

# An Integrated IMU/LiDAR Navigation System For GNSS-Denied Environments

Nader Abdelaziz and Ahmed El-Rabbany (Canada)

**Key words:** GNSS/GPS; Laser scanning; Positioning; Remote sensing; Keyword: LiDAR SLAM; IMU/LiDAR SLAM integration; Integrated navigation system

## SUMMARY

Traditionally, most navigation systems rely on GNSS/ inertial navigation system (INS) integrated navigation systems, in which the INS can provide reliable positioning during short GNSS outages. However, for a prolonged GNSS signal outage, the performance of the system will be solely dependent on the INS solution, which can lead to a significant drift over time. Consequently, integrating complementary onboard sensors is crucial. This study proposes a robust, loosely-coupled (LC) integration between the INS and LiDAR simultaneous mapping and localization (SLAM) using an extended Kalman filter (EKF). The integrated navigation system is tested on the raw KITTI dataset using both residential and highway datasets, which mimics various outdoor driving environments during a complete absence of GNSS signal. It is shown that the proposed IMU/LiDAR SLAM integrated system outperforms the sole use of the INS. The integrated system positioning results yielded an average reduction of the root-mean-square error in the east, north, and up directions of 95%, 56%, and 43% respectively.