EMBEDTEK

Inventive Ways to Use Ultra-Wideband

And What You Need to Know to Get Started

Ultra-wideband (UWB) used to be a well-kept secret. The wireless technology uses radio frequency to measure distance precisely and securely over a short range. And for about 10 years, UWB was almost exclusively used for real-time location systems (RTLS) to track and manage assets inside of warehouses. There was one dominant UWB chip manufacturer and there were limited options.

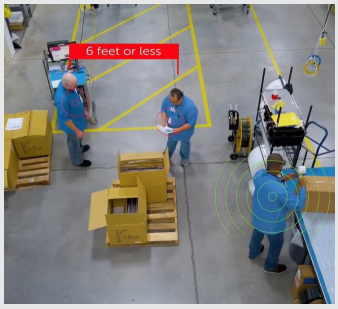
A powerful change happened in the last two years. The secret is out. Now, multiple players are offering a multitude of technology options, with parts more readily available and at competitive prices. As a result, UWB is being used in new and disruptive ways for mapping and location, distance measurement, motion tracking, guidance systems and security applications.

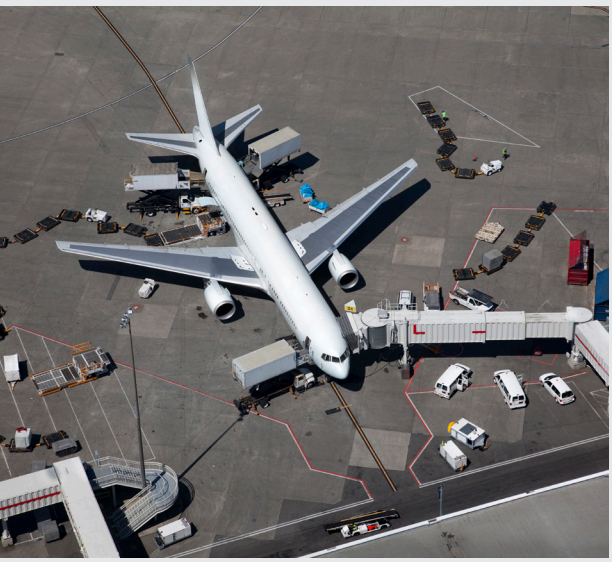
With wider accessibility, UWB has the potential to improve safety, efficiency, and be cost effective across many industries. This white paper details the different ways UWB can be used today and factors to consider before you get started.

Real World Applications for Ultra-wideband

EmbedTek has researched and studied UWB technology and developed product for a variety of applications. Our engineering team has compared UWB's capabilities to alternative wireless communication including Wi-Fi and Bluetooth in addition to ultrasonic and LiDAR. We found that nothing could match the precision and ease of use of UWB. UWB transmits data across a wide range of frequencies. Its range of about 100 meters makes it seemingly immune to signal strength issues.

The traditional use of UWB for asset management is the tip of the iceberg of how it can be leveraged now. The following examples demonstrate the ways different industries can drive market advancement thanks to the benefits of UWB technology.





Mapping and location to prevent ground support equipment collisions

The Flight Safety Foundation estimates that airport apron ramp accidents and incident occur once per every 1,000 departures worldwide every year. According to ***Ground Support Worldwide***, the most common forms of ground damage include pieces of equipment impacting aircraft, or aircraft ingesting objects that were improperly stowed or left in poor positions.

Many organizations and airlines are working to reduce this number in an effort to protect the safety of personnel, aircraft, facilities, and equipment. Software and sensors using UWB can easily be adapted into ground support equipment and vehicles to detect when objects are getting close to one another, resulting in a drastic reduction in collisions, injuries, costs, and lost time.

One way is through dynamic 3D facility mapping and collaborative detection, which would allow vehicles to communicate with each other. This concept would require 3D attributes of the facility and all moving or moveable objects on the apron. 3D mapping software would be used to track all objects real-time throughout the entire apron with everything that is there – 3D models of each type of airplane, cargo equipment, maintenance vehicles, jet bridges, structures, and more. By using 3D dimensions of each object, the 3D mapping program will indicate where and when interference can occur before it happens. For example, if a baggage vehicle operator is about to drive under an aircraft wing, but just happens to have the conveyor up too high, the system could send an alert and issue an alarm.

This software can provide peripheral knowledge of any vehicle an operator is driving. The absolute position known of every vehicle with GPS, UWB, and vector locations can also be detected with compass/gyro sensors which provides an apron manger the ability to determine where every vehicle is in real-time – and foresee potential collisions before they happen.

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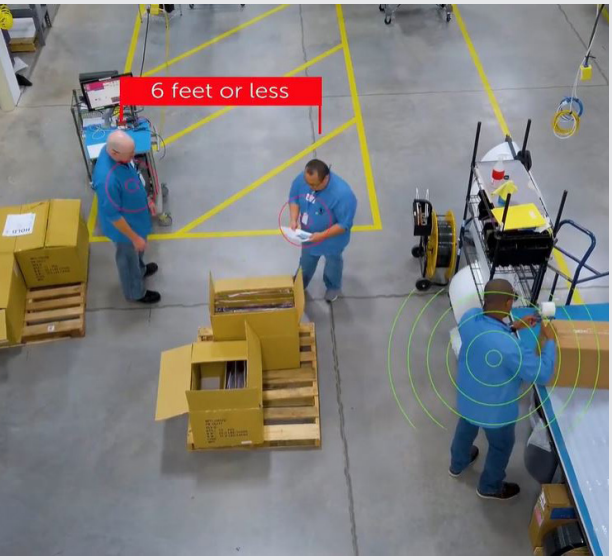

Measuring distance to prevent the spread of infection

For many businesses and institutions, social distancing is difficult. This can put organizations at risk if someone gets ill. Without effective contact tracing, it's nearly impossible to determine who sick people may have infected, and illness can spread rapidly throughout facilities. EmbedTek developed **PariRange™** as a simple social distancing and contact tracing solution to help businesses support workforce health and safety. Most importantly, if an infection does occur, PariRange can help control the spread.

Our team of engineers used UWB and time of flight technology to develop a wearable device which constantly searches for other devices and measures the distance between them. When a worker comes within 6 feet of another device, PariRange vibrates an alert and records the date, duration, and device number the worker came in close contact with. Data is aggregated and stored for 14-28 days. Data is easily viewed through a PariRange Log Reader. It connects to a Windows 10-compatible PC via USB. Log readers also can be placed throughout a facility to pull data from the devices as workers pass by.

EmbedTek engineers selected UWB for its accuracy – PariRange has a rated accuracy of 4 inches. UWB also was attractive because it requires no additional infrastructure. In 2020, during the first year of the COVID-19 pandemic, this made it possible to implement PariRange at essential workplaces within one day. It is scalable for size of workforce and appropriate for all kinds of locations, such as factories, schools, construction sites, and farms.

The PariRange product is a peer-to-peer technology because it measures employees' close contacts. If an organization wanted to measure worker traffic flow an anchor could be added to a backroom or an entryway. Every time an employee with a device walks by, it will be recorded. This data could be used contact tracing later, or to identify peak hours of traffic that could be potentially broken up to prevent the spread of infection.

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Detecting motion to increase efficiency of collaborative mobile robots

Autonomous collaborative mobile robots were created to work alongside humans. The DHL EffiBOT, for example, behaves like a handling assistant, following human pickers through a warehouse and taking on most of the physical labor. When EffiBOT is full, it leaves its human to deliver the inventory and a new, empty EffiBOT arrives to continue the work.

Other versions of mobile collaborative robots help with parts deliveries, assembly, kitting and bagging in warehouses. In hospitals, they deliver medicine and surgical supplies safely as well as clean linens and meals, then return the items to be washed or disposed of.

UWB technology is ideal for collaborative mobile robots because it allows the robot to detect motion and quickly react, but keep an accurate and safe distance from the human it interacts with. A collaborative robot that stays in close proximity and moves when a worker does would allow for a truly hands-free experience while keeping safety a priority.

Authorizing security access to keep senior community residents safe

Another kind of safe environment UWB can help create is to protect the health and wellbeing of seniors with Alzheimer's or dementia disorders. In a senior living community, there are multiple safety considerations such as medication, supply, and equipment rooms residents should not enter; entrances and exits that need to open easily or easily be monitored; and locating a resident when they are in need of help.

A car with a keyless entry feature will automatically unlock the doors when it senses that the car keys are within a specified range. In a similar fashion, UWB tags can be given security clearance based on each individual resident, employee, and visitor. As they approach a door, it will automatically open if it is an area they are cleared to enter. This application could also be used by the security team to see everyone who approached the door throughout the day, whether they were given access or not.

Factors to Consider Before You Get Started

The accuracy and reliability of UWB technology means that whatever application it is used for, you can be confident you have the best technology to detect a contact event. The nature of UWB is to always search for other UWB tags – whether they are worn on employees, installed in vehicles, or anchored to a ceiling to triangulate a precise location.

Before you get started on your own inventive application of UWB-based technology, consider the following factors.

Beware of the downsides

As much as we praise UWB technology in this white paper, it does not come without disadvantages. The first has to do with radio waves. UWB uses low power, broad spectrum, and short pulses of radio frequency to penetrate walls and avoid electrical interference. But radio waves are absorbed by electrical conductive metals such as copper, aluminum, silver, and gold. They also are absorbed by water, including objects made up of water, such as humans. So UWB will penetrate drywall, for example, but not steel, or concrete.

EmbedTek learned firsthand that this makes UWB difficult to implement in a warehouse filled with dense racking. Our engineers considered avoiding racking by placing UWB anchors in the ceiling, but found some accuracy is lost because of the increased distance between the tags.

Another disadvantage is that UWB as compared to Bluetooth Low Energy (BLE) requires more power to operate, mainly because it never turns off. It is always searching. This means tags would need to be recharged every 12 hours. In some applications it may make sense to use a combination of technologies such as Bluetooth to “bracket” the distance of other tags and then use UWB for an accurate distance calculation.

Consider how fast tracked objects will be moving

UWB can tell if an object is stationary or moving, so it can track movements at various speeds. UWB is ideal for tracking rapid movements because of its transmission speed, precision, and reliability. One experiment confirmed UWB technology could accurately locate objects moving at 60km/hr. The speed at which your UWB application can track objects will depend on the maximum update rate and numbers of tags being communicating at the same time.

Consider the distance and environment between tracked objects

According to the UWB chip manufactures, UWM can communicate up to 100 meters. Actual reliable distance will be affected by the number of tags in an area, other RF interference and the environment between the tags. Open line-of-sight will provide the best performance and range. Dense obstructions between tags will substantially degrade performance.

Understand the difference between peer-to-peer and anchor technology

Peer-to-peer refers to moving targets that have a UWB tag – whether it is a person wearing a tag or an object containing one. Anchor technology is used for classic position control. Anchors are similar to tags, but are stationary checkpoints. If you want to determine the X-Y location, anchors are the best solution but if the purpose is for collision avoidance, a peer to peer method may be much easier to implement.

Add infrastructure to create a 3D Space

When working on more than one plane, a combination of anchors and tags can be used for triangulation. A 3D space enables precision location capabilities, which can be used for asset management or collision prevention applications.

Improve performance by supplementing with other technologies

UWB can be used alongside other wireless communication technologies to get the best of all capabilities. Bluetooth, for example, consumes far less battery power than UWB. Let Bluetooth do the continuous searching for a tag, then, once it is located, use UWB to accurately measure distance. Many chipsets are available that include both technologies.

Approach standardized development kits with caution

Each application of UWB is unique, and standardized development kits can create unnecessary limitations. Third party engineering teams like EmbedTek can build a product based on UWB technology to solve a specific need. Our engineers also work with original equipment manufacturers (OEMs) and independent software vendors (ISVs) to take a concept or prototype based on UWB through an effective process from design and validation, to regulatory, manufacturing, and distribution.

How EmbedTek Can Help

EmbedTek partners with OEMs and ISVs to develop IoT solutions by combining imaging and sensor technology with intelligent analytics. EmbedTek designs and manufactures cameras, custom vision systems, computers, industrial displays and supporting application software. The engineering and manufacturing facility headquarters are in Waukesha, Wisconsin. EmbedTek specializes in inventing new wa**ys** to enhance equipment safety, improve performance, and provide a level of consistency the human operator cannot achieve on their own.

EmbedTek is uniquely positioned to solve measurement and tracking challenges and develop new UWB platforms. We have spent decades developing application specific computers, integrated displays, and custom I/O solutions for OEMs. Over the past 10 years, we have expanded our expertise to include cameras, sensors, analytics, machine learning, and artificial intelligence. Throw any challenge at us, from demanding environment and ergonomic requirements to High Level Assembly and nonstandard I/O. We'll evaluate it, carefully attack it, and solve it.