Computer Based Highway Reference System

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INTRODUCTION

Background

The hard copy State Highway System Reference Manual, which is currently being used by the Utah Department of Transportation (UDOT), provides a convenient single reference to correlate inventory data with highway and topographical maps. It provides a standardized means of positively identifying specific locations on any state highway and allows information from many sources to be correlated so specific items can be readily identified. The data most widely and frequently used have been incorporated into the Highway Reference System format. The key elements to identify a location is the Route Reference (state route number) and Reference Number (milepost). Throughout this report, the use of the word "Manual" refers to this hard copy manual.

There are certain potential problems with the Manual. The hard copy of the Reference Manual is a bulky book, making it inconvenient to carry onto the field. Thumbnailing the book (i.e. turning pages one after the other) to access the data about a particular road section is time-consuming and requires a lot of effort. It is laborious and costly to edit or update any particular road section in the book. Adding a small detail to the road section would mean replacing the entire page with a new and updated page to incorporate the new data. This kind of updating calls for an old and obsolete back-up method of saving all the old pages. There is no feature in the Manual that can provide the name of the person who updated that page or the time of an update. Several spreadsheets and PC-based databases (e.g. Paradox) are being used for maintaining the route and inventory data. (about 45,000 records).

Project Objectives

The objective of this project is to produce a prototype CD-ROM containing the Manual in an electronic format, which can be viewed directly from the CD-ROM. Specific objectives include:

1) Establish and meet with a Technical Advisory Committee (TAC) to receive direction and feedback on the project.
2) Consolidate data from various sources at UDOT into a conventional non-proprietary database system.
3) Provide a computer-based editor for maintaining the database.
4) Develop a prototype viewer for displaying the state highways using the UDOT standard GIS Route file, and interfacing the database inventory with the route display.
5) Provide UDOT with the prototype CD-ROM.

DATABASE DEVELOPMENT AND EDITOR

This section of the report discusses the new database and editor for consolidating the data. It was developed using Borland's Dephi 4.0, a rapid application development tool. Database Desktop, a Borland royalty-free development tool, was used for maintaining the Reference Manual's dBase tables. The purpose for a new editor is to provide an interface that is user-friendly, interactive, and easy to maintain

Comparisons

This section describes the features of the old version of the Reference Manual and discusses the drawbacks and disadvantages in using it. It also discusses the reasons UDOT wanted to convert to an electronic manual. This section concludes with a detailed explanation of the advantages of the electronic version of the Reference Manual over the old version.

The following subheadings describe the drawbacks of the hardcopy Manual and the way that these drawbacks are handled by the new electronic CD.

Browsing

The hard copy of the Manual is a bulky book, making it inconvenient to carry into the field for reference. The CD is compact and can be stored in a laptop, making it easier to carry out on to the field. The size of the executable file is 734KB. The size of the database file is 5.37MB. This feature minimizes the efforts of the users in two ways. First, the user does not have to carry the bulky book and second, the user does not have to do two different activities for making the changes/additions in data spreadsheets.

Editing

It is laborious and costly to edit and update any particular road section in the Manual. Adding a small detail to the road section means replacing the entire page with a new and updated one. This kind of updating calls for an old and obsolete back-up method of saving all the old pages. Maintaining an archive of all the updates adds to the difficulty maintaining data integrity. Also, there is no validation of changes to the Manual. The electronic version provides an easy method to minimize the time and effort needed to edit, update, and archive changes to the database file. The user just needs to click a few buttons and enter the required data to edit or update the database. All the changes to the database are validated first by the application, and then the changes to the database table are made permanent. The application also prevents the user from omitting required values for fields. The electronic version has a convenient back-up feature – a copy of all the deleted/updated records is stored in a different database file (an archive database table), which can be accessed by the user by shifting between the tabs, while working with the original database file.

Validation

Currently there is no feature for providing the name of the person who updated a page for the Manual. The electronic version has a feature that automatically inserts the user name and the revised date into the database whenever a change to the database is posted. The user name is the one the user is prompted to enter while logging onto the application. The date is the system date. This provides an option of keeping track of the user who made the changes.

Maintenance

Spreadsheets and PC based Paradox databases are being used to maintain data. Hardcopy drawings are being maintained for the route maps. This system introduces the potential for data inconsistency. For example, the problem could occur when the Manual has the updated information and the spreadsheet has the old information or vise versa. This method of keeping two sets of records that might lead to data inconsistency is eliminated in the electronic version because there is only one set of records and the user can update the soft copy instantly, using the application.

Thus the prototype electronic version is developed in such a way as to be free from most of the disadvantages of the old version of the hard copy Manual.

Database Editor

This section describes the application developed to maintain the database using the user interface.

The application opens with a Log-on Information screen as shown below.

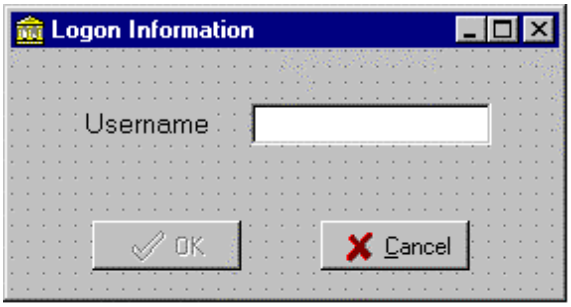


Figure 1. Logon Information Screen

Logon Information Screen

The user is prompted to enter a User Name. The “OK” button in the figure above is disabled. This button will be enabled only when the user types in at least four recognizable characters in the field “Username.” Otherwise, the application invokes an alert asking the user to enter four recognizable characters. Entering the appropriate user name and clicking on the “OK” button will successfully let the user log onto the application and access the database tables for data manipulation. The application stores the user name, which is later posted onto the database table whenever the user commits a change to the database. The user can cancel logging onto the application by clicking the “Cancel” button.

View Database Screen

The figure shown below (Figure 2) pops up when the user enters an appropriate user name and clicks the “OK” button. This form named “View Database” enables the user to view and manipulate the data in the database. Every form in this application is provided with the Windows environment look-and-feel for using the keyboard (hot keys) in place of the mouse. Any button or menu can be executed by using the ALT key on the keyboard in combination with the character that is underlined for the respective button or menu. (e.g. ALT + C would activate the cancel button in the first form (Figure 1) canceling the logging activity).

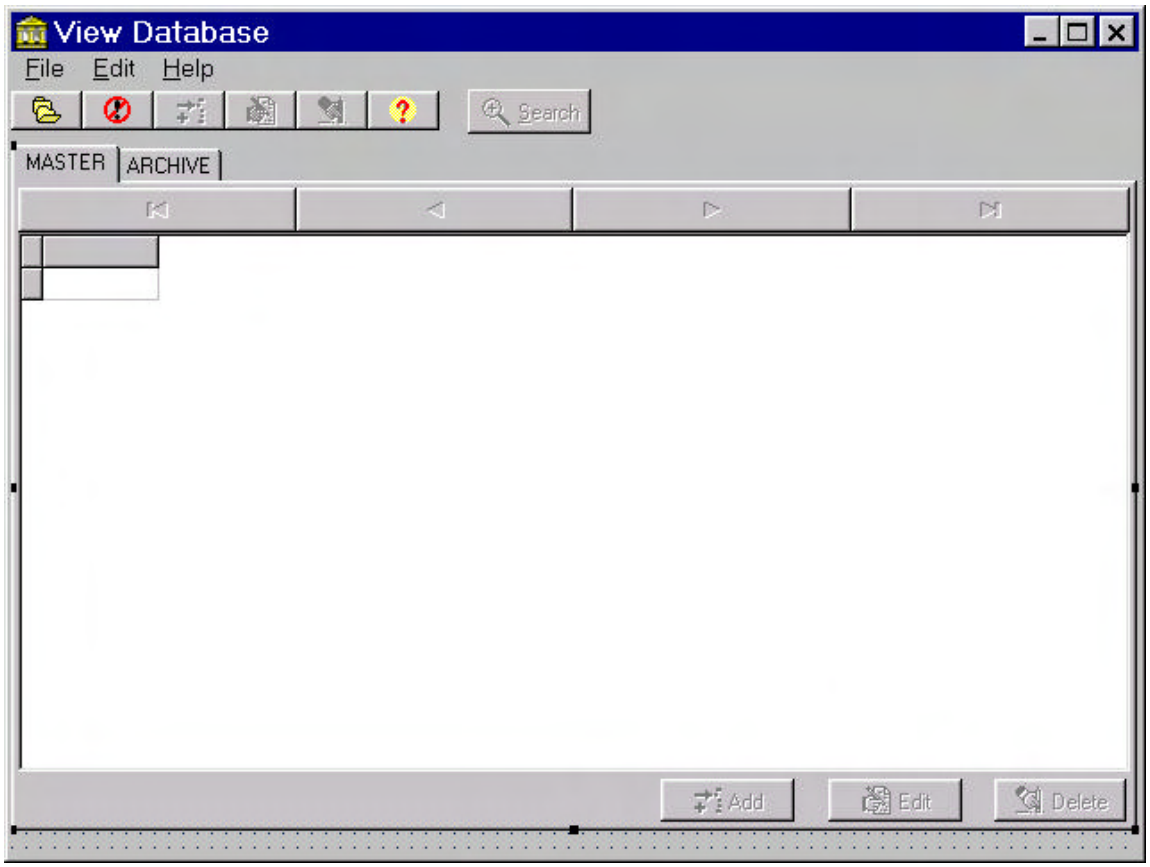


Figure 2. View Database

Interface Description

Figure 2 is the main form of the application, which provides direct access to the database table. The form "View Database" contains the following items:

- A main menu with "File," "Edit," and "Help" drop down menus.

Figure. 3 Main Menu

- A speed bar with the following speed buttons and a “Search” button.

Figure 4. Speed Bar

- A tabbed notebook with two tabs, “MASTER” and “ARCHIVE,” to access the two worksheets containing the master and archive tables.

Figure 5. Note Book Tabs

- A grid in each of the worksheets to display the records from master and archive tables.

- A tool bar to browse through the table.

Figure 6. Navigation Bar

Note: The main menu and speed bar both serve the same purpose. The speed bar provides faster access to the application items.

Main Menu

The main menu (i.e., the drop-down menu) contains a “File” menu. This menu has the following drop down items in it. 1.Open 2. Close

1. Open

Selecting the open item, the user can open any file by browsing through any drive of the computer. If the user opens the appropriate database file, which is usually the master table for the Reference Manual, the table opens up in the grid. This also opens the archive table simultaneously. The user can shift between the tables by clicking on either of the tabs namely master and archive. Opening the tables successfully enables the add, edit, delete and search buttons. These buttons are disabled when the application is started first.

2. Close.

The application can be terminated any time by selecting the close item.

The edit menu of the main menu bar has the following drop down items: 1. Add, 2. Edit, and 3. Delete.

1. Add

To add any record to the master table, select the add item in the edit drop down menu. This opens up a new form named “Append Database.” (Refer to the description for Figure 9).

2. Edit

To edit any record existing in the master table, select the edit item in the edit drop-down menu. This opens up another form named “Edit Database.” (Refer to the description for Figure 10.)

3. Delete

To delete any existing record from the master table, select the delete item in the edit drop-down menu. This prompts an alert “Delete the current record and archive?” Giving a positive response would delete the current record from the master table that the cursor is pointing to and stores it in the archive table.

The main menu bar also contains a help drop-down item. Currently the help drop-down menu item consists of “About” item. Selecting this will prompt a form showing the name of the application and its developers. A future provision for a complete on line help file for using the application is contemplated.

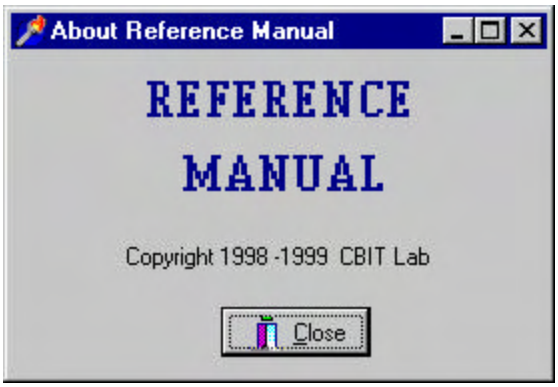


Figure 7. About Reference Manual

Speed Bar Icons

The speed bar contains the following icons, which serve the same purpose as the items in the main menu.

The above icon serves the purpose of open item in the file drop down menu of main menu.

The above icon is used to close the application at any point of time. It is same as the close item in the file drop down item of main menu.

The above icon does the same work as the add item in the edit drop down menu of the main menu.

The above icon is same as the edit item in the edit drop down menu of the main menu and is used to edit the database.

The above icon is used to delete any record. It is same as the delete item in the edit drop down menu of the main menu.

The above icon is used to invoke help file. It is same as the help item in the main menu.

Search Screen

This is the icon for searching. Clicking this button will invoke the following form named "Search Database." This form can be used to search for a particular record using any of the three indexes. ROUTE, ACCMILE, TYPE, REMARKS are the indexes with which the database table can be searched using the search option. To search for records, the user first has to select the index name in the "Sort By Index" drop down list, with which the table is to be sorted. After selecting the index, the user has to type in a string in the "Search String" box and click on go.

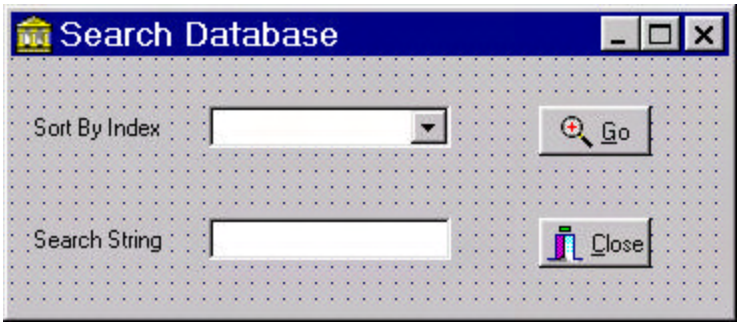


Figure 8. Search Database

This will fetch all the records that meet with the search criteria. An alert saying no records have been retrieved is prompted when no records match with the search criteria. Clicking on the close button at any time will close the search form and returns the user to the main form, view database.

The user can shift between the master and archive tables by clicking on the master tab or the archive tab of the tabbed notebook. This enables the user to view both the master and archive tables during the run time of the application. The user can check both the tables during run time to make sure that no data is being lost during editing or deleting the records.

The grid in the main form is useful in displaying the tables. Each of the worksheets in the tabbed notebook has a grid each for displaying the master and archive tables.

The above tool bar can be used to manually browse through the records to search for any particular data. The first button in the tool bar (with |← icon on it) will move the cursor onto the first record of the table. The second button (with ← icon on it) enables the user in browsing a single record at a time in the decreasing order of record number. The third button (with → icon on it) will enable in browsing a single record each time in the increasing order of record number. The final button to (with →| icon on it) can be used to move across all the records onto the last record. This tool bar is useful when the user wants to browse a single record each time and get back to either the first or last record when browsing is completed.

Append Database Screen

To add any record to the master table, select the add item in the edit drop-down menu. This opens up a form named "Append Database" (Figure 9).

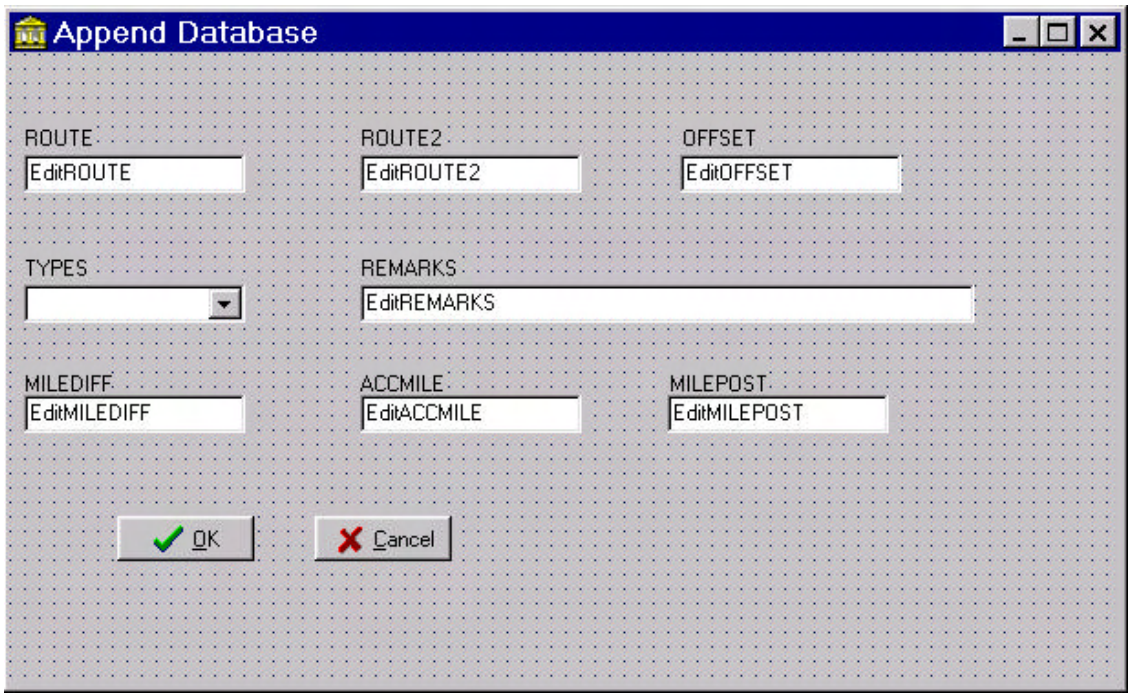


Figure 9. Append Database

This form consists of eight edit fields. The first edit field is ROUTE. This field takes in a valid Route Number. The second field is ROUTE2. The third field is OFFSET. The fourth field is TYPES, which is a drop down list with all the valid types. The fifth field is REMARKS. This field takes in a string as input. If the TYPES is selected as REFPOST, any string typed in the REMARKS field is stored in the database leaving two blank spaces in the beginning of the field. (This is one of the UDOT requirements). The sixth field is MILEDIFF and it takes in only integers. ACCMILE is the seventh field and even this field accepts integers. The final field is MILEPOST, which also accepts only

integers. The user is forced to enter all the fields before he chooses to append the database with the newly created record. Leaving any of the fields blank and trying to post the record will prompt an alert asking not to leave the fields empty. Populating all the fields and clicking on OK will successfully post the new record at the bottom of the existing data table and returns the user into the main form (view database) where the user can browse through the master table and confirm that the record is appended. Clicking on the cancel button at any time will return the user to the main form without posting the new record in the master table.

Edit Database Screen

To edit any record existing in the master table, select the edit item in the edit drop-down menu. This opens up another form named "Edit Database" (Figure 10). The fields in this form are similar to the fields in the append database form (Figure 9). Whenever the user is browsing through the database master table, the fields in the edit database form are populated with the active record's field values. When the user clicks the edit button on the main form, the edit database form opens with the field values in the form same as those of the active record. This option helps the user in browsing through the records and clicking the edit button whenever he finds the record that is to be edited. The user can edit any of the fields and click on the OK button to post the edited record. An alert is prompted with the caption "Post the edited record and archive the old one?" Giving a positive response would post the edited record in the master table and archive the old record.

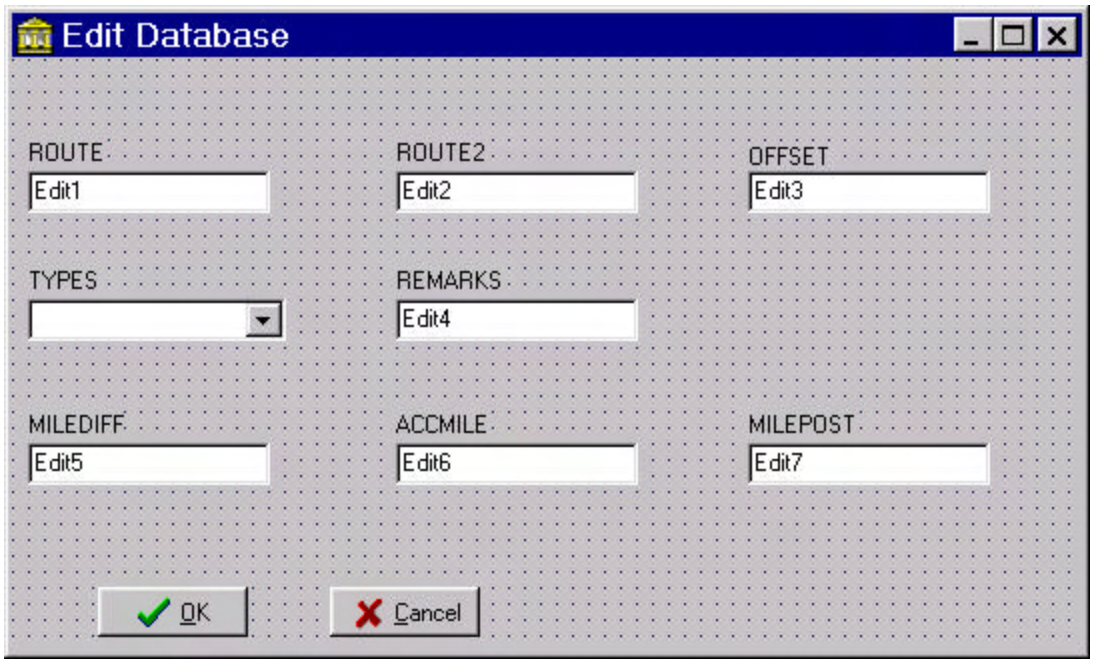


Figure 10. Edit Database

ELECTRONIC VIEWER

Getting Started

The program operates in two windows, as shown in Figure 11. The first is the control window, where data is entered and properties are specified. The second window is the display window where data is displayed according to the properties specified in the control window.

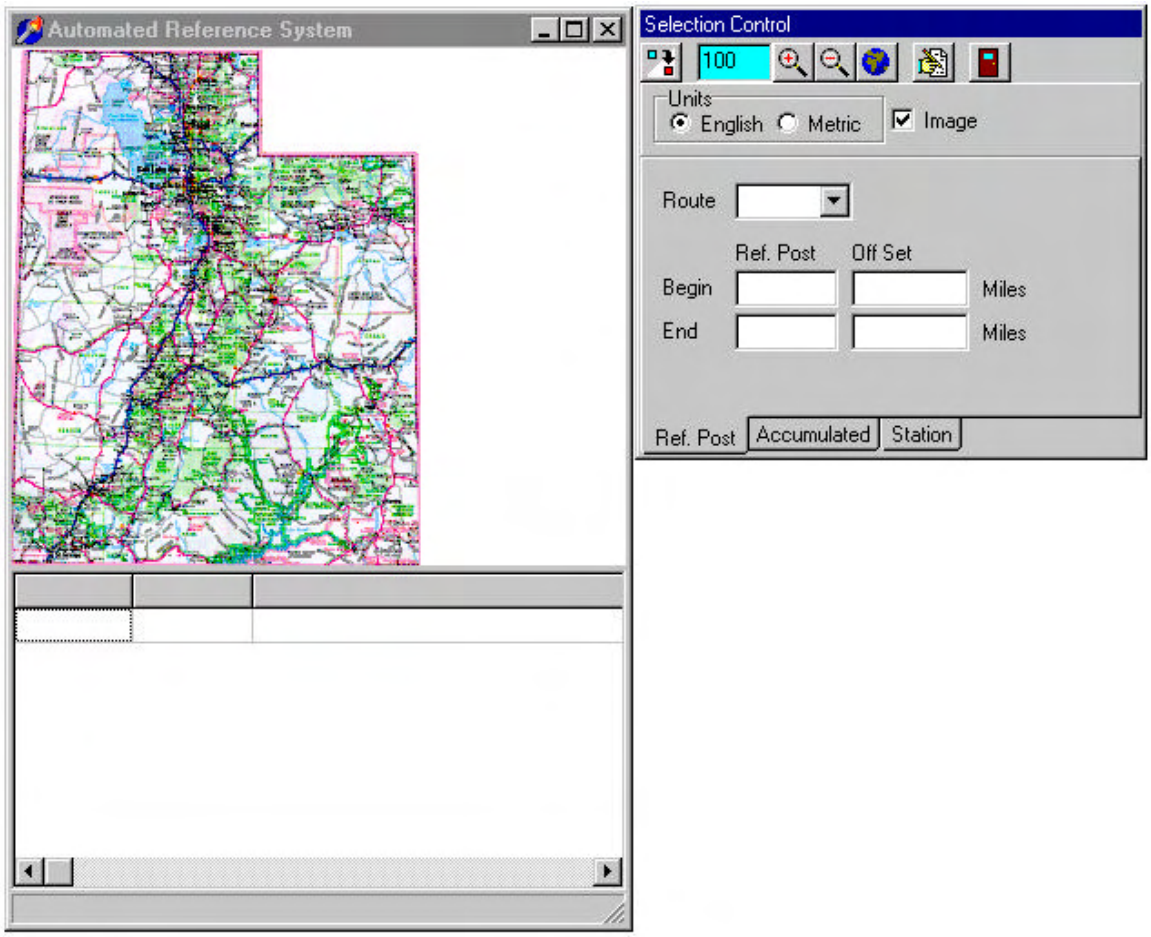


Figure 11

The features in the reference manual are used through the toolbar. The tool bar has six commands. Understanding these six commands is all the user needs to know for use of this program. The six commands and an example of how they are used follow.

Summary of Commands

Exit Command

Use this command to exit the program.

Show Options

This probably will be the most used command. After you click this button a new window will appear (see Figure 12). In the filter tab you choose the fields you want information about. And in the display tab you choose the information that you want for those fields.

The route tab lets you choose the colors that you want on your map. The files tab will let you specify where your data files are located. The first time you run the program it should locate the files and set itself up. But if you have any problems or move the files at a later date, you will need to put the new paths here.

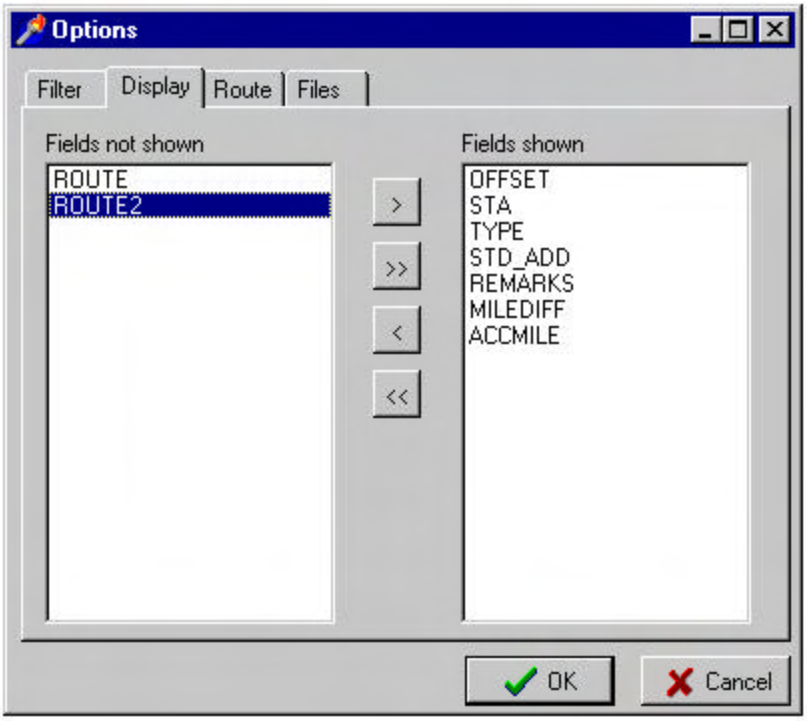


Figure 12

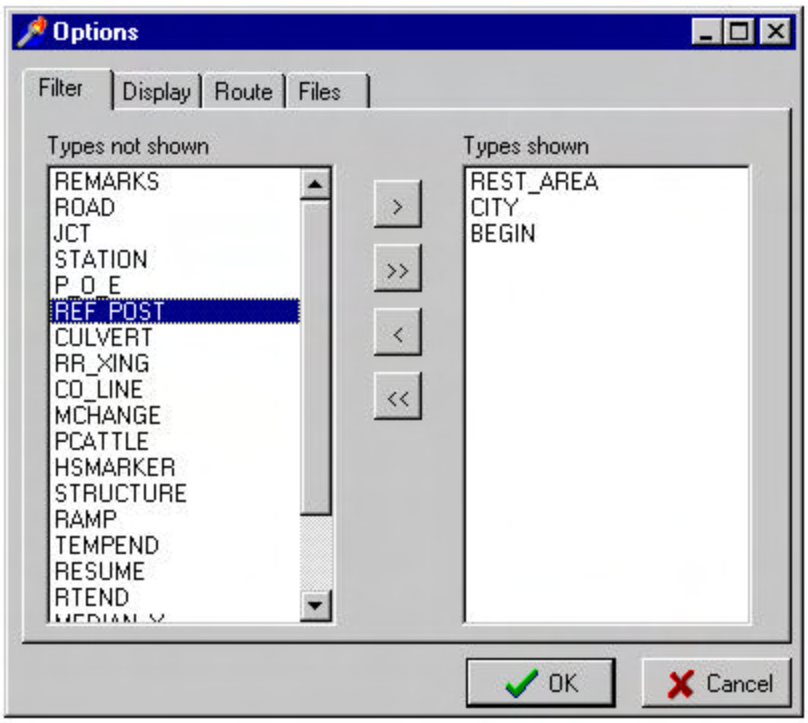


Figure 13

View Selection

After you make your changes in the options window you can see them in the display window by clicking this button. For this command to work you must choose what section of the state you want to display. This is done in the main control window (see figure 14). This can be done three ways. First in the ref. post tab, you choose the route you want displayed, and the two reference posts. It will then display all the information you requested between the two posts. Second is the accumulated tab where you choose the route and the beginning and ending mileposts on that route. The third method is the station tab where you choose the route and the station you want displayed and it will show you all the information around that station. The tab that is active when you click on the view selection button will be the tab from where information is used.

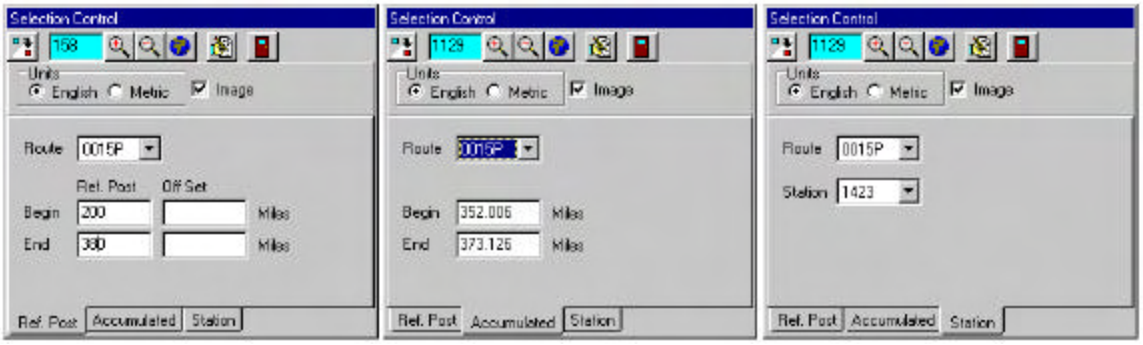
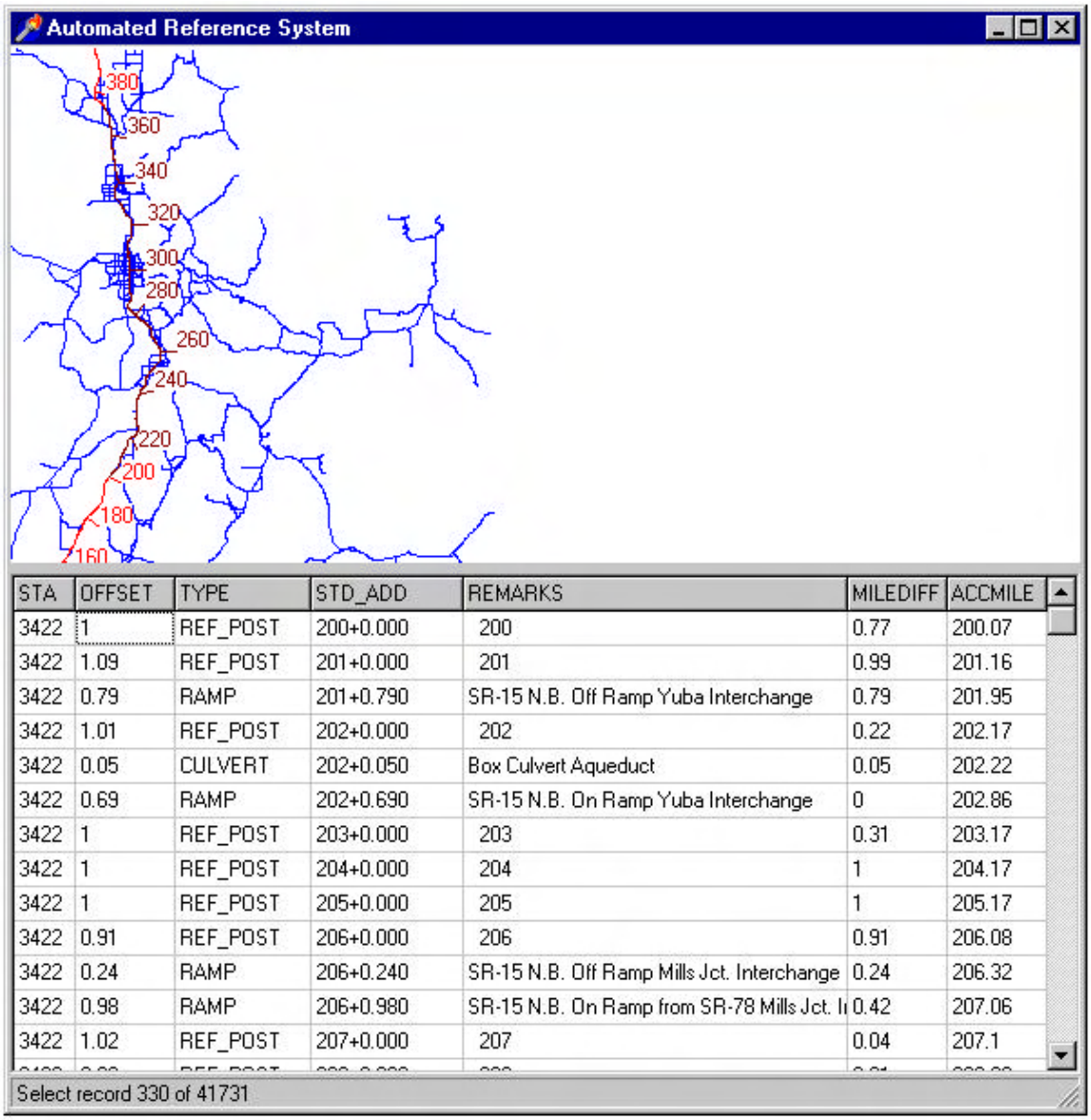


Figure 14

With the information displayed in the options windows in Figure 12 and Figure 13 and the reference posts shown in the ref post tab in Figure 14 the display window in Figure 15 will be brought up.



STA	OFFSET	TYPE	STD_ADD	REMARKS	MILEDIFF	ACCMILE
3422	1	REF_POST	200+0.000	200	0.77	200.07
3422	1.09	REF_POST	201+0.000	201	0.99	201.16
3422	0.79	RAMP	201+0.790	SR-15 N.B. Off Ramp Yuba Interchange	0.79	201.95
3422	1.01	REF_POST	202+0.000	202	0.22	202.17
3422	0.05	CULVERT	202+0.050	Box Culvert Aqueduct	0.05	202.22
3422	0.69	RAMP	202+0.690	SR-15 N.B. On Ramp Yuba Interchange	0	202.86
3422	1	REF_POST	203+0.000	203	0.31	203.17
3422	1	REF_POST	204+0.000	204	1	204.17
3422	1	REF_POST	205+0.000	205	1	205.17
3422	0.91	REF_POST	206+0.000	206	0.91	206.08
3422	0.24	RAMP	206+0.240	SR-15 N.B. Off Ramp Mills Jct. Interchange	0.24	206.32
3422	0.98	RAMP	206+0.980	SR-15 N.B. On Ramp from SR-78 Mills Jct. I	0.42	207.06
3422	1.02	REF_POST	207+0.000	207	0.04	207.1

Figure 15

View All

This command sets the map focus at 100 percent. This setting will show the whole state of Utah on the Map (as in Figure 11).

Zoom Out

This will change the zoom on the map in the display window. It will not zoom out past 100 percent.

Zoom In

This will allow the user to zoom in on the map. To use this feature you must click the button so it is down. Then choose a section of the map you would like to look at then drag a rectangle over this section. The section you just outlined will now take the whole of the view area. The zoom in magnitude will be determined by the size of the box you outline.

SUMMARY

A prototype software application was developed to evaluate the feasibility of replacing the hardcopy UDOT State Highway Reference Manual with an electronic version. The application was implemented for distribution on CD-ROM.

Meetings were held at UDOT and the sources of current inventory data were located. Data from various sources were consolidated into a conventional database system.

The ArcInfo Route file of the Utah highway system was obtained, and original software was developed to directly access and display the coordinates from the native Route file.

An editor interface was developed for the inventory database. The editor provides a number of features to help ensure data consistency, data completeness, and robust archiving.

A viewer was developed to display selected sections of the state highway system, and to display selected inventory items located in that section.

The editor, viewer, inventory database, and route file were implemented on a CD-ROM and distributed to UDOT.

The CD-ROM application was demonstrated to the UDOT Technical Advisory Committee. It provides a scaleable view of the highway route system and fast convenient access to the inventory data.

REFERENCES

[1] Utah Department of Transportation (UDOT). Highway Reference System.

[2] Marco Cantu`. Mastering Delphi 4, 1998. Sybex Inc.