Geographic Information System for Railway Management

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Abstract
Safety and security considered a critical issue in railways. Applying geographic information system (GIS) and Global Positioning System (GPS) in the railway becomes very important. Web-based GIS makes it easy to exchange information and create better public communication through the Web site. It helps to plan for a trip by checking train times, stations and different lines between stations. This is done through the Web site of the railway organization, which contains maps and databases. Therefore, in this paper, the presented research work concentrates on using GIS to retrieve any data related to railway. This is done in real-time at anywhere. Furthermore, it is easy to access information and check its validity through the Internet. In addition to maintaining infrastructure network information, railway organizations are trying to use GIS for decision support operations. Because advanced technology provides interoperability support, it can be used to create a comprehensive railway information system that supports all critical business processes. Railway organizations make use of GIS and advanced technology to perfectly monitor safety and security. Because they are responsible for ensuring the safety and security of railway passengers, railway managers need for rapid response information systems to avoid incidents. The main objective of this research work is to create an efficient railway GIS that makes trains go automatic without human intervention to avoid human mistakes that may cause a lot of accidents.

Keywords— GIS, Railway Information System, Information Visualization, Disaster Management.

I. Introduction
Railway has long been considered as the safest transportation media. Recognizing the need to improve the efficiency of the transportation systems. The statistics show a huge number of accidents are due to human errors. Therefore, having a systematic way for railway operation management and reduction of human intervention or controlling activities and performances could play a significant role in reducing the number and impact of accidents.

Geographic information systems have emerged in the last decade as an essential tool for urban and resource planning and management. Their capacity to store, retrieve, analyze, model and map large areas with huge volumes of spatial data has led to an extraordinary proliferation of applications [1-25]. GIS allows the creation of maps through automated mapping, data capture and surveying analysis tool. It can be used to find out what's occurring within a set distance of a feature. Finally, creating maps include precise details about train crossing and train transfers After creating maps by GIS, then link these maps to railways Database.

GIS benefits organizations of all sizes and in almost every industry. There is a growing interest in and awareness of the economic and strategic value of GIS, in part because of more standards-based technology and greater awareness of the benefits demonstrated by GIS users. The number of GIS enterprise solutions and IT strategies that include GIS are growing rapidly. The benefits of GIS generally fall into five basic categories [11,31,36,37,38,40,41,42,43]:
1. Cost savings resulting from greater efficiency.
2. Better decision making.
3. Improved communication.
5. Managing geographically.

General purpose GIS performs seven tasks [1-25]:
1. Input of data
2. Map making
3. Manipulation of data
4. File management
5. Query and analysis
6. Visualization of results
These are the steps of GIS Project [59,79]:
1. Identification of Project Objectives
2. Creation of Project Database
3. Data Analysis
4. Presentation of the Results

II. Data Collection
In this Section, data collection is split into data capture (map scanning) and data store (input of attribute data).
This paper describes the data sources, techniques, and workflow involved in GIS data collection. Data collection is a time consuming. Data capture includes establishing user requirements, garnering resources. Preparation involves obtaining data, redrafting poor-quality map sources, editing scanned map images, removing noise. Documents are scanned to reduce wear and tear, improve access, provide integrated database storage, and to index them geographically.

Data capture:
The process by which data are received from the real-world (primary source), or from a secondary source such as a paper map, and fed to GIS software. Capturing data from primary source is usually done by using GPS or remote sensing. While performing this from secondary source is usually done by scanning and digitizing. The processes of data collection are also variously referred to as data capture, data automation, data conversion, data transfer, data translation, and digitizing [1-82].
In this research work, data are collected from paper map. We get this paper map from the base station located in Tanta, EGYPT. Paper map consists of stations and base lines between stations as shown in Fig. 1. There is also a book contains data for time table of trains, their types and lines between stations.

Data store
A geodatabase is a database designed to store, query, and manipulate geographic information and spatial data. It is a specialized type of spatial database. There are two types of data:

1. Spatial data
   - Scanning paper map to convert it to raster image.
   - Digitizing the map using Arc GIS.
Converting spatial feature on the map into a digital formats (points, lines)
We have two (layers) shape files as shown in Fig. 2.

   Stations: the shape file is represented in point feature type and show stations on the map.

   Base lines: The shape file is created in line feature type and shows railway lines between two stations are clarified in Fig. 3. Final digitized map is shown in Fig. 4.

2. Attribute data
Here, database is created by using Arc catalog. Database creation basically depends on the quality and quantity of data available from data capture step. Database tables are:
1. Base lines
2. Stations
3. Train_date
4. Trains
The relationship between database tables is described in Fig. 5. The base line table is shown in Fig. 6. The data view is listed in Fig. 7. The primary key of this table is "OBJECTID". The attribute "SHAPE" contains data captured from digitizing process (line feature). "SHAPE_Length" is the length of line. "ID" is the line ID. "Name" is the line name. The design view of trains table is shown in Fig. 8. The data view of trains table is listed in Fig. 9. The primary key is "Train_NO". This table contain train types that are stored in the database. It contains 684 records corresponding to the total number of trains. The design view of train_dates table is implemented in Fig. 10. Here, a composed primary key ("Train_No" and "Station_Name") is used. The data view of train dates tables is shown in Fig. 11. This table consists of four columns (train_No, Station_Name, Arrival/Going, Notes). It contains train dates with more than 6000 records that are stored in the database.

III. Analysis and Development
Here, AspMap for .net is used to show the designed map of the railway. AspMap is a set of server-side mapping controls and components that let maps be added to the Web applications. AspMap can be accessed directly by ASP.NET, VB.NET, C# and other .NET supported environments.

Advantages of AspMap:
AspMap allows to calculate point-to-point, multi-point routes and incorporate turn-by-turn driving directions to the Web applications. AspMap's routing features include [75,76]:
1. Generation of a route between two or more points based on their coordinates.
2. Determination of the shortest routes.
3. Evaluation of the quickest routes based on distance and speed.
4. The calculated route can be plotted on a map as a map layer.
5. Routes are calculated with the use of dynamic segmentation (the ability to construct a route from any selected point along a road segment).
6. Gives access to additional information about road segments and streets, such as the turn angle, distance, time, compass direction, street name, road attributes, start and end coordinates of road segments and streets.

AspMap includes the Road Network Builder utility so we can build road networks from vector format maps such as industry standard TAB files and Shape files. Road Network Builder allows to specify:
1. Road speed for different road classes or road segments.
2. One-way and closed roads.

AspMap tools have been used in this research work:

**Zoom in tool**
Control button allows users to zoom in by either clicking on a map or drawing a rectangle. Zoom in to a station is shown in Fig. 12. When we click at zoom in tool and then click in any point in the map, this point is zoomed in or we may also make rectangle on a range in the map this range will be zoomed as illustrated in Fig. 13. The result is shown in Fig. 14. Zoom in tool has the properties shown in Fig. 15.

**zoom out:**
Control button allows users to zoom out by clicking on the map. When we select this tool and then click at the map at any point, the map will be zoomed out to a reduced scale so the map will be smaller and smaller each time we click. The essential map is shown in Fig. 16. As shown the map in its general view, when we choose zoom out tool and click in the map, the map will be as shown in Fig. 17. The result of Info window tool applying to “Algmalya” station is illustrated in Fig. 18.

**Zoom to station tool**
To select station from drop down list, this is a query to retrieve all train dates of selected station. The code of zoom to a station tool is shown in appendix “A”. An example for choosing zoom to a station is shown in Fig. 19. The result is shown in Fig. 20.

**Hot spot tool**
So fast query tool that cache station names within the map. Map caching is an effective way to make mapping application run faster. When we create a cache, AspMap draws the entire map at different scales and stores copies of the map images as tiles on the server. An example for hot spot at a station is shown in Fig. 21.

### IV. Conclusion

A comprehensive geographic information system for railway has been presented. It has been proved that such system is successful in a number of issues like determination of the best path to get the accident location and perform emergency services.

This research work has achieved the following:
1. Capture data from its resources such as the paper map & catalogue data.
2. Storing attribute data in tables (scan the map and then digitized it ) and create databases.
3. Give the opportunity to recognize any stations in the country on the map.
4. Manage data to show all dates, notes (going/arrival) and types of trains.
5. Find the shortest way between any two new stations.
6. Avoid incidents between trains.
7. Management of disasters and crises.

### References


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Appendix “A”

The Code of Zoom to a Station

protected void statesList_SelectedIndexChanged(object sender, System.EventArgs e)
{
    AspMap.Recordset state;
    int selectedValue = Convert.ToInt32(stateList.SelectedValue);
    state = Map1["Stations"].SearchExpression("ID = " + selectedValue);
    if (!state.EOF)
    {
        Map1.Extent = state.RecordExtent;
        sqlselect = "SELECT Train_Dates.*
FROM Station INNER JOIN Train_Dates ON
Station.Name = Train_Dates.Station_Name
WHERE (((Station.ID)=" + statesList.SelectedValue + "));";
        oledbConnectString = "PROVIDER=Microsoft.Jet.OLEDB.4.0;DATA
Source= + MapPath("Layers/GIS2.mdb");
        da = new OleDbDataAdapter(sqlselect, oledbConnectString);
        DataTable TrainDates = new DataTable();
        da.Fill(TrainDates);
        GridView1.DataSource = TrainDates;
        GridView1.DataBind();
        da.Dispose();
    }
    AspMap.Feature selectedState = Map1["Stations"].Renderer.Add();
    selectedState.Value = selectedValue;
    selectedState.Symbol.FillColor = Color.Green;
    selectedState.Symbol.Size = 15;
    selectedState.Symbol.LineColor = Color.Black;
}
Fig. 1: Paper map shows stations and base lines between them.

Fig. 2: Localization of Stations on the map.
Fig. 3: Railway lines between stations.

Fig. 4: Final digitized map.
Fig. 5: Relationship between database tables.

Fig. 6: Base line table.

Fig. 7: Data view of base line table.
Fig. 8: Design view of trains table.

Fig. 9: Data view of trains table.

Fig. 10: Design view of train_dates table.
Fig. 11: Data view of train_dates table.

Fig. 12: Zoom in to a station.
Fig. 13: Illustration of zoom in property.

Fig. 14: The result of zoom in.
Fig. 15: Zoom in Tool.

Fig. 16: The essential map.
Fig. 17: The result of zoom out.

Fig. 18: The result of Info window tool at “Algmalya” station.
Fig. 19: A request for zooming to “Alferdan” station.

Fig. 20: The result of zooming to “Alferdan” station.
Fig. 21: Hot Spot at “Alsabria” station.