

Research on Indoor and Outdoor Positioning System for Special Population

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Abstract. Special populations, such as empty-nesters, people with a mental health condition, active children, prison inmates, etc., have a considerable number. The WHO noted that there were 47.5 million people with dementia worldwide in 2016. As the number of people with dementia in low- and middle-income countries continue to increase, it is predicted that the total number of people with dementia will reach 75.6 million in 2030 and reach 135.5 million in 2050. The National Health and Family Planning Commission released the "China Family Development Report (2015)", which is half of the total number of elderly people. The number of severely mentally disabled patients registered in the country reached 4.297 million, and there were 1,650 national mental health professional institutions and more than 20,000 psychiatrists. As of 2012, there were 681 prisons in the country, 300,000 people in prison, and 1.64 million prisoners. More than 80% of the prisons have established video surveillance systems. The Ministry of Public Security's "Emergency Release Platform for Children's Missing Information" is about 100 people abducted every year. The number of missing children who are about one-millionth of a year is not found, and the missing rate is about three-tenths of a million. The real-time positioning of the above-mentioned special population has become the key to solving related problems. Relevant nursing homes, community institutions, mental health institutions, and prisons have become the main demand side.

1. Introduction

At present, indoor and outdoor positioning technologies have their characteristics, and the scope of application and positioning accuracy are different. The satellite positioning technology realizes wide-area outdoor coverage, and the positioning accuracy reaches the meter level, the decimeter level, or even the higher precision, but there is no indoor positioning capability.

In terms of indoor positioning technology, Wi-Fi/WSN/Rfid/UWB can achieve local meter-level indoor positioning, and Wi-Fi local area communication network has been established in many public places, such as smartphones and handheld computers. Wi-Fi or Bluetooth communication capabilities provide support for indoor location services. The existing 2G/3G/4G mobile communication network forms the communication network with the largest coverage on the ground and has billions of users. Therefore, the navigation satellite cooperates with the ground network, the coordination of multiple ground positioning technologies, and the high precision seamless of indoor and outdoor coordination. Positioning technology has become a trend in the future.



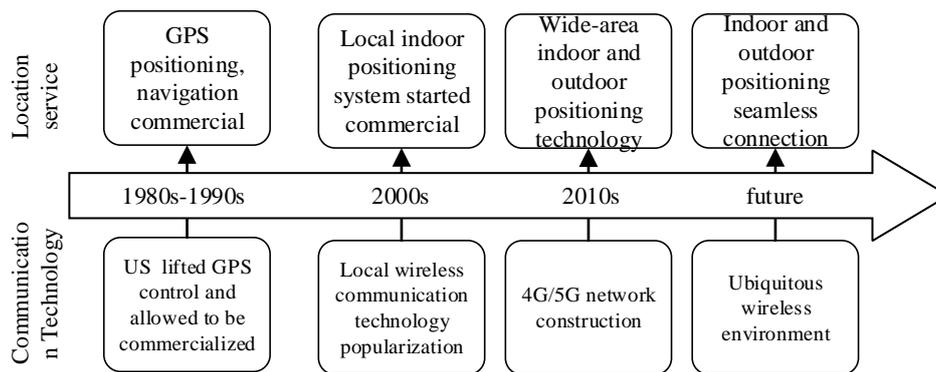


Figure 1. Development of wireless positioning technology.

2. Characteristics of Different Positioning Technologies

With the development of wireless communication technologies, emerging wireless network technologies, such as infrared, ultrasonic, radio frequency identification (RFID), Wi-Fi, ZigBee, Bluetooth, and ultra-wideband (UWB), have been widely used in offices, homes, factories, etc. application.

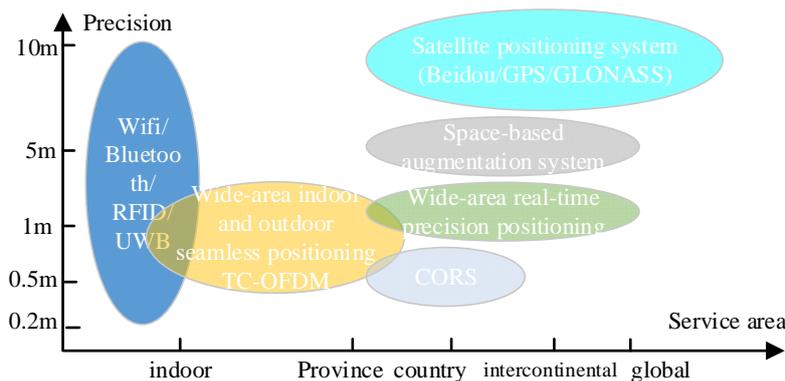


Figure 2. Different positioning system accuracy.

Infrared is only suitable for short-distance propagation, and is easily interfered by fluorescent lights or lights in the room, and has limitations in precise positioning.

Ultrasonic positioning has higher overall positioning accuracy and simple structure, but ultrasonic waves are greatly affected by multipath effects and non-line-of-sight propagation. At the same time, a large amount of underlying hardware facilities investment is required, and the cost is too high.

The shortcoming of Bluetooth is that the price of Bluetooth devices and devices is relatively expensive, and for complex space environments, the stability of the Bluetooth system is slightly poor, and it is greatly interfered by noise signals; the advantage of RFID is that the volume of the logo is relatively small, and the cost is relatively low, but the effect is Close distance, no communication capability, and inconvenient integration into other systems.

Compared with the traditional narrow-band system, the ultra-wideband system has the advantages of strong penetrating power, low power consumption, good multi-path resistance, high safety, low system complexity, and accurate positioning accuracy.

Wi-Fi positioning is a positioning solution for the IEEE 802.11 standard of the wireless local area network. The system uses a combination of empirical testing and signal propagation models, is easy to install, requires few base stations, can use the same underlying wireless network structure, and has a high total system accuracy.

Wi-Fi, Zigbee, pseudo-satellite, etc., achieve localized indoor 1-3m precision positioning but need to arrange a large number of nodes, and the cost is high. Wi-Fi, Zigbee, and other systems cannot be used in the event of a fire.

Table 1. Advantages and disadvantages of different positioning technologies

	advantage	Disadvantage
Infrared positioning	Low cost and high positioning accuracy	Small launch angle, easy to be blocked, small positioning range
RFID identification	Small size and low cost	Small coverage, no communication capability, and poor compatibility with other systems
Ultrasonic positioning	Close range distance measurement, high cost	Vulnerable to non-line-of-sight propagation and multipath effects
Bluetooth positioning	Wide application range and high positioning accuracy	High cost, easy to be disturbed by noise, slightly less stable, and high construction cost
UWB positioning	Low complexity, high positioning accuracy, and safety	Low real-time positioning
Sensor positioning	High positioning accuracy	Vulnerable to environmental interference, positioning accuracy depends on the resolution of the camera
AGPS positioning	Low cost and high positioning accuracy	Not able to locate quickly, positioning is not real-time
WLAN positioning	Low cost, wide coverage and wide use	Influenced by obstructions when propagating in non-line-of-sight environments, interference is present in different channels

The coverage of mobile base stations is wide, and the high-precision indoor positioning of mobile base stations is 1-3 meters, which is of great significance for the development of indoor location services. The accuracy of different positioning systems is shown in Figure 2.

3. The Technical Route Adopted by the Positioning System

Our special crowd positioning system uses the universal GPRS combined with GPS and WIFI positioning method to realize the outdoor positioning function. For the indoor positioning scene, it adopts the form of a Wi-Fi label.

Its function features are as follows: Firstly, the positioning method is seamlessly connected, and the most suitable positioning means is automatically adopted for different scenarios; secondly, the indoor positioning system is very popular for wireless LAN based on Wi-Fi, and the price is cheap, easy to set up and manage; Ultra-low power consumption, the label can be replaced or charged, and it is safe to the human body and has no radiation damage.

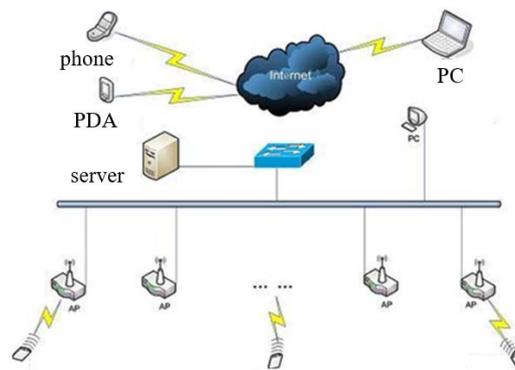


Figure 3. Positioning system software and hardware framework.

With the rapid development of smart terminals, smart children's watches, smart shoes, smart jewelry, and other terminals with outdoor positioning functions and indoor wireless positioning systems are constantly being introduced, partially satisfying people's needs.

However, these terminals have the following disadvantages: First, the concealment is poor, especially in children's watches, when encountering accidents such as kidnapping, trafficking, etc., they are often removed at the first time and cannot play the role; then It is easy to lose. If it is improperly worn or the product is accidentally lost, it is easy for the guardian to fall into the search for difficulties. Finally, the indoor and outdoor wireless positioning functions are not available at the same time, and the application scenario is limited. Once the environment changes, the specific location cannot be obtained in time.

Given the above defects, our advantages are: First, the concealment is good, through the miniaturization, flexibility, and flattening of the terminal, the combination of positioning interruption and clothing is achieved, thereby achieving the purpose of strong concealment; then, it is not easy to lose due to clothes. The specialty is greatly reduced compared with other wearable terminals. Finally, through the combination of GPRS+GPS, it has the commonly used wireless positioning function. On this basis, WIFI is actively sent to transmit tag information to realize indoor wireless. Positioning function, which expands the application surface of the smart terminal.

4. Special Crowd Positioning Software System

We built the MYSQL database storage positioning data on the Linux cloud server, and at the same time, established the positioning display webpage by using the node.js framework, and the positioning device transmits the positioning data in real-time through the network. The website can display the device track in real-time, as shown in Figure 4.



Figure 4. Positioning display webpage based on node.js framework.

We have developed mobile display software based on the ionic mobile app framework. It accesses the cloud real-time location data through the API connected to the EXPRESS framework and displays it in real-time through the front end. The mobile APP display software of the special crowd positioning system is shown in Figure 5.

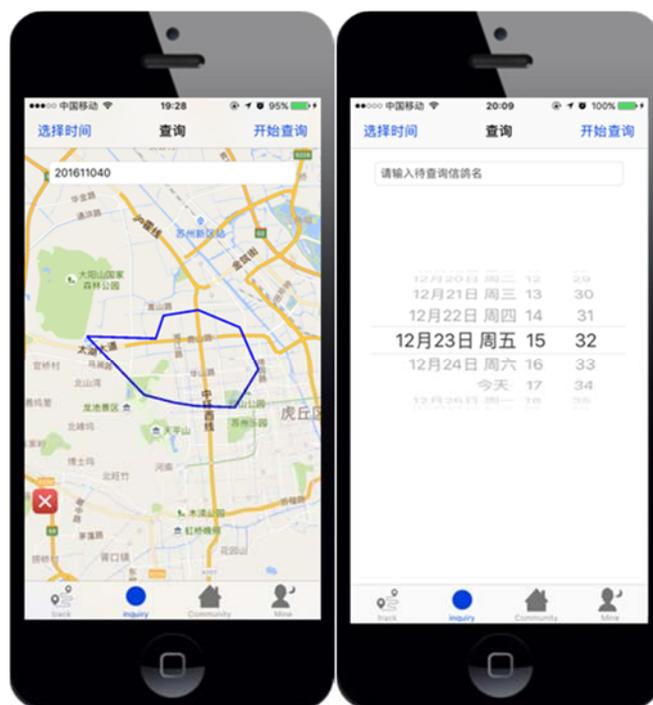


Figure 5. Special crowd positioning APP.

5. Conclusion

In this paper, by using different positioning technologies, the cloud server stores the positioning data, and the webpage and the APP access the API to display the real-time positioning of the special crowd. In summary, through the combination of different positioning technologies, indoor and outdoor positioning can be used to a certain degree of accuracy, which is suitable for different special population positioning.

6. Acknowledgments

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