World Scientific Research Journal (WSRJ) ISSN: 2472-3703
www.wsr-j.org

Research on Indoor Personnel Location Based on Digital Substation

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Abstract: In view of the increasingly prominent problems in the positioning of indoor personnel and equipment in digital substations, this paper introduces several common indoor wireless positioning technologies, describes their advantages, and proposes improvements to improve the accuracy of wireless positioning. Recommendations to effectively promote wireless positioning technology to be better applied and developed in digital substations
Keywords: digital substation; wireless positioning technology; positioning accuracy

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1. INTRODUCTION

The normal operation of the power system is the guarantee of people's daily life and national industrial and agricultural production. Substations are part of the electricity business. The normal operation of the substation can not do without the work of the staff in the substation. Under the principle of people-oriented and safety first, strengthening the safety management of the staff in the substation and reducing the hazards or accidents caused by human factors is the most concern for substations. Therefore, the rapid wireless location monitoring project of the staff in the substation is of far-reaching significance. The wireless location monitoring project can improve the informationization of substation safety production, accelerate the pace of smart grid construction, and at the same time add chips for safe operation of substations [1].

The inspection work of the traditional substation is carried by the inspection personnel carrying paper data. According to the items listed on the inspection inspection card, the inspection is conducted against the actual equipment one by one. However, with the expansion of the scale of the power grid, the increase of equipment, and the increase in the complexity of operations, it is likely that missed inspections and mis-checks will occur during the inspection process, and vacuum zones or inspection blind spots may occur. Therefore, there is an urgent need for a wireless positioning system that automatically monitors the inspection work or other work

within the substation to change the status quo, realize information and intelligence, and ensure the normal operation of the substation [2].

There are several schemes for rapid wireless positioning technology, but if used for digital substation personnel to quickly locate, several programs have more problems, or the accuracy is not so high that it can not accurately determine the precise location of personnel resulting in misjudgment, or cost too high enough that it cannot be widely used. Therefore, it is an important and significant issue to seek a high-precision, low-cost positioning system for the positioning of workers in substations.

2. WIRELESS POSITIONING TECHNOLOGY

Wireless positioning technology mainly uses wireless communication technology to receive radio waves, and then uses corresponding algorithms to calculate the phase, transmission time and other information contained in the radio waves, and then obtains its target position. The precise location of the target determines its specific location. The accuracy of the positioning has a direct relationship with the specific measurement methods. At the same time, the selection and application of measurement methods is also the key to the use of wireless positioning technology in mobile communications.

2.1 Indoor GPS positioning technology

GPS positioning technology is based on satellite technology and is currently a widely used positioning and navigation method [3]. The system is a satellite-based radio navigation and positioning system. The traditional GPS positioning technology works well in the outdoors, but it is not effective in indoor or satellite signals can not cover the place, and if there are no more than 3 satellites above the location, then the system can not achieve positioning from the cold start state. When the GPS receiver is working indoors, the signal is greatly attenuated due to the influence of the building, and the positioning accuracy is also very low. It is not possible to extract the navigation data and time information directly from the satellite broadcasting as it is outdoors. The traditional GPS technology relies too much on the terminal performance, that is, satellite scanning, acquisition, pseudo-range signal reception, and positioning calculations are all integrated into the terminal, thus causing defects such as low positioning sensitivity and large terminal power consumption.

2.2 UWB wireless positioning technology

The UWB full name (Uitra Wide Band), which is an ultra-wideband wireless positioning technology, transmits data by transmitting and receiving extremely narrow pulses with nanoseconds or nanoseconds or less, thus having a bandwidth of the order of 3.1 to 10.6 GHz. "Time difference" and the similar triangulation principle to complete the positioning [4]. Ultra-wideband (UWB) technology has the advantages of high data transmission rate, high time resolution, strong penetrating power, low power consumption, good anti-multipath effect, high security, low system complexity, and precision positioning accuracy. The close-range wireless positioning technology has caused great interest in the complex environment.

Therefore, UWB technology can be applied to indoor stationary or moving objects and people's location tracking and navigation, and can provide very accurate positioning accuracy.

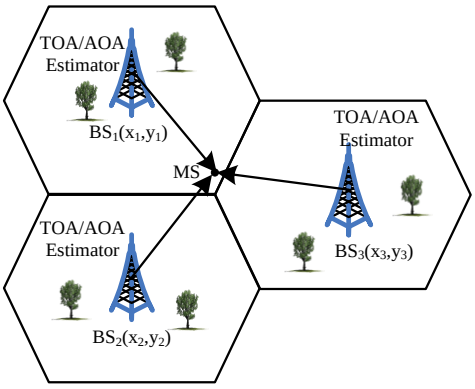

Fig. 1 UWB positioning technology

2.3 Zig bee technology

ZigBee technology is an emerging short-range wireless communication technology with short distance, low power consumption, low cost, low transmission rate, low complexity, and flexible configuration of networks [5]. It is based on signal attenuation algorithms for positioning. The ZigBee wireless positioning technology transmits signals from a positioning mobile node carrying a positioning node module including a positioning engine. A reference node receives a signal and returns a Received Signal Strength Indication (RSSI) and its own position coordinate to a positioning node. The received packet calculates its own position coordinates. Its real-time location for various fields has many advantages, such as short delay, low power consumption, low cost, small positioning algorithm complexity and no need to add extra hardware.

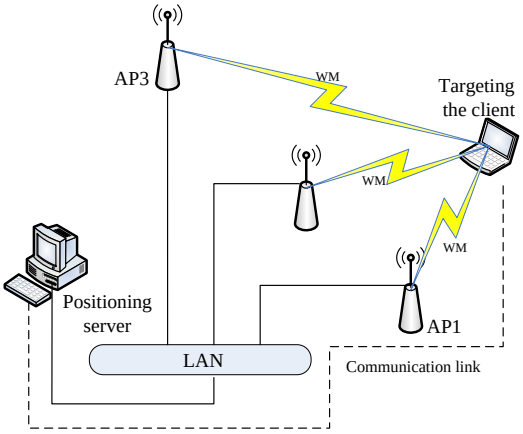

Fig. 2 ZigBee positioning technology

2.4 Indoor Wi-Fi technology

Wi-Fi network positioning technology determines the coordinates of unknown points by combining the signal strengths collected in indoor environments with certain related algorithms [6]. Wi-Fi positioning requires Wi-Fi hotspots, and Wi-Fi hotspots are widely deployed indoors. Therefore, Wi-Fi location technology can use existing facilities without

additional investment. Another important aspect is Wi-Fi signal and ultrasonic signal. Compared with infrared signals, it can still be transmitted in non-line-of-sight environments. In an indoor environment, the presence of objects such as walls, tables, and chairs necessarily hinders the propagation of signals such as ultrasound and infrared rays, while Wi-Fi signals are less affected by them. Suitable for positioning in indoor scenes. Wi-Fi technology uses a combination of empirical testing and signal propagation models. It is easy to install, requires few base stations, can use the same underlying wireless network architecture, and has a high total system accuracy. In recent years, the widespread deployment of Wi-Fi points has made it possible to use Wi-Fi signals for positioning, and the Wi-Fi signal has strong anti-fading capability, which is very suitable for propagation in indoor conditions. The Wi-Fi positioning technology is attracting more and more attention.

2.5 Radio frequency identification technology

Radio frequency identification technology uses radio frequency to conduct non-contact two-way communication to exchange data for the purpose of identification and positioning [7]. The RFID positioning system is mainly composed of a reader, an RFID tag, a back-end server, and a database. First, the Tag sends a signal containing a tag identifying its own identity to the Reader, and the reader sends a signal to the tag. Send to the background server, the background server uses the matching algorithm and data processing means to achieve the location of the tag. The longest effective distance of RFID technology is tens of meters, and the general function distance is short. Its most important feature is its non-line-of-sight and non-contact advantages, and it can obtain centimeter-level positioning accuracy information within a few milliseconds, and it has a large transmission range, a small device size, a low cost, high positioning accuracy, and Fast positioning time. The hotspots and difficulties in its research lie in the establishment of theoretical communication models, user security and privacy, and international standardization. Therefore, it has not been widely promoted.

2.6 Bluetooth technology

Bluetooth technology is a short-range low-power wireless transmission technology that measures the strength of signals to locate [8]. Its working principle is to install the Bluetooth LAN access point indoors, set the network mode to the basic network connection of multiple users, and ensure that the main device of the piconet is always the Bluetooth LAN access point, so as to obtain the user the location information. Bluetooth technology is mainly used for small-scale positioning such as single-storey halls or warehouses. The advantage of Bluetooth positioning technology is that the Bluetooth transmitting device is small in size, easy to integrate in PDAs, PCs and mobile phones, and has a long battery life. It has a good hardware foundation and is easy to popularize. The disadvantage is that the Bluetooth signal has a smaller propagation range, less stability, and the signal is susceptible to noise.

2.7 Infrared positioning technology

The infrared-based active tag Olivetti Research Laboratory (now the AT&T Cambridge Research Laboratory) has developed infrared positioning technology that can be used to locate indoor objects [9]. Its positioning principle relies on the optical sensor installed in the room to

receive the infrared ray mark to transmit and modulate the infrared radiation for positioning. Its advantage is that it has relatively high precision in indoor positioning. However, this positioning technology also has a lot of drawbacks. For example, it can only be transmitted from the line of sight and cannot pass through obstacles. In the non-line-of-sight environment, the signal cannot reach the receiving end, the positioning cannot be performed, and the disadvantage of short transmission distance is exposed, resulting in Indoor positioning is very poor. When the logo is blocked by a wall or an obstacle, it cannot work properly. To solve this problem, more receiving antennas must be installed in each corner of the room, resulting in high cost. At the same time, infrared light is also susceptible to indoor light interference, and is only suitable for close-distance transmission, which has great limitations in positioning accuracy.

2.8 Pseudo-satellite positioning technology

Pseudo-satellite positioning technology can be located indoors by positioning pseudo-satellite devices that can simulate GNSS signals [10]. The advantage of pseudo-satellite positioning is that the GNSS positioning technology is relatively mature and can be directly used by the GNSS receiver to complete positioning, and the pseudo-satellite can achieve seamless switching between indoor and outdoor positioning. However, the disadvantage of this positioning technology is that the hardware cost is also relatively high, and if the indoor GNSS signal is too strong, it may affect the normal positioning of the surrounding outdoor GNSS.

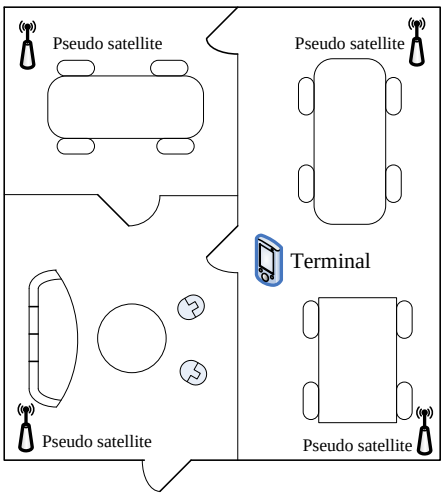

Fig. 3 Pseudo-satellite positioning technology

2.9 Ultrasonic positioning technology

Ultrasonic positioning technology components include signal transmission devices, signal receiving devices, and adjustment systems. Active Bat location system and Cricket Location support system are two ultrasonic positioning systems that have been successfully used [11]. Its positioning principle is to place the signal transmitter on the target object to be measured. Under the control of the control system, the signal transmitter transmits an ultrasonic signal to the signal receiver at a fixed interval, and the ultrasonic signal information collected by the

signal receiver is obtained. Send to the control system, the control system uses the relevant positioning algorithm to calculate the position information of the target object, positioning error can reach a few centimeters. Its advantage is high positioning accuracy, the highest positioning accuracy of 9cm, but the disadvantages of this positioning technology is also very obvious, the cost of ultrasonic transceiver is too high, it is difficult to popularize, and easily subject to environmental interference, affecting the positioning accuracy.

In the substation, relevant personnel of the application unit can carry wireless positioning tags and enter the project site. Through high-precision wireless positioning sensors, the system automatically records the correspondence between the personnel's activity intervals, trajectories and associated time, and provides the basis for personnel position management of back-office systems data. At the same time, it is also possible to paste wireless positioning tags for the main tools and tools, to obtain position information of the tools and instruments through high-precision positioning sensors, and to obtain statistical basic positional data of the tools and tools.

3. CONCLUSION

This article mainly discusses several main indoor positioning technologies based on substation personnel positioning. It can be seen that each method has its own advantages and disadvantages. Under the complicated indoor environment of substations, UWB positioning technology has more advantages than it is. Applied to residences, hotels, office buildings and other places, the prospects are also very impressive. UWB positioning can provide better accuracy and response speed, and it can cover a wider range and achieve seamless and accurate positioning. This will be one of the trends of future indoor positioning technology.

ACKNOWLEDGEMENTS

This paper was supported by Sichuan University of Science & Engineering Graduate Innovation Fund (No.y2016039)

REFERENCES

[1] Xu M, Peng L, Han H Y, et al. The Indoor Personnel Inertial Positioning Based on Image Recognition Technology in Substation Depth [J]. 2017, 11:02005.

[2] Jiang H, Huang G, Zhang X. Design and Implementation of Substation Location Navigation Based on Android [J]. Wireless Internet Technology, 2016.

[3] Shi J, Yuan X, Cai Y, et al. GPS real-time precise point positioning for aerial triangulation [J]. Gps Solutions, 2017:1-10.

[4] Zhou Q, Shen C, Chen X, et al. UWB wireless positioning technology in the application[C]// Wireless Sensors. IEEE, 2017:106-109.

[5] Uradzinski M, Goo H, Liu X, et al. Advanced Indoor Positioning Using Zig bee Wireless Technology [J]. Wireless Personal Communications, 2017(3):1-10.

[6] Bain G L, Huang H S, Zhi-Zheng G E, et al. Optimized Wireless Sensor Network

Positioning Technology [J]. Microelectronics & Computer, 2017.

[7] Zhou C. Application of Radio Frequency Identification Technology in Warehouse Management [J]. China Computer & Communication, 2017.

[8] Zhang X, Zeng Q, Meng Q, et al. Design and realization of a mobile seamless navigation and positioning system based on Bluetooth technology[C]// Guidance, Navigation and Control Conference. IEEE, 2017:1790-1793.

[9] Zhang Q, GAO S. Design of indoor ultrasonic positioning system based on infrared synchronization [J]. Foreign Electronic Measurement Technology, 2017.

[10] Lu W, Sun X, Ji Y, et al. Research and implementation of high precision indoor positioning technology for GPS pseudo satellite [J]. Application of Electronic Technique, 2018.

[11] Lazaro A, Mince D, Dimitrov A. Ultrasonic Positioning System Implementation and Dynamic 3D Visualization [J]. Cybernetics & Information Technologies, 2017, 17(2).