GPS/GIS INSPECTION AND ANALYSIS TOOLS FOR HIGHWAY CONSTRUCTION

PROBLEM STATEMENT

The Florida Department of Transportation (FDOT) annually funds and supervises a multi-million dollar roadway and bridge construction program. An inspection procedure is in place to allow progress payments to be made to contractors during construction; however, the procedure currently is based on traditional methods, most of which are manual. It would be beneficial for FDOT to utilize modern technologies such as the Global Positioning System (GPS) and the Geographic Information System (GIS) to enhance its inspection program on ongoing roadway and bridge construction projects, as well as to perform project analysis during construction.

Computerizing FDOT's construction inspection process through the use of portable computer devices for CAD-Data integration would allow users to do the following:

- graphically compose a selection set of elements for inspection
- input inspection results for the elements, e.g., linear and area pay item instances
- review inspection history by graphically selecting elements
- perform specialized inspection activities using customized forms
- review customized inspection reports.

To implement the proposed modern technologies would require the development of an interface to connect the desired technologies and the current software used by FDOT for its construction project management, (AASHTO's SiteManager).

OBJECTIVES

The overall goal of this research is to develop tools, based on modern technologies, that can be used by FDOT for inspection of ongoing roadway and bridge construction projects. Specific objectives include the following:

1. Use the GPS and GIS technologies to develop tools that can capture spatial data on the construction site and generate an attribute database to store the inspection results. The tools should be able to provide effective and accurate as-built documentation of the construction project.

2. Conduct a pilot study using the Bentley Construction Inspector software to perform certain specialty inspections, e.g., on bituminous materials, concrete placement, and pile driving information. The Bentley Construction Inspector automates data gathering, engineering calculations, and data input into electronic databases for subsequent review and reporting.

3. Develop an interface program for exchange of data between the inspection tools and SiteManager.

FINDINGS AND CONCLUSIONS

An extensive literature review indicated that there is limited direct application of GPS and GIS in construction inspection for measuring quantities; commercial GPS programs exist for construction stakeout, but they are very expensive. A review and brief analysis of contract documents indicated that GPS could be used to locate and measure over 90% of the FDOT's approximately 4,500 standard pay items (English Units) during the construction process. A pilot roadway construction project was utilized to demonstrate some of the methodologies developed during the study. It affirmed the previous analysis, indicating that GPS can be used to measure the quantities on approximately 90% of the project pay items.

During the study, three types of GPS receivers were evaluated: low cost or recreational GPS ($150 - $400 price range), mapping grade GPS ($3000 - $4000 price range), and Real Time Kinematic (RTK) GPS receivers (typically more than $45,000 plus subscription costs). The mapping grade GPS would be recommended based on cost and two additional criteria: spatial modeling of the inspected pay item and the accuracy of quantity estimated from the spatial data captured. Based on a comparison with the quantities measured using the construction inspector's traditional manual methods during the pilot project study, the mapping grade GPS receiver estimated same quantities with less than 3% error. The mapping grade GPS receiver also reduced the overall time of quantity measure by over 80%.

ESRI's ArcGIS and custom written computer programs were used to develop the GPS/GIS tools. A computer interface was developed to connect the GPS/GIS tools and SiteManager, allowing data transfer between the GPS tools and SiteManager's Daily Work Report Module. The Bentley's Construction Inspector program for CAD-Data Integration was also successfully demonstrated on the pilot project, using asphalt pay items, with the development of various Microsoft VB.Net application extension programs (dlls), along with a daily work report of construction.

Further, the current project development procedures at FDOT would enhance the application of modern technologies as demonstrated in this study, particularly with regard to the following: GIS-ready drawings generated from the Microstation; the use of the project survey control points as base stations for differential GPS corrections; and the availability of GEOPAK's Quantity Manager.

BENEFITS

This study has established the relevance and feasibility of applying GPS, GIS, and CAD-Data Integration on FDOT construction projects. Implementation of these technologies has the potential to yield significant savings by reducing inspection times and costs and by identifying available resources within FDOT that could enhance the application of these proposed technologies.

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