TECHSUMMARY September 2015

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DOTD Standards for GPS Data Collection Accuracy

INTRODUCTION

Positional data collection efforts performed by personnel and contractors of the Louisiana Department of Transportation and Development (DOTD) requires a reliable and consistent measurement framework for ensuring accuracy and precision. Global Navigational Satellite Systems (GNSS) technologies, which include the global positioning system (GPS) maintained by the United States, are used extensively throughout government and industry. The increased accuracy, reduced cost, and improved efficiencies of these technologies are rapidly being adopted for new and existing workflows. For this reason, DOTD requires standards and procedures to guide staff and contractors in the appropriate use of GNSS technology that will ensure application-specific data accuracy requirements for mapping-grade devices.

In addition to operational standards, the quality and consistency of GNSS measurements are essential to surveying, engineering design, and other positional measurement practices. Recent advancements to the national spatial reference system (NSRS), from which horizontal and vertical positions are measured (i.e., datums), have resulted in significant changes to the way positions are measured when using GNSS technologies. As a consequence, many professionals, engineers, and scientists have inquired about the short- and long-term implications of these changes on existing operational practices conducted within the Department.

Finally, GNSS positional accuracy is essential for numerous DOTD applications. This is particularly true for the Pavement Management System (PMS) section, which maintains a spatially referenced inventory of all state maintained roads. This inventory, collected by the Moving Vehicle Rapid Mapping (MVRM) system, utilizes advanced GNSS and inertial navigation technologies to capture the horizontal and vertical position of regularly spaced points along state maintained roads and highways. To assess and ensure the accuracy and precision of this inventory, baseline control point measurements are needed to evaluate the quality of the data products delivered by DOTD contractors.

OBJECTIVE

To conduct a three-part study addressing accurate, precise, and consistent positional control for DOTD.

- Establish standard operation and collection procedures (SOCPs) using GNSS technologies for mapping-grade applications. SOCPs provide the guidance and standards of practice for mapping grade devices utilized at the DOTD.
- Summarize the recent enhancements to the nationwide horizontal and vertical spatial reference frameworks to support consistent and accurate access to the NSRS using modern GNSS equipment; and to provide recommendations for recording and maintaining GNSS readings requiring precise, accurate, and consistent vertical control for past, present, and future projects.
- Conduct and provide multiple baseline surveys on state-maintained roads and highways in support of quality-control assessments conducted by DOTD personnel. ; and xamine how vehicle speed affects horizontal and vertical accuracy (jointly and separately) from kinematic surveys enhanced by a real-time network.

LTRC Report 539

Read online summary or final report:
www.ltrc.lsu.edu/publications.html

PRINCIPAL INVESTIGATOR:
Joshua Kent, Ph.D.
Center for GeoInformatics

LTRC CONTACT:
Tyson Rupnow, Ph.D., P.E.
225.767.9124

FUNDING:
SPR: TT-Fed/TT-Reg

Louisiana Transportation Research Center

4101 Gourrier Ave
Baton Rouge, LA 70808-4443

www.ltrc.lsu.edu

SCOPE

The principle focus of this project dealt with the acquisition, maintenance, and management of GNSS positioning data at DOTD. This research is primarily for mapping grade applications, and is not intended to substitute the requirements of the more precise DOTD Location and Surveying Section, but provide guidance for staff and contractors in the use of this GNSS, generally handheld equipment, when applicable.

RESULTS

1: Standard Operating and Collection Procedures Development

An operations and collection procedures document was developed for mapping-grade GNSS applications utilizing a hand-held devices. The SOCPs was developed in coordination through the DOTD GPS Technical Oversight Committee (GTOC), the project review committee (PRC), and guidance obtained through LTRC report 11-2P.

2: Horizontal and Vertical Datum Research

The recent changes to the nationwide horizontal and vertical spatial reference systems were summarized to support consistent and accurate access to the NSRS. Details also included recommendations and methods for managing survey data derived from different realizations of the horizontal and vertical datums.

3: Control Point Measurements for Pavement Management System

Horizontal and vertical position measurements were collected using survey-grade GNSS receives at test sites in each of the nine DOTD districts. Test sites included mile-long road segments that were selected by the DOTD and previously assessed in LTRC Report 09-2GT. Scenario-based kinematic measurements were also collected at varying speeds using both mapping and survey grade technologies.

CONCLUSIONS

The standards-of-practice for mapping-grade GNSS technology were examined. The functional accuracy and precision of the handheld GNSS device were summarized. Methods, techniques, and recommendations for achieving optimal positioning were provided in the SOCPs. The SOCPs developed for this project represent a first of its kind for operating mapping-grade GNSS devices at DOTD. While it cannot possibly address every application, the information and guidance provided within the document will be invaluable to personnel that need to collect reasonably accurate and consistent locations that do not require a licensed surveyor. Furthermore, the SOCPs outlined are not static. Rather, these operating procedures should be regularly re-evaluated to evolve as the needs of the department and operator change.

The recent adjustments to the NSRS has improved the positioning accuracy and precision for all GNSS operators. These changes, however, require DOTD personnel to become cognizant of the impact these changes will have on surveyed positions used in older projects. One-to-one comparisons are not possible without very specific translations and transformation of the original data.

Finally, the PMS has received and are currently utilizing the GNSS baseline observations collected at the test sites around the state. These measurements ensure the quality of the data products delivered by DOTD contractors.

RECOMMENDATIONS

The department should implement the SOCPs under the guidance of the GTOC. This should include the creation of a pool of capable devices, available to staff, to ensure that mapping grade accuracy is achieved, stored, and available in the future.

Because terrestrial reference frames are constantly evolving, it is absolutely imperative that all GNSS-derived observations include both geometric and geodetic positions. Corresponding to the best practices typically employed for surveying, departmental data should include specific references to the horizontal and vertical datums used to obtain the position. Translating between different realizations of the same datum [e.g., convert NAD 83 (CORS96) to NAD 83 (NA 2011)] can be accomplished using the same mathematical computations as those employed for datum transformations. Tools and resources for performing these recommendations are both commercially available and within the public domain.

Finally, the horizontal and vertical control surveys conducted for this project should be used to assess the accuracy and precision for the MVRM data deliverables. The comparison of the results on a test site while re-creating the conditions commonly expected to be experienced in the field will allow the prediction of the MVRM system performance.