

Research on Personnel control and early warning technology of industrial and trade enterprises based on UWB positioning

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Abstract: This paper is engaged in the industry and trade enterprises based on UWB positioning personnel control early warning technology discussion. After a brief introduction of UWB positioning technology, combined with the adjustment of industrial and trade enterprises based on UWB positioning of personnel control early warning needs are analyzed. Then, demand-oriented, this paper discusses how to realize personnel real-time positioning, action track playback, video linkage and other functions based on UWB positioning technology. Only in this paper, for China's industry and trade enterprises for reference and reference, industrial and trade enterprises to provide technical support for the construction of safe and stable production environment.

Key words: UWB positioning; Industry and trade enterprises; Real-time positioning; Action track playback; Video linkage

The production of industrial and trade enterprises has the characteristics of large production scale, complex site, scattered area, dense personnel, messy materials and so on, which will bring difficulties to the management of personnel and materials for enterprise managers. The quick search and positioning of personnel is very key to improve the production efficiency and safety management of enterprises. An accurate personnel positioning system can give managers real-time feedback on the location of workers and monitor workers' activities, which is conducive to optimizing work processes and improving production efficiency, but also can warn potential safety risks, thus guaranteeing workers' life safety and business continuity.

1. Overview of UWB positioning technology

UWB (Ultra Wideband) positioning technology is a positioning technology using ultra-broadband, low power, short pulse signals, which can measure the time difference (TOF) of signal arrival in an ultra-short period of time, so as to calculate the receiver's position through multiple positioning moments. The technical principle of UWB positioning technology is to use the relationship between the transmission delay of ultra-short pulse signal through the transmission medium and the transmission distance, according to the bandwidth required by the pulse to determine the frequency bandwidth of its transmitted signal, and then according to the factors such as multi-path attenuation reflection path signal to remove the impact on the signal, and finally the distance difference between the base station and the device is measured by the time difference. Thus the specific location of the device is obtained.

The first feature of UWB positioning technology is ultra-wide frequency, which covers a total of 7G frequency band, including 3~5G, 6~10G, and a single channel bandwidth of more than 500MHz. The second is low power. According to FCC and other relevant laws, UWB output power is limited to -45dBm/MHz, based on 500MHZ single channel calculation, UWB channel power is -14.3dBm. Third, ultra-short pulse, UWB pulse maintenance time is usually only a few tenths of a nanosecond.

2. Industrial and trade enterprises personnel control early warning needs

Combined with the production characteristics of industrial and trade enterprises, their needs for personnel control early warning can be concentrated on the four core functions of real-time positioning, action track playback, video linkage, personnel statistics and inspection management.

1. Real-time positioning. Based on UWB technology to achieve real-time tracking of employees, enterprises can text, phone and even alarm the specific location of employees, in order to ensure the safety of workers and business continuity.

2. Action track playback. UWB technology is used to record the position and movement path of employees in the historical time period, and the track playback function is implemented to conduct follow-up analysis and optimize management of employees' line paths.

3. Video linkage. Connect the UWB technology with the existing installed video system, set the corresponding video surveillance camera in the production site, improve the control of the enterprise to the current monitoring, and maintain the safety and production efficiency of the production site.

4. Personnel statistics. Use UWB technology to quickly count the number of personnel entering, leaving and on-site real-time, timely adjust the number of people and adjust the production of enterprises, so as to improve production efficiency and save resources.

3. Based on UWB positioning of industrial and trade enterprises personnel control early warning technology realization path

(1) System architecture

The personnel control and early warning system of industrial and trade enterprises based on UWB positioning is divided into field hardware layer, network transmission layer, data algorithm layer and application layer. Figure 1:

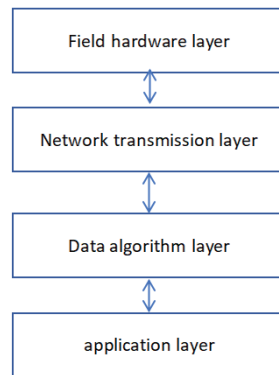


Figure 1 Structure of personnel control early warning system of industrial and trade enterprises based on UWB positioning

Under the system structure, the field hardware layer is the foundation of the system, which mainly includes UWB positioning equipment, camera, card reader and other devices. UWB positioning device is used to obtain individual location information in real time, and interact with other devices, that is, including camera and video surveillance and linkage. The card reader is used to identify employees and record entry and exit. The goal of the field hardware layer is to obtain field information in real time and accurately.

The network transport layer is the key link to transmit the data collected in the field to the back-end system. It is responsible for ensuring the reliable transmission and real-time performance of the field data. The network transmission layer can use wireless network, Ethernet and other ways to transmit the data collected by the field equipment to the back-end system for processing and analysis. The data algorithm layer is the core link of processing and analyzing the data collected on site. This layer mainly includes data preprocessing, real-time positioning algorithm, action track playback algorithm, alarm rule judgment, personnel statistics algorithm and so on. The data preprocessing can filter and denoise the original data. The real-time positioning algorithm uses UWB positioning data to calculate the real-time location of employees. The action track playback algorithm can record and play back the employee’s moving path. The alarm rule judgment algorithm will judge the situation of employees entering restricted areas and dangerous areas according to the rules set in advance. The personnel statistics algorithm is used to count the number of employees and generate the corresponding report. The application layer is the layer in the system that provides functions and interfaces for users. Based on the analysis results of the data algorithm layer, it provides real-time positioning, action track playback, video linkage, personnel statistics, alarm management, electric fence, inspection management and other functions. The application layer can provide users with graphical interface and various management tools, which is convenient for users to configure, query and manage the personnel control and early warning system.

(2) Personnel real-time positioning function

The realization method of the real-time positioning function of industrial and trade enterprises based on UWB is to install and deploy, install UWB base stations in accordance with a certain density within industrial and trade enterprises, and give priority to covering key areas. Second, assign a wearable UWB tag to each employee in the industrial and trade enterprise, and bind the relationship between the tag and employee identity. Third, the base station periodically sends a positioning signal to the surrounding area, and the UWB tag receives the signal and records the arrival time. Fourth, through the multilateral positioning calculation, according to the signal arrival time difference and distance relationship between the base stations, the accurate position of the employee is calculated. Fifth, the UWB label transmits the location data to the background server through the network, and the server processes and stores the data. The background server will analyze and display the positioning data, and display the position and track of the employee in real time through the visual interface. Figure 2 is a typical UWB personnel location effect diagram:



Figure 2 Typical UWB personnel location rendering

In addition, based on the realization of personnel positioning, UWB positioning technology can provide personnel alarm function, which is mainly oriented to parameters including environmental parameters, employee status parameters and electronic fence parameters. First of all, the system will collect environmental information around employees through sensors, monitoring cameras and other equipment, including temperature, humidity, odor, light, etc., to form multi-dimensional monitoring data, to provide support for subsequent alarm

processing. Secondly, the system will monitor the status of employees by monitoring their movement and behavior, such as tilt, vibration, resting, etc., and predict the possible abnormal situation of employees. Thirdly, industrial and trade enterprises can according to the safety rules and regulations and the characteristics of the working environment of employees, pre-set some alarm restricted areas, such as employees entering prohibited areas, or employees staying in a certain position for a long time, the system can trigger the alarm mechanism. Finally, after setting the corresponding threshold of the above alarm conditions, when the position, status or environmental data of the employee triggers one or more alarm rules, the alarm processing procedure will be automatically started. The alarm procedure will first send alarm information to other security equipment (such as shout system, access control system) in the monitoring area, and automatically report the relevant information to the system management desk

(2) Action track playback function

As mentioned above, in order to achieve accurate positioning, every employee in the industry and trade enterprise is wearing a UWB label. The UWB base station sends an ultra-short pulse signal to the label regularly, and the label records the arrival time of the signal after receiving the signal. First of all, according to the distance between the signal arrival time and the base station, the position of the label can be calculated. The UWB tag uploads the employee's location information to the background server, which is stored in the database. Secondly, when the background server receives the transmitted location information, it will process the data and store the data in the database. The location information of each employee is stored through the designed data model. Finally, the managers of industry and trade enterprises can enter the playback time period in the front-end interface, parse out the employee location information of the corresponding time period from the background database, and show the employee's action track in the form of a time line. At the same time, the UWB positioning management system interface can display the position of employees at different moments in the form of a map. Through the interface operation, users can more clearly understand the activities of employees during working hours, efficiency and problem bottlenecks.

(3) Video linkage function

During the positioning management of UWB industrial and trade enterprises, video linkage is the integration and linkage of real-time positioning data and surveillance video, so as to achieve the purpose of investigating personnel anomalies more quickly and effectively. The principle of the function is based on the existing personnel positioning system, according to the personnel location information and other data, the construction of video surveillance system, its specific implementation principle is divided into five steps. First, the base station and the camera are connected to each other to realize the docking of the video surveillance system and the personnel positioning system. Second, based on the real-time location information and other information provided by the personnel positioning system, intelligent analysis and identification are carried out, and the surveillance video is automatically triggered. Third, based on the action status and abnormal situation of personnel, automatic scheduling of surveillance video footage, timely lock the target object and shoot. Fourth, the surveillance video is associated with the positioning data, and the data is uploaded to the background for storage and analysis through data transmission. Fifth, through the background analysis, the real-time positioning and monitoring video is integrated, and the playback data within a certain time is provided in the realization of real-time visual monitoring, which is used to trace and analyze historical events.

(4) Personnel statistics

The personnel statistics function of industry and trade enterprises based on UWB is to achieve accurate personnel statistics through positioning data collection, data processing and analysis, personnel identification and classification, and activity statistics on the basis of personnel positioning. First of all, the base station arranged in the enterprise is used to collect and transmit the location information of employees to the background server in real time. The positioning chip carried by the UWB tag will send a pulse signal and calculate the distance from the base station, and then upload the location information to the background server. Secondly, after receiving the location data, the background server will process and analyze the data. Through the algorithm processing, the location data of each employee is clustered, filtered and counted. Thirdly, in terms of personnel identification and classification, each anchor point is identified and classified according to the employee's label information and other identity information, such as employee ID or job number. This can ensure that each employee is unique in the statistical information, which is convenient for subsequent analysis and query. Finally, the system carries out personnel activity statistics, and according to the location data and time stamp, the activities of employees are statistically analyzed. The scope of activities, duration of activities, stay time, etc. of employees in a specific time period can be counted, as well as the relative position relationship between employees.

Epilogue:

To sum up, this paper studies the personnel control and early warning technology based on UWB positioning in industrial and trade enterprises. Based on the overall structure design of the system, this paper discusses how to realize real-time positioning, action track playback, video linkage and personnel statistics functions of industrial and trade enterprises based on UWB positioning technology. In the future, after realizing the above functions based on UWB positioning technology, industrial and trade enterprises should continue to explore how to give better play to the advantages of UWB positioning technology and deeply develop the application mode of the technology, such as combining big data technology and production data with UWB positioning technology, so as to form a more refined monitoring and management system and provide help for enterprise security and stable production.

Bibliography

- [1] Minpeng Ji . Research on high density Precision Positioning Technology based on UWB [J]. Application of Automation,2023,64(1):245-248.
- [2] Shaowei Yang. Research on High precision positioning technology of UWB based on Internet of Things [D]. Xi 'an Technological University,2023.