Advanced Traveler Information System for Hyderabad City

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***Abstract*—The advanced traveler information system (ATIS) is a type of intelligent transportation system application areas that implements emerging computer, communication, and information technologies to provide vital information to the users of a system regarding traffic regulation, route and location guidance, hazardous situations and safety advisory, and warning messages. ATIS requires a large amount of data for processing, analysis, and storage for effective dissemination of traveler information to users. A geographical information system (GIS) allows large data to be effectively processed, stored, analyzed, logically associated, and graphical displayed. Thus, GIS-based ATIS provides a convenient and powerful tool for storage and graphical representation of information, which can be useful users. Further, by availing the powerful GIS functionalities, a user can conceive a problem and allow the appropriate software to assist him in the decision-making process regarding optimum route selection and trip planning. In this paper, the authors present a GIS-based ATIS for Hyderabad City, India. Development of this GIS-based ATIS has been carried under the ArcView GIS environment. This user-friendly system provides comprehensive information about Hyderabad City, such as road networks, hospitals, government and private offices, stadiums, bus and railway stations, and tourist places within the city limits. This system can be used effectively in bus stations, railway stations, airports, and tourist information centers, as well as in personal computers to provide information to travelers and to facilitate travel.**

***Index Terms*—Advanced traveler information system (ATIS), geographical information system (GIS), intelligent transportation system (ITS), route planning.**

I. Introduction

TRANSPORTATION functions are an indispensable basis for any county's development and have the ability to provide benefits to the society. Generally, there is widely accepted link between economic well being and good transportation. Export and import, industry, agriculture, defense, social services (such as health and education), general administration, maintenance of law and order, exploitation of resources, mobility of persons and goods, etc. are some of the many areas of activity that are very closely linked to the availability of adequate transportation infrastructure. Policy makers, transport planners, traffic engineers, and the private sector engaged in developing new transport technologies are constantly looking forward to find solutions to lessen the energy consumption, land usage, congestion, casualties, and money required to build new transportation infrastructure. As a result, developed countries have shifted their priority from infrastructure- and capital-intensive transportation strategies to more balanced and sustainable transportation solutions. This is where the intelligent transportation system (ITS) comes into play. It implicitly holds the promise of sustainability. ITS is an integrated system that implements existing or emerging computer, communication, information, and vehicle-sensing technologies to coordinate transportation systems in a safe and efficient manner, monitor traffic conditions, control traffic flow, and provide information to the motoring public about traffic conditions. ITS includes a wider application of technology to transit systems as well as private cars and highways. Benefits given by ITS deployment to any transportation system are improved safety, improved traffic efficiency, reduced congestion, improved environmental quality and energy efficiency, and improved economic productivity.

The advanced traveler information system (ATIS) is one of the most widely used ITS. ATIS implements a wide range of technologies, such as Internet web sites, telephones, cellular phones, television, radio, etc. to assist travelers and drivers in making informed decisions regarding trip departures, optimum routes, and available modes of travel. ATIS provides both pretrip and *en route* information to the users, both of which offer distinctive advantages. Table I gives an overview of ATIS [22].

The availability of pretrip information drivers enhances their self-belief to use freeways and allows commuters to make better-informed transit choices [22]. *En route* information and guidance saves travel time, helps a traveler avoid congestion, can improve traffic network performance, and is more efficient than paper maps or written instructions. In a 1999 survey, people using the Advanced Regional Traffic Interactive Management and Information System (ARTIMIS) telephone traveler information service in Cincinnati, OH, rated the ARTIMIS as a beneficial service. More than 99% of people surveyed in that city said that they benefited by avoiding traffic problems, saving time, reducing frustration, and arriving at destinations on time and 81% said that they had recommended the service to someone else [24]. Some of the existing traveler information systems are as follows:

1) telephone information lines (prerecorded messages for a selected area or corridor);
2) invehicle navigation systems (global positioning systems and dynamic route guidance);
3) dynamic message signs (drive-time systems);

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TABLE I
OVERVIEW OF THE ATIS

Subsystem	Functional characteristics
Routing and Navigation	Trip planning
	Multi-mode travel coordination and planning
	Predrive route and destination selection
	Dynamic route selection
	Route guidance
	Route navigation
	Automated toll collection
	CVO-specific (route scheduling)
Motorist Services	Broadcast services/attractions
	Services/Attractions directory
	Destination coordination
	Message transfer
Safety/Warning	Immediate hazard warning
	Road condition information
	Automatic aid request
	Manual aid request
	Vehicle condition monitoring
	CVO-specific (cargo and vehicle monitoring)
Augmented Signage Information	Roadway guidance sign information
	Roadway notification sign information
	Roadway regulatory sign information
	CVO-specific (road restriction information)
Commercial Vehicle Operations (CVO)-Specific	Fleet resource management
	Dispatch
	Regulatory administration
	Regulatory enforcement

4) Internet (congestion maps and client–server applications).
5) radio and television broadcasts (pretrip and *en route*).

Further advanced information technologies, such as the geographic information system (GIS) can be effectively implemented in ITS to improve the efficiency and safety of the transportation infrastructure. GIS is the type of integrated information systems that consists of an organized collection of computer hardware, software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information. GIS can be used effectively for route guidance, *en route* driver information, and identification of an incident location. GIS-based advanced traveler-information systems assist individual and fleet drivers of changing traffic conditions *en route* by using wireless technologies and spatial databases. GIS-based ITS applications acquire real-time traffic data from global positioning system (GPS) units, video cameras, and road-monitoring units for *en route* traffic-information dissemination.

II. OTHER GIS-BASED ATIS APPLICATIONS

Commonly, GIS applications to ATIS are for solving tactical logistical problems of vehicle routing and scheduling and traffic-data dissemination. This section portrays some of the GIS-based applications to ATIS, specifically in the field of route planning and traffic-data dissemination.

A. GIS-Based Multimodal ATIS (MATIS)

Mouskos *et al.* [15] developed a GIS-based MATIS that provides travelers with access to information concerning route planning by private automobile, mass transit, and ride sharing. The ystem was developed under the ARC/INFO GIS environment and census and graphic data are acquired from the topologically integrated geographic encoding and referencing (TIGER) files from Union County, NJ.

B. GIS-Based Transit Itinerary-Planning Decision Support System (GIS-TIPDSS)

Li and Kurt [18] developed a GIS-TIPDSS for assisting passengers with itinerary decision-making. GIS-TIPDSS was designed and implemented within the MapInfo, Troy, NY, GIS environment. GIS-TIPDSS was implemented on a personal computer and intended for potential transit users.

C. GIS-Based Decision Support Tool

Wu *et al.* [16] developed a GIS-based decision support tool for modeling dynamic network congestion and conducting minimum cost routing. The system predicts network flows at a detailed level of temporal resolution, capturing dynamic congestion propagation effects. System works under ARC/INFO GIS software and custom Dynamic Traffic Assignment (DTA) module written in C++.

D. Road-Management System for Europe (ROMANSE)

A GIS-based traffic monitoring and analysis system (ROMANSE) has been developed for Hampshire and Southampton, U.K. ROMANSE uses ArcView GIS extension, namely the Strategic Information System Client, for displaying an overview of transport environment using information from the urban traffic control (UTC) [9].

III. GIS-BASED ATIS DEVELOPMENT

A. Methodology

Developing ATIS under the ArcView GIS environment was the objective of current project. In this ATIS, GIS-enabled modules for the shortest path, closest facility, and city bus routes have been included. Besides these features, location-wise information and intercity traveler information, such as bus, train and airways timing, are also included. Methodology involved in the development of the system is described in later sections.

1) Route Planning: Route planning is a process that helps vehicle drivers to plan a route prior to or during a journey. In the shortest-path scheme for route planning, the objective is to select and implement vehicle routing algorithms for intercity and intracity route planning while addressing the following issues [9]:

1) shortest distance;
2) quickest route;
3) vehicle traffic restrictions;
4) driver's travel preferences.

In the current ATIS, route planning is carried out by using a graphical user interface of the system. For the shortest path computation, length and speed limits of the road segments on that road are stored in a digital database and the travel time was calculated (distance/speed limit). The calculated travel time is used as travel cost in the performance of path optimization. The

travel cost represents the cost of traveling over the link or the measure of resistance to the movement of goods through the link and depends on many factors, such as distance, travel time, travel speed, and number of turns. Path optimization has been carried out using ArcView Network Analyst (AVNA). AVNA implements a modified Dijkstra's shortest path algorithm with a d-heap in combination with a custom memory-management scheme for finding the shortest path from a given starting node s to a destination node t, which has the lowest possible cost [19]. Heaps or priority queues are one of the types of data structure that allow the insertion of elements and extraction of the least element. The d-heaps are the generalization of more commonly known binary heaps. All nodes of a d-heap have d children. A d-heap requires $O(\log_d n)$ time to do insert and decrease the Key operation, but needs $O(d \log_d n)$ time for each deleteMin operation. Dijkstra's algorithm is implemented using d-heaps with the d value equal to 2. Using d-heap, Dijkstra's algorithm takes $O(m \log_2 n + 2n \log_2 n)$ time. AVNA builds the topology, creates a travel-cost matrix, and then run the analysis.

2) Closest Facility: In the closest facility problem, route length and travel time (drive time) are considered as travel costs. Different facilities, such as hospitals, bus stations, and tourist places, have been taken as themes in the project. The closest facility algorithm calculates all the routes from the selected origin to facilities based on travel cost. It compares travel costs of these routes and gives one optimal route as output [25].

3) City Bus Routes: City buses with their numbers are stored in a database in a compressed format because there will be more than one bus on one road segment. A search algorithm is used to find bus service number from a selected origin and destination. According to the bus number, road segments on the map were selected and highlighted with different color. The schematic flow chart of the ATIS is shown in Fig. 1.

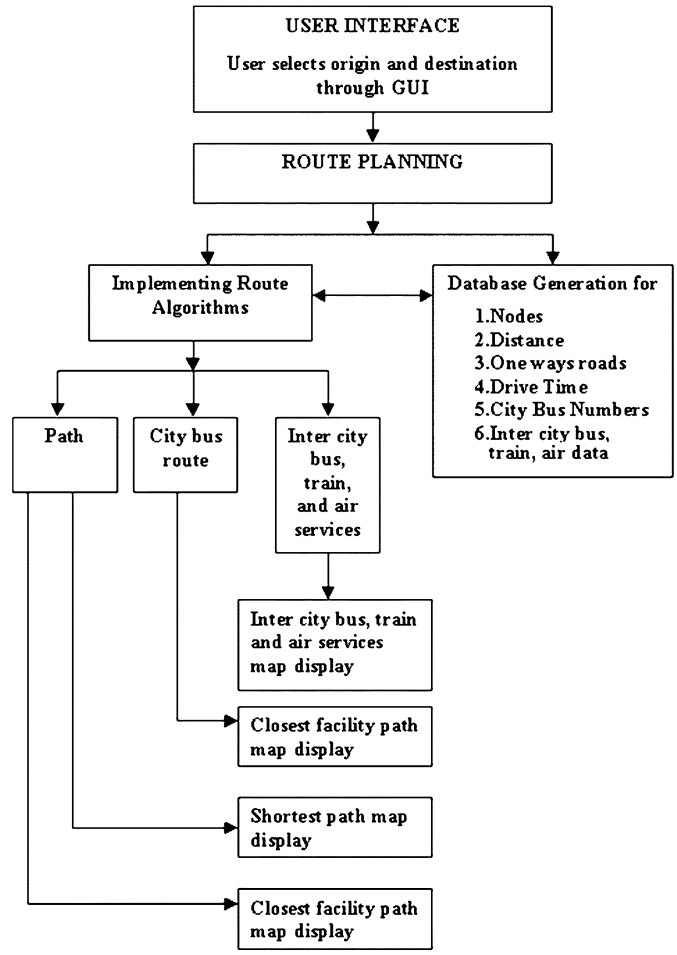

Fig. 1. Schematic flow chart for the ATIS.

B. Source Program

The source program for this package has been written in the Avenue programming language. Avenue is an object-oriented scripting language for ArcView GIS in order to automate tasks, add new capabilities, and build applications. The source code is divided into many scripts; each is used for a particular purpose.

C. Work Plan

The following systematic steps are followed for the development of the ATIS:

Step 1) collecting of maps;
Step 2) scanning of maps;
Step 3) georeferencing of scanned maps;
Step 4) digitization of the road network;
Step 5) database creation;
Step 6) software development in ArcView GIS.

D. Georeferencing

Georeferencing is the process of registering a geographical data set to an established coordinate system [3]. Scanned maps does not usually contain information as to where the area represented on the map fits on the surface of the earth. The location information delivered with aerial photos and satellite imaginary is often inadequate to perform analysis or display in proper alignment with other data. To establish the relationship between an image (row, column) coordinate system and a map (x, y) coordinate system, we need to align or georeference the raster data (image). The image-to-map rectification approach is used for georeferencing. This approach involves the measurement of the image coordinates of the reference cell and their corresponding ground control points [3].

E. Digitization

Digitization is the process of converting paper or scanned maps into digital files in order to encode geographic features in digital form as x, y coordinates [3]. In this paper, the georeferenced raster images of Hyderabad City are digitized through an online digitization procedure using ArcView GIS 3.1. The road network of the study area is digitized as line features. Lakes and rivers are digitized as polygon features. Bus stations, railway stations, hospitals, places of tourist interest, offices, educational institutions, and stadiums are digitized as point features. The spatial data above is organized as themes in this paper.

F. Input Data

ATIS development is carried out for the Hyderabad and Secunderabad twin cities. Hyderabad City is an administrative and commercial center, the capital of the Andhra Pradesh

state. It also is the fifth biggest city in India. Secunderabad is the satellite town of Hyderabad City. The total area of the region (Hyderabad and Secunderabad) is around 500 km^2 and it bounded by latitudes—17°-30′-00″ N and 17°-19′-48″ N—and longitudes—78°-22′-12″ E and 78°-34′-48″ E. The following data was collected and used in the development of ATIS:

- topographical maps of representative fraction (RF) of 1: 25 000 for NW, NE, SW, SE directions;
- time tables of intercity bus, train, and air services;
- speed limits on roads;
- road names;
- information of one-way road segments.

G. Themes and Database

For the current ATIS, all the important geographical details of Hyderabad City are categorized as separate features as depicted as follows:

- road networks;
- places of tourist interest;
- educational institutions
- hospitals and offices;
- bus stations, railway stations, and the airport;
- lakes and the river.

For the current ATIS, topographical maps are taken as data inputs; these features are spatially represented as themes. Each theme has discrete characteristics known as attributes that emphatically separate it from other themes. For example, attributes of a street might include its name, type, length, code, number of lanes, or pavement type. Features and their attributes are linked to each other; therefore, a user can access or locate any feature from its attributes. All the important information associated with each feature was entered into its theme's attribute table, to analyze it in a later stage. This was accomplished by adding the required number of fields (columns) to the table and entering the data for all the features in their corresponding records (rows). Table II gives the details of fields. In the road network theme, more than 1200 roads were identified and digitized. Roads in the city were classified as highways, major roads, and minor roads. This classification was done by giving separate identification number (know as a label) to each category in the database.

Roads that have names were identified and that data was stored in this database. More than one bus will travel on one road. Storing all bus numbers traveling on each road segment is an intricate task; besides, this increases the size of the database. All bus numbers in one road segment were stored in one field in a compressed format. Three different city bus services (metro liners, metro express, and ordinary) are available in Hyderabad City. A database for these three categories was created and stored in three different fields. A database for one-way road segment length, speed limit, and drive time was created.

Names of places of tourist interest, educational institutions, hospitals, bus stations, railway stations, offices, lakes, and the river were stored in their corresponding databases. A description and information of fields in databases of different themes are given in Table II. Besides these databases for intercity bus services, databases for train and air services were also created.

TABLE II
DESCRIPTION OF FIELDS AND THEMES

Theme	Fields	Description
Road network	Name	Name of the road
	One-way	Contains information of one-way road
	Speed Limit	Speed limit on that road segment
	Length	Length of the road
	Drive time	Drive time calculated based on speed limit and length
	Category	Category key number
Places of tourist interest	Name	Name of the tourist place
	Label	Label of the tourist place
Transport	Name	Name of the transport station (airport, bus and rail stations)
	Label	Label of the transport station (airport, bus and rail stations)
	Category	Category key number for local and main rail stations, bus stations and airport
Hospitals	Name	Name of the hospital
	Label	Label of the hospital
	Category	Category key number for private and Govt. hospitals
Educational institutions	Name	Name of the Educational institutions
	Label	Label of the Educational institutions
Offices	Name	Name of the office
	Label	Label of the office

Distances from Hyderabad, departure timings, and service name were included in these databases, which were created in Microsoft Excel.

IV. USING ATIS

A. Menus

A menu displays a list of commands that are available to the user. Because menus make commands visible and searchable, a user can use them to his advantage while recognizing commands without remembering them. A menu bar, one of the most common forms of a menu interface, is a special area displayed across the top of a graphic user interface (GUI) directly below the title bar. Table III gives a description of the menu on the general view of ATIS and their functionalities.

B. Buttons and Tools

Buttons and tools are used to provide quick access to specific commands or options. Their name and functionality are shown in a tool tip text when a user moves the cursor on them.

Buttons and tools bars are shown in Fig. 2 and their description is given in Table IV.

TABLE III
DESCRIPTION OF MENUS

Menu name	Sub menu	Function
File	Close	Closes hyderabad view
	Print	Prints hyderabad view
	Print setup	Edits the printer and the printing options
	Exit	Exits from the package
View hyderabad	By location	Displays location wise with details
	Full	Displays full view
	Search	Searches for different features in hyderabad
Path	Shortest path	Gives shortest path
	Closest facility	Gives closest facility path
	Site tour	Gives optimum path for site tour
City bus routes	Metro liners	Gives bus route for metro liner city bus service
	Metro express	Gives bus route for metro express city bus service
	Ordinary	Gives bus route for ordinary city bus service
	General	Gives general information about city bus services
Intercity	Bus services	Gives intercity bus services from hyderabad
	Train services	Gives intercity train services from hyderabad
	Air services	Gives intercity air services from hyderabad
	General	Gives general information about intercity services

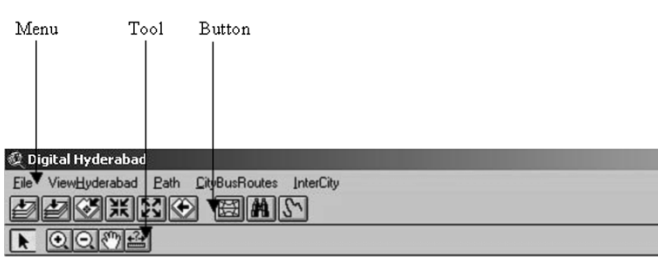

Fig. 2. Menus, buttons, and tools.

C. Using General Functions

Fig. 3 gives the full view of map with all themes in the ATIS. Guidelines for general usage of the map are as follows.

1) Legend of the map is shown on the left side of the map.
2) Turn themes on and off by clicking a checked box in front it to view the desired themes.
3) Zoom in or out the map using zoom tools and buttons.
4) Click on the measure tool and any point on the map and move the cursor to the desired point on the map. A line drawn between those two points and distance in kilometers is shown in the status bar.
5) Click on a measure tool and on any point on the map and move the cursor to the desired point on the map. A line draws between those two points and the distance in kilometers is shown in the status bar.

TABLE IV
DESCRIPTION OF BUTTONS AND TOOLS

	Type	Function
Buttons	Zoom to full extent	Zooms to the extent of all themes
	Zoom to active themes	Zooms to the extent of active themes
	Zoom in	Zooms in on the center of the display
	Zoom out	Zooms out from the center of the display
	Zoom to previous extent	Goes back to the previous extent you were viewing
	By location	Has same functionality as by location sub menu
	Search	Has same functionality as search sub menu
	Shortest path	Has same functionality as shortest path sub menu
Tools	Select	Selects any point on map
	Zoom	Zooms in at a point we click or zooms in on a rectangle we drag
	Zoom Out	Zooms out from a point you click or zooms out to include a rectangle you drag
	Pan	Drags the display in the direction we move the cursor
	Measure	Measures distance and displays it on status bar
	Closest facility	Has same functionality as closest facility sub menu

D. Viewing the City Location-Wise

Clicking the "by location" submenu in the "view Hyderabad" menu or the location button by using the mouse console, the user can view information for the area, as shown in Fig. 4. The steps are as follows.

Step 1) Click on the "location" button or on the " by location" submenu.
Step 2) Select an area to view.

The selected area will be zoomed with all details. For a full view of Hyderabad, click on the "full" submenu in the "view Hyderabad" menu.

E. Searching for Features in Hyderabad

Following are steps for searching desired features such as offices, places of tourist interest, educational facilities, health facilities, etc., in Hyderabad.

Step 1) Click on the

button or the "search" submenu in the "view Hyderabad" menu.
Step 2) Select the type of features from the "search for" list.
Step 3) Select the feature from the list.

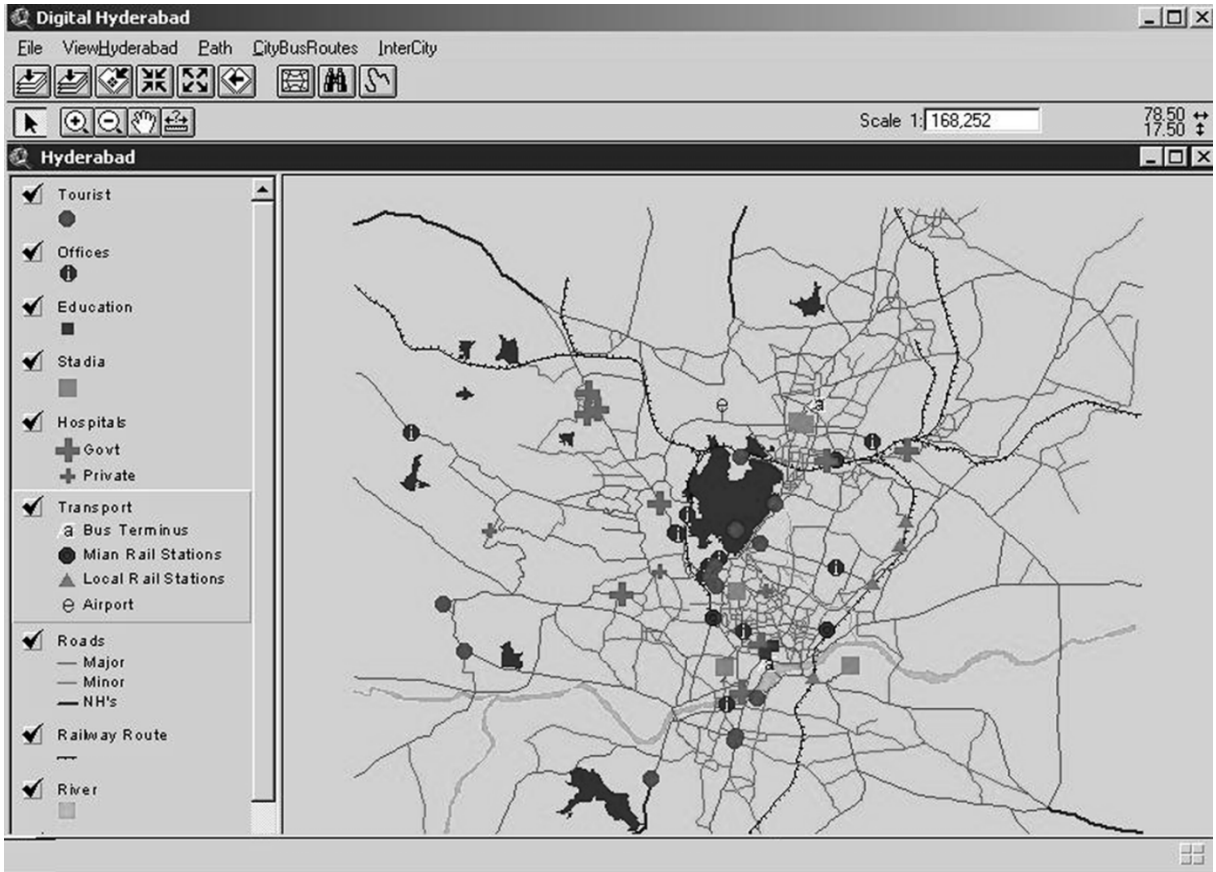

Fig. 3. General view.

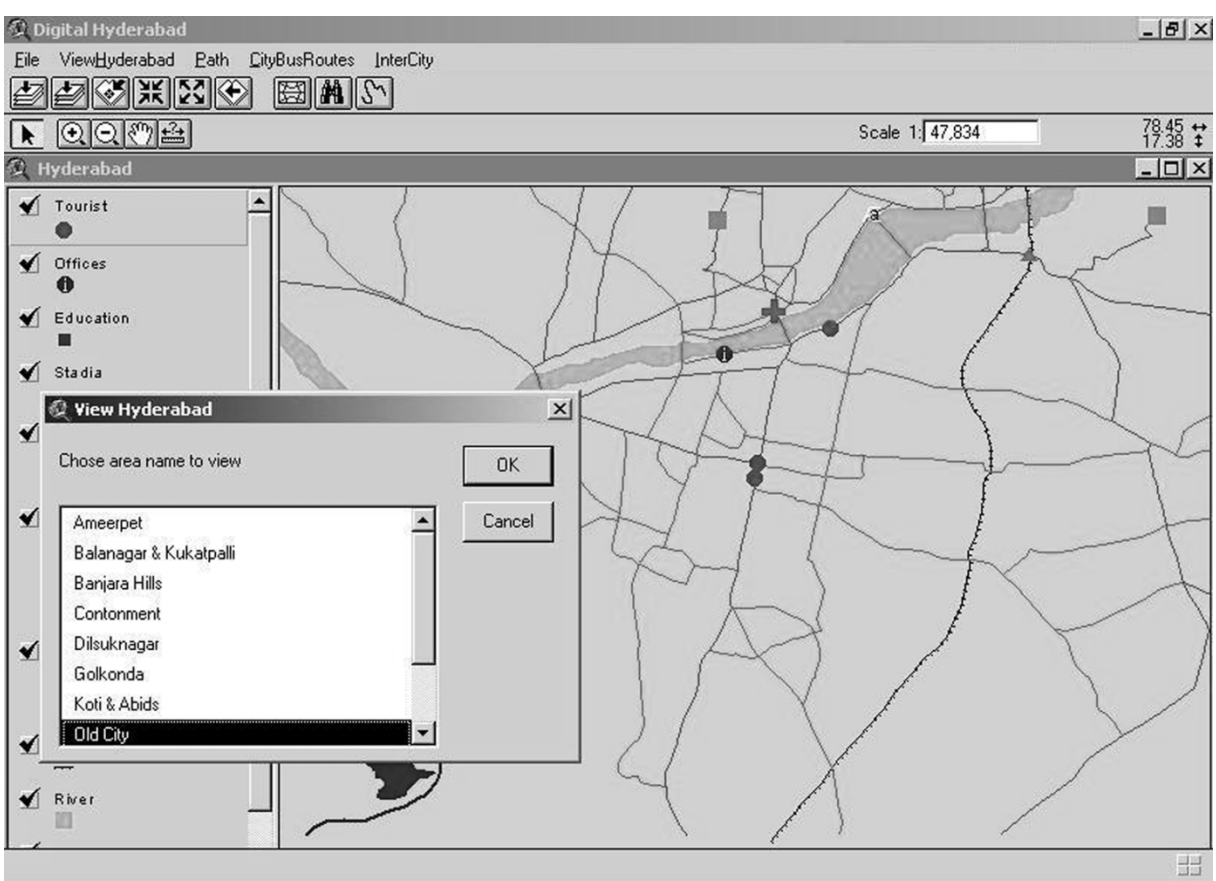

Fig. 4. Location-wise view of Hyderabad City.

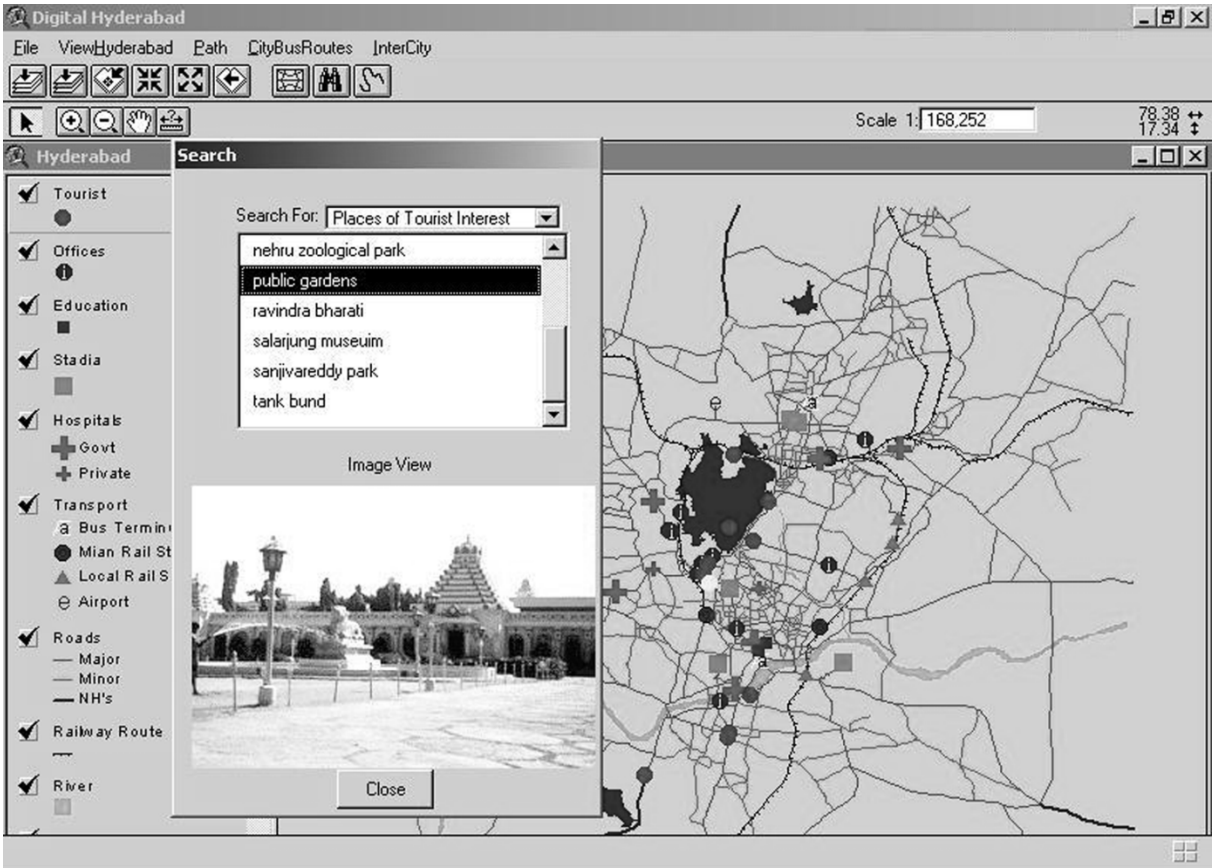

Fig. 5. Searching for features in Hyderabad City.

The selected feature will be highlighted in yellow in the map and if the image is available it will be shown in the search's dialog box, as given in Fig. 5.

F. Shortest Path Module

The shortest path module for finding the shortest path with different options, i.e., either the user selects the origin or destination from the database or by clicking desired location on the map, as shown in Fig. 6. In this ATIS, four options are given for finding shortest path, as follows:

1) shortest path with the given origin and destination;
2) shortest path with a user-given origin and destination;
3) shortest path with a given origin and user-given destination;
4) shortest path with a user-given origin and user-given destination.

1) Shortest Path With Given Origin and Destination: Click on the "shortest path" submenu or on the

button. Select any "with given origin and destination" option in the shortest path dialog. Select the type of origin and, from that list, select the origin. Select the type of destination and, from that list, select the destination. Click on the

button and select travel cost (line length or drive time).

The shortest path will be displayed in yellow on the map and directions from the origin to destination will be displayed in the "shortest path" dialog.

2) Shortest Path With User-Given Origin and a Given Destination: Click on the "shortest path" submenu or button. Select the given origin and given destination option in the shortest path dialog. Select the origin by clicking any point on the road network.

Select the type of destination and, from that list, select the destination. Click the "run" button and select the travel cost (line length or drive time).

The shortest path will be displayed in yellow on the map and directions from the origin to destination will be displayed in the "shortest path" dialog.

3) Shortest Path With a Given Origin and Given Destination: Click on the "shortest path" submenu or the button. Select any "with given origin and user-given destination" option in the shortest path dialog. Select the type of origin and select the origin from the given list. Select the destination point by clicking any point on the road network. Click the "run" button and select travel cost (line length or drive time).

The shortest path will be displayed in yellow on the map and directions from the origin to destination will be displayed in the "shortest path" dialog.

4) Shortest Path With User-Given Origin and User-Given Destination: Click on the "shortest path" submenu or button. Select any "with given origin and user-given destination" option in the shortest path dialog. Select the type of origin and select the origin from given list. Select the destination point by

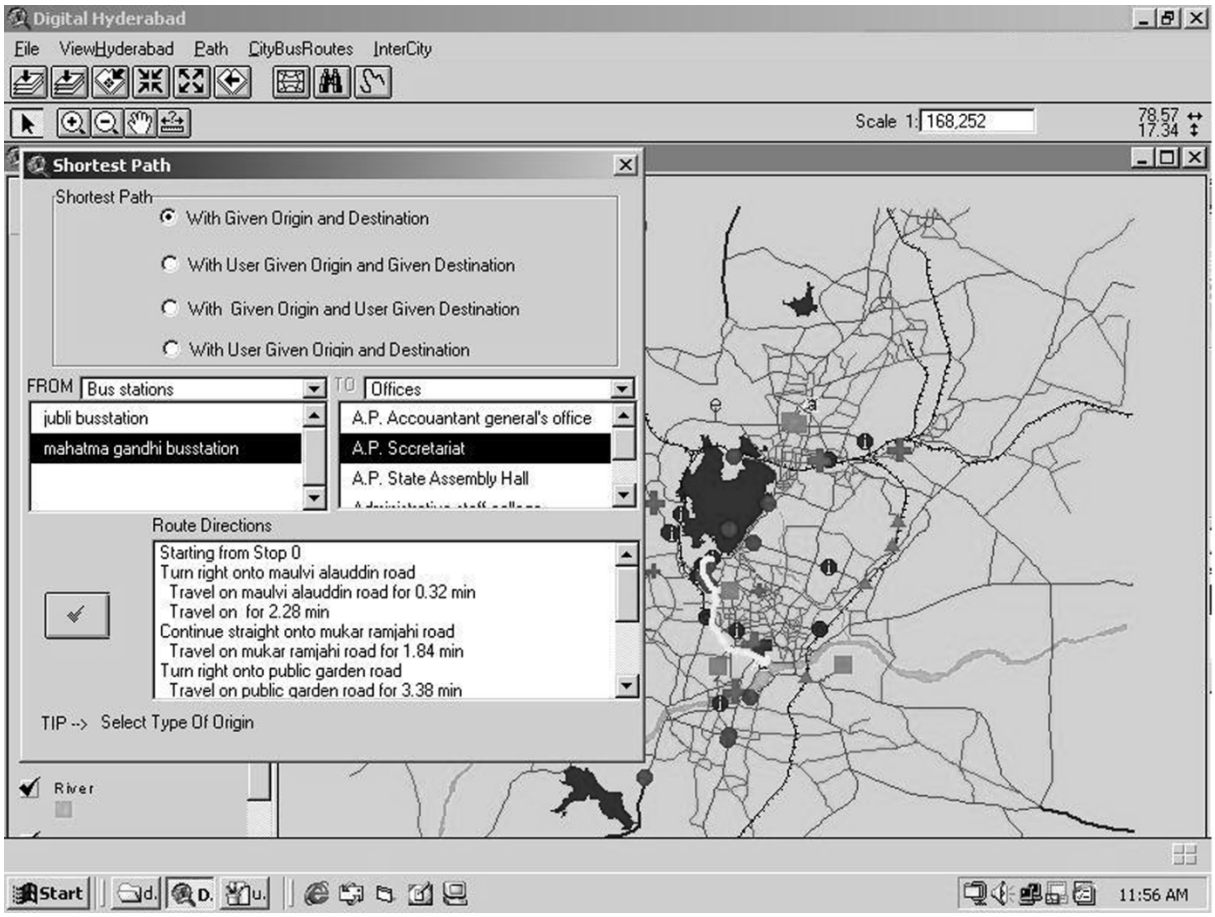

Fig. 6. Searching for the shortest path with a given origin and destination.

clicking any point on the road network. Click the "run" button and select the travel cost (line length or drive time).

The shortest path will be displayed in yellow on the map and directions from the origin to destination will be displayed in the "shortest path" dialog.

G. Closest Facility Path Module

The closest facility module is for finding nearby facility (offices, places of tourist interest, educational facilities, health facilities, etc.) from any location on the road network. Steps for finding closest facility are as follows.

Step 1) Click on the "closest facility" submenu or button. Click on the

button given in the dialog and select any point by clicking the road network.

Step 2) Enter the range in kilometers where the closest facility is to be found. The default value is 0, which means the closest facility in the whole map.

Step 3) Select the type of facility (hospitals, offices, transport, etc.).

The optimum path to the closest facility from a selected point will be displayed in yellow on the map and directions from the origin to destination will be displayed in the "closest facility path" dialog, as shown in Fig. 7.

H. Site Tour Module

The site tour module is for itinerary planning. When a traveler wants to visits several locations in the city, this module gives the traveler a systematic plan for travel, which is based on the shortest distance to different locations from the origin. Steps involved for itinerary planning are as follows.

Step 1) Click on the "site tour" submenu.

Step 2) Select places to visit from the places of tourist interest list in order of visit by holding the SHIFT key.

Step 3) Click the "go" button.

The optimum path for the site tour will be displayed in yellow on the map and directions will be displayed in the "site tour" dialog, as shown in Fig. 8.

I. City Bus-Service Module

This module is for finding city bus services that are available from one location to other in Hyderabad City. Fig. 9 shows the city bus-service module. The following are the steps for searching for available city bus services.

Step 1) Click on the "metro liner," "metro express," or "ordinary" submenus in the Citybusroute menu according to the type of city bus services.

Step 2) Select the origin point from the origin list.

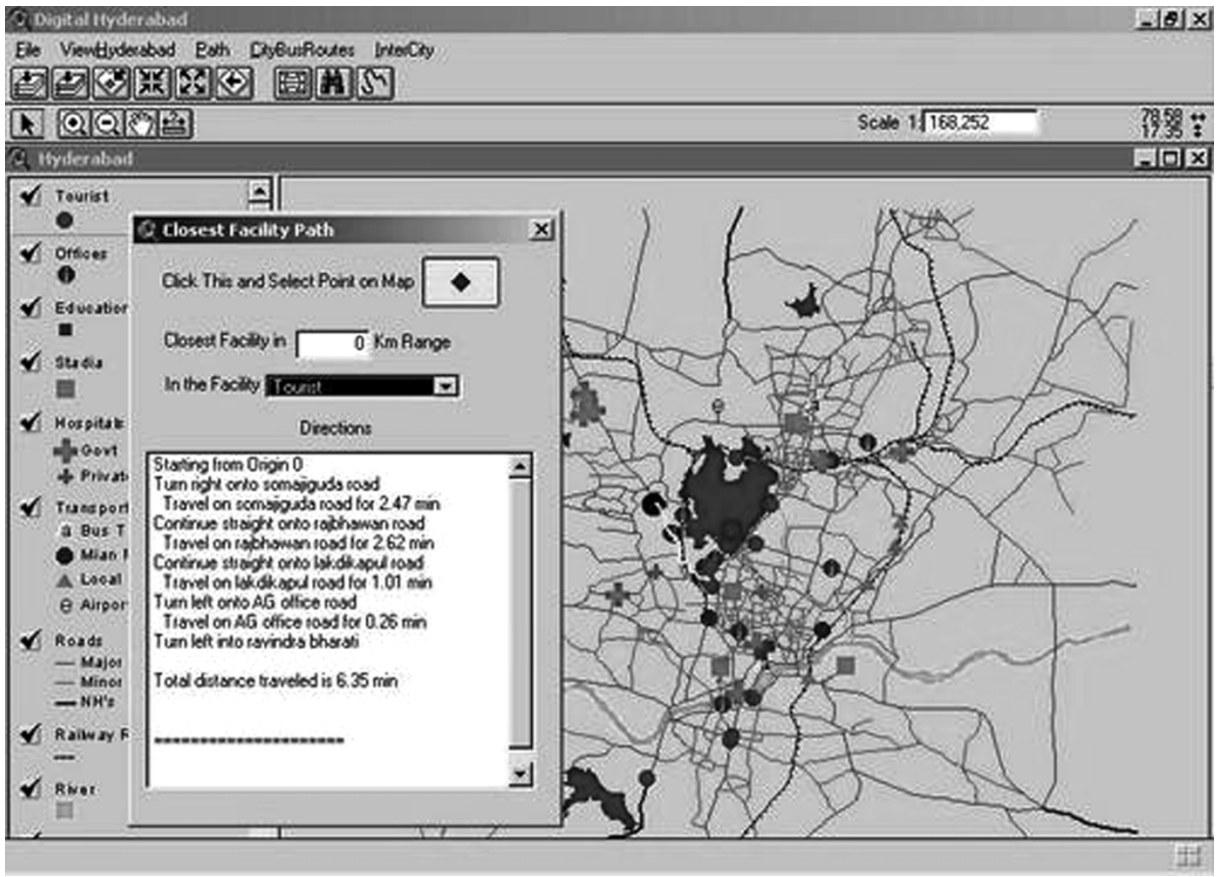

Fig. 7. Closest facility path module.

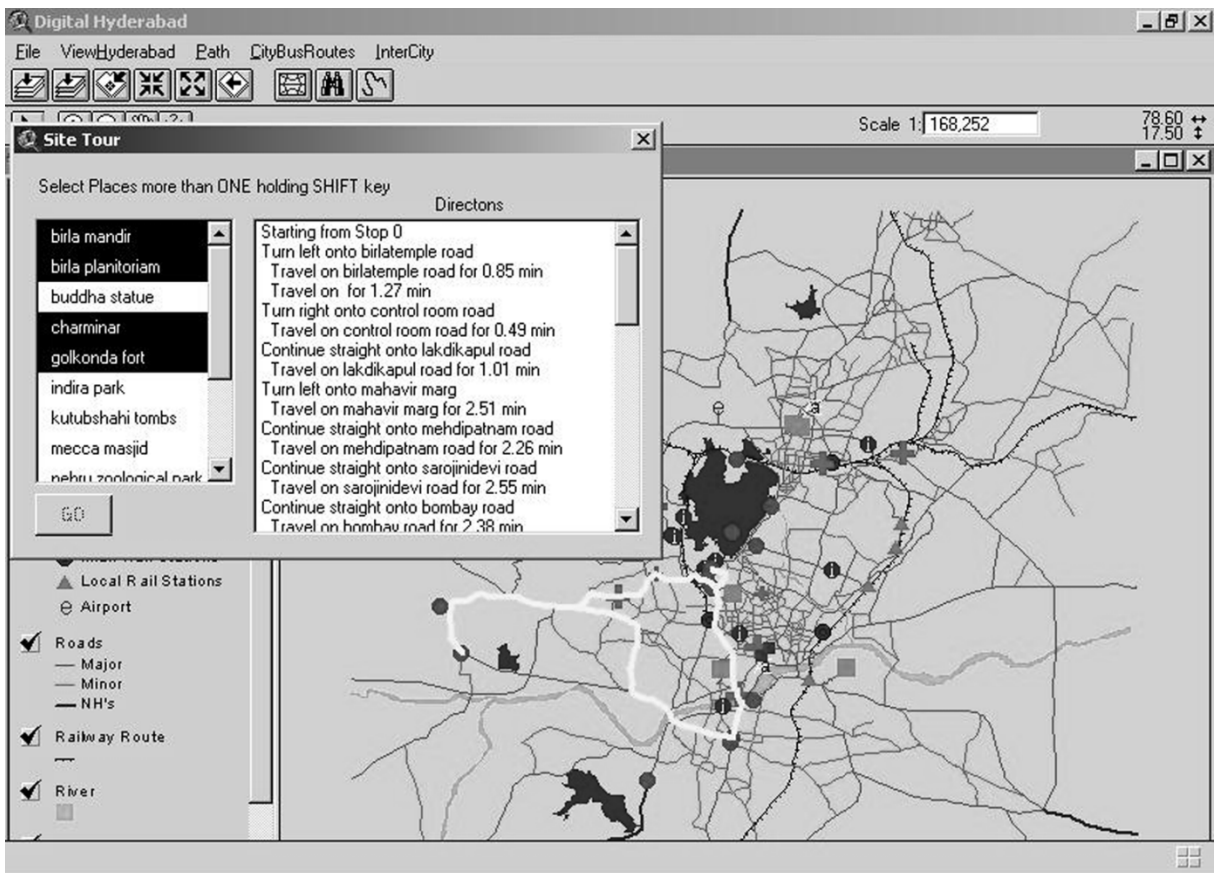

Fig. 8. Site tour module.

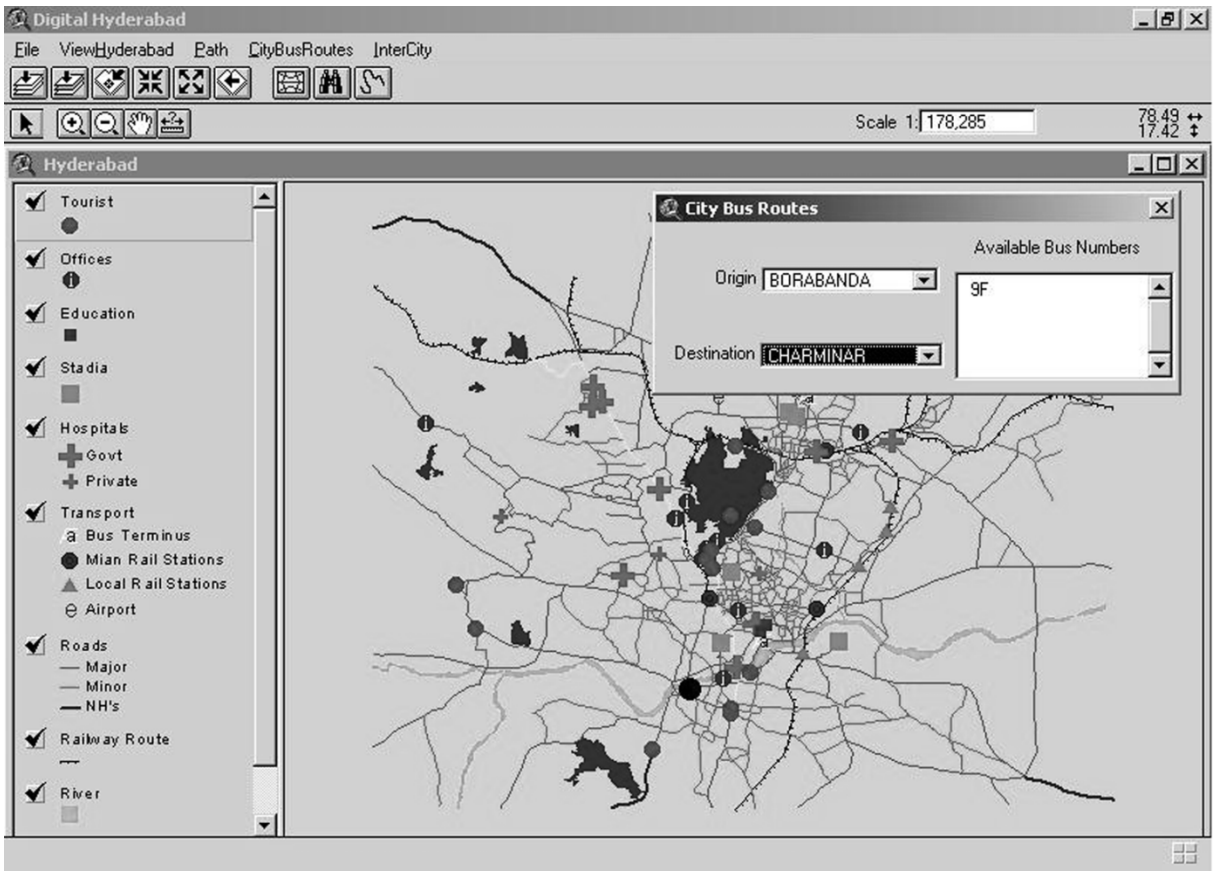

Fig. 9. City bus-services module.

Step 3) Select the destination point from the destination list.
Step 4) Select any bus number from the available bus numbers to view its route.
Step 5) Selected bus number's route will be displayed in yellow color on the map.

J. Intercity Bus Services Module

This module is for finding available intercity bus services from Hyderabad to other cities. The following are the steps for finding intercity available buses.

Step 1) Click on the "bus services" submenu in the intercity menu.
Step 2) Enter the destination city name.
Step 3) Click on the "go" button.

Distance and timings of buses will be displayed on bus services dialog.

K. Intercity Railway Services Module

This module is for finding intercity railway services that are available from Hyderabad to other cities. The following are the steps for finding available intercity buses.

Step 1) Click on the "train services" submenu in the intercity menu.
Step 2) Enter the destination city name.
Step 3) Click the "go" button.
Step 4) Train numbers to destination city will be displayed.
Step 5) Select any train number.

Train name, arrival and departure times, and the train's starting station in the Hyderabad and Secunderabad twin cities will be displayed on the railway services dialog, as shown in Fig. 10.

L. Intercity Airline Services Module

This module is for finding intercity airline services from Hyderabad to other cities. Following are the steps for finding available intercity airline services.

Step 1) Click on the "air services" submenu in the intercity menu.
Step 2) Select the destination city name from the list.

An airline's name, flight number, stopping details, departure time, and operating days of all flights will be displayed on the bus-services dialog.

V. Future Scope

The proposed ATIS can be modified further to an Internet GIS-based application, so that the user can have easy access to it via Internet. Further, this ATIS can be provided with several routing systems to allow users to select from one of several travel objectives used to direct the path search. Typical options include minimizing travel time, minimizing travel distance, and maximizing use of freeways links.

In the future, when the integration of highway systems with real-time traffic surveillance and control strategies will take place in India, this ATIS can be modified to provide route

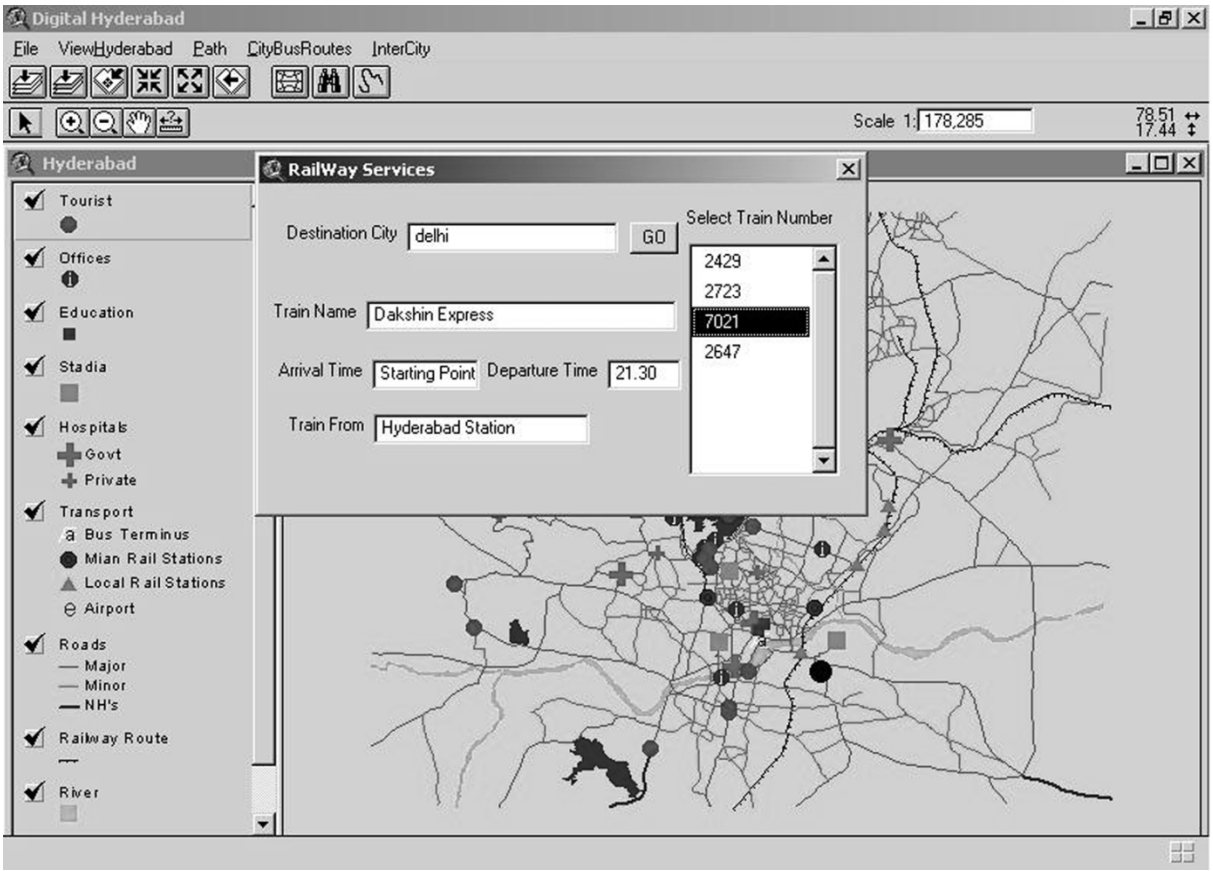

Fig. 10. Intercity railway services module.

choices based on actual or predicted traffic conditions with the help of real-time data acquisition from equipped road networks.

VI. Conclusion

ATISs are most widely deployed ITS application areas. With the rapid increase of the Internet and wireless communications in recent years, the application of Internet-based and wireless GIS-T applications to ATIS is growing rapidly (such as the ROMANSE project in Europe). Implementation of GIS in combination with other advanced communication computer technologies to traveler information systems enables the conspicuous dissemination of information pertaining to fixed route facilities, such as offices, educational institutions, health facilities, places of tourist interest, etc.; route planning and spatial and attribute information on other transportation facilities within the cities, including highways, airports, marine ports, and passenger rail systems.

Developed GIS-based ATIS has a point-and-click graphical user interface and also is user friendly.

The developed package has the following capabilities:

- finding the shortest path based on distance and drive time;
- finding the closest facility and its path based on distance and drive time;
- city bus routes;
- search engine—which searches different facilities in Hyderabad city;
- provides intercity bus, train, and airways information (timings, distance, and service name);
- site-tour planning.

The developed package can be used in the following areas to give information to the travelers:

- bus stands;
- railway stations;
- airports;
- tourist information centers;
- in personal computers.

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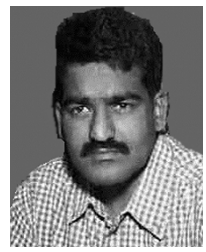

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