Published October 28 2005, Technical Insights Aerospace and Defense Technology Alert Service

Revolutionary New Navigation System Combines Multiple Technologies for Robustness, Reliability

A research team at the Oak Ridge National Laboratory (ORNL) is developing a new navigation system that promises robust, reliable guidance for warfighters in the near future. The system is designed to overcome the obstacles that can sometimes limit the effectiveness of existing navigation technologies, like the Global Positioning System (GPS), and is expected to be highly effective in rough terrain, urban settlements, and areas covered by dense foliage. The novel system rides on yet another ORNL innovation – the Theater Positioning System (TPS), an entirely new robust navigation technology developed at the lab.

The system, called Triply Redundant Integrated Navigation and Asset Visibility (TRI-NAV), is an integration of three different navigation technologies: GPS, inertial navigation (INS), and the special ORNL-developed TPS navigation system. According to Gary Steimer, senior program manager at ORNL's National Security Directorate, the three component systems that make up TRI-NAV work in a manner that allows them to complement each other, while at the same time providing a significant level of system redundancy.

Global Positioning System very well regarded throughout the world, for its superlative accuracy in navigation. However, GPS has certain weaknesses that can become liabilities in a warlike situation: GPS can be jammed by enemy forces, eliminating navigation capabilities for its user, and signal reception can fail in unfavorable terrain (in mountainous regions, for example, and in built-up urban areas). While GPS would the first choice for most navigation requirements, its drawbacks need to be addressed in order to ensure that soldiers in the field are provided with robust, failsafe navigation.

TRI-NAV functions – and innovates - both at a conceptual and at a hardware level. By combining three different navigation systems, each based on different technologies, it ensures a level of system redundancy, and provides robust navigation; the technologies are chosen in a manner designed to complement each other.

A core component of the TRI-NAV system is the innovative new TPS guidance and navigation technology. Developed by ORNL, and with a demonstration due in approximately four to five months from the present time, TPS uses a group of optimally located radio transmitters to send signals out to receivers, which use the principle of

Rahul Nayar
Research Analyst – Technical Insights
rnayar@frost.com
www.technicalinsights.frost.com

triangulation to determine their current location. TPS uses a frequency-agile RF scheme, using a special 'hopping' protocol that allows it to switch from one frequency to another 'on the fly' – a feature that makes the system very difficult for hostile forces to jam. It also allows makes the system noise resistant, something that is especially significant for operations in urban areas, where the presence of densely-packed buildings can interfere with radio signals. An LPI/LPD signal (Low Probability of Intercept/Low probability of Detection) is utilized, using a new spread spectrum system developed at ORNL that makes communication more robust in harsh environments.

TRI-NAV uses TPS in combination with GPS and inertial navigation to provide robust and reliable navigation and guidance to the warfighter. In actual use, the TRI-NAV system would typically use GPS as its guidance technology of choice, by virtue of its superb accuracy. However, in the event of GPS failure, TRI-NAV would still be able to sustain navigation capability: the INS would record the last signal received from the GPS satellite, and use that as a baseline with which to provide adequate navigation. INS' weaknesses are also compensated for - as a technology, INS is notoriously prone to drift, and cannot sustain accurate navigation for more than a few hours at a time; however, TRI-NAV is able to compensate for this weakness in turn, by providing a guidance signal to the INS, hence negating the effect of drift and ensuring an adequate degree of navigation.

TPS technology could be used in different ways, in different contexts, conferring this versatility to the integrated TRI-NAV system. One scenario where TPS would be effective might consist of a situation where a friendly military force is in the process of invading and establishing a foothold in enemy territory: in such a case, powerful transmitters operating in the 80-120 kHz range could be located *outside* the actual theater of operations, providing navigation signals that could be received throughout a large landmass (according to Steimer, the signals could be used out to distances varying from 1000 to 2000 km, with adequate power). These signals would not be greatly affected by jamming from hostile forces - jamming is typically being localized, in its effect, and would find it difficult to effectively interfere with signal transmission on such a large scale. TPS transmitting towers would be safely located outside hostile territory, and, Steimer says, could be set up in two to three days.

Importantly, such a system would, by design, not interfere with signals from the LORAN navigation system, which also works in this bandwidth; according to Steimer, the TPS system could be made to receive LORAN signals, adding an extra dimension of functionality to the TPS device. Further, the TPS infrastructure could also be used to receive GPS data, and pass it on to the TRI-NAV receivers, should the need arise.

A second scenario might cover a situation where a friendly force would already have established itself within a territory; in such a case TPS could be used on a smaller scale, at higher frequencies and lower power, with transmitters located within the territory itself, inside designated safe areas. An area of about twenty square miles could be covered with smaller towers transmitting a 3.3 MHz signal. TPS transmitters can also be

Rahul Nayar
Research Analyst – Technical Insights
rnayar@frost.com
www.technicalinsights.frost.com

located in balloons, and can be transported in mobile units, with transmit power being determined in all cases by the actual placement of the transmitters.

TRI-NAV's conceptual flexibility also allows it make use of the best technology available, at the component level. TRI-NAV's GPS component would consist of the best off-the-shelf technology available at the time; the inertial navigation system is being developed in collaboration with Pennsylvania State University; and TPS has benefited from the extensive development program at ORNL itself. Technology development on any of these three fronts could conceivably benefit the TRI-NAV system as a whole.

The next major task, according to Steimer, is to integrate the three components of TRI-NAV together, a development that await the success of the TPS system. The ultimate goal is to deliver a hand-held, robust device that can easily be used by soldiers on the ground, with Steimer estimating readiness for operational testing in as soon as eighteen months, if funding were to be maintained at appropriate levels.

Details: Gary R. Steimer, Senior Program Manager, National Security Directorate, Oak Ridge National Laboratory, PO Box 2008, One Bethel Valley Road, Oak Ridge, TN 37831. Phone: 865-574-3041. Fax: 865-241-1052. E-mail:steimergr@ornl.gov.

Rahul Nayar
Research Analyst – Technical Insights
rnayar@frost.com
www.technicalinsights.frost.com

Filename: Revolutionary New Navigation System Combines Multiple Technologies for Robustness Reliability.doc
Directory: C:\Documents and Settings\ffs\Local Settings\Temporary Internet Files\OLKD37
Template: C:\Documents and Settings\Frostie\Application Data\Microsoft\Templates\RNAYAR.dot
Title: Published October 28 2005, Technical Insights Aerospace and Defense Technology Alert Service
Subject:
Author: Frostie
Keywords:
Comments:
Creation Date: 10/29/2005 11:28:00 AM
Change Number: 2
Last Saved On: 10/29/2005 11:51:00 AM
Last Saved By: Frostie
Total Editing Time: 80 Minutes
Last Printed On: 11/16/2005 1:27:00 PM
As of Last Complete Printing
Number of Pages: 3
Number of Words: 1,092 (approx.)
Number of Characters: 6,230 (approx.)