TECHSUMMARY

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Reference Measurements of Pavement Management System Roadway Elevations

INTRODUCTION

New, more efficient methods of measuring road surfaces, including using moving vehicles, are being developed and deployed. Testing the veracity of such data presents its own problems. Busy, heavily traveled highways do not lend themselves to easy occupation for careful measurement by conventional means. The advent of GULFNet by the Louisiana State University (LSU) Center for Geoinformatics (C4G) provides the ability to get highly precise and accurate positions anywhere within the state, tied to the National Spatial Reference System (NSRS), which enables the establishment of benchmark sections of roadways against which the performance of the new methods may be tested.

The LSU C4G with the cooperation of the personnel of the Louisiana Department of Transportation and Development (LADOTD) accessed and measured the elevation and location of points quickly and safely along test sections of highways in each LADOTD district in the state. The precisions of the measurements, as reported by the Real-Time Kinematic (RTK) engine, average better than 3 cm and three standard deviations (3σ).

OBJECTIVE

LSU's C4G proposed to provide highly precise and accurate positions to LADOTD and provide recommendations on how to test Moving Vehicle Rapid Mapping (MVRM) systems to assess the precisions reasonably expected under a variety of circumstances.

The primary objective of this study is for LSU C4G to provide quality control information to LADOTD against which MVRM data may be compared. To achieve this goal, 11 areas at several locations throughout the state were selected by LADOTD as useful and convenient to perform quality control (QC) for MVRM surveys; at least one location was selected in each district.

The secondary objective is to provide a general recommendation to LADOTD for utilizing these data in QC of MVRM systems. To achieve this, literature was examined and experience studied to arrive at suggestions for appropriate techniques of applying these data to evaluate the quality of MVRM surveys. These can be found in the Recommendations section.

SCOPE

The scope of the study involves a data set of elevation values and the horizontal position of those values for at least one test area in each LADOTD district. Each roadway is no longer than a mile. In each district, a test section was identified (three in District 61) by LADOTD to be measured by LSU C4G using the LSU C4G GULFNet. Points were measured at intervals of approximately 10 ft., except during occasional periods of interference or blockage that did not compromise the overall results. The target precision of the measurements was finer than 3 cm at three standard deviations (3σ). The measurements are to serve as a quality control check for MVRM systems.

METHODOLOGY

C4G in cooperation with the National Geodetic Survey (NGS) has created the Louisiana Spatial Reference Center (LSRC). LSRC is building a state-wide network of high precision Global Positioning System (GPS) receivers, termed GULFNet, that will re-establish the official

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federal reference system within the state. This state-wide positional infrastructure will be the backbone for surveying, mapping, and other applications in Louisiana. It will also support all GIS development, detailed topographic mapping, precision farming, navigation, and other geospatial applications. The system will focus on pinpointing the location of subsidence and measuring exactly how fast the coast is sinking. The GULFNet system will provide current road heights and locations used to assess the veracity of MVRM providers.

RESULTS

Researchers at C4G in cooperation with LADOTD accessed and measured the elevations and locations of points quickly and safely, along test sections of highways. LADOTD selected the test sites with at least one site located in the nine LADOTD districts. Researchers employed a method of walking along the test section using GULFNet Virtual Referencing System (VRS) RTK with an antenna mounted on a fixed-height pole fitted with a wheel.

Figure 1
The author demonstrating RTK field technique with wheeled antenna rod

Elevations were reported with respect to the North American Vertical Datum of 1988 (NAVD88). Lateral coordinates were measured and reported with respect to the North American Datum of 1983 (NAD83). The precisions of the measurements, as reported by the RTK engine, averaged better than 3 cm at three standard deviations (3σ).

Recommendations were made for using measurements at the sites for testing the MVRM systems to assess the precisions reasonably expected by these systems under a variety of circumstances.

CONCLUSIONS

The data reported will serve LADOTD in efforts to perform QC analysis of MVRM data. Redundancy is one of the most reliable ways to verify data. These data provided to LADOTD may be made more valuable and its veracity improved by repetition.

The beneficial value of the LSU C4G GULFNet system was demonstrated as it made possible and provided the means for collecting this data accurately related to the NSRS across the entire state in every LADOTD district. It did so at a cost several times more economically than similar results could have attained through more conventional means. Successful application will ensure the state receives accurate information from MVRM projects to base all manner of decisions regarding road settlement, maintenance, asset management, and drainage studies to planning safe hurricane evacuations.

RECOMMENDATIONS

The MVRM system is an integrated system that typically uses Global Navigation Satellite System (GNSS) RTK and inertial navigation to accurately place the position of its measurements in the world. The most usual cause for loss of GNSS output is the loss of signals from satellites from obstructions such as bridges, relief in the terrain, and tress. The primary benefit of a MVRM system is its ability to provide accurate positions despite the loss of GNSS output. There are four operational states for the MVRM. Each needs to be tested to help predict the veracity of the data it produces and estimate the confidence to put in it.

The use of the GULFNet GPS Reference Network and collected data at the test sites will allow LADOTD to obtain and verify accurate measurements of Louisiana highways. Accurate and precise measurements will allow proper planning and management of Louisiana highways by the Pavement Management section and other LADOTD sections.

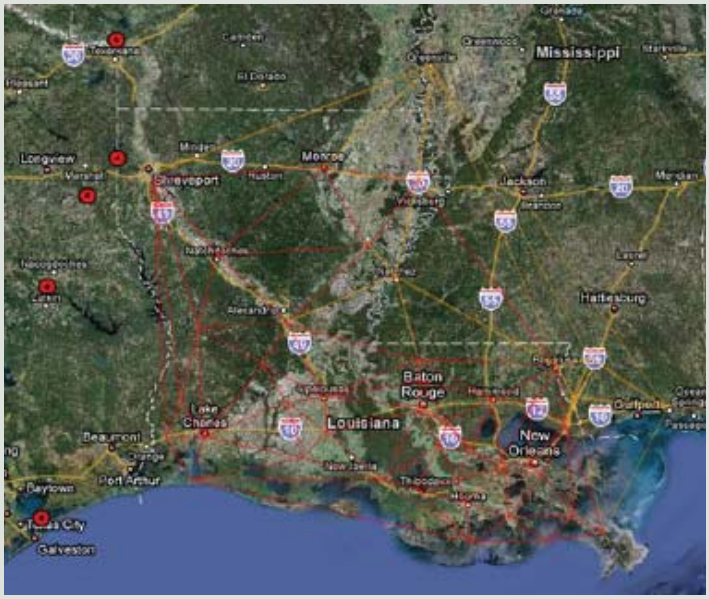

Figure 2
Map illustrating the LSU C4G network called GULFNet