Prasuna DVG Reddy, Post-Doctoral Fellow
Institute of Transportation Studies

Paul W Grant, Programmer/Analyst
Information Technology

Ryuichi Kitamura, Professor
Paul P Jovanis, Professor
Institute of Transportation Studies

Uni. California at Davis
DAVIS, CA USA 95616
Telephone: (916) 752-4194
Fax: (916) 752-6572

PRE-TRIP PLANNING USING IMAGE INTEGRATION AND NETWORK

The pre-trip planning systems will provide information to select a best path depending on conditions of travel by different routes. Here ARC/INFO is front-end software to the user and it has a database about the road network and traffic flows. The traffic flow data contains link flow volumes, maximum travel speeds and delay timings at intersections. This data also contains geocoded data for address matching. ARC/INFO modules NETWORK, IMAGE INTEGRATION and FORMEDIT are used for this application.

INTRODUCTION

Pre-trip planning systems are proposed as part of establishing information systems for Intelligent Vehicle Highway System (IVHS) program; the systems will provide information on conditions of travel by different routes and are either geared towards optimizing travel routes and schedules or selecting priorities for intermediate points between origin and destination.

Pre-trip planning information systems provide travelers with current information on available transportation services. Present systems are configured to deliver data on transit service status, expected arrival times, and other dynamic information to the travelers' home or office in a timely manner, thus improving their pre-trip travel planning. Pre-trip planning systems are expected to provide direct user benefits by facilitating the selection of better travel options. They also may contribute to increased transit patronage by making routes, schedules, and other vital transit information available to potential users. This in turn will improve the performance of the entire transportation system by better balancing modal split.

COMPLEXITY OF INFORMATION SYSTEMS

The characteristics of the information system have a very significant effect on how well the driver can obtain the necessary information efficiently and accurately (Swift and Freeman, 1986; Walker et al., 1990; Imbeau et al., 1989; Aerde and Blum, 1988). A complex information system may provide a great deal of information but be hard to follow. This results in reduced performance, thereby making the system inefficient. In fact, a recent FHWA study found that navigational displays with medium levels of complexity are better than higher levels of complexity (Walker et al., 1990). This is the basis for this application and the system will provide information with a simple interface. Where a more complex interface is required for getting information, those features are not included in the system development.

WHAT IS NEW

In addition to pre-trip planning, future systems may incorporate a wide variety of information functions(e.g.: dynamic traffic conditions, electronic pages, information about parking and real images of different facilities.). Although an onboard unit may aid drivers in a given task, drivers prefer to get information as close as possible to real information. The present systems do not have a good representation of the above facilities. For example: if a driver defines his origin and destination, the system will give him a shortest path representation on a network in a simple line diagram. But no system will navigate the driver from origin to destination with real images. Here, navigation means providing a view of how a particular road link looks when a driver enters into that link. The other main drawback in present systems is that they will not display the image of the destination or particular facility. If the driver knows the shape, color, elevation and perspective of the destination, it helps him to identify it quickly. If he knows what the intermediate route or landmarks look like, then the probability of making mistakes is much less.

AIM

The aim of this work is to develop a geocoded address database which overlaps the network. This explains every address in the study area. Geocoded image data for most of the points (e.g., shopping malls, intersections, hospitals, bus stops, etc.,) will be developed. In the first phase of the study, image based geographical points will be developed. This helps users to view intermediate points of their planned route and destination. In the second phase, the image database will be expanded to major intersections and some facilities available in yellow pages. All these facilities will be accessed by giving the address. In the final phase of the project, a navigational database and image database of different facilities (which is called electronic pages) will be developed. This final phase also contains the image query language to access required images.

OVERALL SYSTEM

The overall system is divided into five stages.
1. User interface

2. Network building
3. Address matching
4. Image integration
5. Developing query system

The user interface is the central part of all other modules. The module FORMEDIT with Arc Micro Language (AML) is used to develop a user interface. The user-interface is structured depending upon the user requirements.

The next stage of the project is network building. The network module is used to develop a network layer. Before this, the network cartographic information will be extracted from the TIGER/LINE database. Once this database is viewed on the screen, the network is furnished with turning movement restrictions and average travel speeds in each link. This creates two additional tables, a turning movements table and an impedance factor table with the INFO database. The Yolo county Tiger file is converted into an Arc layer and geocoded for the city of Davis.

The network layer is provided with addresses by doing geocoding and address matching. These addressees may vary from household to yellow pages. In the first stage, a limited address match from Tiger files are used for image integration. The missing addressees and road links will be updated in second stage of the project. At present, the images of the facilities can be accessed by clicking on the facility.

(The IMAGE INTEGRATION is an image display tool that displays vector and raster data concurrently in ARC/INFO. Black and white, gray scale, pseudo color and true color images can all be displayed on the screen or sent to a hard copy device. This helps to georeference an image to real-world coordinates, store a set of spatially related images in an image catalog, and control the display of an image or image catalog. Images encountered in geographic applications are grouped into two classes: 1) images that are associated with features in a geographic location of interest, such as a scanned architectural drawing of a building representing a point feature in a coverage, or an oblique photograph from a vista point along a road represented as a linear feature in a coverage, and 2) images that occupy the geographic space of interest, such as an aerial photograph, a satellite image or a scanned topographic map or scanned view of a building.

Images can be viewed on the screen or output to a hardcopy device. Images can provide additional attribute information about coverage feature and, when registered to a real world coordinate system, can serve as a backdrop to coverage data, assisting data input, update and verification. After doing this, all the images are classified into image catalogs. ~~This part of the work will be done in the third phase.~~ An image catalog is an organized collection of spatially referenced, possibly overlapping geographic images, that can be accessed as one logical image. Image catalogs typically contain images that depict the same thematic information for a given geographic area of interest. For example, a group of scanned photos of a particular road link or different hospitals under hospital catalog, or different car rental agencies under an automobile rental catalog. This is otherwise called 'Electronic pages' which are similar to telephone yellow pages. The electronic yellow pages are the computer database for existing yellow pages and can be graphically accessed to required features.)

The last part of this work is developing a query system which helps in locating a feature in the electronic pages. This totally depends on the type of user who is going to access the electronic pages.

WHAT IS DONE

We selected the city of Davis as a study area for developing a prototype. Using Tiger/Line files, the Davis town map has been created as one of the layers in ARC/INFO. Later we collected information about maximum speed limits on each link of major arterials in Davis. The data has been transferred to network file. The remaining links (neighborhood streets) assume a speed of 25 mph. The turning movement restrictions are classified into signalized intersections, links with stop signs and uncontrolled intersections. Each class was assigned a constant set of turning movements restrictions regardless of traffic volumes. Once the network file was ready, we did some tests to find out shortest paths to verify the validity of the network developed. It shows fully accurate shortest paths because Davis is a small town with no traffic congestion.

The next step is the collection of images. In this process we surveyed and selected some important facilities in the town and used a digital camera to acquire images. At the same time, the recording of their geographical addressees has been done. These images were ported to a DEC station 5000 where ARC/INFO is available. Using IMAGE INTEGRATION the locations for images are fixed. At present, we can view any image by clicking on the facility in the network coverage with point data. That means all these facilities are stored as point data type. At present we are geocoding all addressees on Davis and developing a user interface using FORMEDIT.

A fundamental problem addressed by network analysis is finding a shortest path in which to visit a series of locations/facilities in a network. The cost is determined using distance as an attribute of the network. In ARC/INFO, networks are represented with line coverages, stops, or the locations to be visited (in pre-trip planning) in an INFO file. The shortest path is computed and saved as a 'route' in a 'route-system' that can be graphically displayed using the route display commands in ARCPLOT. The network commands PATH and TOUR are used for finding minimum paths.

A 'Path' is a minimum impedance course through a network where the stops are visited in predetermined order. The other NETWORK utility is 'Tours' where both the order in which to visit the stops and the shortest path between the stops must be found. The 'Tour' is a path determined by ordering the stops and then finding the least-cost path that visits them. The classical example related to this application is a person having an agenda for the day and trying to allocate ranking of events in the agenda depending on the time and network travel times. This feature will be included in the system later.

In practice, most problems similar in nature to above problem (traveling salesman problem) impossible to solve exactly. Finding the true optimal solution would require too many calculations to be feasible. NETWORK uses a heuristic (informed guessing) approach that finds an approximate best tour. For most situations, this method yields a tour for pre trip planning very close to the optimal solution, yet computationally manageable.

The whole application is dependent on features of the database. That means all the analysis is done with point database while specifying origin, destination and intermediate points in pre-trip planning. So, if anybody want to find the closest facility from where they are, we used the allocation command. For example, a person want to locate the closest gas station or hotel, this feature helps him very much.

Assigning portions of a network to a location based on pre-determined criteria is referred to as 'allocation'. The ALLOCATE command assigns areas of the network to be served by a facility. In NETWORK, allocation is based on three criteria: 'supply, demand and impedance'.

Supply refers to the quantity of resource a facility, referred to as a 'center', has available for utilization through the network. Demand quantifies the utilization of the resource as portions of the network are assigned to the center. An allocation completes when the total demand assigned to a center matches the supply of the center. For example, a shop has a quantity available for people who live in homes located on the streets of a city. Impedance is the cost associated with utilization of the supplied resource through a network. Here Distance is used as impedance.

All these features are transformed into images using IMAGE INTEGRATION module. ARC/INFO coverage exists in a real-world or map coordinate system, measured in feet or meters. The X-coordinate increases from left to right, and the y-coordinate increases from the bottom to the top. For coverages and images to be displayed simultaneously, the rows and columns of the image must be mapped onto the x, y plane of a map coordinate system.

An image-to-world transformation that converts image coordinates to map coordinates must be established. REGISTER is an interactive program that allows you to enter a series of links, or displacement vectors, identifying location in an image and their corresponding locations in the map coordinates. A six-parameter transformation is then calculated using the links as a series of control points. REGISTER creates a multi window display with functions to pan and zoom around the image, add and delete links, register the image using the current links, and save the computed transformation. Links are added using the mouse to identify an image point and its corresponding map coordinate point.

CONCLUSIONS

The outlined system provides a new way of graphically manipulating and displaying large scale GIS applications in a networked environment. This system also developed a bridge between a Geographic Information System (GIS) and a visual database system in the pre-trip planning context.

REFERENCES

Aerde, Van and Blum, Yuval. Electronic Route Guidance in Congested Networks. ITE Journal. Vol. 58, No. 8, August, 1988.

Imbeau, Daniel, Wierwille, Walter W., Laurie D. Wolf and Gail A. Chun. Effects of Instrumental Panel Luminance and Chromaticity on Reading Preference in Simulated Driving. Human Factors, 31(2): 147-160.

Swift, D. W. and M.H. Freeman. The Application of Head-Up Displays to Cars. Vision in vehicles, Edited by A. G. Gale et al., Elsevier Science Publishers, B. V. (North-Holland), 249-255, 1986.

Walker J., Alicandri E., Sedney C. and Roberts K. In-Vehicle Navigation Devices: Effect on the Safety of Driver Performance. FHWA-RD-90-053. Office of safety and traffic Operations, Research and development, Federal Highway Administration, McLean, Virginia, May, 1990.