TRC0507

Evaluation of Geomedia and Surveyor to Build A Roadway Asset Inventory Database

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TRANSPORTATION RESEARCH COMMITTEE

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EVALUATION OF GEOMEDIA AND SURVEYOR TO BUILD A ROADWAY ASSET INVENTORY DATABASE

By

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Introduction

An accurate and complete asset inventory is the foundation of a functioning asset management system. However, due to the scope of the work and the staff involved, it has been very challenging for state agencies to accomplish it in a timely and consistent manner. The need for an accurate and comprehensive roadway asset database has been always an issue at the Arkansas State Highway and Transportation Department (AHTD) and now becomes more impending.

On July 6, 2012, Moving Ahead for Progress in the 21st Century Act (MAP-21) passed legislation and becomes effective. MAP-21 is a funding and authorization bill to govern United States federal surface transportation spending. In MAP-21, each State is required to develop a risk-based asset management plan for the National Highway System (NHS) to improve or preserve the condition of the assets and the performance of the system. States must address pavements and bridges but are encouraged to include all infrastructure assets within the highway right-of-way in their risk-based asset management plan.

Currently, AHTD keeps inventories on pavement and bridges on a regular basis. However, inventory of other assets, such as guardrails, culverts, signs etc., are not available. Adding the other assets inventories for the system requires tremendous effort, time, and cost. This project is motivated by the possibility and potential benefits of integrating some of the existing tools in the department to accomplish this task.

Surveyor

ARAN (Automated Road ANalyzer) provides large amount of data including pavement condition data, road geometrics, 1-mm resolution pavement images, 5 ROW images for each data point and GPS coordinates etc.. Data is collected every 5 meters

1

along the entire state highway system. Surveyor is one of the processing software from ARAN software package. It allows users to measure visible features and geographically locate them within the right-of-way. Using digital video obtained from the video camera, Surveyor locates roadside objects through the use of a Distance Measuring Instrument (DMI), gyro system, ultrasonic sensors, and a global positioning system (GPS). Each video frame is tagged with a reference and recorded to hard disk. Using Surveyor, you point and click with the mouse to measure the position and dimensions of signs, guard rails, overhead structures, or virtually any other object along the roadway.

Accuracy of Surveyor

Asset management section (Pavement management section at that moment) has evaluated the Surveyor program back at 2005. Early stage of this project found that Surveyor provides accurate result most of the time, but also has limitations in terms of measuring some of the assets. The accuracy is compromised by the following factors:

1) Distance from the vehicle

Objects closer to the vehicle are more accurately located because Surveyor uses the geometry of the vehicle and pixels on the display to locate objects. Objects further from the vehicle are represented by fewer pixels and thus be less accurately located.

2) Superelevation or small radius curves

Objects measured transversely on superelevated curves or sharp curves can produce erroneous offset measurements.

3) Vehicle interference

Vehicle that passes between the asset and the camera can obscure an assets "location points" and may not allow the user to accurately locate the asset.

2

4) Vehicle orientation

Even with four camera views, some assets are not in the field of view for more than one frame – most asset data items collected by Surveyor require selecting the asset on two consecutive images.

Geomedia

Intergraph's GeoMedia is a geographic information system (GIS) application for working with and conducting analysis on geographic information as well as producing maps from that analysis. GeoMedia is used for: creating geographic data; managing geospatial databases; joining business data, location intelligence and geographic data together; creating hard and soft-copy maps; conduct analysis in 'real-time'; base platform for multiple applications, geographic data validation, and publishing geospatial information and analyzing mapped information. It is an enterprise-based system, providing an organization the ability to access, conduct analysis and distribute information through the organization.

The Mapping and Graphics Section, Research Section, and the Environmental Division have used GeoMedia extensively to display spatial data collected using various GPS equipment. The staff gets well-trained and Geomedia became the common tool used in various planning, analyzing and processing tasks. The combination of GeoMedia and Surveyor provides a very promising solution for building up a comprehensive assets inventory. GeoMedia provides the overview of all the assets while the ARAN provides close-up views of each asset.

Currently, the data sources that is linkable in Geomedia platform includes: Road inventory, Bridges, Materials, Traffic, Crash history and Programmed Jobs.

Accuracy of Geomedia

3

GeoMedia has proven to be an accurate platform for the display of spatial data. For the purposes of this research, it is necessary to use GeoMedia in conjunction with aerial photography. The use of ortho-rectified aerial imagery to locate roadway assets is the basis of this research. GeoMedia is not designed to be a data collection tool; however, it can be used to accurately locate roadway assets. There are several factors that can affect the quality of the data collected using GeoMedia, some of these are:

- The quality of the aerial imagery
- Shadows from tree canopies and terrain
- The resolution of the aerial imagery
- The accuracy of the ortho-rectification process
- The number of control points
- Accurate control point location
- The detail of the digital elevation model (DEM) etc.

Aerial imagery and the ability to display it accurately in GeoMedia is the most important component of this research. The imagery must be of good quality, the control points used in the ortho-rectification process must be accurate, and the DEM must be detailed enough to produce accurate elevation offsets for the area being surveyed.

Aerial imagery used for this project was provided by the Photogrammetry Section of the Surveys Division. The Imagery is printed on film positives and scanned to a resolution of one foot. One-foot resolution imagery allows feature location to within ±6 inches in GeoMedia. Doubling of the scanned resolution (to six inches) would allow a user to locate assets to within ±3 inches. Increasing the scanned resolution increases image file size. Doubling the scanned resolution will quadruple file size.

Currently, an image scanned to one foot resolution produces a file of acceptable size for storage purposes. In the future, with storage capacity becoming less of an issue, an increase in scanned resolution may be acceptable. Storage space is really not the over-riding issue; it is the ability of current software and hardware to display files of such a large size.

The ortho-rectification process is a daunting one. Several issues affect the process: 1) Overlapping images are stitched together by matching and mating common data points to produce a mosaic image, the accuracy of the mosaic is dependent on the number of points, One county is typically composed of 400-500 images 2) The DEM should be as accurate as possible. The higher the resolution of the DEM, the better the fit of the imagery.

The use of GeoMedia to locate assets using imagery is highly dependent on the ortho-rectification process. If the images do not line up with control points, or other known features, the geographic coordinates corresponding to located assets will not be correct. The amount of error introduced can be significant.

Integration

Even though the possibility of using Geomedia or Surveyor to locate the asset separately and the accuracies of each tool have been evaluated thoroughly, the original goal of integrating them together has not been reached. The primary barrier comes from Surveyor. As a vendor-provided program, Surveyor does not support interface with user programming.

In addition, it is hard to promote Surveyor to other sections/divisions in the department. It needs tremendous initiative effort to establish the dataflow and it will

involve considerable amount of training and dedicated personnel is needed for maintenance.

Starting 2012, new study focuses on the development of a tool that links Geomedia with MMHIS. Directly tagging the assets from the aerial photos in the Geomeida environment allows building up a statewide asset database quickly. With MMHIS provide the close-up views of the assets, visual survey can be conducted.

MMHIS

MMHIS is an in-house developed video-log tool that is extensively used in the department for employees with various backgrounds, from field crew to data analyst, to management. The advantages of MMHIS include: 1) intuitive to user and well-accepted in the department 2) well-established/maintained data flow 3) contains history data 4) includes multiple datasets across the department such as job record, bridge, crash etc. It is not only a video-log but a powerful multi-media platform. It is extremely useful and reliable for location-specific data. Integrating MMHIS with GIS will greatly expand its capability assisting data analysis/reporting.

MMHIS & Geomedia

GeoMedia is the department-selected GIS software. It will be ideal if a full integration between MMHIS and Geomedia can be done. It will greatly save time and effort for data analysis and reporting activities.

A custom Geomedia command that links MMHIS and Geomedia has been developed in the final phase of this project. The integration requires custom programming in Geomedia Professional.

The capabilities of the custom Geomedia command includes: 1) Allows user to launch MMHIS in Geomedia view 2) The geographic location of the current image frame

6

in MMHIS is shown in the Geomeida view 3) Line feature can be drawn on the Geomedia view and the geometrical properties of that line can be extracted and saved in the user-defined database, 4) Point feature can be tagged on the Geomedia view and the geographical properties can be extracted and saved in the user-defined database.

Geomdia Custom Coding

There are three ways to approach GeoMedia Professional programming. One way is to create a custom application. This is done by selecting only the GeoMedia Professional objects for performing desired functions. For example, a custom application may only use Map View, coordinate system, legend, and GDO database automation. These objects would be referenced and programmed through a project to produce an application.

The second approach is to drive GeoMedia Professional as a server application. This is typically used when working across applications. In this approach, the GeoMedia Professional Application object is created by the CreateObject method or returned from a running instance by the GetObject method. The Application object is then available for programming.

The third approach, the approach that is adopted in this project, is to build custom commands. The commands are created in Visual Basic by using the GeoMedia Professional Command Wizard. The wizard registers the command and creates the necessary project files required for producing a DLL. The project files contain boilerplate code that incorporates selected command features (such as view listening). The command is completed by adding the automation code and compiling a DLL.

The Command Wizard creates and defines a Visual C# (or other languages) project used for a GeoMedia Command. To create the project, the Command Wizard

7

presents a series of questions about the command. When the Command Wizard is done, it creates a Visual C# project that implements the command server functions. These functions include configuring the command for event and view listening, passing the Application object to the command, and so forth.

The result of the command wizard is a Visual C# project in which boilerplate code and comments have been added. The code is dispersed among several methods. The methods, forms, and code contained within the project depend on the type of command created (modal, special activation requirements, forms, and so forth).

Communication between MMHIS and Geomedia

The most critical part of the project is to establish the communication between the in-house developed MMHIS and the vendor-provided Geomedia. Geomedia is synchronized with MMHIS in two directions. 1) Double-Click event in Geomedia captures the GPS coordinates of the point in the view, converts it to route, section, direction and logmile string, writes it into a MMHIS temp file that can pass the location information to MMHIS. 2) MMHIS stores the current frame's GPS coordinates in a temporary file in real-time and Geomedia load it in and display it in the view.

Installation

To run this program, the following components need to be placed in the computer: a control file, available route list in MMHIS and other supporting library files.
The procedure is below:

1) Copy files

    a)   Copy   SecFinder.dll,   ControlFile2008.Raw,   ControlFile2009.Raw,

    ControlFile2010.Raw,   ControlFile2011.Raw,   ControlFile2012.Raw,

ControlFile2013.Raw and QueryIndex.dat to C:\WINDOWS\system32 in the new machine.

b) Copy .dll,.xml,.ini to C:\workAHTD\GMAutomation or any other folder in the new machine.

2) Register command

First, navigate to C:\Program Files \GeoMedia Professional\Program in dos mode. Then find the command name from the xml file in the <ProgID> tag. Command name and Dll name will not be the same. Here, for example, the command name is found to be "GeoMediaCommandCSModeless.Line"

Lastly, execute the following command line:

InstallAppCmd.exe /cmdset <Command name to store in registry> /dll <The path where the command dll file is placed> /loc <The path where the command xml file is placed>

Here is an example:

InstallAppCmd.exe /cmdset GeoMediaCommandCSModeless.Line /dll C:\workAHTD\GMAutomation /loc C:\workAHTD\GMAutomation

3) Add the command in GM

Go Tools-Customize-Menu-Custom, select the command click "Add"

Pilot Run

As an initiative for asset management system plan in the state, also as needed for a rumble stripe project for traffic safety, a pilot project that aims at building an inventory

9

for all the passing zones on the state highways has been conducted at the end of 2012. The Geomedia custom command developed in this report was used as well as the state's videolog system-MMHIS (Multi-Media Highway Information System), and the statewide aerial photo flown by the Survey Division at AHTD. This program allows the user to tag the features shown on the aerial photo (inside Geomedia) with the geometry, LRS (Linear Reference System) and other custom attributes automatically exported into a user-defined inventory database. The program also synchronizes the MMHIS with Geomedia so the ROW image for the selected location in GIS is displayed simultaneously, providing a supplemental view to verify the assets and the condition. The project lasts four months. Totally about 1,000 labor hours are spent. At the end of the project, about 6500 miles of the no passing zone were identified.

It was found that the factors that will affect the accuracy of the inventory includes: 1) The resolution of the aerial photo 2) the frequency of the video log 3) the accuracy of the LRS system. Overall, the methodology was proven to be accurate, consistent and cost-efficient. It can be used to conduct inventories for other assets such as intersection, guardrail, retaining wall etc.

Conclusion & Recommendation

Evaluation was conducted for the accuracy of using Surveyor and Geomedia as a tool to locate assets on the state highway system. A tool that links MMHIS and Geomedia platforms was developed. It shows the potential of using this tool to quickly locating assets and compiles it into a comprehensive assets inventory along the state highway system. Compare to traditional manual survey, this methods shows dramatic saving on the cost and time.

From:	Hou, Zhiqiong "Jacqueline"
Sent:	Thursday, October 23, 2014 2:35 PM
To:	Tamayo, Sarah
Subject:	RE: TRC0507
Attachments:	TRC0507_Report_10_23.docx

Sarah,
Here is the report for TRC 0507.

Due to the upgrade of our OS, the command I developed for this project is not implementable anymore.

Best Regards,
Jacqueline

From: Tamayo, Sarah
Sent: Monday, September 29, 2014 1:35 PM
To: Hou, Zhiqiong "Jacqueline"
Subject: TRC0507

Hey Jacqueline

Do you have any updates for TRC0507?

Thanks,

Sarah