Introduction

Many transportation agencies and Department of Public Works (DPW) users have the need to perform road inventory, pavement inspection, and roadside features inventory on a regular basis. In the past, the completion of these tasks requires significant cost and extensive field effort. Enterprise Information Solution, Inc. (EnterInfo) used an integrated system, EnterRoadInfo, to complete road asset inventory and pavement rating projects for Charles County, Maryland and Howard County, Maryland for a fraction of the time and cost compare with the traditional approach. The system components include GPS, digital cameras, GIS, digital compass, and a gyro navigation system.

EnterRoadInfo captures digital images while the vehicle is traveling. GPS coordinates (and/or the linear reference mile point) as well as the pointing angle of each image are being calculated and recorded in a database. Using this approach, the location, dimension, and the type of the asset objects in the image can be calculated.

GASB34 and Asset Inventory

The **G**overnmental **A**ccounting **S**tandards **B**oard is a national independent organization that establishes standards for the preparation of financial reports and statements by local and state governments. **GASB** Statement **34** requires the measurement and reporting of the value and condition of all major infrastructures annually. These financial reports and statements are subject to verification by audit. Therefore, the data used to generate the reports needs to be accurate, easily retrieved and regularly updated.

The purpose of these reports is to show the financial health of a governmental entity. Elected officials, taxpayers, bonding companies and investors are all interested in knowing whether the infrastructures are assets or liabilities. Are the buildings, utility systems, highways, parks, etc. being maintained adequately? If they are, then an entity's bond rating would be enhanced. If they aren't, then their bond rating could go down with an increase in the cost of borrowing.

The compilation of accurate information about the thousands of items that comprise a Department of public works infrastructure is a time consuming and expensive effort that can be greatly enhanced with improved data collection and GIS. Accurate reporting requires that the component parts of major infrastructure items be evaluated. In a building, for instance, the roof, heating system, air conditioning, windows, etc., must all be evaluated. It can then be determined if the building is an asset or a liability. Other major infrastructure items like the water, sewer and highway systems are also made up of component parts. A highway system is comprised of the components of the system within the road right-of-way. Pavement, curb and gutter, sidewalk, trees, traffic signals and signs, streetlights, drainage facilities and bridges are some of the components of the system. Each of these components should be accurately identified and evaluated so that the condition of the highway system can be reported for GASB34.

For verification purposes it is necessary to store and retrieve the information that was used to develop the data that generated the reports. Preparing the data tables and then populating the fields with data for thousands of items could consume years of work if done manually. Also, the base information used to develop the data must be in a format that allows for the cross checking of data to source.

Updating the data for the annual reports must be done on a regular basis throughout the year. As items are added, deleted or improved this information must get into the data tables as it happens.

Project Requirements

Charles County had a need to perform field data collection and data validation services related to their automated Pavement Management System. The primary objective of the project was to properly segment the County's road network to support their current data model in Cartegraph PavementView Plus. Additionally, the County desired to construct the county road and sign database. Sample records included in the database are:

- Change in the number of road lanes
- Width of each lane including shoulder widths
- Type of pavement
- Type and location of County signs
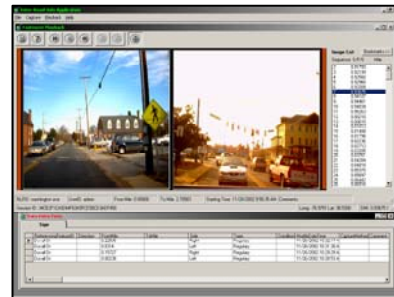
The Howard County Bureau of Highways (HCBH) performs pavement rating annually to determine its road maintenance budget. A video based asset-tracking solution was required to create and register digital images and voice descriptions to the county GIS road layer.

Solution Components

The project solution integrates Global Positioning System (GPS), Geographic Information System (GIS), vehicle Distance Measuring Instrument (DMI), gyro navigation system (optional) with digital cameras.

The system, equipped in a vehicle, produces digital images at known coordinates (and/or linear reference mile point) and pointing angle. With the use of the 3D computer graphic modeling, the coordinates of the objects in the images can be calculated. Consequently, the collection of roadside asset objects is accomplished.

Digital Cameras
The camera(s) can be mounted anywhere on the vehicle. Typically it is mounted on a roof
rack with an environmentally protected housing or on the dashboard. Usually one of the
cameras should point straight at the roadway and an additional camera can be mounted to
point at the side of the road. In the event that multiple cameras are desired, the distance and
the angle between two cameras must be accurate to ensure the accuracy of the Multi-Camera
Stereo Correction. Also, the specification of the lens and the Camera View and tilting angles
must match with the 3D measuring setting. Multiple cameras can be set up and the user can
select which camera(s) to record images and which camera(s) only capture images when user
clicks the Capture Snapshot button.
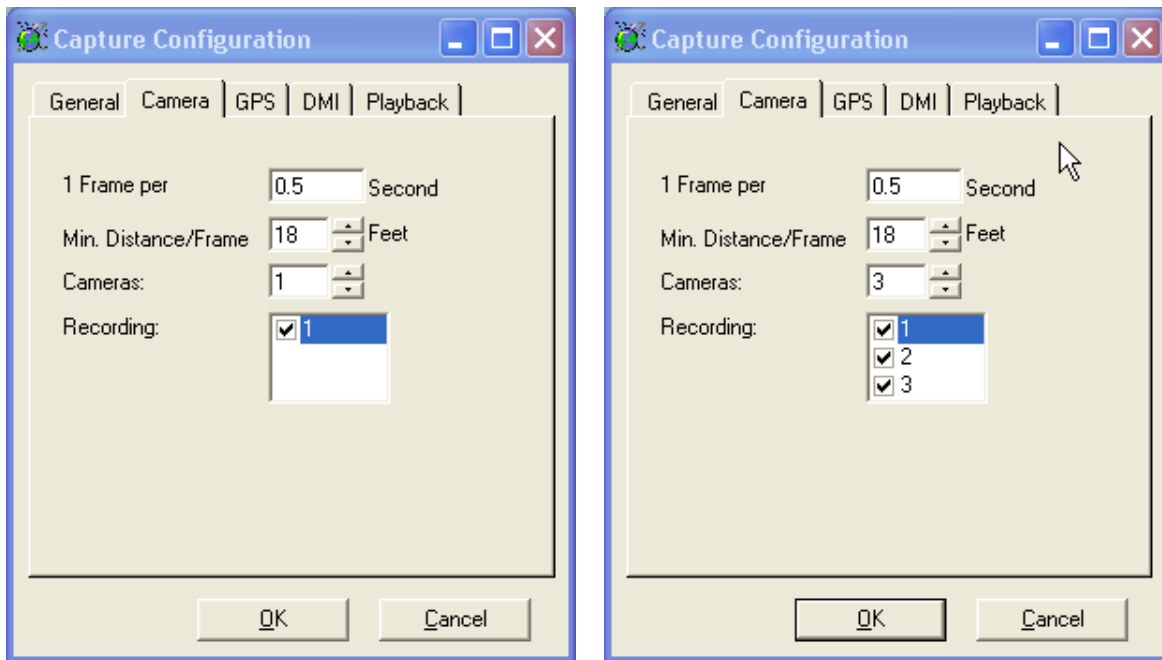
DMI
Enter-Road-Info uses distance measuring instrument (DMI) devices to track the linear
reference mile point along the road. For the two referenced projects, the DMI units used are
the Nu-Metrics NITESTAR Model NS-60.

GPS
EnterRoadInfo supports any NMEA-183 compatible GPS.

Gyro Navigation Device
EnterRoadInfo uses an optical gyro device to calculate the vehicle-pointing angle
continuously. In the event that GPS satellites are not sufficient, the data produced by the
DMI and gyro continue to fill in the gap and calculate the coordinates and pointing angle of
each image.

Component Configuration

Capture configuration and playback configuration is done through the "Capture Configuration" form. This form is accessible from both Capture and Playback modules.
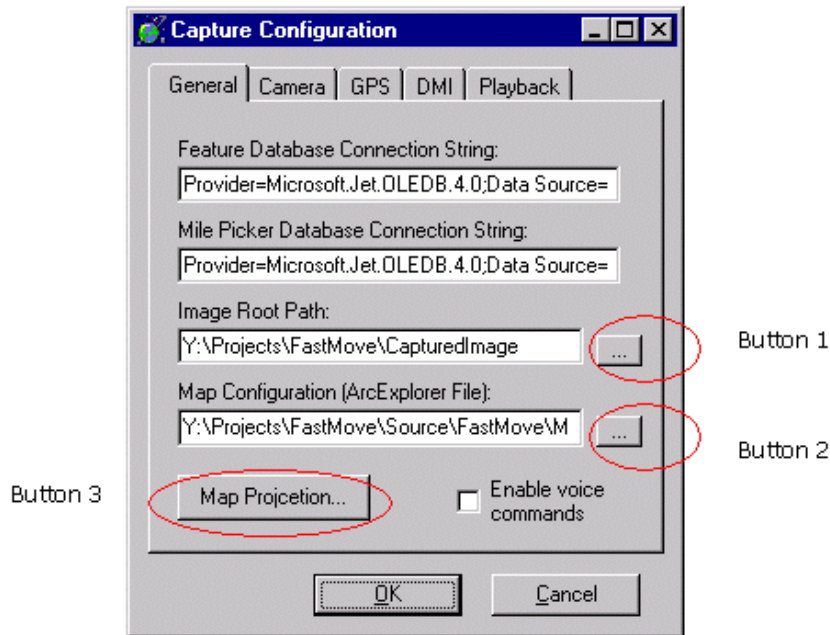

GIS Integration

The system is read for GIS integration. All a user would need to do for the images to register to the desired map projection is to provide the map layer projection information to the system so that correct projection conversion can be done. The user should know in advance what projection the base map layers use. User clicks the button labeled "**Map Projection**" to display the "Choose Projection" form. User selects the desired projection and clicks "OK" to set the map projection.
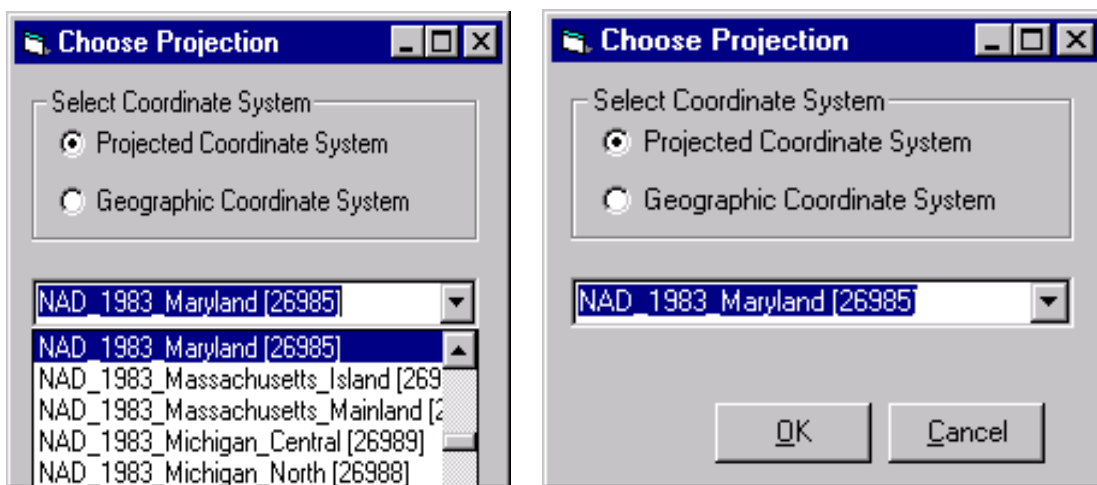
Location Track on Map

The user can optionally display the map by clicking on the "Show Map Window" item under File menu. The map will zoom to the road associated with current session. If "Tracking Location on Map" item is checked under File menu, the map will highlight the location of the currently displayed picture on the map.
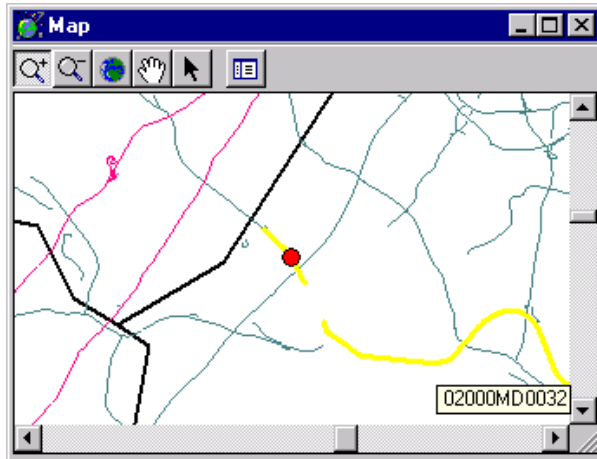
Add Asset Objects to the database

EnterRoadInfo's standard "Data Entry" interfaces were used to create the data records in the database. When users saw an interested asset item in the video (continuous images playback), he/she can clicked on the buttons to create the corresponding asset record in the database. The application was used to track both point features and linear features for the projects.
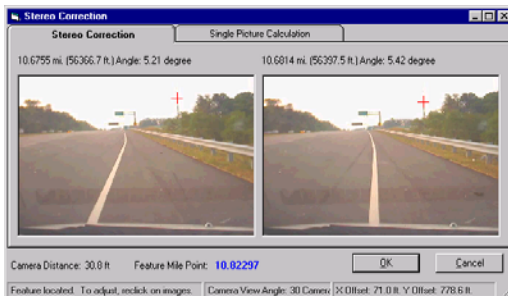
Dead Reckoning Using Gyro Inertial Device

The information produced by the integrated gyro-navigation device also provides the dead reckoning navigation capability to continue track the vehicle location even when the GPS satellites data are not adequate. The gyro system allows location tracking in many conditions, including tunnels, cities, mountains, and forested areas.

Project Results

The EnterRoadInfo project approach minimized the time required in the field and allowed the collected data to be validated in the office. Although most of the data was collected while in the vehicle using the touch screen input panel, data can be verified and added using the Playback module of EnterRoadInfo back in the office.

For the Howard County project, EnterRoadInfo is used to perform pavement rating. The EnterRoadInfo system was used to complete the required fieldwork for some 960 miles roads in 5 weeks. Back in the office, EnterRoadInfo allowed the creation of inventory database using its configurable input interface. The coordinates and dimension of the objects in the images can be obtained and input into the database using mouse clicks. The video display is synchronized with the vehicle location on the map. The user can click on any road segment to playback the images and the available voice files on the segment. The user can fast forward to the marked images to reduce the viewing time.

The input of the road ratings took about three weeks. Once the rating is completed, the road budget reports using various repairing strategies are produced automatically. The Howard County Bureau of Highway also planed to use the images for tracking inventory of pavement markings, parking lots, curb and gutter, sidewalks, signs, trees, streetlight, guardrail, fire hydrant, and drainage structures.
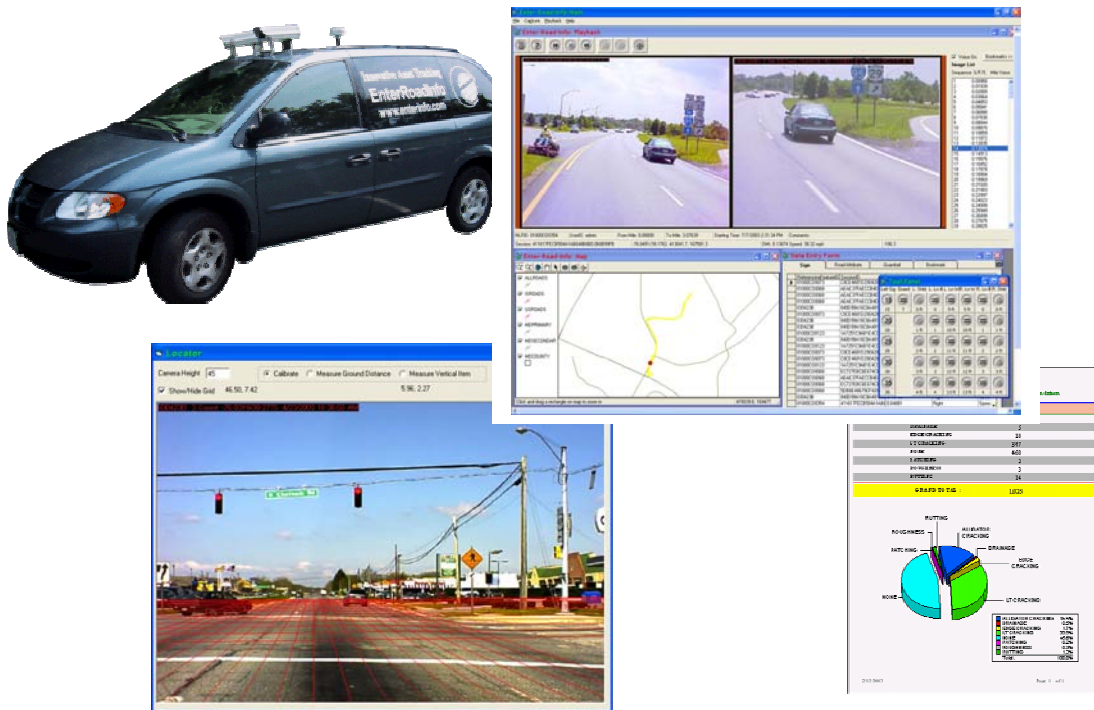
For the Charles County road inventory project, EnterRoadInfo was used to collect the road and sign attributes include county MUTCD type signs, number of lanes, and widths of the

road and shoulders. EnterRoadInfo's end product is a countywide GIS map showing each road segment within the county. The user can click on the road to view the video as if they are driving along the road.

EnterRoadInfo supports the display of available road layer in the background. For the Charles County project, the Maryland State Highway Administration digital maps were used as the base maps. The two-member data collection team drove every county road in the database with the map displayed on the EnterRoadInfo Screen. The images were collected at a rate of 2 frames per second. GPS coordinates and DMI values are collected and synchronized for every image. Two cameras were used. One camera was pointed forward and the other was pointed rearward. This camera configuration allows the traffic signs in the opposite driving direction to be seen in the video. The required road characteristics were collected while viewing the video in the office so the sign collection requirements could be completed in one pass. All of the data was stored in a database. In the office, the project staff used one of the built-in EnterRoadInfo functions to calculate offsets and capture additional data. After all the required attributes were created, a synchronization utility uploaded the data to the central database.

Conclusion

The use of EnterRoadInfo significantly reduced the time and cost required to complete the projects. For the Charles County project, the average distance of roadway covered per day was 50 miles for a total of 925 miles of county roads. The only delay was the weather (Maryland received historic amounts of snowfall in the 2002-2003 winter). The completed data sets included over 5,000 inventoried signs and 4,500 attributed road segments that integrated all of the required information. The entire project data was delivered as a functional and portable GIS database that can be used to maintain and update the pavement database in the future. Charles County not only completed the project cost effectively, the County's GIS users now also have the capability to click on an ArcView screen to view the road attributes and images.