Finding yourself in the great indoors

Real-time locating systems measure and track objects in an indoor enivornment using a variety of technologies.

23 November 2010 Beth Kelley

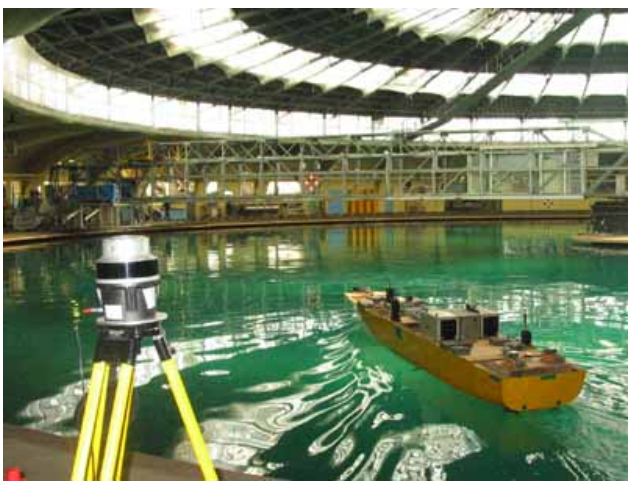
Global Positioning Systems (GPS) and satellite tracking have provided vast amounts of information about the world around us, from the deepest ocean canyons to the highest peaks. But how do we take that same capability indoors?

Real-time Locating Systems (RTLS) provide the same abilities as GPS, but in cramped quarters. RTLS can be used to measure industrial freighters or ships, determine available space for storage, or locate a person, device or object in a building.

RTLS are a class of technologies, encompassing coordinate measuring machines (CMM), laser radar, or indoor GPS (iGPS). Sensors using IR, laser, radio, and other wave signals are set up around a structure to triangulate and provide information on distance, height, and other measurements and coordinate information. These signals are transmitted over Ethernet, Wi-Fi or other communication system back to a central database that converts the signals into Cartesian positions and orientations of the sensors, at high data rates that allow for real-time coordinates. This in turn provides extremely detailed spatial awareness and measurements of the length of anything intercepting the sensors, such as a ship, or locating a person within the sensing range.

"Indoor GPS is a term used to describe RTLS," says Caroline Brown, communications manager of Ubisense (Cambridge, UK). "It is described like this so that everyone can easily relate to it as GPS is so well known."

"Indoor GPS, or iGPS, is a large-scale metrology system capable of simultaneously measuring and tracking a large number of stationary and/or moving targets," says Jarrad Morden, general manager North American Operations, Nikon Metrology, Canada (Waterloo, Ontario).



DGA runs iGPS to measure ship hydrodynamics in large gyration water tanks. (DGA/Bassin d'essais des Carènes is part of the French Ministry of Defense in charge of hydrodynamic studies performed on surface vessels and submarines for the French navy.) (Nikon photo)

Germany's Rheinisch-Westfälische Technische Hochschule researches the huge dynamic manufacturing potential of iGPS-enabled industrial robots. (Nikon photo)

Traditional GPS and other location technologies have long been used for outdoor surveillance and large-scale mapping. However, traditional GPS was limited in its scope, and could not be used to measure any internal structures. Coincidingly, cell towers and other radio signals are not strong enough to reach the far corners of a building or get through thick container walls. RTLS technologies use several different strategies for mapping internal structures.

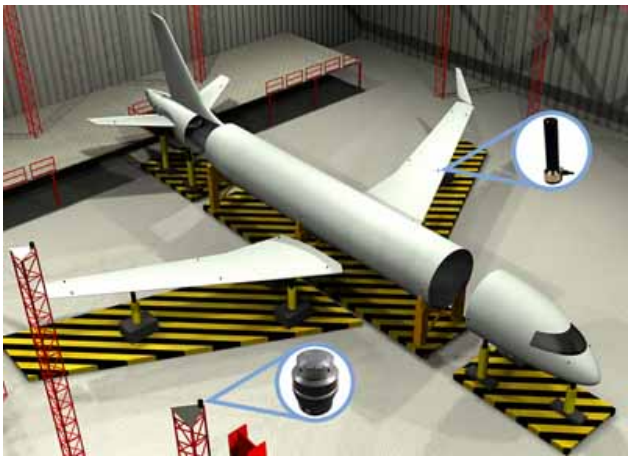
Nikon's iGPS, for example, works by installing an array of infrared laser-pulse transmitters around objects to be measured, usually large manufactured items such as parts and assemblies for aircraft, automobiles or ships. The transmitters flood the production vicinity with encoded laser light at a rotational speed of approximately 3,000 rpm. Each transmitter is able to communicate with sensors about 50 times per second. Sensors then pick up the signals from the transmitters, and calculate angle and position based on the timing of the arriving light pulses. An amplifier converts the analog signals into digital pulses, and a receiver converts the pulses into angle data. Network software processes the angle data.

"Ubisense solutions use ultra-wideband technology (UWB)," says Brown. "This is essentially radio/ radar technology and very resistant to signal distortion or reflection."

Another solution is to re-transmit GPS throughout a building. U-blox (Thalwil, Switzerland) has developed an Indoor Messaging System (IMES) that replicates traditional GPS signals within a building using signal repeaters so that GPS receivers will be able to read the insides of structures.

"This technology is in the prototype phase, and is meant for use in buildings where GPS satellite signals are 100% blocked," says Carl Fenger, communication manager of U-blox.

Many RTLS technologies are a one-way, receive only technology, so there aren't the privacy worries that go alongside some kinds of global location services.



iGPS in airplane assembly. (Nikon image)

The only potential drawback to RTLS systems is the amount of sensing equipment needed to get accurate measurements. "Our technology can provide accurate location using only two sensors in a large indoor area in a clutter free environment," says Brown. "But the more objects and obstructions there are, especially metallic ones, the more sensors will be required to give a highly accurate location."

CMMs were also notorious for being sensitive to environmental influencers and had to be recalibrated often.The original application of RTLS was to assist in the production of large industrial ships, containers, and other large industrial manufacturing. Not only could it measure components as they were assembled, but could also check for damage either during or after the construction, looking for scratches, gouges, bubbles, holes, and cracks of an object quickly and thoroughly.

This technology has found huge fans among other manufacturers, such as in the automotive industry. RTLS can be used to track the location of manufacturing parts and sub-assembled parts inside a building. It is also helpful for part to part alignment, tracking and directing robotic devices around a structure, and provides the basis for using hand-held measurement tools.

"Our solutions are used by Airbus to track parts of planes during final assembly, Aston Martin to improve the finishing process and BMW to automatically calibrate tools on an assembly line," says Brown.

Lockheed Martin used a CMM designed by Carl Zeiss IMT to measure the wing skins of their new F-35. "This wing skin is unbelievably large. It forms the whole skin for the fighter's wing, and it requires some incredibly tight tolerances over the entire length of the wing," said Kevin Santilli of Carl Zeiss in a press release. The Zeiss MMZ gantry CMM used to measure the F-35 wing skin has a measurement range of 5-m wide x 16-m long x 2.5 m in the Z axis.

It has also found applications in transportation, such as in ship yards, transit yards, rail yards, sports performance monitoring, luggage in an airport, packages at the post office, bank monitoring, and even tracking livestock.

"Whether the object is an aircraft part, AGV, or robot end effector, iGPS sensors can either be precisely tooled to points of interest, or quickly attached and characterized through a setup measurement plan," says Morden.

These capabilities have also been applied to tracking people in indoor environments.

"From our side, the most interesting aspect is the ability to track people and assets whilst inside an enclosed structure," says Carl Fenger of U-Blox.

RTLS can be used to track of patients in hospitals, or navigating through a factory. This capability has made all the more possible with RFIDs and other geolocation capabilities available on personal smartphones and electronic devices. Geolocation capabilities are becoming more familiar to the average consumer, and people appreciate the ability to orient

themselves, locate a store in a multi-level department store, or find the bathrooms at a large sports stadium. Geolocation games like Foursquare and SCVNGR are also becoming popular. Nokia and other phone providers have developed various capabilities for their phones so users can have the capability of location and triangulation indoors.

The American Museum of Natural History earlier this year launched an app for museum goers called "Explorer." Designed as an indoor GPS within the Museum, it works by using the museum's Wi-Fi system and triangulates the user's whereabouts. Visitors can download the app and pinpoint their location in the museum, and receive turn-by-turn directions throughout the 500,000 square feet of the museum, encompassing 45 permanent exhibition halls, theaters, restrooms, cafés, and shops.