National Aeronautics and Space Administration

technology opportunity

Real-Time Tracking System Uses Ultra-Wideband RF Signals

Pinpointing emergency and military personnel in remote or hostile environments

A real-time locating system (RTLS) developed at NASA's Johnson Space Center (JSC) uses ultra-wideband (UWB) radio frequency (RF) signals for tracking and reporting the position of transmitter-equipped people and objects in a variety of environments. The technology has 100 to 1,000 times finer granularity than conventional narrowband RF RTLS systems and achieves a tracking resolution of less than 1 percent of the range (tested up to 3,500 feet). Originally designed for use in tracking lunar and Mars rovers, robots, and astronauts during exploration missions, the technology has a number of terrestrial applications including long-range tracking of emergency, military, and mining personnel in limited access or hostile environments where global positioning systems are not reliable.

Benefits

- **High performance:** Operates in proximity to other radio communication systems with little or no perceptible mutual interference due to low power spectral density of UWB pulses
- **High resolution:** Offers high temporal resolution (on the order of picoseconds) due to waveform shape and short duration of UWB pulses
- **Accurate:** Permits precise measurements of propagation time while transmitting data due to high fidelity of timing circuitry and superior granularity
- **Scalable:** Offers ability to increase system range, with additional cells
- **Dual use:** Provides a simultaneous communication channel in addition to precision locating capabilities

Applications

- Aerospace rovers, robots, and astronauts on exploratory missions
- Emergency workers (firefighters, police, and emergency medical personnel) in limited access areas where GPS is not reliable
- Military personnel and equipment on battlefields and in other hostile environments, supply depots, and base operation locations
- Mining industry to locate and communicate with underground personnel
- Oil companies for use in drilling operations
- Commercial and museum environments for tracking high-value inventory

Technology Details

UWB systems coexist with other RF systems, such as Wi-Fi and cellular, due to their wide bandwidth and extremely low power spectral density. These systems are particularly useful for fine-resolution ranging, communication, and ground-penetrating radar applications in military and law-enforcement settings where GPS is not reliable.

How It Works

The JSC-developed innovation builds upon conventional UWB hardware by incorporating tracking methodology and algorithms in addition to external amplifiers for signal boost. The tracking methodology is a triangulation calculation consisting of Angle of Arrival (AOA) and Time Difference of Arrival (TDOA) using a cross-correlation peak detection method. By directly estimating TDOA information from UWB pulses, the method achieves the high temporal resolution (on the order of picoseconds) needed to measure AOA with extreme precision.

The system uses a PC to synchronize and process data in real time from two receivers, or clusters, to display the position of the transmitter-equipped person or object. The interface software enables the PC to access the two data sets simultaneously through separate sockets. In the data collection process, data segments from each receiver are interleaved with those from the other receiver in chronological order of collection. Within the PC, the data segments are stored in a separate buffer; therefore, the contents of the buffers are representations of the same UWB pulse waveform arriving at the two receivers at approximately the same time. This data synchronization provides the separate and simultaneous collection of waveform data that the tracking algorithm requires for accurate real-time tracking.

Why It Is Better

Conventional AOA tracking methods use antenna arrays to extract phase information from a continuous sinusoid signal and then convert phase information to angle information. Due to characteristics of the continuous signal, resolution obtained this way is low, resulting in tracking errors. In contrast, the JSC method combines the advantages of accurate TDOA information achieved using UWB technology with the geometric advantages of two-cluster tracking to provide accurate location information at long ranges.

Patents

Johnson Space Center has received patent protection (U.S. Patent No. 8,116,350) for this technology.

Licensing and Partnering Opportunities

This technology is part of NASA's Innovative Partnerships Office (IPO), which seeks to transfer technology into and out of NASA to benefit the space program and U.S. industry. NASA invites companies to consider licensing this technology for Ultra-Wideband (UWB) Two-Cluster Angle of Arrival (AOA) Passive Tracking System Design technology (MSC-24184-1) for commercial applications.

For More Infomation

If you would like more information or want to pursue transfer of this technology, please contact us at:

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