Locata: Serving Those Positioning, Navigation & Timing (PNT) Applications That GNSS Can Not

Chris Rizos
Introductory remarks… GNSS

• U.S.’s GPS has been a fully operational GNSS since 1995
• Russia’s GLONASS system is fully operational
• EU’s Galileo and China’s BeiDou are currently in deployment phases, nearing completion
• Many economically valuable industries in Australia are reliant on augmented GNSS to deliver gains in productivity
• Sophisticated DGNSS techniques can now deliver cm-level accuracy, in real-time, for precision navigation & guidance applications
• There will be an expansion of applications that require Precise Positioning
• **GNSS cannot address PNT requirements in many environments where it is increasingly needed…**
GPS visibility: Sydney
10deg elev, 7 December 2016

http://www.taroz.net/GNSS-Radar.html
GNSS visibility: Sydney
10deg elev, 7 December 2016

This is about 4x number used for standard GPS positioning...

http://www.taroz.net/GNSS-Radar.html
“But... GNSS is like Swiss cheese... ... it’s full of holes”

Nunzio Gambale
Locata Corp
There is no shortage of non-GNSS engineering options

Some technology options:
- “signals-of-opportunity”
- bespoke ranging systems
- autonomous (non-signal) systems

Some are appropriate for mass market applications

Few can provide high accuracy PNT capability for pedestrian or vehicle applications

**Locata is one such solution... considerable media interest**
UAV/UGV
TARGET ROBOT TAKES A HIT FOR SAFETY

PLUS
DETECTING UNDERGROUND NUCLEAR EXPLOSIONS

PRODUCT SHOWCASE
GNSS ALMANAC

Robot: Target on Its Back
Two Autonomous Vehicles Seek Safe Avoidance in Critical Tests

A new state-of-the-art research center runs car-makers’ safety systems through their paces, in tandem with a soft-target robot that can be crash-impacted without adverse effects. Precise positioning and exact repeatability of test sequences are key criteria.

Paul Perrotta, Perrone Robotics

The Insurance Institute for Highway Safety has undertaken a $30 million expansion project at its Vehicle Research Center near Washington, D.C., enlarging and enhancing a state-of-the-art vehicle test track and building a new 700 x 300-foot (213 x 91-meter) covered track for weather-resistant testing.

The VRC will use new robotic and positioning technologies to achieve required levels of precision and repeatability for vehicle testing of frontal collision avoidance and other safety systems. Tests of both the same and different vehicles must be conducted under identical, controlled conditions for the results to have comparable fidelity.

Crash tests and research conducted at the VRC help drive life-saving improvements in vehicle designs. The new facility will enable staff to evaluate emerging automated vehicle technology in commercial vehicle systems intended to prevent crashes or lessen their severity, with the goal of encouraging the entire industry to adopt the most effective new features.

Safety systems in vehicles to be tested include the following:

- Adaptive Cruise Control
- Collision-avoidance braking
- Lane-departure warning/correction
- Other automated technologies

Such functions represent semi-automated functions aboard vehicles now on the road. The system is also designed to address and test the full spectrum of semi- to fully-automated vehicles, addressing evolving levels of autonomy and ultimately producing driverless vehicle technology.

IIHS has contracted Perrone Robotics, Inc. (PRI), to deliver a robotic system for testing such vehicles. PRI develops new applications using MAX Robotics and suite of automation software building blocks. MAX enables rapid integration of a range of sensor and actuator types and has evolved with several frameworks, including MAX-UGV for unmanned ground vehicles. PRI has used MAX-UGV to build automated passenger cars, all-terrain vehicles, tractors, custom platforms, and rockstar Neil Young’s long-range electric LinckVolt, a converted 1959 Lincoln Continental.
Synchronized Ground Networks Usher in Next-Gen GNSS
Locata Fills Satellite Availability Holes in Obstructed Environments

Chris Alroz, Nunele Gamble, and Brendan Lili

An integrated GNSS-Locata system installed on drills, shovels, and bulldozers — the full complement of high-precision machines on site — at Australia’s Newmont Boddington Gold Mine has increased positioning accuracy and availability, as well as mine operational efficiencies, demonstrating an improvement in availability over GNSS only of 75.3 to 98.7 percent.

Many of the new paradigms in mining have at their core the requirement for reliable, continuous centimeter level positioning accuracy to enable increased automation of mining operations. The deployment of precision systems for navigating, controlling, and monitoring machinery such as drills, bulldozers, draglines, and shovels with real-time position information increases operational efficiency, and the automation reduces the need for workers to be exposed to hazardous conditions.

GPS simply, and GNSS collectively, despite their accuracy and versatility, cannot satisfy the stringent requirements for many applications in mine surveying, and mine machine guidance and control. Increasingly, open-cut mines are getting deeper, reducing the sky-view angle necessary for GNSS to operate satisfactorily.

A new terrestrial high-accuracy positioning system can augment GNSS with additional terrestrial signals to enable centimeter-level accuracy, even when there are insufficient...
Locata components...

- **Signal Structure**
  - Licence-free ISM frequency band (2.4GHz)
  - Dual-frequency carrier signals
  - CDMA PRN codes
  - Precise TDMA pulsing
  - >1 Watt output power - *range of over 10’s km*

- **LocataLite**
  - Time-synchronised transceiver network
  - Dual Tx antennas
  - Uses low-cost clock, shared by receiver section
  - Network time is “relative” to master LL

- **Locata Receiver**
  - CPH or PR single point-positioning
  - CPH requires ambiguity resolution
  - Real-time positioning at 10Hz
Locata deployments & tests... over the last few years...

- Static Deformation Monitoring
- GNSS+Locata Open-Cut Mine Positioning
- Static & kinematic Indoor/Outdoor Positioning
- Multi-Sensor Positioning
- Timing & Time Transfer
Multipath (signals bouncing off metal) make GPS systems unusable for most of the automation applications in ports... is multipath
The problem with RTK-GNSS in ports... *multipath*

**REAL-WORLD Multipath Example**  
German port – Oct 2016

Locata straddle near ships and cranes  
The straddle is stationary

RTK GNSS  
Wandering 50+ metres into the ocean because of cranes moving nearby
Locata’s VRay Orb Antenna

A decade of development by Locata

Produces 2.5 MILLION Virtual BEAMS PER SECOND!
Port Terminal Automation... where GNSS does not work well
Locata multipath mitigation... VRay antenna

VRay Antenna delivers cm-level survey-grade positions where other radio-based systems fail.
Locata VRay Antenna on Straddle - Germany

Locata VRay Antenna (with Laser Prism on top)
LocataLite infrastructure...

LocataLite Transmitter Enclosure (with Power and Comms)

LocataLite Antennas (x3) & Installation on Lighting Tower
Example test runs... 29 September 2016
Note: The measured distance between Locata antennas was **6.289 metres**. Therefore a PERFECT measurement would be equal to that figure.
Typical result... *Test Case 17*

*Note:* The measured distance between Locata antennas was **6.289 metres**. Therefore a PERFECT measurement would be equal to that figure.
BREAKING NEWS – 15 November 2016

Ports of Auckland aims high with pioneering automation concept from Terex Port Solutions

tags:

Locata partner TEREX (Germany) announces the first container terminal contract using Locata across the entire port as the radiopositioning technology (no GNSS will be used for completely automated machines)

Published: 15.11.2016, company: Terex Port Solutions

Terex Port Solutions (TPS), the pioneer and technological pacesetter in terminal automation, starts a new chapter for operators of container terminals with Terex®
LocataNet coverage area – Auckland NZ

~1.1 x 1.3km, ~50 autonomous straddles

~3cm positioning for autonomous straddles
What Locata automation is enabling...

Real-world results –
time after time after time = <3cm
Locata Correlator Beamforming for Multipath Mitigation at Relatively Low Cost: Initial Performance Results

Dr. Sanjeev Gunawardena
Dr. John Raquet
Dr. Mark Carroll

Air Force Institute of Technology
Wright-Patterson AFB, Ohio

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Portland OR
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Antenna based on correlator beamforming could be 3 orders of magnitude cheaper than standard CRPA...
Concluding Remarks

• LocataLite deployments are a viable solution to providing continuous, high accuracy positioning capability for machine automation in environments where GNSS-RTK does not work.
• Apart from GNSS signal obstructions, GNSS multipath is the most critical factor preventing cm-level positioning accuracy using GNSS-RTK.
• **Locata addresses signal availability challenges, not just because of its extra ranging signals, but because it also has sophisticated multipath mitigation technology.**
• Locata is an Australian innovation that addresses high accuracy PNT requirements for industrial applications.