Study on the impact of accurate gravity compensation on GPS/INS-based direct sensor orientation and targeting.

PI: Dorota A. Grejner-Brzezinska, **Co-PI:** Charles K. Toth
Sponsor: National Geospatial-Intelligence Agency (NGA)

Figure 1. OSU land-based test vehicle

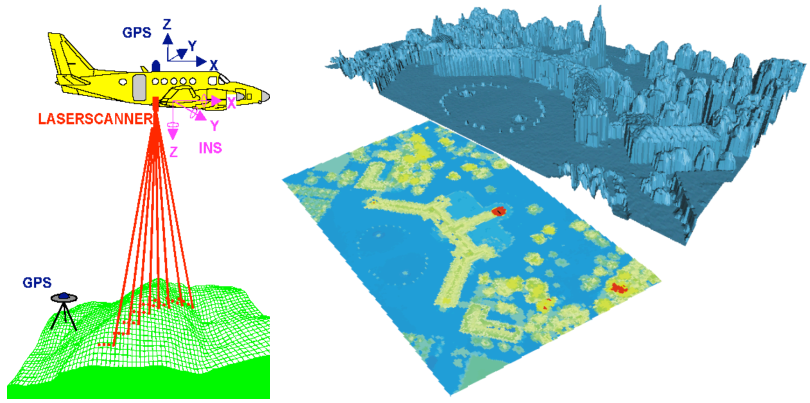

Figure 2. Directly georeferenced airborne LiDAR: the concept

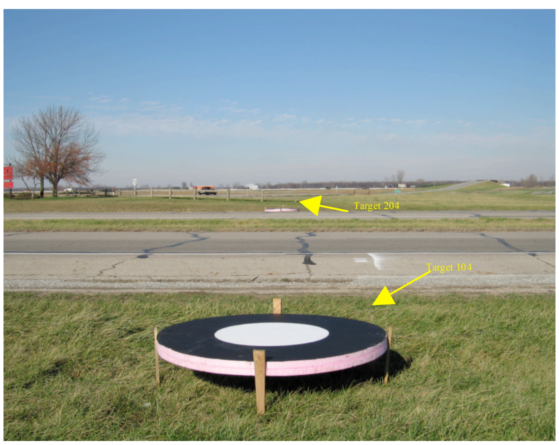

Figure 3. Ground-based LiDAR target

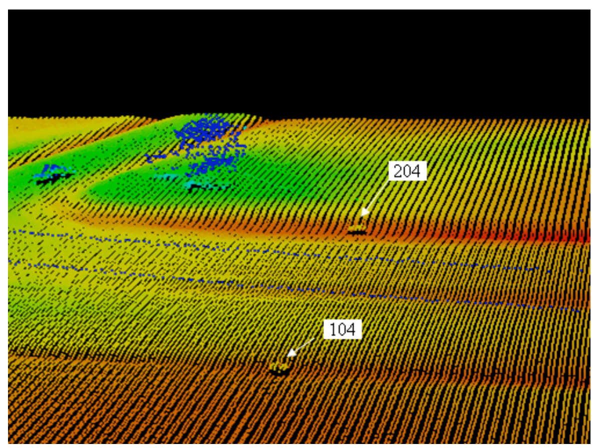

Figure 4. LiDAR image of the ground-based targets

This research project investigates the methods to improve the geolocation problem from the navigation sensor side for airborne platform-based remote sensing systems, which include GPS/IMU navigation components and imaging sensors. The overarching idea is to use the extended gravity compensation for the inertial navigation sensors, which improves the imaging sensor orientation process. In particular, the effectiveness of the gravity compensation is addressed with respect to various imaging sensor classes, including different IMUs and error models. In addition, the effects of varying direct orientation accuracy on the ground target coordinates under varying platform dynamics with and without GPS are studied for airborne LiDAR (Light Detection and Ranging) and frame CCD. Detailed error models were derived for these sensors, and the Quality Control/Quality Assurance (QC/QA) metrics will be developed as a function of georegistration accuracy, flight altitude and the type of sensors used.

Study of RTK technology and support infrastructure suitable for long-range instantaneous, centimeter-level positioning as related to the US NSRS network

Analysis of the ambiguity resolution, error modeling techniques and support infrastructure for nationwide three-frequency real-time kinematic (RTK) GPS positioning.

PI: Dorota A. Grejner-Brzezinska
Sponsor: National Geodetic Survey (NGS)/National Oceanic and Atmospheric Administration (NOAA)

The primary objective of these projects was to develop algorithms suitable for network-based real time kinematic (RTK) GPS positioning with cm-level (to sub-decimeter) accuracy, using the national Continuously Operating Reference Station (CORS) network. The desired station separation was up to 200 km. This study focused on a number of problems inherent in RTK technology and the support infrastructure necessary for instantaneous, centimeter-level positioning:

1. What is the maximum effective range for robust ambiguity resolution in either single epoch or multi-epoch modes?
2. What error sources must be considered, and what are the effects of their correlations on the accuracy derived?
3. Will precise absolute positioning be achieved with the enhancement of the RTK technology and mathematical models, or, what additional augmentation may be required?
4. Can real-time support products, such as high-resolution ionospheric grids, improve RTK algorithms?
5. Can virtual stations be used as additional reference stations for multiple stations ambiguity resolution and RTK positioning?

The project was completed in 2005 with a successful implementation of the RTK network-based algorithms and demonstration of the cm-level performance under normal to moderate ionospheric conditions. In the second phase of the project, the processing engine and the ionospheric error models were implemented in the rapid-static approach that is currently under testing and consideration by the NGS staff for implementation as new rapid-static module of the NGS OPUS (On-line Positioning User Service) system (OPUS-RS).

Remote sensing of transportation flows - feasibility of near real-time automated flow

Geo-referenced digital acquisition and processing system using LIDAR technology

PI: Charles K. Toth, **Co-PI:** Dorota A. Grejner-Brzezinska

Sponsor: Federal Department of Transportation
Ohio Department of Transportation (ODOT)

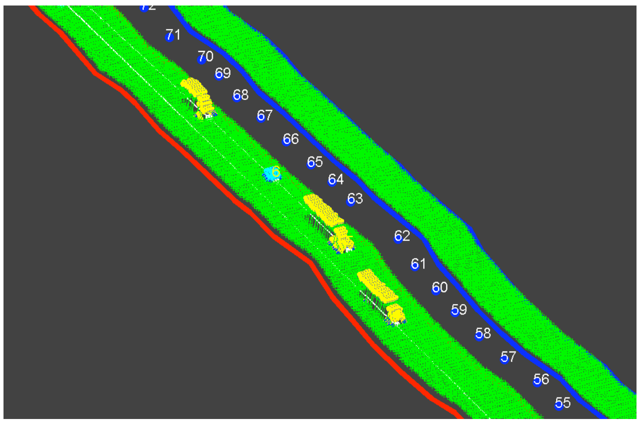

Figure 1. Vehicles in LiDAR data

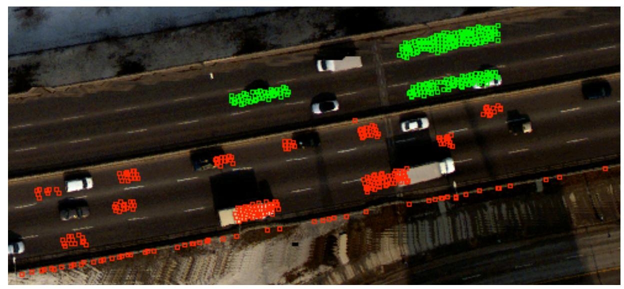

Figure 2. LiDAR and image data fused

The primary objective of these projects was to develop and implement an efficient procedure of vehicle extraction and automatic vehicle speed detection, from the airborne multi-sensor imaging system. The primary imaging sensors of interest were a frame CCD (Charged Coupled Device) digital camera and a LiDAR (Light Detection and Ranging) system, supported by an integrated georeferencing system based on GPS/INS developed at OSU.

In the first stage of the project, the major focus was on enabling a seamless and highly automated multi-sensor image data acquisition and processing technology for the ODOT Office of Aerial Engineering (OAE). The new system, including a modernized aerial data acquisition platform and a largely automated post-processing production, which offer better spatial data at a substantially reduced cost, were acquired, calibrated and tested. The research tasks completed in 2005 included: procurement and integration of a LIDAR system into the OAE airborne platform, introduction of the LIDAR data into the surface extraction process, including LIDAR registration, calibration techniques, QA/QC control and specialized filtering techniques the production environment.

The second stage of the project focused on investigation of the effectiveness of using LiDAR data to estimate velocity and flow patterns over high-traffic highway corridors. In addition, an assessment of the feasibility of combining LiDAR and simultaneously acquired imagery for the same purpose was provided. This combination of sensors offers a very robust method for vehicle identification and motion estimation as both shape and textual information is provided.