Spatial Application of city using Oracle Spatial Database, MapViewer, and Map Builder

Dipti Sharma, Parteek Bhatia

Abstract— It was not possible in case of traditional database to store, analyze, visualize, and integrate spatial data in business and government applications. GIS systems store spatial and non-spatial data separately. This split data model has several drawbacks. Oracle spatial provides a completely open and standards-based architecture for the management of spatial data within a database management system. This research paper describes the process of developing a spatial application of Patiala city using Oracle spatial technologies. A simple graph is first created using the map of Patiala (obtained from Google Maps tool) and the coordinates of main locations of Patiala are figured out using this graph. A spatial database is then designed by using tables for colleges, roads, banks and Thapar University. MapViewer tool is used to integrate and visualize spatial data with maps. Oracle Map Builder tool is used to define the MapViewer mapping metadata that includes styles, themes and base maps. MapBuilder is used to define line styles for road map of Patiala city. Different color styles are used for representing colleges, roads, banks, Thapar University and main locations of Patiala. Themes are defined by combining different styles and it gives visual representation of data layer. Predefined themes are grouped together to form a base map. This provides a convenient way to include multiple themes in a map request. A base map is generated by putting one or more themes at one place. Data source and Tile layer has been created in MapViewer to connect with the database. The spatial application is developed in HTML and JavaScript code with the use of Map Viewer's JavaScript mapping library. This application shows the map of Patiala city and is featured with various map options like navigation panel and distance tools etc. Our developed system has the provision to view different locations depicted in the map. It has also a feature to find the distance between two locations in the map.

Index Terms— Oracle Spatial, MapViewer, MapBuilder, Spatial application.

I. INTRODUCTION

Location is an inherent part of business data. A picture is worth a thousand words. This is particularly true when trying to capture the complexity of interactions among people, resources, products and business processes distributed over geographic space. The organizations maintain customer address lists, own property, ship goods from and to warehouses, manage transport flows among their workforce, and perform many other activities. People have relied on maps to capture and simplify these complex relationships, turning them into readily consumable, powerful packages of

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unambiguous information for many centuries [8]. All of this location information is stored, analyzed and exchanged between multiple systems and is the basis for making the entire operation cheaper, faster and more reliable. Traditionally, data is managed in proprietary formatted files and displayed using special (Geographic Information System) GIS applications. In Spatial databases there is no need of GIS software. Oracle Database 10g/11g provides an open and standard-based geographic data management solution via either Oracle Spatial or Locator [1]. Oracle Spatial is part of the Enterprise Edition of Oracle Database 10g/11g [2]. It is a foundation for the deployment of enterprise-wide spatial information systems, and Web-based and wireless location-based applications requiring complex spatial data management. It provides a rich set of natively supported open standard data types and models, as well as a coherent and high performing SQL interface for accessing and managing such data [7].

II. ORACLE SPATIAL

Oracle Spatial is an integrated set of functions and procedures that enables spatial data to be stored, accessed, and analyzed quickly and efficiently in an Oracle database. Spatial data represents the essential location characteristics of real or conceptual objects as those objects relate to the real or conceptual space in which they exist. Oracle Software provides SDO_GEOMETRY object to store the spatial data in the database. SDO_GEOMETRY object, can be used to store various types of simple geometries and complex geometries in the database [3, 5].

III. YISUALIZATION OF ORACLE SPATIAL DATA

Another important aspect of Oracle Spatial is the visualization of spatial data using maps[4]. Oracle uses the map-based visualization of spatial data using Oracle MapViewer supported by Oracle MapBuilder tool. These tools provide a variety of features that make it possible the visualization and analysis of spatial data in various types of applications. MapViewer is a component of Oracle Fusion Middleware. It allows developers to incorporate maps and spatial analysis into business applications. MapViewer is a mid-tier toolkit that runs as a service inside an instance of Oracle Container for J2EE (OC4J) or other J2EE container. MapViewer version 11g is certified on Oracle WebLogic Server version 10 and higher.Oracle Map Builder is a standalone application that lets us create and manage the Oracle Application Server MapViewer mapping metadata (styles, themes, and base maps) in the database [6].

IV. DEVELOPING SPATIAL APPLICATION OF PATIALA

The case of 'Patiala' city with respect to Thapar University has been considered in order to develop an application, more specifically a spatial application, using spatial database in the background. Patiala district is one of the famous princely states of erstwhile Punjab. Forming the south-eastern part of the state, it lies between 29°49' and 30°47' north latitude, 75°58' and 76°54' east longitude. Geographically, Punjab is divided into four regions, Malwa, Majha, Doaba and Puadh. Patiala district falls in the Puadh region. Thapar University, formerly known as Thapar Institute of Engineering and Technology was founded in 1956 by Karam Chand Thapar. The university is situated in Patiala, Punjab. It lies in 30°21'16" North latitude and 76°21'58" east longitude. A simple graph, as shown in Figure 1, is created using the map of Patiala (obtained from Google Maps tool) and the coordinates of main locations of Patiala are figured out using this graph.
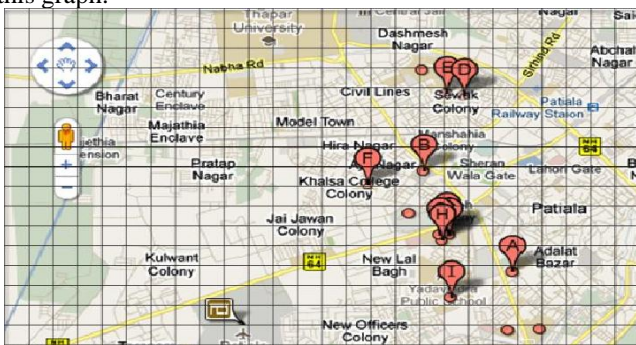
Figure 1: Road map of Patiala city

The following steps are involved in this process:
- Spatial Database Designing.
- Working with the SQL plus: Table Creation and Record Insertion.
- Working with the Oracle Map Builder Tool: Defining Mapping Metadata.
- Working with the Oracle MapViewer: Data Source and Tile Layer Creation.
- Designing, Developing, Deploying, and Running the Spatial Application.

A. Spatial Database Designing

A spatial database is designed by categorizing the identified locations of Patiala under the heads given below:
1. Colleges
2. Roads
3. Hospitals
4. Banks
5. Thapar1

The database contains the spatial tables for each of these categories. The schema of each table is given below:

Table 1: Schema of Table STBL_CLG

S.No.	Column Name	Datatype
1.	Clg_id	Number(Primary Key)
2.	Clg_name	Varchar2(40)
3.	Clg_shape	Sdo_Geometry

Table 2: Schema of Table CLG_ROAD

1.	Clg_Road_id	Number(Primary Key)
2.	Clg_name	Varchar2(40)
3.	Clg_shape	Sdo_Geometry

Table 3: Schema of Table STBL_HOS

1.	Hos_id	Number(Primary Key)
2.	Hos_name	Varchar2(40)
3.	Hos_shape	Sdo_Geometry

Table 4: Schema of Table STBL_BANK

1.	Id	Number(Primary Key)
2.	Name	Varchar2(40)
3.	Shape	Sdo_Geometry

Table 5: Schema of Table THAPAR1

1.	Id	Number(Primary Key)
2.	Name	Varchar2(40)
3.	Shape	Sdo_Geometry

B. Working with sql plus: Table Creation and Record Insertion

The tables conceived during database design phase are created and insertion operations are performed by storing the data compliant to the data type assigned to each column. Figure 2 and Figure 3 shows the creation and insertion operation for the table CLG_ROAD and STBL_CLG.

Figure 2: Create queries running in SQL plus for table CLG_ROAD

Figure 3: Insert queries running in SQL plus for table STBL_CLG

Similar to the STBL_CLG table, the insertion operations are performed for the tables STBL_HOS, STBL_BANK, CLG_ROAD, and THAPAR1. Also, the record insertions into USER_SDO_GEOM_METADATA view are made and indexes for the each table are created. USER_SDO_GEOM_META view is created automatically when a new user is created. In this view, a record regarding the geometry column of the table is inserted. Further, the work with the Map Builder tool is done for defining the mapping metadata.

C. Working with the Oracle Map Builder Tool: Defining Mapping Metadata

Using this tool, the styles, themes, and base map are defined for the application. Basically, this mapping metadata is used by the MapViewer to generate map at run time. Moreover, the preview of the map of any table, theme or base map can be seen in the Map Builder. The following steps are involved in this process:

- Connection with Database
- Style Creation
- Theme Creation
- Base Map Generation

Figure 4 shows the preview of the table STBL_CLG with User Defined styles, whereas Figure 5 shows the preview of the tables STBL_CLG and STBL_HOS.
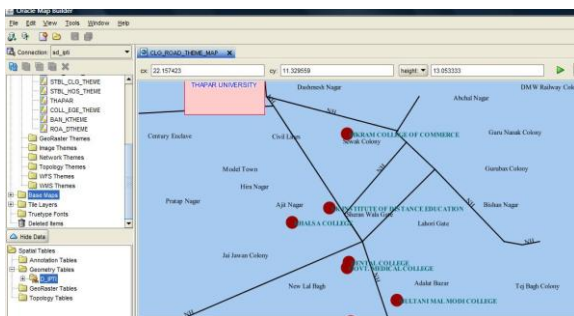

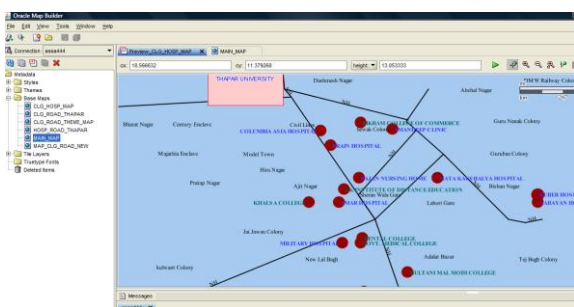**Figure 4: Preview of table STBL_CLG with user defined styles**

Figure 5: Preview of table STBL_CLG and STBL_HOS with user defined styles

D. Working with MapViewer: Data Source and Tile Layer Creation

Oracle MapViewer works as a map server. Whenever any application requires any activity related to map like map-generation, and map-processing *etc*., it is all done by the MapViewer. Figure 6 shows the map of Patiala city created in Mapviewer.
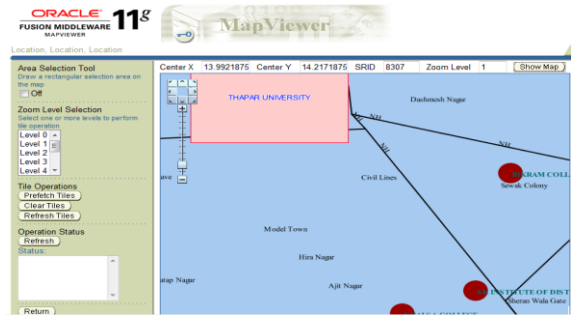

Figure 6: Patiala city map in MapViewer

E. Design and Development of Spatial Application

The application is developed in HTML and JavaScript code with the use of MapViewer's JavaScript mapping library. Our proposed application has the following provisions:

- To show the map with the use of legend items with different styles.
- To view any target area of Patiala city with zoom and distance measure tool options.
- To navigate the map with navigation panel and overview map options

Figure 7 shows the Patiala spatial application in running mode. Figure 8 shows the distance between ICICI bank and Bikram College of commerce.
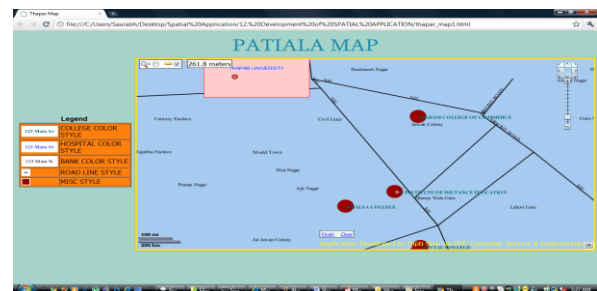

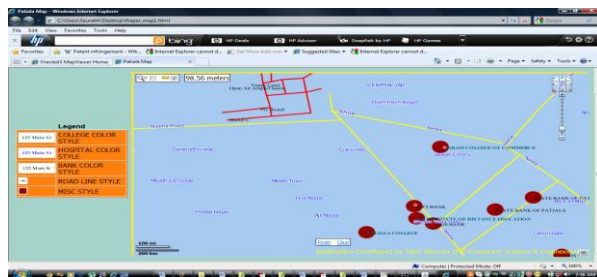**Figure 7: Spatial application of Patiala in running mode**

Figure 8: Spatial application showing distance between ICICI bank and Bikram College of commerce

V. RETRIEVAL OF DATA FROM SPATIAL APPLICATION

The SDO_NN (NEAREST NEIGHBOUR) operator returns the rows in order of proximity. Figure 9 shows nearest hospitals in order of proximity to Thapar University.

Figure 9: Query result returned by SDO_NN operator

VI. CONCLUSION

Oracle Spatial can be used to design very powerful and robust spatial applications. It was not possible in case of traditional database to store, analyze, visualize, and integrate spatial data in spatial applications. GIS systems store spatial and non-spatial data separately. This split data model has several drawbacks. Oracle spatial provides a completely open and standards-based architecture for the management of spatial data within a database management system. The condition of spatial application development is not much satisfactory in India. Most of the application development works are still approaching the traditional framework of application development and avoiding the powerful features of spatial technologies. In this research paper the overall process of making the Patiala city spatial application has been presented. In that process, the spatial database for the Patiala city has been created. This stored spatial data is used by Map Builder and MapViewer in various steps of application development. At last, the spatial application generates the map of Patiala showing the nearby hospital, colleges and banks to Thapar University. Spatial application for Patiala possesses features like navigation panel, distance tool, marquee-zoom tool *etc.* which make the application more interactive. The application is designed using 2-d geometries in the map but further 3-d geometries can be used to draw locations in the Patiala city map. This application can be featured with more tools in order to make it more versatile. The examples of other features include theme-based FOI layer, Event Listeners for a Theme Based FOI layer, Add/Remove and Show/Hide FOI, Red Lining, Map Event Listeners, Multiple Base Maps, Circle Tool and Rectangle Tool. Finally, it is concluded that Oracle Spatial is armed with very big concepts and suit of technologies that make it easier to draw our invisible thoughts in form of visible maps.

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