible developing environment for developers by suggesting auto suggestions and bug fixes. Therefore Eclipse is one of the best choices by the developers. Netbeans is a popular alternative.

3.4 HTML

HTML, Hypertext Markup Language is the basic foundation in developing web pages. The HTML provided tags are used by web browser to interpret the statements written inside HTML tags. This is a way of writing a structured document with heading, text style, paragraph, lists. HTML5 which is the latest release, allows including images and videos. These days the internet is evolving so rapidly that there is a lot of competition for creating interactive web pages. It helps to organize the web pages and its components.

There are HTML editors that will help to write HTML lines faster by providing all the tags available and suggesting while you are writing. CSS is a cascading style sheets which works together with HTML. It is used to work on the presentation of a page and apply styles to it. Initially all the styling tags were included with in HTML code, but CSS provides a separate styling file which helps for better readability and brevity.

3.5 DBF Explorer

DBF Explorer is an interesting software available for free for editing the dbf (database files) files. This software allows to open up a dbf file for any map layer and edit, add, delete the contents, columns and structure of it. One of the advantages is that, it does not
require any connection to the database [12]. Thus it is easy to add columns to the non-locational data associated with a shape file.

The shape files can be created using the CSV files, but the attributes for the respective shape files can be created using this explorer. We can add any number of columns and by specifying the data type of each using DBF Explorer.

3.6 CDBF-DBF Viewer and Editor

This is powerful software for editing the dbf files. This file contains data in the form of tables and hence you can add, delete each table entry. This tool gives the full control over the dbf file which allows correcting the file using hexadecimal editor. This also helps to port the dbf files to different scripts [13]. This is not open source.
CHAPTER 4

KNOW MORE ABOUT INDIA

4.1 OVERVIEW

Republic of India is a country with vast cultural diversity. There is a need to know about this versatile culture and the traditions followed by the country. The application gives details of languages spoken in different parts of India. The application also gives statistical numbers for Census data. According to census 2011, the total Indian population is 1.21 billions, the number of males is 62.37 crores (a crore means 10 million), number of females is 58.65 crores [14]. India’s population growth in 2011 since 2001 is 17.64 percent in comparison to 21.15 percent in 2001 and India’s population is increased by 181 million [14]. The detailed figures of population, literacy rate, sex ratio are shown in the application. One of the important statistical data showed is the HDI of each state in India. This index shows whether the state is under developed or highly developed or moderately developed.

4.2 INDIA FACTS

India facts are among the important information provided by the tool. It educates the user about famous faces and facts of India like President of India, Indian Emblem, etc. This will give the user the important personalities and symbols of the country.

4.3 CULTURE

The land of India is multicultural and multilingual. This section provides vast information about the cultural divisions based on the different regions of the country. The country is divided into Northern, Western, and Eastern and Hindi belt regions. It shows how each region’s culture is unique and why they are significant. It is hence required to spread cultural knowledge among people from different countries. Cultural institutions are set for cultural exchange programs.
Culture can be represented through costumes, traditions followed, art, literature followed by a community [15]. The lifestyle of people will be affected by the natural environment and thus shaping the culture [15].

4.4 DANCE FORMS

Dance is a joyful art form which is acknowledged by everyone. It is a way to express freedom and joy. There are different dance forms followed all over the country. Knowing different forms helps to synthesize the knowledge about it and to spread the cultural values.

Different parts of India have different dance forms followed as their classical dance. This gives a brief description about classical dance forms of India like Bharatnatyam, Kathak, Odissi, Kathakalli, Bihu, etc. Wikipedia links are provided to read in detail about other dance forms of India. The YouTube video links are provided to visualize how each dance form differs from each other in their gestures and costumes. The folk dances are culturally important, and widely practiced. The Gujarati annul folk dance festival at San Diego convention center is attended by thousands of people.

4.5 FESTIVALS AND HOLIDAYS

Festivals are celebrated as a remembrance of past religious events. In India festivals are celebrated with great joy and hope because, it is the only time where a community that follows the same culture get together, and it is a strong way to unite family and friends together irrespective of caste, sex, religion. This application lists, out the major festivals celebrated in India and the National holidays when National festivals are celebrated. Wikipedia links are provided to read in detail about other festivals of India.

India is the only country with so many festivals being celebrated every year and in every part of the country which is praiseworthy. Some festivals involve worshiping God’s Idols with enormous respect and beliefs and some are celebrate for fun and to unite people together. Different festivals are originated because of different cultural and religious variations. The National holidays are mentioned which are celebrated with elation all over India.
4.6 Politics

India is a sovereign and a secular state with a democratic republic backbone with President being head of the union and the Prime minister being the head of the government. The President is elected, from a group of nominees, by the elected members of the Parliament of India. The Prime minister is head of the ruling party. The state government is ruled by a chief minister, who is the head of the ruling party in that state. Since the dawn of independence two major parties have played an Important role in building the constitution of India, The Indian National Congress and the Barhithya Janata Party. Although India is one of the foremost pioneers in democracy, it also the most chaotic government in the world with the democracy suspended once [16].

4.7 Armed Forces

The Indian Armed forces mainly consist of Army, Navy and Air Force. The Armed forces is led by the Ministry of Defense, while the President is the Supreme Commander. Indian Armed forces is one of the largest in the world, with the Indian Air Force having a major share in active standing and reserve army. The budget of the Indian Armed Forces is roughly around $36.03 billion. India is a major importer of arms having a huge arsenal of missiles and nuclear weapons [17]. India honors its Armed forces on 7th December which is celebrated as Armed Forces Flag Day [17].
CHAPTER 5

SOFTWARE PROTOTYPE

Software prototype is a necessary component in a software development process. It is basically a sequence of draft versions of the final outcome of the application. A prototype in the development process serves multiple purposes. It drives the development process in a direction and gives a perspective into the challenges ahead. It invites feedbacks from both supervisors and customers.

Software prototype serves as an initial model which is refined along the development process to meet the requirements. The precursor to the development of software prototype is to gather requirements and specifications. Prototyping is part and parcel of agile software development.

The initial prototype for this application was developed as shown in Figures 5.1, 5.2, and 5.3. The application will have a login page for the user to enter the application. The initial application launch had the user interface as shown in Figure 5.3. The India states and capitals were displayed and the custom tool bar and menu were added. The application had the following features:

- The application displays states and capitals of India.
- The states include the census data of 2011.
- The custom tool bar and menu to add, delete and to label the map layers.

At every stage in the development process there was a scope for improvement to include more information and to provide better knowledge to the user. Hence the application is refined to develop a final effective tool which includes all the information for a complete understanding about the country. The final application is shown in the later chapters.
Figure 5.1. Login screen.

Figure 5.2. Incorrect username and password.
Figure 5.3. Prototype of the application.
CHAPTER 6
ARCHITECTURAL DESIGN

This chapter will give us the architecture details of this application to know about India. The architecture will show the software components involved in this application, and the interaction between the components.

Architecture is the fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution [18]. It serves as a blue print indicating what tasks and development have to done. In other words it is an early analysis of the end product and designing structural models to it. Figure 6.1 shows the architecture diagram for the GIS based tool implemented as part of this thesis project.

Figure 6.1. Software architecture diagram.
The following explains the architecture of the application:

- The Login page, upon submitting the correct user name and password launch the application. The application is integrated with MapObjects which provides built-in tool bars and built-in functionalities for which Java methods have already been implemented.

- The UI has four parts, the left panel is the ‘Legend’ where the layers added are listed. North panel has Zoom pan toolbars, selection tool bars and custom tool bars. The Right panel consists of buttons to learn about India. The bottom panel displays the coordinates of the mouse cursor.

- The user interface in this application is developed using Java Swings. Hence menu items, tools were easily added.

- Each layer in the table of contents is a shape file which is projected on to the map using MOJO methods. Other required files are dbf files and shx files. The dbf files are displayed using the menu provided. An shx file is an index into the shape file geometries.

- All the required files like image files shape files, dbf files, HTML files are stored in a separate folder and accessed whenever necessary.

- Some shape files were created using ArcView.
CHAPTER 7

SETUP DEVELOPER’S ENVIRONMENT

As we discussed earlier the Eclipse IDE is a friendly development environment. We will see how to set up ECLIPSE and integrate MOJO to it. Install Eclipse IDE from the Eclipse website [10]. Install the MapObjects Java Edition. Then we integrate the MOJO to Java by importing the ESRI MapObjects Libraries. We need to import only two libraries which are sufficient enough for the development of this application. The jar files required are shown in Figures 7.1 and 7.2. Now we are ready to develop the tool.

Figure 7.1. Adding ESRI library.
Figure 7.2: Importing MOJO jar files to Eclipse.
CHAPTER 8

LAYERS AND SHAPEFILES

8.1 PROJECTING LAYERS

MOJO, MapObjects provides a predefined set of methods to play with the map layers. Once there is an existing shape file for a layer, then we can include it in the TOC using the predefined method addShapeFileToMap().

We can create new layers (shape files) from existing map layers using the tools ‘select feature layer’ and ‘create Layer from selection’. The base map for India was created this way. One of the most challenging tasks was to create shape files using Arc View software for generating shape files for rivers, mountains.

ArcView is GIS software developed by ESRI. This tool was used to create new polygonal shape files and projected on to the map. The tool ‘add Layer’ is used to project the generated .shp file on to the existing map. In this application we are concentrating mainly on the physiographic layers and hence added physiographic information on layers.

8.2 HOW TO CREATE SHAPEFILES

The tools are implemented in the application to create new shape files when required. ‘Create Layers from Selection’ is used to create a shape file. By using a select feature tool, we select some features from the existing map and use theme->create layer from selection and mention the name you want to give to the shape file, and the location to store it. The steps followed to create a shape file are explained in Figure 8.1.

In Figure 8.1, we select the select feature tool and chose the features we want to convert to a new shape file. The yellow part is the selected features. Then go to menu theme->create layer from selection, which will open up a dialog as shown in Figure 8.1 to enter a name and the location for a newly created shape file.
8.3 EDITING RECORDS OF SHAPEFILES

A trial version of CDBF Viewer and Editor was used to edit attribute data for a shape file. The data for a shape file will be created in a dbase file which has the .dbf file extension. Figure 8.2 shows the CDBF environment to edit a dbf file. DBFExplorer is one of the other editors that can also be used to edit dbase files. The attributes can be added, deleted or modified depending on the requirements.

The ESRI software called ARC View is another effective tool that can also be used to add records and fields to the dbase file.

Figure 8.2 shows how the CDBF editor looks, when you open up a .dbf file for editing. This editor is user friendly which lets the user add additional records and fields.
Figure 8.2. CDBF viewer.

Figure 8.3 shows how to add an additional column to an existing dbase file. Click on the file, then modify structure which gives us a dialog window as shown to add additional column fields.

8.4 TABLE RECORDS AND FIELDS

This section describes the table content for the important layers in the application. The Census data is displayed using tables. Clicking on the ‘open attribute table’ display the table for the respective layer. The table record for state layer displaying Census data is shown in the Table 8.1.
Figure 8.3. Add additional field to the existing attribute table.

Table 8.1. Column Fields of States Attribute Table

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HDI</td>
<td>Year of establishment</td>
<td>Area</td>
<td>Density 2001</td>
<td>Density 2011</td>
<td>Region</td>
<td>Language</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER 9

TOOLBAR AND ITS SIGNIFICANCE

Toolbars are implemented for users to have a greater interaction with the application so that they can have a lot of things to do, to learn more from this application. MOJO provides toolbars and the ones which are used in this application are ‘ZoomPantoolbar’ and ‘Selection toolbar’. We will have a detailed description about these tools and their significance in this application. The toolbars are described as follows [19].

9.1 ZOOMPANTOOLBAR

ZoomPanToolBar provides basic functionality required in this application. The important tools here are Zoom in, Zoom out and identify. See Figure 9.1 for details of the each tool in ZoomPanToolBar.

![Zoom Pan Toolbar Image](image)

Figure 9.1. Zoom pan toolbar.

The list goes as follows:

- **Previous Extent**: This is used to zoom in the map to the previous extent stored.
- **Next Extent**: This is used to zoom in the map to the next extent available.
- **ZoomToActiveLayer**: This tool is used to zoom in to the features selected on the map which is active at that moment.
- **ZoomToFullExtent**: This tool is used to zoom the map to an extent which covers all the layers on the map within its extent.
- **Zoom In**: This tool is used to zoom into a particular portion of the map.
- **Zoom Out**: This is used to zoom out of a particular portion on the map.
- **Pan**: This tool is used to pan the map depending on the mouse movement by the user.
- **Pan One Direction**: This tool is used to pan map only in one direction.
- **Identify**: This tool is used to identify the selected feature on the map.
9.2 SELECTION TOOLBAR

Selection Toolbar is another tool bar which is enabled only when a layer is selected or active. This tool bar mainly used for selecting required features from the map. We will look at the details of tools in the selection toolbar. The tool is as shown in Figure 9.2.

![Selection toolbar](image)

**Figure 9.2. Selection toolbar.**

This tool bar is used when we want to create a new shape file, query the attributes and to view the attributes table for a map layer [7].

The list of tools in selection toolbar as per Figure 9.2 is as follows [7]:

- **Find tool**: This tool is to find the feature mentioned in the find dialog.
- **Search tool**: This tool is used to find the features on the map from a stored query results.
- **Query Builder tool**: This tools gives user the option of writing a query and selecting the features on the map as a result of the query.
- **Select Feature tool**: This tool is used to select feature by using any of the polygons available to select. Make a layer active and drag the mouse to select the portion of map.
- **Clear Selection tool**: This tool is to deselect all the features that are selected using select Feature tool.
- **Buffer**: This tool is to develop a buffer polygon for selection features.
- **Attribute Table**: This tool is used to display attribute table for the layer selected. This table consists of fields and records of dbase file.

9.3 CUSTOM TOOLBAR

This tool bar is created to add additional functionalities for an user make a more powerful application tool. This toolbar has options for adding new layers, drawing points on a map, projecting CSV (Comma separated values) files on to the map, etc. Figure 9.3 shows the custom tools available.

![Custom toolbar](image)

**Figure 9.3. Custom toolbar.**
The following are the functions of Custom Toolbar:

- **Point tool**: This tool lets the user place a point on the map.
- **XY tool**: This tool is used to add a layer from a CSV file.
  
  This tool works as follows:
  
  Step 1: clicking on this tool opens a dialog to a file browser.
  
  Step 2: browse to a CSV file containing latitude, longitude and any other fields the user wants to add in the records.
  
  Step 3: Then click ‘ok’ to get points on the map at the specified coordinates.
  
  In this application, adding a CSV file for the 5 highest mountain peaks is shown in Figures 9.4 and 9.5. The code snippet in Figure 9.6 shows how to add features from a CSV file.

![Figure 9.4. Clicking on XY tool to browse to a CSV file.](image)

- **Symbol tool**: This tool is specifically designed to know about the Indian National Symbols. It lists out the national symbols and their images to educate the user regarding them. See Figure 9.7.
Figure 9.6. The points are added on to the map by reading longitude and latitude from a CSV file.

```java
public class XYfeatureLayer extends BaseFeatureLayer{
    BaseFields fields;
    private java.util.Vector featureVector;
    public XYfeatureLayer(BasePointsArray bpa, Map map, Vector s2){
        createFeaturesAndFields(bpa, map, s2);
        BaseFeatureClass bfc = getFeatureClass("Peaks", bpa);
        setFeatureClass(bfc);
        BaseSimpleRenderer srd = new BaseSimpleRenderer();
        SimpleMarkerSymbol sms = new SimpleMarkerSymbol();
        sms.setType(SimpleMarkerSymbol.TRIANGLE_MARKER);
        sms.setSymbolColor(new Color(0, 255, 0));
        sms.setWidth(12);
        srd.setSymbol(sms);
        setRenderer(srd);
        XYLayerCapabilites lc = new XYLayerCapabilites();
        setCapabilities(lc);
    }
}
```

Figure 9.6. Snippet feature layer to display triangle marker on the map.
Add layer tool: This tool lets the user add a shape file layer to the map. This can only be used to add .shp extension files.

Arrow tool: This tool is used to get back the cursor to the normal functioning, after using other tools from the tool bars. Once the user finish using a particular tool, clicking on this arrow tool returns the cursor to the default cursor.

9.4 HOTLINK

This is an important tool. This tool is used in many GIS projects. The lightning bolt icon is used for both the tool and the cursor icon. This tool is basically used to check with a user chosen active layer. In this application, the hotlink tool has been implemented for the desert layer and the highest mountain peaks layer. The implementation code snippet for Hotlink tool is given in Figure 9.8. The identify tool allows the user to view .dbf file information, and the hotlink tool makes available additional information.

Click on the hotlink icon, and then click on any desert or any peak to get a pop up dialog which gives a brief description, and an image for the layer you have clicked on. Figure 9.8 shows the execution of Hotlink tool.
Figure 9.8. Hotlink tool displaying the brief description about the Indian desert clicked on the map.

Figure 9.9 we show some of the code needed to use the hotlink tool feature for polygons. The code to identify which polygon a user is clicking inside is very complex. Fortunately ESRI has solved this problem for us. They use an identify class and a PickListener for this purpose.
```java
class MyPickAdapter implements PickListener {
    //implements hotlink
    public void beginPick(PickEvent pe){}

    public void endPick(PickEvent pe){}

    public void foundData(PickEvent pe)
    {
        FeatureLayer flayer2=(FeatureLayer)pe.getLayer();
        Com.esri.mo2.data.feat.Cursor c=pe.getCursor();
        Fields f = (Feature)c.next();

        fields = f.getFields();

        String sname = fields.getField (1).getName();  //to get the
        name column of desert layer.
        String mydesert= (String)f.getValue(1);
        try{
            HotPick hotpick = new HotPick(flayer2);//opens dialog as displayed above
            hotpick.setVisible(true);
        }catch(Exception e){}
    }
}
```

**Figure 9.9. Snippet implementation of Hotlink tool.**
CHAPTER 10

CUSTOM MENUS AND THEIR FUNCTIONS

This chapter mainly concentrates on different menus available for the user and their functions in this application. This enhances the user knowledge about the Layers used and their properties. It is always common to have menus which do various things in the GIS user interface. Let us look at the important features available. See Figure 10.1.

Figure 10.1. Custom menus available.

10.1 LEGEND EDITOR

Legend Editor is under the file menu and permits the user to change the color of the map and read the different properties of layers through color variations on the map (see Figure 10.2). Layer properties and rendering are implemented and the Legend editor window has three tabs for symbols, labels, and general. The attributes of a layer can be analyzed visually by rendering the colors using graduated symbols. By selecting a graduated symbol, if we project the HDI field of states layer, the light colored states indicates poor HDI rate and the dark colored states indicates states with high HDI as shown in Figure 10.3. By portraying the attributes values on to map using the Legend Editor, we can clearly analyze the statistical data. The HDI color intervals are shown in Figure 10.3.

The Legend Editor is an important tool to analyze the data since we have statistical data of India Census 2001 and 2011. Figure 10.3 shows that the Kerala is the highly developed state according to the HDI values of 2011.

10.2 LABELING THE LAYERS

The legend Editor is used to label the layers on the map. Click on Legend Editor in the File menu and click labels tab. Choose the type of font for labeling and the column name to be used for labeling and click ok. The labels are displayed on the map as shown in
Figure 10.2. Symbols tab to select color rendering. File -> Legend Editor.

Figure 10.3. Displaying HDI intervals using graduated symbols in Legend Editor.
Figure 10.4. The Legend editor can also be used to change the name of a layer, or performs automatic labeling of the features in a layer as shown in Figure 10.4.

10.3 LAYER CONTROL

This menu has two functions, promote layer and demote layer. Promote layer is used to move a layer one level up in the legend hierarchy in the TOC. This is useful when one layer is hidden behind another visually.

Similarly demote layer tool is used to move the selected layer one level lower in the legend hierarchy.

10.4 GRAPHS

Figure 10.5 is an important menu which helps to see the graphical representation of statistical data of India Census results. The data is shown using the bar and pie graphs. Here we can get the clear understanding about the growth rate, percentage increase of literacy rate,
Figure 10.5. Displaying the sex ratio graph using ‘graph->sex ratio’ menu.

sex ratio, and population growth according to current census data of India. MOJO does not provide a very robust charting facility, so these graphs were not constructed using MOJO.

10.4 HELP

Figure 10.6 is the most important tool which guides user in using the tools available and the purpose of the tools. This serves as a brief guide to the user to walk through the application.
Figure 10.6. Help tool displaying the guide for using the tools available.
CHAPTER 11

CONCLUSION AND CHALLENGES

This thesis was presented as an intuitive GIS enabled application to share knowledge of the rich heritage and culture India possesses with the world over. The GIS application tries to broaden the user’s knowledge about India by sharing interesting facts such as dance forms, festivities, armed forces and politics. These features are coupled with the GIS map which inculcates major Indian features with the Census data of 2011 to give the user a general understanding of the diversity of India and its people. The GIS application makes use of pictures and videos to make the learning experience enjoyable and interesting at the same time. The GIS application offers a simple yet comprehensive insight into India and its people.

The challenges involved while application development was polygon drawing. As it was hard to find the shape files for each physiographic information, the polygons were drawn using Arcview software to make shape files of deserts, mountain ranges, rivers. This was challenging enough to create shape file for each one of the above mentioned layers. One of the major challenges was to make choices due to vast scope of the project. Making the choices well for the intended audience of people unfamiliar with India.
CHAPTER 12

FUTURE ENHANCEMENTS

While the GIS application tool developed to learn about India satisfies the basic requirements, there are many improvements that can further ameliorate the tool, by providing more knowledge about India. The further enhancements would be:

- More information can be included about India to make the tool more effective as part of the learning process.
- The application tool can be made bilingual or trilingual to increase the number of users who lack a good knowledge of English.
- This can be implemented as a web based application and also to mobile devices.
- Extra tools like a comments section or quiz can be implemented to increase understanding and to motivate users.
- This tool has layers concentrating on physiography, but can also be done for various other categories with different button for each category.
- Suggestions for future improvements would ideally be gathered from people testing out the software, then commenting on what they perceive as valuable changes or additions. So a ‘contact us’ under Help would be titled with suggested improvements.
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