Inertial Labs
Attitude is Everything

“Tunnel Guide” Feature for GPS-Aided INS Improves Performance During GNSS Outage

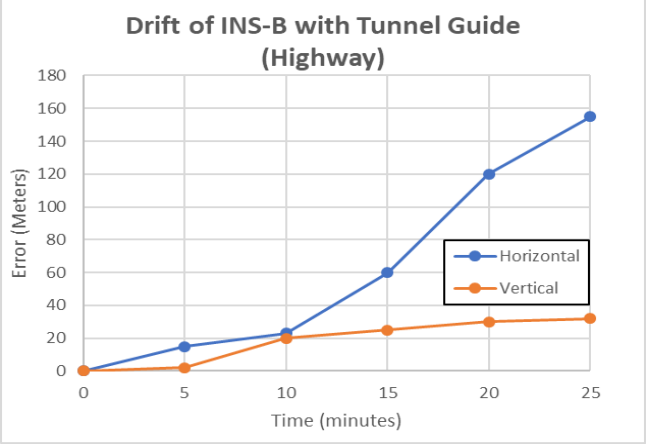
Understanding the Problem

For years **Inertial Labs** has produced high accuracy Inertial Navigation Systems (INS) at the world's best price-performance ratio. An INS estimates the position, attitude, and velocity using the gyroscopes and accelerometers contained inside an inertial measurement unit (IMU). Position accuracy can be greatly improved when the INS is aided by Global Navigation Satellite System (GNSS). However, GNSS is not always available. Customer requirements demand for better performance of an INS during GNSS outage. Outages can be caused by tunnels, urban canyons, roads under bridges, etc. During GNSS outage, position error growth is inevitable. Inertial navigation using any IMU will accumulate error due to integration and double integration of unknown accelerometer and gyroscope biases. Using GNSS allows the INS to estimate and correct these biases. However, when satellite communication is lost, bias instability and noise still cause drift. A MEMS-based IMU would drift by thousands of meters over 20 minutes of GNSS outage; a navigation-grade IMU INS, like Northrop Grumman LN-100G, which uses high accuracy ring laser gyros, claims to drift 120 meters after a 20-minute GNSS outage. Instruments like this are simply too large, too expensive, and too power hungry for most applications, especially for the emerging ones. As an effective alternative, **Inertial Labs** developed the **Tunnel Guide** feature for the GPS-Aided INS: an advanced algorithm that implements continuous dynamic modeling for land vehicle motion. As a result, the INS is able to mitigate error and increase accuracy of its MEMS IMU during prolonged GNSS outage. Now the position error of a land vehicle remains low even in a GNSS outage area such as: a tunnel; a city with signal blocking buildings; or any area where satellite communication is blocked.

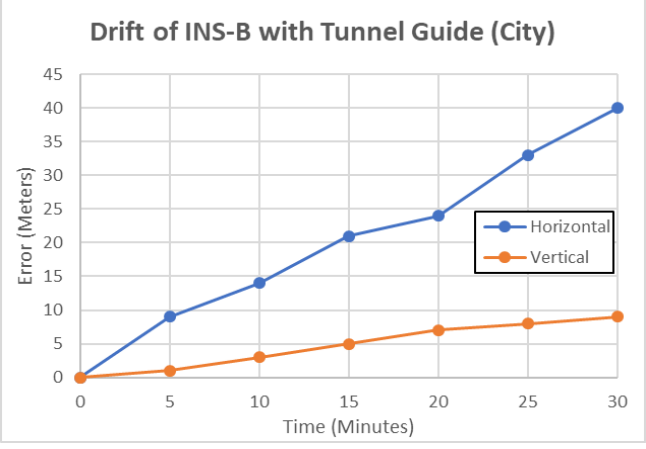
The Effective Solution

Sample data was gathered to demonstrate the effectiveness of **Tunnel Guide** for different application methods in purely inertial mode, only using inertial sensors together with sophisticated modeling of land vehicle motion.

For both of the following sample sets, a driving test was conducted using an **Inertial Labs** INS-B with **Tunnel Guide** without any aiding data from a Distance Measurement Instrument (DMI). The first test was run on a highway driving at an average speed of 60 mph (96 km/h). The plot below shows accumulated drift of approximately 160 meters, with outage time of 25 minutes. This leads to an approximate drift rate calculation of 0.4% of Distance Travelled (DT) for a 25-minute outage. This is already comparable to a navigation-grade INS (120-meter drift over 20-minute outage), yet the size, weight, power, and cost are an order of magnitude lower.



For applications involving more frequent turns, **Tunnel Guide** will only improve in its accuracy. A plot from another sample test was produced in a similar manner but in this situation the vehicle was driven in a city environment. This sample set shows the effective nature of **Tunnel Guide** when vehicle dynamics allows better observability of the system state. This driving test was done at an average speed of 25 miles per hour (40 km/h) with frequent turns, and the GNSS outage lasted for 30 minutes. The plot below shows performance of the INS using Tunnel Guide with no aiding data from a DMI.



The average drift rate of the second sample set was calculated to be 0.2% DT over the course of the 30-minute outage with a peak drift of approximately 45 meters. These results show that **Tunnel Guide** significantly improves performance accuracy during GNSS outages, at a much lower cost.

In addition, if the vehicle does have a DMI – be it an external wheel sensor or a sensor provided by the vehicle itself via its digital bus* – using this instrument, automatically calibrated by **Tunnel Guide** algorithm, will further improve the INS accuracy, bringing the position error down to 0.05% DT or lower.

*ask Inertial Labs sales engineers for details

In Summary

Regardless of your land vehicle application, keeping accuracy during a GNSS outage can be the deciding factor in meeting expectations of your project requirements. For **Inertial Labs**, the development of the **Tunnel Guide** feature is a solution that provides increased position accuracy without increasing the cost of our devices. The GPS-aided INS-B is **Inertial Labs** basic model INS unit, but with it comes accuracy and advanced features that ensure that saving money doesn't mean cutting corners on performance.

What Do You Think?

Here at Inertial Labs, we care about our customers satisfaction and want to continuously be able to provide solutions that are specifically tailored to problems that are occurring today, while vigorously developing products to tackle problems of tomorrow. Your opinion is always important to us whether you are a student, an entrepreneur or an industry heavyweight. Share with us your thoughts of our products, what you would like them to be able to achieve, ask for test results or just say hello at info@inertiallabs.com

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INS-B

now with embedded

8 GB Data Logger

Specifications	RTK	PPK
Horizontal Position Accuracy	0.01 (m)	0.005 (m)
Pitch and Roll Accuracy	0.05 (deg)	0.006 (deg)
Heading/Yaw Accuracy	0.1 (deg)	0.03 (deg)
Velocity Accuracy	0.03 (m/s)	0.01 (m/s)
Gyroscopes Bias in-run Stability	1 (deg/h)	
Accelerometer Bias in-run Stability (±8 g)	0.005 (mg)	
Weight	280 grams	
Size	120 x 50 x 53 mm	

All accuracies/stabilities displayed were calculated by method of RMS.
RTK – Real Time Kinematics; PPK – Post-Processing Kinematics

About Inertial Labs Inc.

Established in 2001, Inertial Labs is a leader in position and orientation technologies for commercial, industrial, aerospace and defense applications. Inertial Labs has a worldwide distributor and representative network covering 20+ countries across 6 continents and a standard product line spanning from Inertial Measurement Units (IMU) to GPS-Aided Inertial Navigation Systems (INS). With application breadth on Land, Air, and Sea; Inertial Labs covers the gambit of inertial technologies and solutions.

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Inertial Labs, Inc.
39959 Catoctin Ridge Street,
Paeonian Springs, VA
20129 USA
phone: +1 (703) 880 4222
sales@inertiallabs.com
www.inertiallabs.com