



*The Ohio Department of Transportation  
Office of Research & Development  
Executive Summary Report*

**High Accuracy Dynamic Highway Mapping Using a GPS/INS/CCD System  
with On-The-Fly GPS Ambiguity Resolution**

*Start Date:* October 1996

*Duration:* 6 years

*Completion Date:* October 2002

*Report Date:* September 2004

*State Job Number:* 14661 (0)

*Report Number:*

FHWA/OH-2004/013

*Funding:*

\$314,483

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**Problem**

Conventionally, the road centerline surveys have been performed by the traditional survey methods, providing rather high, even sub-centimeter level of accuracy. The major problem, however, that the Departments of Transportation face, is the safety of the survey crew and the disruptions to the traffic flow, and to a large extent – even inaccessibility of some highways to the surveys crews due to safety hazard. The survey cost also becomes an issue, as due to the traffic and other environmental constraints, these surveys are relatively expensive, while the rate of production is slow, and therefore, frequent updates (re-surveys) are not feasible. This prompted the Ohio Department of Transportation, District 1, to replace the conventional survey by an automated mobile mapping system, which would collect the data while moving at the traffic speeds, ensuring at the same time the safety of the survey personnel.



## Objectives

During the last decade of the 20<sup>th</sup> Century the concept of Mobile Mapping Systems (MMS) has been established and evolved from rather simple land-based systems to more sophisticated, real-time multi-tasking and multi-sensor systems, operational in land and airborne environments. Mobile Mapping technology has made remarkable progress, notably expanding its use in remote sensing, and surveying and mapping markets. The major objective of this project was to design and develop a new GPS/INS/CCD integrated system for precise monitoring of highway center and edge lines.

## Description

The GPS/INS/CCD Integrated Survey System (GISS) is designed to work as a system of customized and off-the-shelf (COTS) hardware and software for the purpose of collecting global positioning system (GPS) data, inertial navigation system (INS) data and digital imagery (in phase II of the project). The system depends upon precise timing in order to integrate the data to produce highly accurate map information.

## Conclusions & Recommendations

A state-of-the-art mobile mapping system has been developed and implemented to support ODOT District 1 mapping operations. Several surveys have proved that sub-decimeter accuracy can be achieved under normal conditions. Besides the high positioning performance, the main advantage of the system is the reduced requirement for human interaction, which is primarily limited to the post-processed GPS/IMU navigation computation. The processing of the road images is totally automatic, and requires time comparable to the processing of the navigation solution. For a one-hour survey the totally autonomous processing of the images takes about less than two hours, which is comparable to the time required to download and organize the GPS and IMU data, followed by the processing of the navigation solution. Therefore, the system can be considered near real-time, as the final results are available in a rather short time after the survey is completed.

For the future developments, a faster image acquisition rate can further improve performance and could potentially open the door for stereo processing, as gaps in the image sequence will disappear. Additional conditions for this to happen are the substantially improved computer resources and the availability of more robust matching schemes.

## Implementation Potential

The implemented single camera solution and monocular processing have resulted in a reliable extraction of the centerline points. Several comparison tests have proved that the monocular model could achieve the required performance in a robust and timely way without any human interaction. In addition, this model is invariant with respect to the discontinuities. Repeated results on a test range have shown a consistent performance of 6-8 cm RMS (3D).