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Integrating ArcGIS, MapObjects, and ArcIMS for a Railroad Crossing Inventory

Using a combination of GIS office and field applications, Patrick Engineering Inc. (Patrick) is developing a comprehensive railroad crossing inventory for the State of Illinois. The inventory will include 10,780 railroad crossings and involves extensive field data collection. To facilitate the inventory project and to maintain maximum quality control, Patrick developed two user-friendly ArcGIS applications for non-GIS professionals. In addition, Patrick developed a MapObjects field application that is deployed on ruggedized Fujitsu handheld computers. A comprehensive quality control process is used to validate the data before being presented to State of Illinois officials through a secure ArcIMS site.

Project Overview

In 2002, the Illinois Commerce Commission (ICC) awarded Patrick Engineering Inc. a five-year contract to update a crossing inventory of all public highway/rail crossings in the state of Illinois. Information about crossing locations, roadway conditions, rail ownership, traffic, signage, and structures must be collected for approximately 9,800 grade crossings and 2,800 grade separation structures, like bridges and viaducts. The ICC will use the inventory data to prioritize projects in its Crossing Safety Improvement Program and to submit data to the Federal Railroad Administration's Crossing Inventory.

GIS is being used in many aspects of the project including the inventory database design, preliminary data collection, field crew management, field data collection, and online data delivery. The specific ESRI technologies being utilized are ArcGIS and ArcObjects, MapObjects, and ArcIMS.

Database Design

All crossing inventory data and field crew information are stored in a Microsoft SQL Server database. This single master database drives all of the GIS applications incorporated in this project. The database is used to not only capture preliminary and field inventory data but to also catalog digital photos of all crossings, track the status of data collection efforts and field crew assignments, and dynamically generate crossing location sketches online.

Database managers and project managers run custom programs to automate data transfer to and from the SQL Server database. These routines release predefined batches of crossing records onto portable pen-tablet computers carried by field crews and then upload the new field data back into the master database. All data transfers are time-stamped, and the data are automatically checked for inconsistencies. Potential

errors are flagged within the database.

Preliminary Data Collection

Preliminary data collection includes identifying general crossing location information and basic crossing inventory data. Digital aerial photography, road data, and municipality data are all used in this process.

First, spatial analysis functions in ArcMap are used to automatically collect general location information for each crossing such as the surrounding township or municipality and adjacent roads and crossings. This information is gathered to help field crews navigate to each crossing.

Next, basic crossing inventory data is gathered from digital aerial photography. A custom ArcMap macro using ArcObjects allows office personnel to quickly navigate through a series of crossings and collect basic data that can be interpreted from the aerial photos. The macro includes a data collection form and utilizes ArcMap functionality for editing crossing point locations, picking track locations, locating the centers of railways and roads, and measuring bridge lengths. Other information gathered includes the crossing grade, number of tracks, surrounding land use, and calculated crossing angle.

Field Crew Management

Project managers utilize another custom ArcMap macro to check the accuracy of the preliminary inventory data and assign batches of crossings to field crews. This macro allows managers to select crossings in a particular order along any chosen route, assign the selection to a crew, and then print location maps of all crossings to assist the field crews. The managers can also flag errors in crossing records. The data transfer programs prevent the release of incorrect data to the field crews until the potential errors have been addressed.

Field Data Collection

The field crews carry Fujitsu pen-tablet computers and programmable Canon digital cameras that are interfaced with the computers. The pen-tablet computers themselves are ruggedized to accommodate outdoor work; they are protected by a soft case that can be strapped to the user's forearm and have LCD monitors that are visible in outdoor light. The digital cameras are entirely operated through the pen-tablet computers; the users can view a preview image, control the zoom level, and take a picture using controls on the pen-tablet. Because the cameras are interfaced with the computers, image file names are automatically generated from the crossing database record and are based on the crossing identification number, crossing view number, and date. The image file names are stored directly in the database with each crossing inventory record, and the images themselves can be stored directly on the pen-tablets rather than on the camera memory cards. This allows field crews to collect more images each day and greatly facilitates the transfer and cataloging of images from the field computers to the master database.

The crews use a custom MapObjects application to record data at each crossing. The application includes a map interface showing an aerial photo of each crossing and labels designating the quadrants of each road/rail intersection. Based on their observations at the crossings, the crews can pick the locations of features such as signs, sidewalks, and traffic control devices on the aerial photos. The application also contains drop-down lists and menus that are already populated with preliminary inventory data. The crews collect additional data, take measurements, and enter comments for each crossing. The crews also take a series of digital photos at each crossing site. When field crews return to the office, all of the data are uploaded into the master database.

Some of the data collected include:

Roads -
- Roadway surface
- Roadway width
- Number of lanes of traffic
- Road profiles
- Parallel roadways
- Sidewalk location and width

Signs/Traffic -
- Pavement markings
- Advance warning signs
- Posted highway speed
- Lightning
- Traffic control devices

Bridges -
- Horizontal and vertical clearance
- Railroad bridge number
- Bridge length
- Highway structure number

Railroads -
- Crossing number
- Railroad milepost
- Nearest rail stations
- Railroad owner

Data Delivery

The crossing inventory data and digital photos are delivered to the ICC through an ArcIMS website built on Active Server Pages (ASP). Users can navigate to a particular crossing on a statewide map or may search for a crossing based on crossing identification number, county name, or municipality. For each crossing, the ICC may view a report and crossing location sketch that is dynamically generated from the crossing inventory database and can link to digital photos of each crossing.

Conclusion

This spring Patrick Engineering Inc. began the second year of field data collection for the ICC crossing inventory. Upcoming improvements to the project methodology will include utilizing ArcSDE layers to serve aerial photography and crossing point data through the ArcIMS website.

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