

GPS-Aided Inertial Technology for the Geospatial Industry

Until somewhat recently, Inertial Measurement Units (IMUs) and GPS receivers were seldom mentioned in the same sentence. One uses gyroscopes to measure position changes while the other uses external reference points to triangulate location. One provides data hundreds of times per second while the other refreshes once every second. It wasn't long before someone discovered that the two technologies could actually work better in support of one another.

By Anthony Melihen

prolonged periods when GPS is unavailable or unreliable. As a result, the modern IMU technology applied in conjunction with GPS assistance has given the geospatial sciences a relatively new tool that goes well beyond simple navigation. Today, the ability to know exactly where one is and exactly where one is looking allows us to effectively measure on the move: Precise Vehicle-Based Geospatial Surveying.

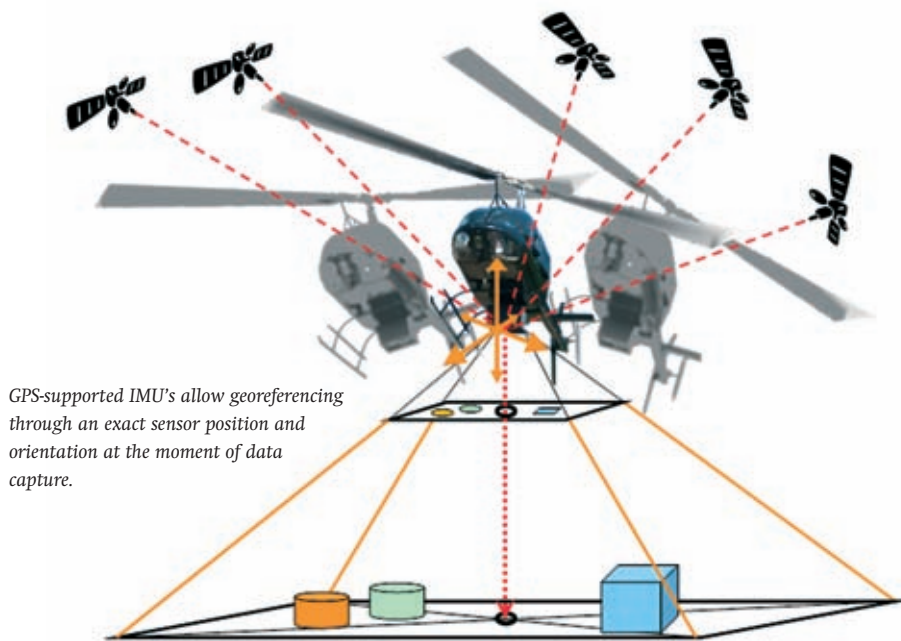
Precise Vehicle-Based Geospatial Surveying

If perpetually given the correct position and exact orientation of both a survey vehicle and its sensors, we can calculate the position and orientation of the sensor at the instantaneous moment of data capture, thus allowing the collected information to be accurately georeferenced. This establishes a geographic relationship between captured image pixels and the actual real-world ground coordinates, all with the same results as if the data was captured from a motionless survey platform. Collection of ground control points becomes unnecessary and larger areas may be surveyed with incredible accuracy while in full motion, creating unprecedented efficiencies for data collection.

Airborne Digital Sensor System

Applanix airborne digital sensor system (DSS) captures imagery from fast moving platforms using a medium-format airborne digital camera system tied to a GPS-aided IMU. Given microsecond position and orientation data, the collected imagery is directly georeferenced, allowing for fast corrections, orthorectification, and mosaicking. The ground object accuracy required for direct georeferencing in airborne surveying places a heavy reliance on the high performance of the GPS-supported IMU. Given its digital data format and direct georeferencing capability (with no reliance on

Applanix Corporation has been involved in GPS-assisted IMU development for over 15 years. Their three divisions: Airborne, Land, and Marine Vehicles, each offer products that exemplify how GPS-aided IMU solutions are being applied towards very unique vehicle-in-motion surveying applications that rely upon IMU technology to meet very different challenges.



GPS-supported IMU's allow georeferencing through an exact sensor position and orientation at the moment of data capture.

To understand inertial navigation in its simplest form, imagine you and a friend are standing at one end of a long hallway. Your friend blindfolds and centers you, and then you start walking. As you proceed, you naturally detect the slightest changes: your step, balance, position, speed, etc. You may proceed quickly at first, compensating as needed and covering early ground with confidence. Eventually, however, you begin to lose your sense of alignment. Relative speed, position, and distance, as well as revised time to destination... even balance... all become weaker approximations. Bumping a shoulder becomes increasingly likely, as does hitting the wall. This ability to successfully navigate when denied a visual frame of reference, represents our own basic human form of inertial navigation.

Inertial guidance with GPS can be demonstrated using the same hallway. This time,

while blindfolded, your friend verbally directs you once per second. Chances become far greater you will proceed faster, never touch a wall, and will stop safely at the end. At a walking pace, a balance seems to have been found. Now let's exaggerate the situation only slightly and imagine you are told to run. The distance traveled between verbal direction gaps becomes greater as does the risk of collision and our reliance on our internal gyroscope between commands. The overall advantage of having both working in cooperation (and in higher frequency) is increasingly clear.

Inertial Systems

Advanced inertial measurement systems record even the slightest changes in physical motion through a triad of accelerometers and gyros. Given a starting reference point, all movements are accurately measured hundreds of times each second, even throughout



ground control), the DSS solution is becoming more and more popular for rapid response applications as well as affordable plug-and-play airborne surveying, especially for corridor mapping.

Land Vehicle Navigation

Aircraft seldom have difficulty obtaining line of sight to four or more GPS satellites. Not so for slower-moving land survey vehicles traveling along city streets, through tunnels, over rough roads, and over twisting highways in mountains or urban canyons. Quite often if GPS signals are not completely blocked, they are often limited or reflected (multipath effect), resulting in potential position errors. Solutions for land vehicles place greater reliance on advanced IMU technology for position data, especially during prolonged survey periods without proper GPS support. The result is uninterrupted, robust, and reliable data collection across urban armatures, rural roadways, and rugged terrains.

Marine Positioning

Most demanding of all three services, nothing tests GPS-assisted IMU technology more than the marine environment. Although rare, GPS blockages do occur when surveying rivers and canals with bridges or tall buildings near by. And although marine survey vessels tend to be slow moving and operate in open water where GPS signals are abundant, they are continuously subjected to random heave, wake, and wave forces from all directions. To make matters more interesting, marine surveyors typically lack access to target control points due to water depths. Yet despite all this, the same high degree of position control from millisecond to millisecond is needed for multibeam sonar systems to adhere to International Hydrographic Survey standards under all dynamic wave conditions.

Coupled with GPS technology, inertial measurement solutions are helping to dramatically lower the cost, effort, and risk of geospatial data collection. In less than two decades, the modern IMU has become a powerful generator of efficiencies for spatial analysis applications by making mobile surveying and mapping a very practical reality and an ideal tool.

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For more information on Applanix, visit www.applanix.com.