Optimizing the Accuracy and Efficiency of Mobile Mapping and Surveying using the Latest GNSS Constellations and Frequencies and LiDAR Adjustment Technology

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SUMMARY

Collecting geospatial data from mobile platforms such as aircraft, automobiles, marine vessels and even human portable devices is a well proven method for highly accurate and cost-effective surveying, mapping, and performing 3D reality capture. This is especially true when autonomous platforms such as UAV (Uncrewed Aerial Vehicles), USV (Uncrewed Surface Vessels) and land robots (wheeled, quadruped and biped) are deployed to carry the sensor payloads.

The data from the sensor payloads (i.e. cameras, LiDAR) are georeferenced using a high-rate position and orientation solution (i.e. the trajectory) computed by combining measurements from Global Navigation Satellite Systems (GNSS), Inertial Measurement Units (IMU), odometers (mechanical and optical), cameras (photogrammetry), and LiDAR. The typical method of combining these measurements is using an Aided-Inertial Kalman Filter based architecture in post-processing (either desktop or more recently in the Cloud) to take advantage of the ability to process the data both in the forward and reverse directions, and access ground reference data (such as local and global GNSS corrections) without having to transmit data to the vehicle.

Recent expansions of the GNSS constellations including China's BeiDou (BDS-3) has resulted in over 100 Satellite Vehicles (SV's) with multiple frequencies in full operation that can now be used for accurate positioning in what were previously marginal conditions (such as in urban centers). The introduction of low cost, low noise, high-repetition rate, miniaturized LiDAR scanners now provide a cost-effective method of measureing relative position and orientation on mobile platforms that can be used to correct drifts in the trajectory when GNSS is obstructed, or even as an alternative to GNSS.

Trimble's Applanix POSPacTM 9 software using Trimble© ProPointTM GNSS, Trimble

CenterPoint© RTX, Applanix IN-Fusion+TM, and Applanix PCDATM technology is an advanced Aided-Inertial post-processing software package that has been optimized for mobile surveying and mapping applications. This paper presents how POSPac 9 incorporates the latest GNSS constellations and frequencies to produce unparalleled position and orientation accuracy for georeferencing mobile sensor data, and how the Applanix PCDA technology works to use the LiDAR point clouds to optimally correct drifts in the trajectory when GNSS is obstructed.

Test results from land vehicle data sets collected in deep urban canyons show that including the latest GNSS SV's with single base station carrier phase differential processing can result in an increase of position accuracy by over 100% percent, while data from a Velodyne VLP-16 can be used to correct the trajectory drift due to GNSS outages from meters down to cm's. Furthermore, test results using Post-processed Trimble CenterPoint RTX on a series of UAV flights show how Trimble's advanced PPP service can reliably obtain cm level positioning even on trajectories as short as 10 – 15 min.