Real-Time Integrated GPS/Inertial Systems for Machine Control Applications

Erik Lithopoulos, Bryan Kliewer, Dr. Bruno Sherzinger

Applanix Corporation
550 Alden Road, Unit 113
Markham, Ontario, Canada, L3R 6A8
Tel: (905) 475-2221
Fax: (905) 475-2965
E-mail: erik@applanix.com

Abstract

The use of Real Time Kinematic (RTK) GPS has made real-time decimeter and centimeter positioning possible. Standalone GPS, however, does have shortcomings: At least four satellites must be visible at all times to maintain positioning. If satellite view is obstructed, position information is no longer available. When satellites become again visible it may take a few minutes before RTK positioning can be re-established.

An integrated GPS/Inertial system combines the long term stability of GPS with the short term precision and immunity to GPS drop outs of inertial sensors. This paper describes an integrated GPS/Inertial Position and Orientation System (POS) that measures the six degrees of freedom (position and attitude) in real-time. By integrating inertial with GPS and other aiding sensors POS can provide:

1) High-accuracy, high-dynamic position and attitude measurements at real-time rates of up to 100Hz.
2) Significant reduction in GPS outage and multipath related problems.
3) Autonomous measurement capability over extended periods of GPS outages.

POS can be described as an aided strapdown inertial navigator that uses a Kalman filter and a closed-loop error controller to provide an optimally blended position and orientation solution from data from an inertial measurement unit (IMU) and aiding data from a GPS receiver and other secondary aiding sensors such Distance Measurement Indicator (DMI), Doppler radar and scanning lasers. POS uses a small and light IMU which can be mounted directly to a mobile survey instrument or platform carrying the instrument. POS can also be configured to record the raw real-time data for post-mission processing. This paper gives a brief description of POS and provides results which demonstrate the performance POS in the field. Some work in integrating inertial sensors with other aiding sensors for precise positioning without the use of GPS will also be described.