



3DMGQ7-GNSS/INS

GNSS Outage Test Report



Test Setup



Two UBlox ANN-MB antennas were mounted to the roof of the vehicle with a 1.5m baseline.



RTK corrections were provided over a cellular network using the **3DMRTK**.



A Michigan Scientific High Resolution Wheel Pulse Transducer E512 was used for odometer aiding



The route traveled included both rural and urban areas

Test Methodology

30 minutes of navigation data was collected using a test vehicle in a standard automotive environment. During the course of the run, the **3DMGG7** had consistent RTK coverage for a high precision navigation solution, and the EKF was allowed an initial convergence period before starting the first outage. An external navigation reference sensor was used to evaluate performance during GNSS outages.

Kalman Filter Configuration

Outage performance was evaluated with three different system configurations.

- 1. Free integration:** In this configuration, no aiding or constraints were supplied to the EKF.
- 2. Wheeled vehicle constraint:** Similar to the free integration configuration, this setup only uses integrated inertial data for navigation. However, a wheeled vehicle constraint was applied to the EKF. This constraint sets the bodyframe velocity perpendicular to the direction of travel to zero.
- 3. Wheeled vehicle constraint + Odometer aiding:** In addition to the wheeled vehicle constraint, a speed measurement was supplied to the EKF from a wheel odometer.

Results

In order to get a statistical measurement of outage performance, a series of 60 second GNSS outages were simulated in post-processing. Using the exact same EKF algorithm that runs in real time on the **3DMGQ7**, the data was reprocessed 50 times, each with a different GNSS outage time window. Figure 1 shows this error distribution for the odometer-aided configuration

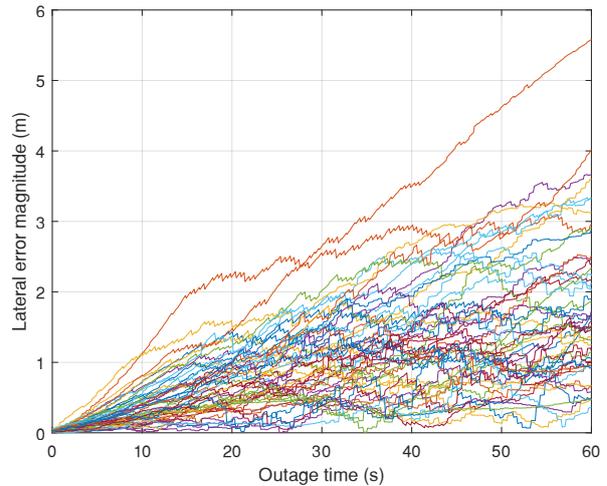


Figure 1: Lateral error distribution, wheeled vehicle constraint + odometer

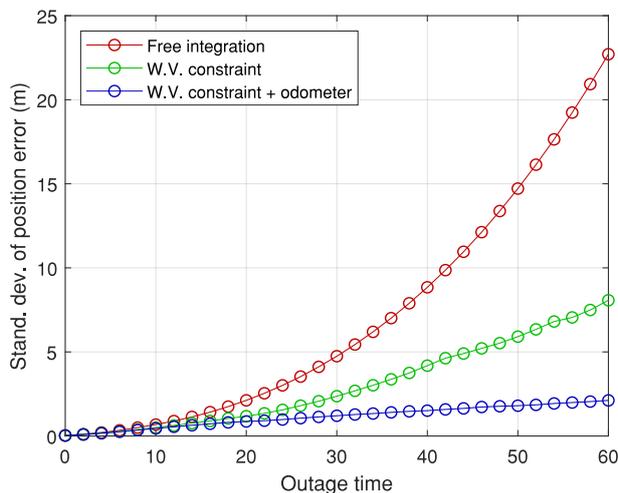


Figure 2: Lateral error for each configuration

Outage performance was then defined as the standard deviation of position error at each time step. The plot to the left shows lateral navigation performance for each of the three sensor configurations.

Outage performance (m)

| | 10s | 30s | 60s |
|--------------------------------|------|------|-------|
| Lateral, no constraint | 0.68 | 4.74 | 22.70 |
| Lateral, w.v.c | 0.50 | 2.36 | 8.07 |
| Lateral, w.v.c + odom. | 0.45 | 1.20 | 2.12 |
| Vertical, no constraint | 0.43 | 1.98 | 5.93 |
| Vertical, w.v.c | 0.37 | 0.97 | 1.24 |
| Vertical, w.v.c + odom | 0.37 | 0.97 | 1.19 |