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Analysis of the Future of Ultra-Wideband

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ABSTRACT: UWB (ultra broadband wireless communication technology) is the core of the impact radio technology. It has become the focus of attention in the field of wireless communication. This paper aims to analyze the future of ultra-wideband. The definition, principles, and performance characteristics of UWB technology are introduced. The result shows that its bandwidth is greater than all other communication technologies' bandwidth, and it has the advantages of anti-interference performance, high transmission rate. It has shown great application potential not only in military applications, but also in civil and other fields. UWB shows its advantages in some small and medium-sized enterprises and home environments. It meets the social demands. The research result demonstrates the popularization and prospects of this technology.

1. INTRODUCTION

Nowadays, UWB technology has been more and more widely used. The first is the iPhone 11, which has an ultra wide band chip. The iPhone with the U1 chip provides a UWB connection. Combined with the Internet of things (IOT) technology, it can provide spatial perception, that is, the ability of the mobile phone to recognize the surrounding environment and objects in it, and use the nearby interaction in the application to obtain the location of the device with the U1 or UWB chip. Now it also appears in note 20 ultra, which means that it is beginning to gain a firm foothold in the Apple ecosystem and the Android ecosystem. This technology is now receiving more and more attention, and its advantages are also very obvious. It's extremely difficult to intercept because short-pulse excitation generates wideband spectra-low energy densities, and low energy also minimizes interference to other services. It's multipath immunity. The time-gated detector can excise delayed returns. Its price is lower.

Research and development of the UWB receiver needs to address the following key technologies:

(1) Receiver technology: the UWB pulse signal has a natural multi-path resolution ability, so the Rick reception technology can be used to combat the time dispersion caused by the multi-path channel.

(2) Synchronization technology: it cannot reliably receive transmitted data without an accurate synchronization algorithm.

(3) Channel estimation in order to ensure the system's transmission reliability and power efficiency.

Based on this, this paper will discuss why the technology has not gained greater popularity. It describes the definition and rationale of this technology. The relevant contents of this paper will have guiding and explanatory significance for the future application of this technology.

2. INTRODUCTION OF ULTRA-WIDEBAND

2.1. Definition

Ultra broad band (UWB, Ultra Wide Band) technology is a new wireless communication technology. It gives the signal a bandwidth of the magnitude of GHz through the direct modulation of impulse pulses with a very steep rise and fall time. The term "UWB" as it is now commonly referred to was first used in 1989, and before that it was known as pulse radio technology. In the 1960s, ultra-wideband communication without carrier short pulses first appeared in Ross GF's research on time-domain electromagnetic. In the 1970s, Ross GF, Harmuth, Paul van Etten and others made important contributions to the development of ultra-wideband technology. In 1973, the US patent invented by Ross GF was approved, which is a landmark patent for ultra-wideband communication. From 1969-1984, Harmuth published a series of documents, studied the basic structure design of ultra-wideband transmitters and receivers, and made important contributions. In 1977, Paul van Etten conducted experimental tests of ultra-wideband radar systems, developing the system design and antenna concepts.

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2.2. UWB is radio Jim

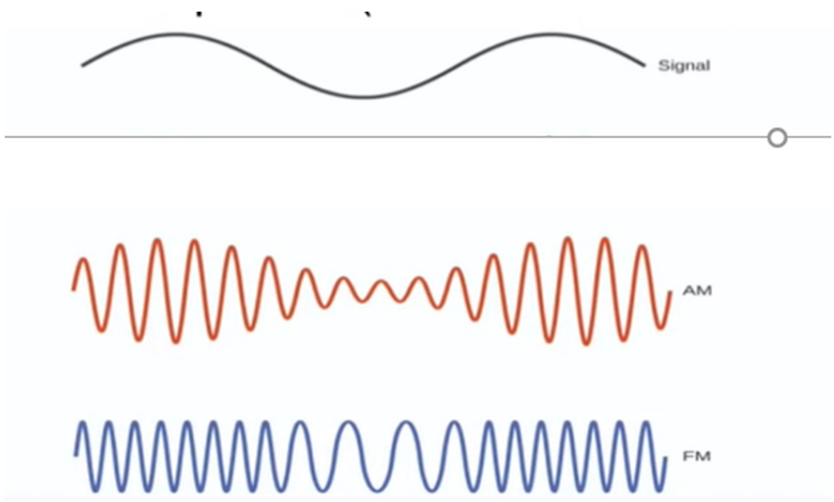

Figure 1 Different particular types of radio

There are many particular types of radio, like AM radio, FM radio phase shift keying, which is found in Bluetooth. Now they're always modulating modifying a radio wave that's already following a kind of sine wave. Therefore, modifying the amplitude, frequency, and phase of signal strength, and other things can be combined with other types of modulation.

UWB uses pulses. Therefore, it does not change the radio wave in the form of a sine wave, but sends out very short pulses one by one. In fact, they can be up to just two nanoseconds apart. More importantly, it rises first and then falls. People can change the shape of the actual pulse.

There are some different ways. There's a kind of inverted one zone, but that's not important. The point is the policies, rather than trying to actually carry the information on a radio wave that's following the sine shape.

It stayed at that limited low power effect of less than one milliwatt. This article will also study its coverage, not just 5 gigahertz or 2.4 gigahertz, just like WiFi and Bluetooth. This starts at 3.1 gigahertz and goes all the way to 10 degrees. It's a huge area that can be used. The reason that uses that huge area is that it's underneath the threshold of what would be kind of the noise level. So if it's in that space doesn't need to be licensed. People don't need to have permission to use it because the power levels are so low that it can't interfere with anything. So it's low down and people don't need to get a special license from a state organization whatever to call to prove their use of this radio power could be very small.

2.3. The feature of UWB

Most wireless systems use a central frequency, and then a few megahertz either side, and that's called a band. It's actually quite a narrow band. As a result, the frequencies of some devices are typically between 2080 and 2400 megahertz, such as Wi-Fi, which has a frequency of 2.4 gigahertz and uses a 22 megahertz channel. So it's very narrow. Now, ultra wideband uses 500 megahertz as a minimum, and it can go up to 1.3 days, or 1300 megahertz [1]. That's a huge edge, which gives an advantage for different reasons.

There's also some one gigahertz stuff that's floating around that's not really been implemented very much. Of course, scientists are working at very low power now. The theoretical maximum range in line of sight, which means a clear open factory floor or a clear field or something, is 200 meters. But really, the optimal range for when someone wants to do stuff at high speed is about 10 meters, and of course, people can go further away, but data rates will drop. But 10 meters is a good number to be thinking about.

Because of that wide bandwidth of up to 1.3 gigahertz [1], people can get theoretical data rates of up to 480 megabits per second. However, the currently defined standards is basically 27 megabits per second [3] which means it is greater than Bluetooth but not as good as WiFi. The other difference is the low power of less than one milliwatt, which is what WiFi is now. All of this wideband stuff actually allows us to do great location detection and location arranging.

So basically, down to the centimeter level, people can work out where something is. Because first of all, so many different pulses are sent out every nanosecond, which means they can be measured. It does play well with other wireless technology. That means two important things. One is high accuracy, location and range, better than WiFi and traditional Bluetooth. Of course, Bluetooth now has some location stuff built into it as well. Radar type apps, in the sense that they can send out these pulses and can get pings back from things, because they're pinging back and forth at these two nanosecond intervals, it's easy to calculate how far away different things are. The other thing that's really interesting is that it's good for security.

3. ADVANTAGES OF ULTRA-BROADBAND TECHNOLOGY

Firstly, improving the utilization rate of the frequency band. Ultra-broadband utilizes the unlicensed frequency band, that is, the 3.1-10.6GHz frequency band, and makes the most of this frequency band without interfering with other wireless communications. Secondly, the transmission rate is high. According to Shannon's theorem, the maximum transmission rate of data is related to the signal bandwidth as follows:

$$C=BW \log 2 \, (1+SNR)$$

Among them, C represents the channel capacity, BW represents the bandwidth, and the transmission rate is proportional to the bandwidth. Therefore, for the UWB system, the potential for a high data transmission rate depends on the specific UWB protocol.

Thirdly, the use of UWB is very flexible. For different application fields, there are different parameters and functional requirements, such as data rate, power consumption, transmission range, and other parameters, for communication, positioning, and other functions. UWB can provide a variety of application requirements without needing additional hardware resources. Fourthly, high time resolution. The pulses emitted by UWB are extremely narrow and the time resolution is very high, so it has excellent performance in anti-multipath effects [2]. It has high positioning accuracy or ranging accuracy.

4. THE REASON THAT UWB TECHNOLOGY WILL FLOURISH IN THE FUTURE

4.1. More and more widespread usage and applications

Based on the above advantages, UWB has applications in many aspects. When realizing communication between devices, it can also be used in military and civilian applications such as positioning, radar, automobile collision avoidance, and ranging. Therefore, UWB technology has become a strong competitor to short-range wireless communication technology. Because this technology has such characteristics and advantages, it will definitely be more respected in the future.

4.2. Appointment and improvement of relevant agreements

The second reason is the formulation and improvement of the Ultra-Broadband Protocol. At this stage, UWB is mainly used in the military, radar and other fields. In the 1980s, UWB research mainly focused on the realization of the physical layer of short pulse transmission. With the development of UWB technology, applications for UWB have appeared in new directions, such as liquid level sensing, positioning systems, height measurement, and other fields. In 1989, the US Department of Defense named it "UWB" [3-4].

In 2002, the FCC (Federal Communications Commission) issued relevant regulations for ultra-wideband transmission [5], which is defined as the bandwidth below 2.5GHz exceeding 20% of the center frequency or the bandwidth above 2.5GHz exceeding 500MHz. The average emission PSD (Power Spectral Density) is limited to a certain extent, which is expressed by EIRP (Effective Isotropic Radiated Power). The unit is dBm/MHz, which means the transmit power of 1MHz bandwidth. It is divided into indoor and outdoor. The working frequency band is mainly concentrated in the frequency band below 960MHz and 3.1-10.6GHz [6-7], and the output power spectral density peak is -41.3dBm/MHz.

4.3. The further development of the related industries and the extension industry

The third reason is the vigorous development of related companies and their derivative industries. The AL5100 RF transceiver of Alereon, a foreign company, integrates RF analog front-end, such as PLL, Filter, LNA and PA, etc., supports single-ended connection to the antenna, does not require an off-chip balun, and has low transmit error vector magnitude (EVM, Error Vector Magnitude), low input noise factor, high linearity, wide dynamic range and other characteristics. The operating frequency band is 3.1-10.6GHz. The DW1000 ultra-wideband communication transceiver integrated chip launched by UWB chip supplier Decawave is in line with the IEEE 802.15.4-2011 protocol standard. The working frequency band is in the range of 3.5-6.5GHz, and has the functions of communication and positioning. The positioning accuracy reaches 10cm, and the transmission distance up to 290m, it can simultaneously support the ultra-wideband regulations in the United States, Europe, China, Korea, Japan and other regions. The chip has been launched for several years and has a very high market share in the global public UWB market.

According to the latest report [8-10], at the beginning of 2020, Decawave was acquired by Qorvo. The deal valued is at $400 million in ultra-wideband wireless technology. Qorvo is a well-known RF semiconductor company that provides chips for Apple's iPhone. Qorvo President and CEO Bob Bruggeworth also said: "Having Decawave join us can build our position as an accurate and secure short-range positioning solution in emerging markets." In the future, Qorvo will definitely develop UWB vigorously and launch more UWB products.

Finally, of course, Apple, which brought UWB into the public eye, released the iphone 11 with an ultra-wideband (UWB) transceiver in 2019. The ultra-wideband chip is an independent chip U1, making the ultra-wideband technology that has been silent for many years widely received.

5. DISCUSSION

Currently, UWB has brought value to products and services in more than forty vertical markets, including consumer, automotive, industrial, and commercial, by improving the operational efficiency of factories and warehouses, improving worker safety, and supporting robotics and drone autonomy. Navigate to new user interface forms for consumers based on location. In addition, it enables safe and hands-free access to cars, front doors, homes, and offices thanks to its safe and effective distance-limiting feature.

In the current battle against the COVID-19 outbreak, UWB has proven to be the only technology that can really help with contact tracing and social distancing, as accuracy and reliability are designed to efficiently resolve where data needs to be trusted. Key features of the program. Unlike other wireless technologies, UWB provides the accuracy needed to trace COVID-19 contacts and maintain social distancing. It can calculate the distance between people (to the nearest centimeter) to determine whether someone is close enough to others to spread the virus.

With the recent adoption of UWB technology in smartphones, it will also be the next ubiquitous use case for wireless connectivity in daily lives (from home to office to public spaces). Embedding UWB technology in smartphones is an important first step towards large-scale applications. In addition, interoperability between all devices must be ensured. The fast-growing industry consortium FiRa has restructured more than 50 companies in the semiconductor, mobile, infrastructure, and consumer sectors and is actively working on protocol definition to ensure such interoperability. This enables developers to use UWB technology in a variety of new ways, such as indoor mapping and navigation, smart home applications, vehicle access control, augmented reality, and mobile payments. Ultimately, the future of indoor positioning is really only limited by the imagination of developers. It is believed that this technology will be more popular and successful in the future.

6. CONCLUSION

UWB directly modulates the signal with a pulse, which has the advantages of low transmission power, high processing gain, strong multi-path resolution ability, high transmission rate, large system capacity, high penetration ability, convenient multi-function integration, low power consumption, and strong anti-interference ability. It is not limited to military applications. Since February 2002, when the Federal Communications Commission approved UWB technology for the development and development of civil products, UWB technology has shown its advantages in the home environment and within small enterprises within 10m. The compatibility of UWB and other wireless communication equipment requires more effort to improve.

This paper discusses the basic theory and technology of ultra-broadband wireless communication technology. After reading a large amount of literature and combining it with their own work, the future popularization of the technology is briefly demonstrated. UWB technology is slowly entering the life making the life faster, more flexible and convenient. This paper summarizes the principles, technical advantages, and relevant reasons of UWB technology from the theoretical level, enriching the academic research content in this field, and providing some theoretical support for the wider application direction of UWB in the future. Future research will be combined with relevant experiments to conduct relevant discussions at the technical level, so as to solve the technical problems encountered in the application of specific fields.

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