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UWB POSITIONING TECHNOLOGY

horizon

Exafore Ltd
Sales: Aki Korhonen +358 44 544 7357 aki.korhonen@exafore.com

UWB Positioning Technology

What is UWB Technology?

UWB is a short-range radio technology for data communication that uses long sequences of nanosecond level RF pulses to create a signal with a wide bandwidth. With suitable transceiver hardware it is possible to measure the timing of these pulses with sub-nanosecond accuracy and therefore measure distances with decimeter level accuracy, one nanosecond being about thirty centimeters at RF signal propagation speed, i.e., the speed of light. This provides for its use in positioning systems and applications. The UWB signaling is standardized in the IEEE 802.15.4 standard.

Timing Measurement Techniques:
Time Difference of Arrival (TDoA) vs. Two-Way Ranging (TWR)

There are two timing measurement techniques that can be used with UWB to determine location: Time Difference of Arrival (TDoA) and Two-Way Ranging (TWR). Both of these methods can be used in Real-Time Locating Systems (RTLS) consisting of stationary devices (base stations) and mobile devices (tags), which perform UWB signaling and measurements between each other.

In TDoA, a tag sends a signal that is received by two base stations, and the difference between the reception times is measured. The base stations need to be highly accurately synchronized, which can be costly to arrange. One-way communication is sufficient: tags need only to send signals at regular intervals, and base stations need only to receive them.

In TWR, both tag and base station send and receive signals. Basically, a single back-and-forth messaging between tag and a base station is done in both directions, with the tag first initiating a measurement and then the base station initiating another one. This would require four messages to be sent over the air, but since the base station responding to the tag and base station initiating a measurement can be folded into a single message, a total of only three messages need to be sent.

TWR does not require accurate synchronization between base stations, or between base stations and tags, and suppresses certain error sources. It therefore provides better accuracy and lower complexity than TDoA.

Two-way data transmission allows sensor data collection from each tag and controlling of the tags remotely. The sensor data could be, for example, environmental data such as ambient temperature – or whatever else is needed by the application and supported by the tag hardware (HW). The remote tag control enables keeping the tags in clock synchrony with the base stations to an accuracy level that allows time division multiplexing (TDM) of the radio channel, resulting in efficient radio channel usage, even with tags using relatively inexpensive and inaccurate clock in their HW. It also enables sending alarms to the tag user, for example.

Since there is no messaging from base stations towards tags in TDoA, the tags will be completely asynchronous to base stations and each other, leading to RF transmission collisions as the number of tags grows, and consequently inefficient radio channel usage and variable measurement availability. In TDM operation that can be used with TWR, such collisions can be avoided completely, and measurements can be made with a continuous, constant rate.

A TWR measurement is the real distance between a tag and a base station. Because of this simple physical meaning, applications can use the measurements as is, with or without computed tag positions. For example, proximity detection to each base station is possible.

The Benefits of UWB

UWB provides various benefits in RTLS use over other technologies, allowing it to be used in applications where other systems cannot operate or where their performance or other characteristics are unsuitable or insufficient. Here is a shortlist of such benefits:

- UWB can provide decimeter level positioning accuracy independent of range. Positioning solutions based on signal strength (RSSI), for example, typically provide multi-meter accuracy levels, while in angle-of-arrival (AoA) based systems such as BLE AoA, the measurement error increases as distance between tag and base station increases.
- UWB signal can be measured through obstacles such as partition walls, furniture, pallets of goods etc.; a visible line of sight between base station and tag is not required. Consequently, UWB positioning can work also in rooms where there are no base stations, for example.
- No RF fingerprinting is required during installation or when radio environment changes, as UWB positioning is not based on fingerprinting.
- UWB tag transmission and reception times can be relatively short, providing for low power consumption for tags.
- UWB natively supports 3D operation with X, Y and Z coordinate output. 2D operation is also possible.
- UWB is resistant to interference from narrowband radio systems, since each one of them affects only a small portion of the whole UWB signal spectrum.
- A UWB tag does not need a large antenna or any other large components, providing for small and lightweight tag designs.

Summary

UWB is a tried-and-tested technology for different types of indoor positioning applications, including both real-time tracking applications and offline location data analysis applications. It provides a number of benefits over other technologies, such as high accuracy and reliable operation even in complex environments.