Abstract

People using public transportation systems (PTS) plan trips in such a way so as to reduce their travel times, route lengths and have a comfortable journey. Manual trip planning is a tedious job since it involves referring to a number of timetables (supplied by the PTS) depending on the user's origin and destination. A transit information systems (TIS) is developed here to reduce the burden of manual trip planning. The TIS plans a trip quickly for the user to travel from his/her origin to his/her destination. The planned trip involves a shortest travel time path using bus routes. The TIS also provides alternative paths to reach his/her destination so that user can have a back-up option if he misses the buses running on the shortest travel time path. A user friendly interface is designed to take the input (user's origin, destination, journey starting time and other preferences related to trips) from the user and also display graphically the paths the user has to follow. Geographical Information Systems is used to develop the TIS.

Chapter 1

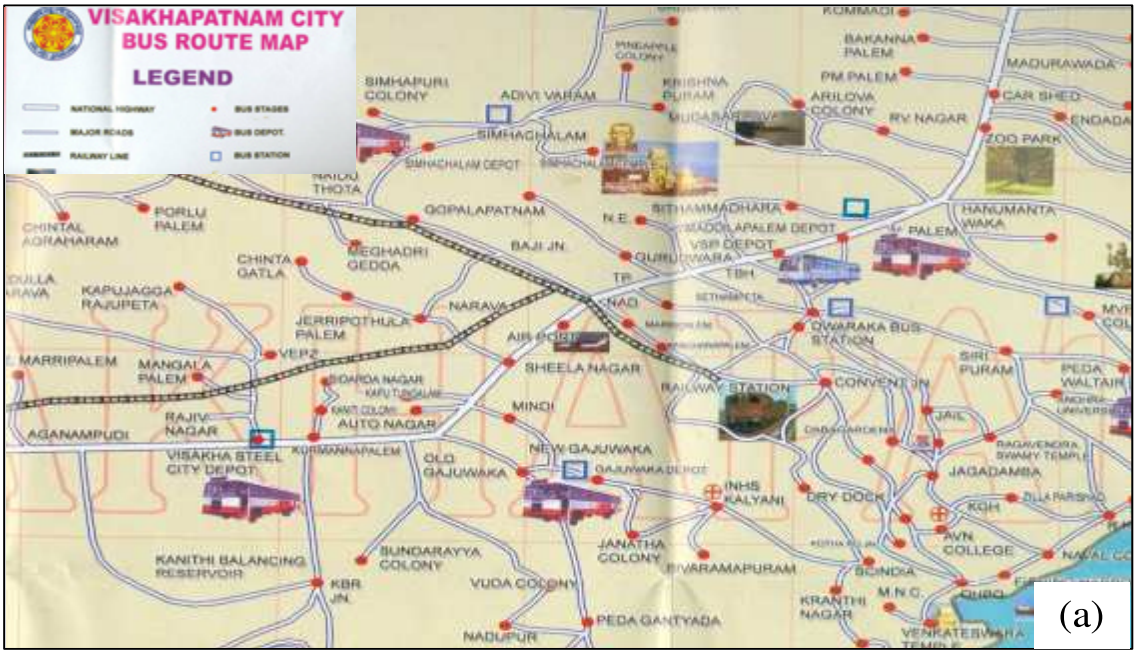
Introduction

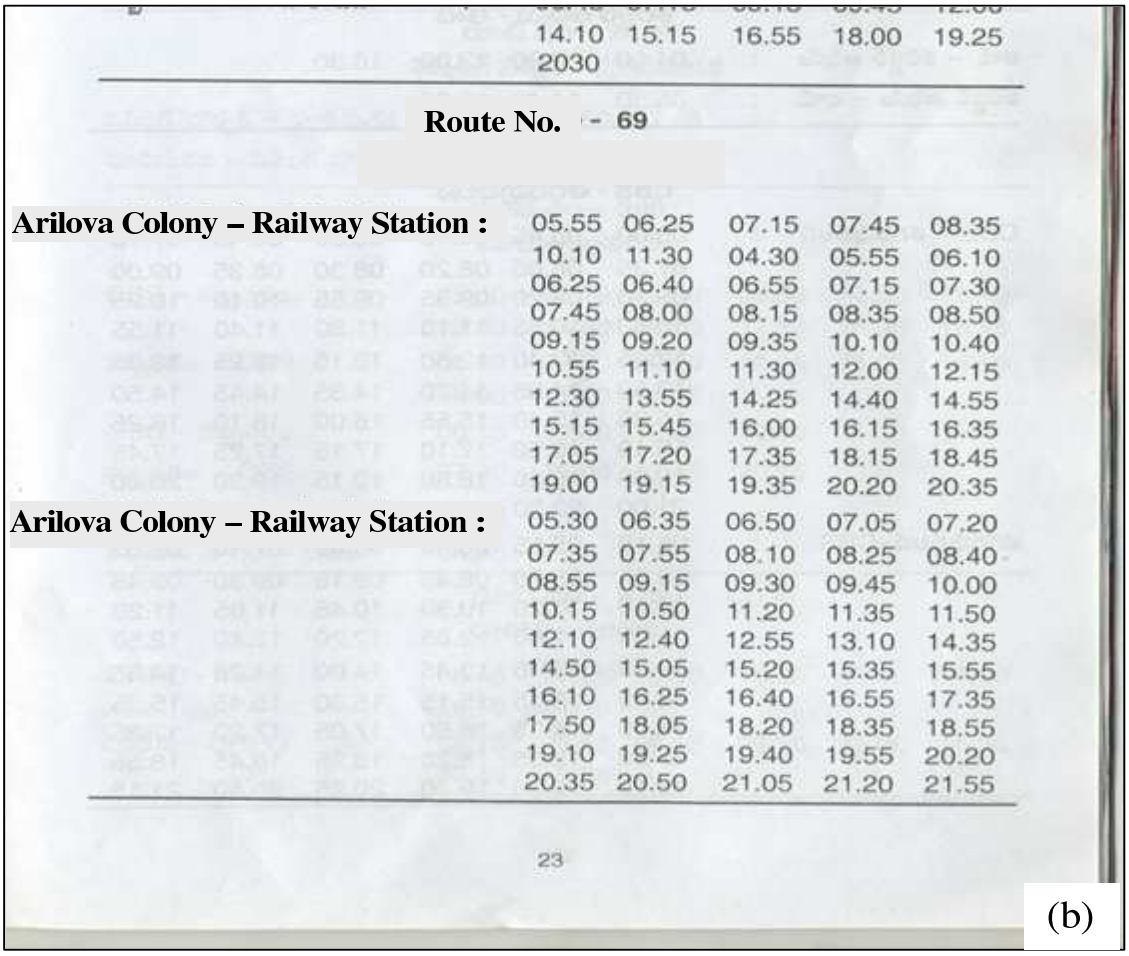
1.1 Transit Information Systems

One of the major problems faced by the transportation authorities is congestion due to traffic. With the increase in traffic more and more congestion occurs on streets. Congestion causes not only delay to vehicles but also pollution problem. To reduce the traffic congestion, transportation authorities encourage people to shift to public transportation systems (PTS). PTS includes buses, trains, etc. The PTS service can be improved if prospective users can be provided information on how to use the PTS to reach from one place to another. With this information, people can plan their trips to reduce their travel times. Currently most of the information is available in books in the form of tables and maps. The tables describe details of the buses and trains running in the city, their arrival and departure times at different stops or stations, travel times, and fares. Maps would be city maps and route maps. A typical information supplied by PTS is shown in Figure 5.1.

Though PTS authorities provide information about the buses and trains running in the city, they are not very useful to users. The first reason is that the users might feel difficulty in understanding the layout of the timetables. Second, the information of buses and trains are provided in numerous timetables. If a user wants to plan a trip from a Point 'A' to Point 'B' he has to refer to many of these tables, which is a big task for him. To reduce the burden of the users, the PTS authorities provide customer services in some places. These customer information systems plans trips for customers (travellers) in addition to providing customers with information about routes and schedules. However, such agents cannot help too many users.

Trips can be planned better by providing users, an interactive information system at bus stations, railway stations [9] and on the internet. For this, data base management system (DBMS) will be required to handle the large volume of data





14.10 15.15 16.55 18.00 19.25
2030

Route No. - 69

Arilova Colony – Railway Station :	05.55	06.25	07.15	07.45	08.35
	10.10	11.30	04.30	05.55	06.10
	06.25	06.40	06.55	07.15	07.30
	07.45	08.00	08.15	08.35	08.50
	09.15	09.20	09.35	10.10	10.40
	10.55	11.10	11.30	12.00	12.15
	12.30	13.55	14.25	14.40	14.55
	15.15	15.45	16.00	16.15	16.35
	17.05	17.20	17.35	18.15	18.45
	19.00	19.15	19.35	20.20	20.35
Arilova Colony – Railway Station :	05.30	06.35	06.50	07.05	07.20
	07.35	07.55	08.10	08.25	08.40
	08.55	09.15	09.30	09.45	10.00
	10.15	10.50	11.20	11.35	11.50
	12.10	12.40	12.55	13.10	14.35
	14.50	15.05	15.20	15.35	15.55
	16.10	16.25	16.40	16.55	17.35
	17.50	18.05	18.20	18.35	18.55
	19.10	19.25	19.40	19.55	20.20
	20.35	20.50	21.05	21.20	21.55

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(b)

Figure 1.1: (a) Map of a city showing bus routes, bus stops. (b) Time table for a particular route

and a graphics software to display graphical data e.g. route map etc. Further, software capable of linking timetable data and spatial route data is required so that the results on the planned trip can be seen on the map. All these facilities are available in Geographical Information Systems (GIS).

In the present work an attempt is made to reduce the burden of manual trip planning. A method to develop a transit information systems (TIS) using GIS is proposed. This method can automatically plan a trip, display shortest as well as other good routes, and answer questions regarding the availability of buses. The proposed method has been applied on buses only and not for other modes of transportation. The method has been tested on two cities, namely Newark, Delaware (USA)- a small town, and Visakhapatnam, Andhra Pradesh, India-a medium sized city. Its on speed and accuracy with which this method gives alternative solutions have been carried out. It is shown that the proposed method is accurate and fast.

Chapter 2

Problem Definition

The main aim of the thesis is to develop a traveller information systems. This traveller information systems (TIS) should be able to provide users with details on how to use the transit system to go from their origin to their destination. Typically, the information system should be able to give more than one alternative. Further the alternative should be provided quickly to the user.

2.1 Problem

As stated earlier the problem is to quickly determine alternative ways of going from the user's origin to the user's destination using the transit system. Input to TIS would typically be user's origin and destination, journey starting and/or ending time or time window, and an allowable maximum walking distance (search radius) within which bus stops are to be searched. The output from the TIS will be a detailed trip plan and include the actual journey starting time, the boarding stop, the boarding time, the transfer stop and time (if any), alighting stop and time, and journey end time.

The input is to be provided through a graphical user interface (GUI) using either mouse clicks or brief entries to questions. The output is to be provided graphically, clearly showing the origin bus stop, transfer stops (if any) and the destination stop. The display should also show the bus routes and the path to be followed. The output should also be provided as a narrative stating where should the person go, what bus route should the person board, etc.

The problem, as described above has three components, (*i*) the GUI and narration, (*ii*) the knowledge base, i.e, the database on road network, bus routes, bus stops, and bus schedules, and (*iii*) the search engine, which given the requirements will determine the alternative solutions.

Chapter 3

An Example

For example consider that a person has arrived at Visakhapatnam's railway station around 9:30 AM and he wants to go to Rama Krishna beach. He wants to start from the railway station after refreshing up and decides that he would like to leave for the beach not before 11 AM. He approaches TIS to help him with information on how to reach the destination.

Over the next few pages the process of how TIS will guide the person to his destination is shown. The steps shown here, starts from the input phase to the output phase.

Step 1: Activate the TIS with Visakhapatnam as city of interest. The screen, as shown in Figure 8.1 (a) appears.

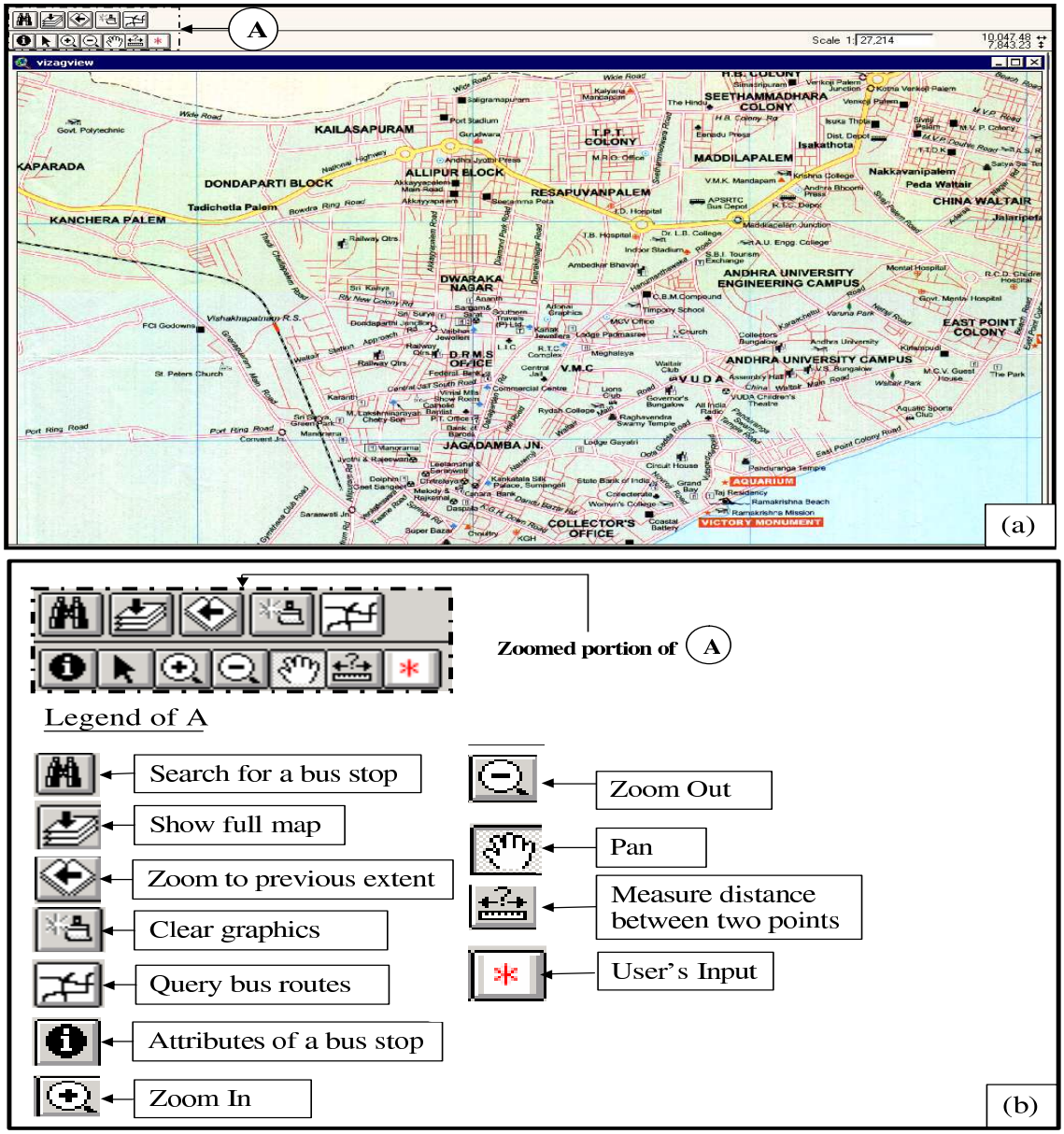

Figure 3.1: (a) Interface to take input from the user; (b) Explanation of icons in (a).

Step 2: The user now has to give input on his origin and destination. For this, the user has to go through the following steps.

1. The user has to zoom into the required location (i.e origin). This is shown in part(a) of Figure 8.2. He has to locate the origin on the map by clicking the left button of the mouse. The moment he clicks the left button he sees a red star and a text **O** (indicating origin) written in red. This is shown in part (b) of Figure 8.2.

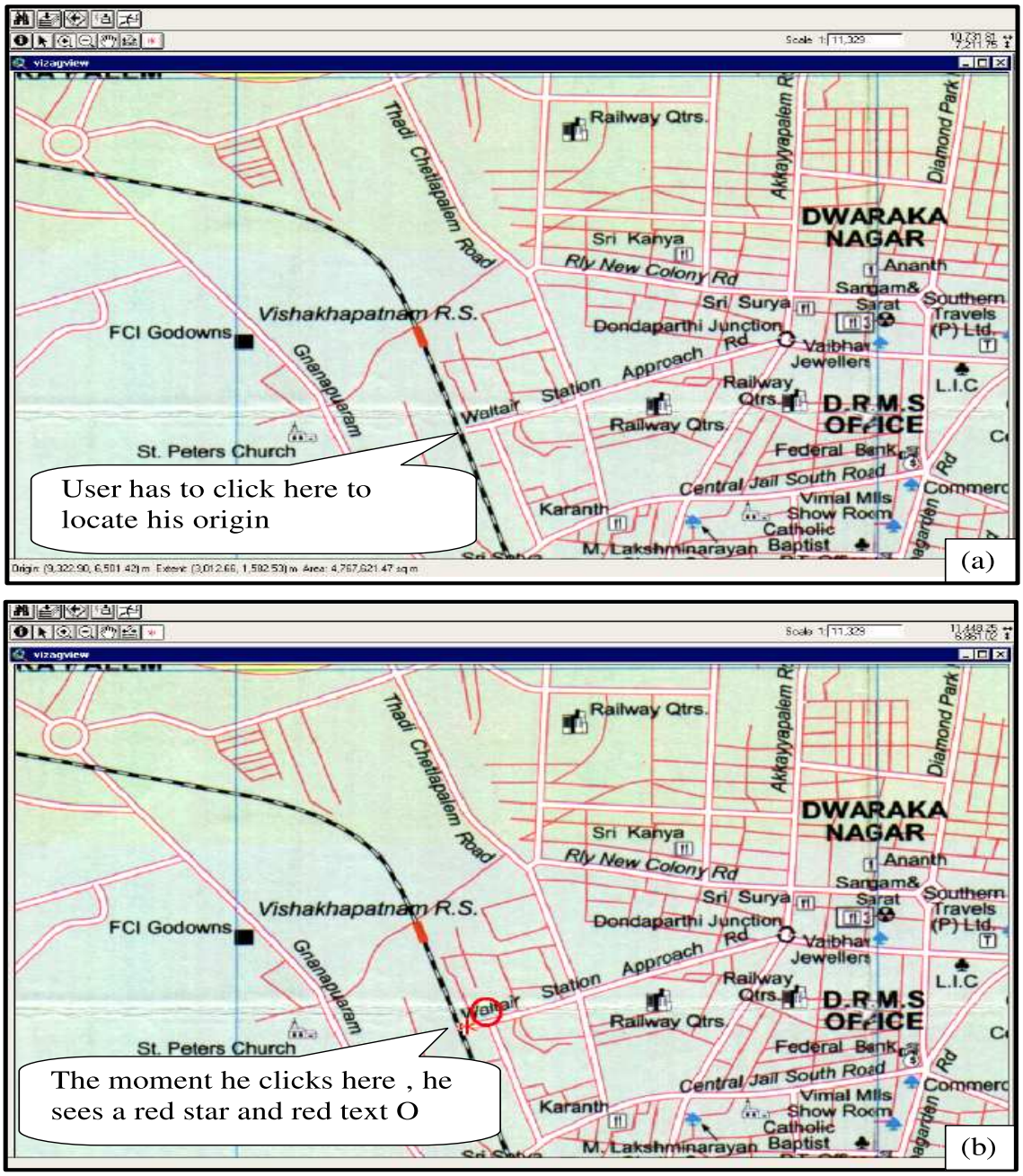

Figure 3.2: The interface during step 2 (origin input phase)

2. Similarly he has to zoom into the destination. This is shown in part (a) of Figure 8.3. He has to locate it on the map by clicking the left button of the mouse. The moment he clicks the left button he sees a green star and a text **D** (indicating destination) written in green. This is shown in part (b) of Figure 8.3.

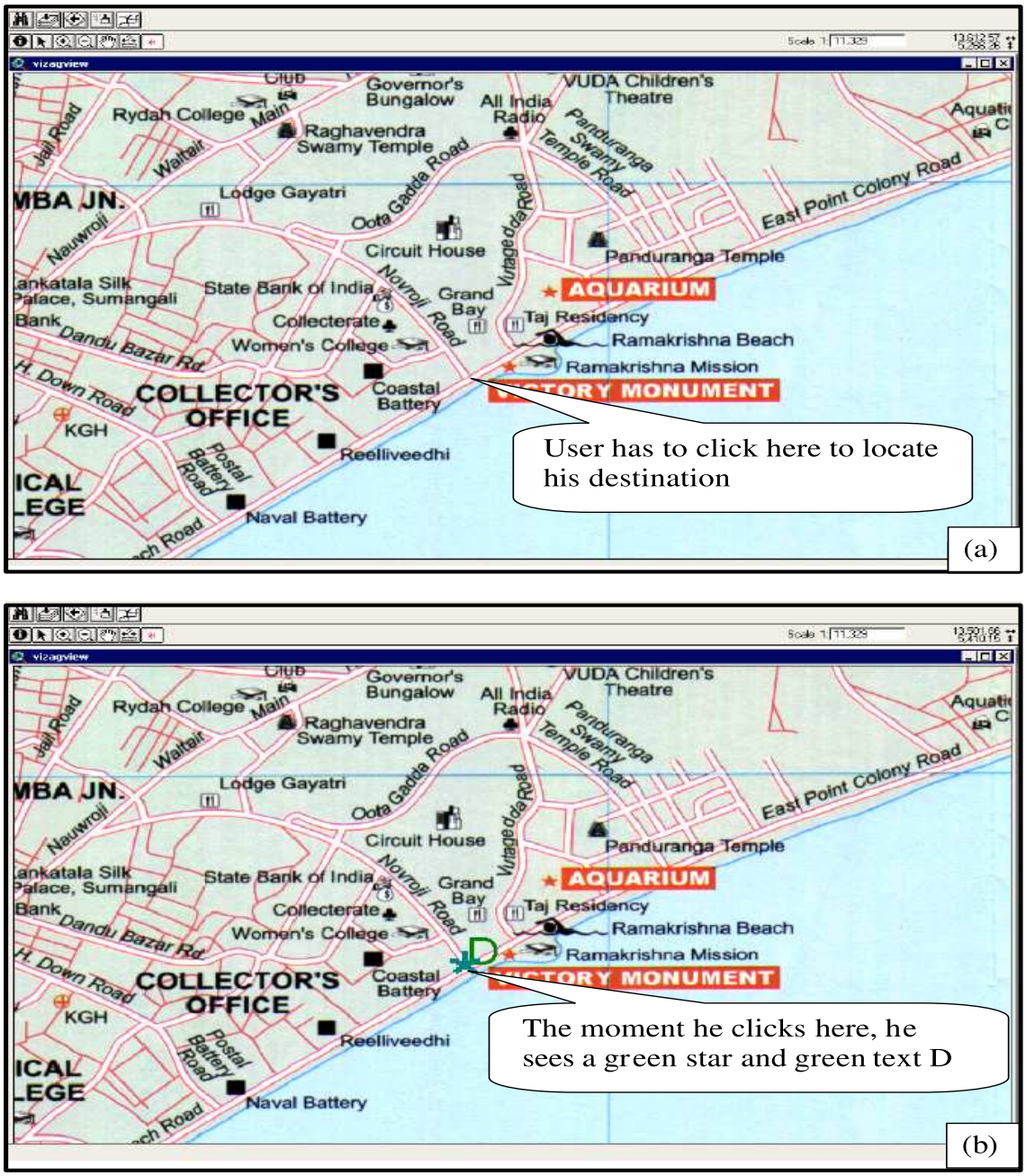

Figure 3.3: The interface during step 2 (destination input phase)

Step 3: After the destination is entered the user is prompted with a window asking him for the following information. The window has five parts A, B, C, D, E. Each part is bounded by a rectangle and is shown in Figure 8.4. The input to be provided in each of these parts is explained here.

- **Part A:** This window asks for user's choice of time to start his journey, i.e., the journey starting time. In this case, the user enters 11:00 AM.
- **Part B:** This window asks for the user's choice of whether he wants TIS to search for direct trips only, or one transfer trips only, or both . Say, the user wants both.
- **Part C:** This window asks for user's choice of whether TIS should search all the buses available in the city or for buses available within a specified time period.This period is entered as a real number having hour as its unit. In this case, it is assumed that the user definitely wants to leave before evening and would be to move out by 4:00 PM (i.e. 5 hours from 11:00 AM).
- **Part D:** This window asks for user's choice of whether TIS should display all the solutions found or few good solutions one by one. The user wants to see 15 good solutions.
- **Part E:** In this part, the user can specify the maximum distance he is willing to walk to reach the bus stop from his origin or to his destination from a bus stop. The user is asked to specify the following details minimum radius ($\mathbf{r}_{min}$), maximum radius ($\mathbf{r}_{max}$), and step size (**ss**). Typically only the second in the list will be modified by the user, the first and the third will operate with default values. In this case, the user specifies the default values of 0 m and 250 m and a value of 250 m for the maximum radius. Once the user completes entering all the details in the window, he has to press the 'ok' button present on the top right corner of the window. The TIS then starts searching for the routes that can take the user from origin to destination. The results can be viewed in graphical and in text format.

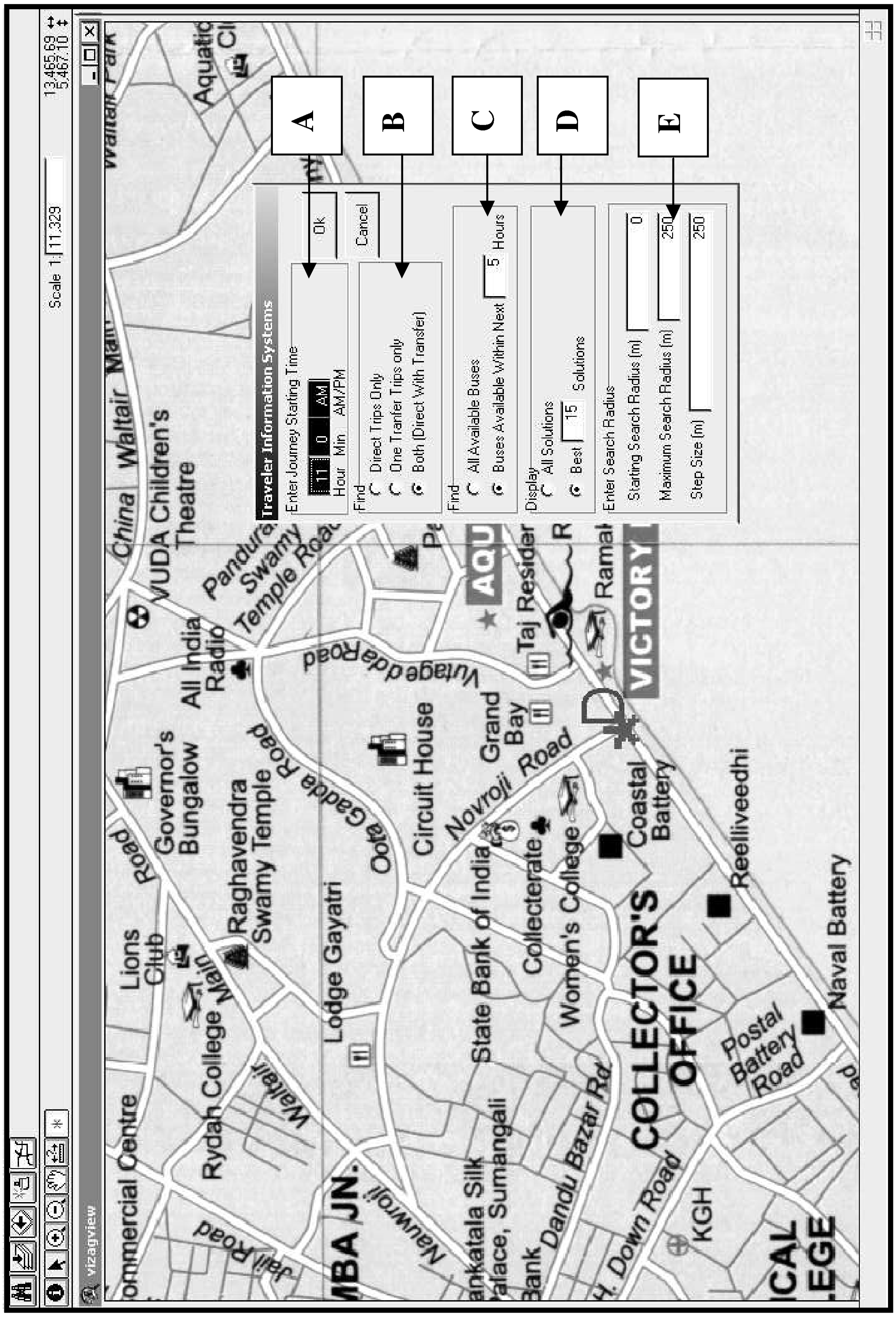

Figure 3.4: The interface at Step 3

Step 4: In this step the output is shown to the user. The graphical format of the result is shown in Figure 8.5. For each solution, the graphical format displays details like origin point, boarding bus stop, intermediate bus stops on the route/s, transfer bus stops if exist, alighting bus stop, destination point and the arrival time of the user at the above points. It also displays the path in which the user has to move. Graphical format shows one path at a time and a small window that contains the following details.

- **Solution number:** This indicates the number of the solution that is being displayed.
- **Origin bus stop within:** This indicates the range of distance within which the displayed boarding bus stop is located from the origin.
- **Destination bus stop within:** This indicates the range of distance within which the displayed alighting bus stop is located from the destination.
- **Trip type:** This indicates the type of the trip that is being displayed, i.e., whether result being displayed is a direct trip or transfer trip.
- **Total travel time:** This indicates the total travel time for the displayed result. The total travel time would be the time he started from origin to the time he reached the destination.
- **Downward arrow button:** Pressing this button gives the previously displayed solution. The previous displayed solution would have a travel time smaller than the present displayed solution's travel time, unless the present one is the first solution.
- **Upward arrow button:** Pressing this button gives the next solution to be displayed. The next solution to be displayed would have a travel time higher than the present displayed solution's travel time.

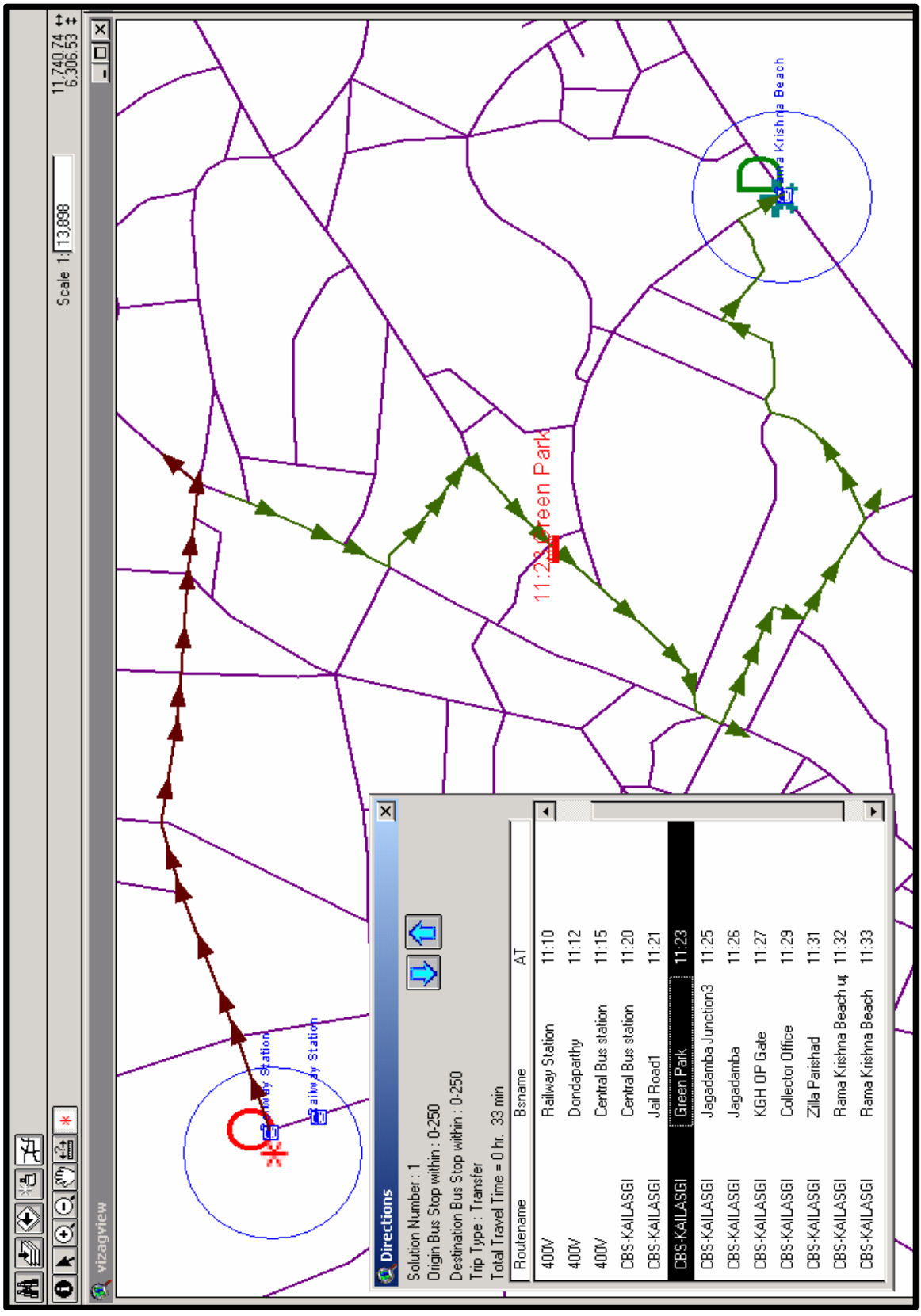

Figure 3.5: Display of output in graphical format. (The background map is removed for clarity purpose.)

The text format of the output is shown in Figure 8.6. The text format gives all the paths leading to destination. It gives the complete itinerary for each path found in the search process.

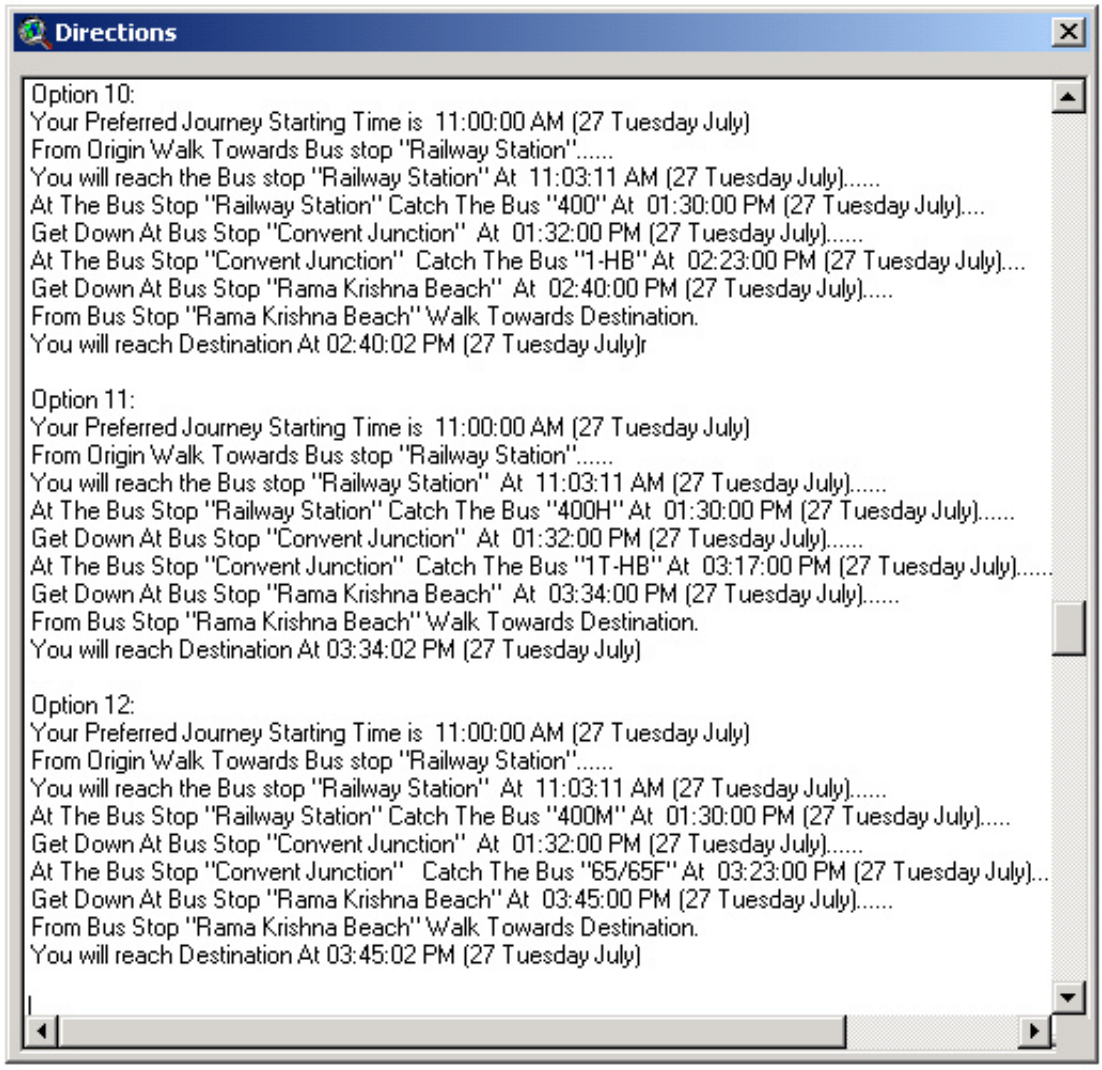

Figure 3.6: Display of the output in text format.

Chapter 4

Conclusions

The aim of the thesis is develop a GIS based transit information systems that can guide a user from his origin to his destination by giving him the shortest path (shortest travel time path). The thesis also aimed at providing him other alternatives of going from origin to destination. The alternative paths give the user a backup option to take the other routes if he misses the route that takes him by shortest path. The paths are to be given as quickly as possible. Different issues related to development of TIS like, the interface to take the input (origin, destination, journey starting time, and other trip related preferences), database management has been discussed in previous chapters. An algorithm has been proposed to give the shortest path and alternatives as quickly as possible. The algorithm gives output in a reasonably quickly. Results in Chapter 4 attest to this fact. Although the results are good both in terms of search breadth (the number of alternatives formed) and search speed still some improvements can be made.