

# **A Benchmarking Measurement Campaign in GNSS-denied/Challenged Indoor/Outdoor and Transitional Environments**

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**Key words:** GNSS/GPS; Laser scanning; Low cost technology; Photogrammetry; Positioning; cooperative positioning; indoor positioning; mobile mapping vehicles; sensor integration; UWB; LiDAR, inertial sensors

## **SUMMARY**

This paper reports about a sequence of extensive experiments, conducted in GNSS-denied/challenged, indoor/outdoor and transitional environments at The Ohio State University as part of the joint FIG Working Group 5.5 and IAG Working Group 4.1.1 on Multi-sensor Systems. The overall aim of the campaign is to assess the feasibility of achieving GNSS-like performance for ubiquitous positioning in terms of autonomous, global, preferably infrastructure-free positioning of portable platforms at affordable cost efficiency. Therefore, cooperative positioning (CP) of vehicles and pedestrians is the major focus where several platforms navigate jointly together. The GPSVan of The Ohio State University was used as the main reference vehicle and for pedestrians, a specially designed helmet was developed. The employed/tested positioning techniques are based on using sensor data from GNSS, Ultra-wide Band (UWB), Wireless Fidelity (Wi-Fi), vision-based positioning with cameras and Light Detection and Ranging (LiDAR) as well as inertial sensors. The experimental schemes and initial results are introduced in this paper. The results from the experimental campaign demonstrate performance improvements due applying CP techniques.

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