Ultra-wideband: spatial awareness for smart things

EXPERT ARTICLE

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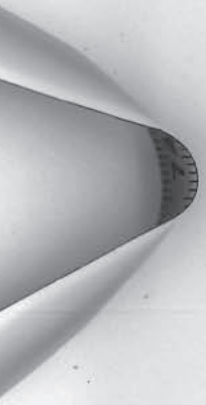
ULTRA-WIDEBAND (UWB) WIRELESS TECHNOLOGY IS QUIETLY MAKING ITS WAY INTO OUR EVERYDAY LIVES. IT'S ALREADY SUPPORTED BY MANY SMARTPHONES, AND THE FIRST PRODUCTS ARE ALREADY ON THE MARKET. WHAT EXACTLY IS UWB, AND WHY IS THE TECHNOLOGY SO REVOLUTIONARY?



Controlling things by pointing your smartphone at them? Devices that can configure themselves on their own? Never losing anything again? These are just a few of the scenarios made possible by the widespread use of ultra-wideband. UWB will provide the things around us spatial awareness. But how?

What makes UWB so powerful

UWB is actually nothing new. The technology has been used in industry for some time. What is new is that it's now finding application in the consumer world and thus becoming accessible on a broad basis. This has been made possible by increasing standardisation and massive price drops. Another important factor is support from industrial alliances such as the FiRa Consortium, a non-profit organisation that promotes UWB for different use cases.

Unlike narrow-band wireless technologies such as Bluetooth Low Energy (BLE) and Wi-Fi, UWB uses very wide frequency bands for data communication. Data are transmitted in very short pulses. This gives UWB a whole series of advantages versus other wireless technologies.

Most importantly UWB can measure the propagation time of the radio signal between the transmitter and receiver very accurately. This enables distances to be determined to the centimetre – securely, robustly, energy-efficiently and in real time. UWB thus closes a gap for location-based services at close range and complements existing wireless technologies. Less in focus at present but no less interesting is the use of UWB for transmitting data. This allows, for example, the creation of extremely energy-efficient wireless sensors powered by small solar cells around them.

From distance measurements to localisation systems

Using more than one antenna on the receiver side also enables not only the distance, but the direction of the transmitter to be determined relatively accurately. Users see the distance and direction to the desired object displayed on their smartphone and can aim at it. UWB also enables real-time locating systems (RTLSs) to be set up that allow the absolute coordinates of people and things to be determined. In buildings these systems basically consist of two components: permanently installed "anchors", the positions of which are known, and the mobile devices that to be located. It still requires a considerable amount of effort to set up and operate a UWB RTLS in a building. But even simple distance measurement has many potential use cases.

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Access without action

Passive access systems have been around in the automotive sector for many years. The vehicle locks or unlocks automatically depending on whether the key is close by. An access system of this sort requires the process used to be highly accurate and secure. Existing solutions are vulnerable to so-called relay attacks, where attackers use relay stations to forward the wireless signal between the key and the vehicle, enabling them to unlock it from a distance. Thanks to its ability to measure distances precisely, UWB provides good protection against attacks of this sort. A high degree of standardisation also allows smartphones to be used as car keys. Various manufacturers are already using this technology, including BMW in its iX.

UWB-based access systems are also suitable for buildings: using digital keys on UWB-enabled smartphones makes it possible to manage access rights on an entirely digital basis, reducing equipment and materials, administration and costs. UWB's ability to measure distances accurately enables a door to automatically unlock when an authorised device approaches and afterwards lock itself again reliably.

Naturally the principle can be abstracted and is interesting for many sectors: in one scenario, a commercial coffee machine automatically charges the espresso to the user standing in front of it. Another possible use case is making it safer to use dangerous machinery by ensuring that the equipment only works when nobody is within the danger zone.

Things that literally know their place

Things that have spatial awareness can also configure themselves on their own. For example, once a wireless thermostat has been installed it can integrate itself autonomously into the room's climate control system. Or wireless light switches that link to the smart lighting in the same room automatically. Automatic mechanisms of this sort also translate into other scenarios, for example a tow bar that folds out automatically when a vehicle approaches the trailer.

Benefits for commerce, logistics and manufacturing

UWB could also help users find their way around buildings. For example a shop or museum could have a locating system that enables

The core characteristics of UWB

RANGE OF AROUND 50 M

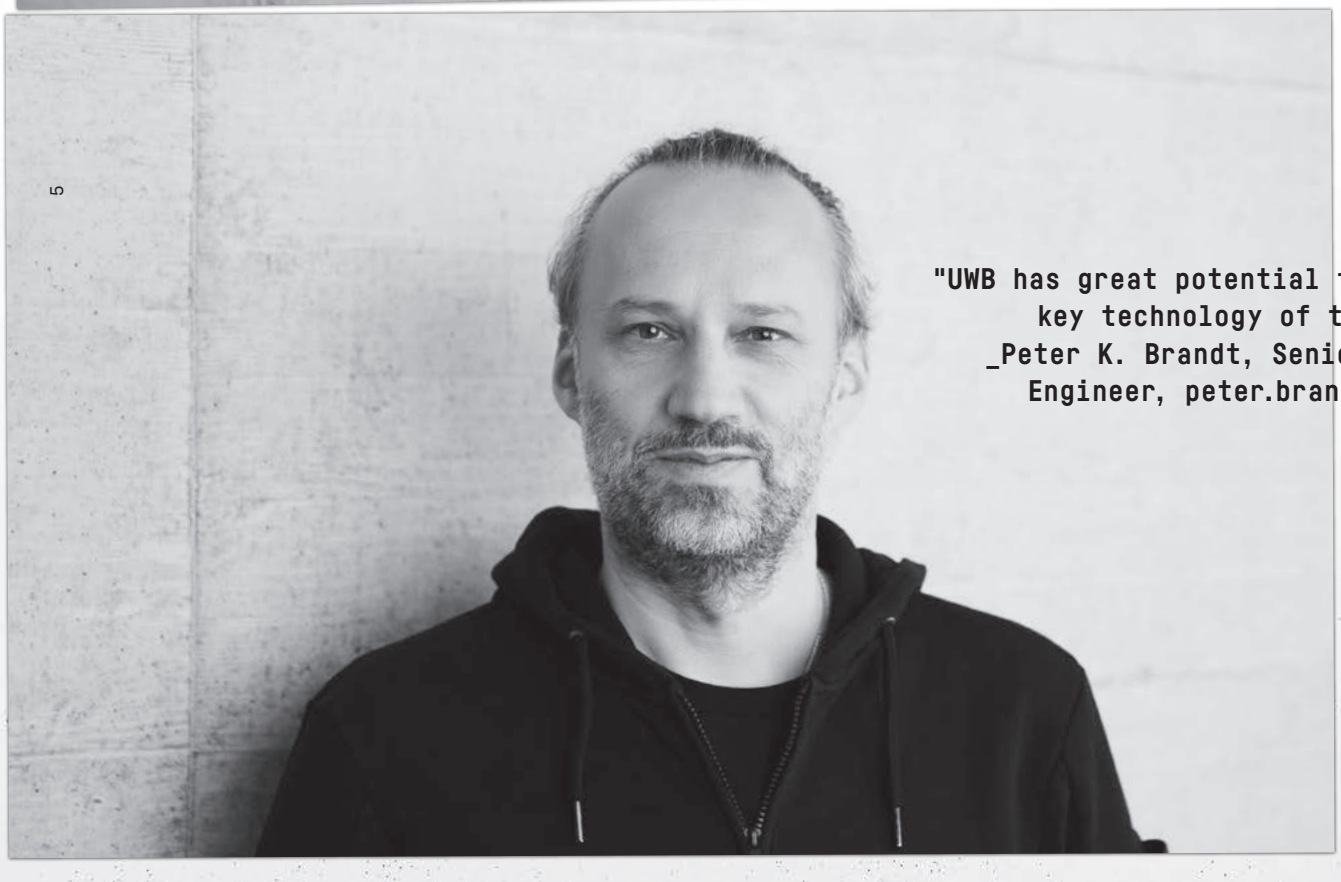
DATA COMMUNICATION AT UP TO 27 MBIT/S

ROBUST, INTERFERENCE-RESISTANT DATA TRANSMISSION WITH LOW LATENCIES

MORE ENERGY-EFFICIENT THAN BLE OR WI-FI

MEASURES DISTANCES RELIABLY TO WITHIN A FEW CENTIMETRES

"UWB makes our things a little bit smarter again."
_Dr. Benedikt Ostermaier, Head of IoT, benedikt.ostermaier@ergon.ch



"UWB has great potential to become a key technology of the future."
_Peter K. Brandt, Senior Software Engineer, peter.brandt@ergon.ch

visitors to navigate all the way to the precise product or exhibit they're looking for. Another particularly relevant use case is in facility management, where a UWB-enabled device could be used in the course of repair or maintenance work to locate equipment mounted behind screens or false ceilings. In this case a locating system isn't even necessary; the bearing is sufficient.
UWB could also simplify processes in manufacturing and indoor logistics. For example it would be possible to avoid manual procedures such as scanning barcodes. Often the scanned barcode triggers a process step in a control system: the selection of a tool, a component or a machining specification. Thanks to UWB's high locational accuracy, this would work even when there were many components and tools in a confined space, for example in assembly line production. Forklift trucks in warehouses, for their part, could be fitted with UWB tags. In combination with a locating system this would show what pallets had been unloaded or picked up where in the warehouse. Simpler tags based on QR or barcodes, for example, would be sufficient for the forklift truck to identify pallets.

A start has been made
Apple is helping raise acceptance of the first UWB use cases with its AirTags. These small locating devices are about the same size and weight as a Swiss five franc coin. They can be attached to objects such as key rings so that they can be found if lost. If the AirTag is close by, the user's own smartphone locates it. With UWB this is done very accurately. Even if the AirTag is further away there's a solution: the Find My Network uses the Apple devices of participating customers to find the lost AirTag.

In addition to newer iPhones, the Apple Watch and the HomePod Mini smart speaker also support UWB. Samsung, Xiaomi and other manufacturers are following suit. Soon we're likely to see the emergence of an ecosystem of compatible devices and applications. The quiet proliferation of UWB in the mass market is setting a new standard almost unnoticed, taking smart technology to the next level. Maybe in your industry too in the near future? />