Management of High-Asset Instruments and Equipment Based on Lora Technology and Rfid Technology

Yujun Han

Jiangsu Vocational Institute of Commerce, Nanjing, Jiangsu, 210000, China

Keywords: Lora technology, 125 kHz rfid low frequency wakeup, Device positioning, Rfid technology, Energy measurement

Abstract: The management of high-asset training equipment and how to improve its use efficiency is a problem for schools. Schools mostly use manual statistical input to conduct asset inventory and use management, and lack effective data support. This article is based on the management of high-asset instruments and equipment based on the Internet of Things LoRa technology + 125 kHz RFID technology. It can accurately and intuitively manage the operating status and storage location of the instrument and equipment. Through statistical analysis, we can further understand the frequency of use of the instrument and equipment. Compared with manual management, it greatly improves the management efficiency of instruments and equipment, and the overall investment cost is lower than the solution realized by pure RFID technology.

1. Introduction

There are many types of training equipment in colleges and universities, among which there are more high-asset equipments. The users and departments of these equipments also change from time to time. It is easy to appear that the working status of the equipment cannot be monitored in real time, the storage location is unknown, and the utilization of the training equipment is uneven For other issues, the management staff and the functional management department cannot timely and accurately grasp the status of the training instruments and equipment, and lack effective support in equipment purchase, management, and service. The current cost of more RFID solutions is too high and requires a lot of construction and wiring, which is not suitable for deployment across the school. In response to the above problems, this article mainly designs a set of integrated management solutions including information collection, data transmission, background management, and detection statistics through 125KHz RFID positioning + LoRa technology. This is a set of cost-effective campus high-asset equipment management solutions. This plan is designed and implemented by taking a practical training building as an example [1].

2. Introduction to Related Technologies

2.1 Lora Technology

There are various technologies for communication transmission, and there are also various wireless technologies in the interim. The analysis of various wireless communications is shown in Table 1, and the comprehensive analysis selects LoRa communication technology. LoRa is one of the LPWAN communication technologies. It is an ultra-long-distance wireless transmission scheme based on spread spectrum technology adopted and promoted by the US Semtech company. It is based on linear frequency modulation spread spectrum modulation and maintains the same low power consumption as FSK modulation. Feature, but significantly increases the communication distance. The advantage of LoRa is to change the contradiction between transmission distance and power consumption, to achieve long-distance and low power consumption coexistence, a single LoRa base station can cover 3 square kilometers of buildings.

DOI: 10.25236/icembe.2020.111

Table 1 Wireless Transmission Technology Analysis Table

Wireless transmission technology	Type of transmission	Communication characteristics	Coverage distance
RFID technology	Near field	Medium bandwidth, low price, low power consumption	Coverage distance 5-8 meters at low power consumption
Bluetooth technology	Near field	Good protocol compatibility, high price, and power consumption	Coverage distance 5-8 meters at low power consumption
WiFi technology	Near field	High bandwidth, high price, high power consumption	Cover visual distance about 30 meters
LoRa Technology	Wide area	Long coverage distance, low bandwidth and low power consumption	Covering a viewing distance of more than 3 kilometers

2.1.1 Khz Rfid Locator

The RFID locator selected in this solution is mainly composed of five parts: 125 kHz broadcast, Ethernet, Bluetooth, POE power supply, DC power supply. 125 kHz refers to the LC resonance frequency of 125 kHz, using the law of electromagnetic induction. The modulation method uses the OOK debugging method. The 125 kHz low-frequency wake-up technology uses the principle of inductive coupling, adopts the transformer model, and realizes the coupling through the spatial high-frequency alternating magnetic field [2]. It is based on the law of electromagnetic induction, so as to achieve contactless information transmission and achieve recognition. The 125 kHz signal has strong penetrability and can penetrate non-metallic magnetic materials, such as water, concrete, plastic, etc., and is suitable for information transmission on multiple floors.

The main functions of 125 kHz RFID locator are as follows:

(1) The locator regularly uploads heartbeat messages to the management information system;

(2) Broadcast 125 kHz wake-up frame with fixed periodic frequency;

(3) Realize the control of the locator by the management information system, such as distance adjustment, broadcast frequency adjustment, etc.

2.2 Semi-Active Electronic Tags

Electronic tags are divided into active tags, passive tags and semi-active tags. The semi-active electronic tag is selected in this scheme because the semi-active electronic tag has its own unique advantages. A semi-active tag is an RFID electronic tag powered by a power source. When awakened by a reader, the semi-active tag can communicate with the reader as a transceiver. Semi-active tags have the advantage of lower power consumption than active electronic tags, and have the advantage of a longer communication distance than passive electronic tags.

Combined with the above technology, design and formulate the positioning and energy consumption label of high-asset instrument equipment that meets this plan. This equipment is composed of five parts: battery, LoRa module, 125 kHz wake-up receiving module, light sensor, and energy metering.

1) Battery, used for electronic label power supply;

2) LoRa module, used for electronic tag data transmission [3];

3) 125 kHz wake-up receiving module, used for receiving low-frequency wake-up information;

4) Light sensing, positioning electronic tags to prevent disassembly, used for dismantling alarm;

5) Electric energy measurement, used for statistics of usage efficiency and energy consumption data statistics.

3. Implementation of Technical Solutions

3.1 Specific Technical Solutions for High-Asset Equipment Management

Combining with the characteristics of colleges and universities, college asset instruments and equipment will move positions according to needs, change the use position, and manual management methods need to input information. This requires more timely processing, which increases the work of asset management personnel. You can automatically update the position of the equipment and understand their current status.

The specific technical solution for the management of high-asset instruments and equipment consists of five parts: 125 kHz RFID locator [4], which can be deployed in each room or corridor. The deployment density determines the positioning accuracy, positioning & energy consumption tags, LoRa base station, LoRa Server, APP Server (management system). Each device is pasted with an electronic label with positioning & energy consumption. Each label can communicate with the LoRa base station through the LoRa protocol, the LoRa base station and the LoRa Server communicate through the IP protocol, and the LoRa base communicates with the station LoRa Server through IP. The specific program composition is shown in Figure 2-1 below:

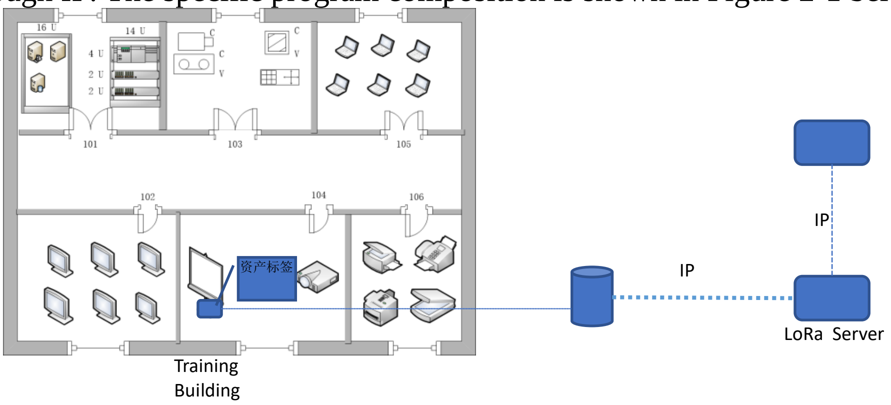

Fig.1 Schematic Diagram of the Technical Scheme of the Equipment

Analysis of the advantages and disadvantages of this solution and traditional RFID:

Compared with traditional RFID solutions, using LoRa technology to return data has the following advantages:

1) Lower cost: With the feature of LoRa transmission covering a long distance, the number of data backhaul base stations and the cost of cable construction can be reduced by multiples;

2) Anti-interference: LoRa adopts a frequency hopping mechanism for different terminals, that is, it will detect the RF environment to perform an adaptive algorithm, and select different optimal communication channels (a total of 320 optional channels from 470 to 510M) to avoid interference.

3.2 Implementation Process of High Asset Instrument Management Solution

1) 125 kHz RFID locator broadcasts wake-up frames at a certain period [5];

2) The low-frequency wake-up chip on the positioning & energy consumption label is constantly listening to the 125 kHz wake-up signal. When the low-frequency wake-up chip receives the wake-up frame, the chip begins to receive 125kHz data and determines whether the data content in the wake-up frame is Transmission logic, if it matches, wake up the LoRa device for LoRa backhaul;

3) The energy consumption label adopts a non-isolated energy collection scheme to monitor the current change of the equipment in real time, and upload the data through LoRa technology;

4) LoRa base station is connected to LoRa Server and transmits data to LoRa Server;

5) APP Server connects with LoRa Server, obtains data from LoRa Server, and performs corresponding processing and information presentation according to the obtained data.

LoRa transmission uses the official LoRaWan protocol, and the terminal communicates as Class A. When the tag is woken up by the locator and meets certain judgment logic, then LoRa information is transmitted. The transmitted message will contain the tag's own ID and the locator's ID, so that the management system will know that the tag is now within the coverage of the locator. The coverage of positioning is generally between 0 ~ 3m radius, so the accuracy of positioning is within 3m.

3.3 Room-Level Positioning

When the locator is placed in the room, the room-level positioning effect can be achieved. Similarly, place the locator on the floor or at the entrance of the building [6]. When the tag is awakened and learns that it is under the locator of the entrance, it will communicate this message to the management system and tell the management system that the "tag is in this position". Message, the management system will display the specific positioning effect on the corresponding interface. The solution can also cooperate with the school's indoor and outdoor GIS (geographic information system) platform to achieve accurate indoor positioning.

Through the above technical means, the positioning, online / usage status and statistical analysis and management of high-asset instruments and equipment are realized. The common basic framework for realizing room-level positioning is shown in Figure 2-2. The basic implementation steps are as follows:

1) The locator continuously broadcasts 125 kHz low-frequency wake-up messages, and the low-frequency wake-up broadcast messages contain information such as device ID and control commands;

2) After receiving the locator broadcast message, the locating tag screens the message, distinguishes it by pattern and CRC, reads the DATA data and RSSI data, and uploads its own ID and locator ID and other data to the base station [7];

3) After receiving the uplink information of the tag, the base station does not calculate the data, but only transparently transmits the data;

4) The management system judges that the position of the tag is near the locator by the uploaded locator and tag ID. Because the position of the locator is known, and the coverage range is generally 0 ~ 3m, when a locator is placed in a room, this principle can be used to locate the tag in the room where the locator is placed, thereby achieving room-level positioning.

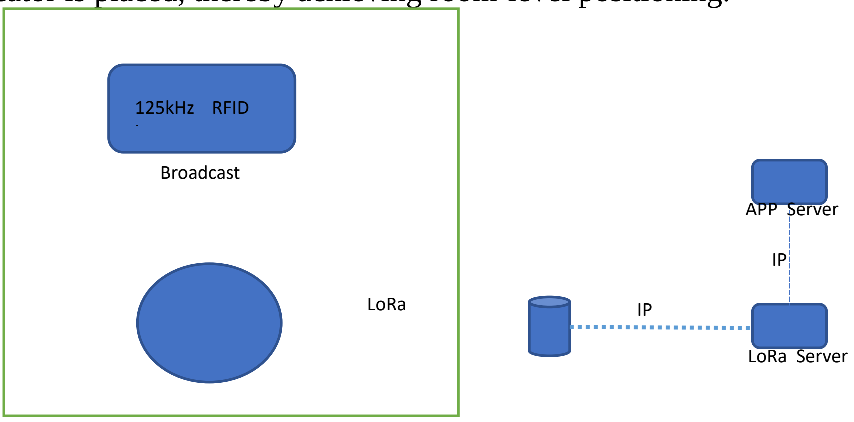

Fig.2 Room Location Architecture

3.4 Tamper Alarm

The hardware of the positioning & energy consumption label integrates a light sensor and makes corresponding openings in the bottom of the device casing. When the label is removed and the opening is exposed to a normal environment, and the light intensity detected by the light sensor is greater than the set threshold, the light sensor will generate an interruption and send an alarm signal and its own ID, and the last time to wake up its own locator ID, uploaded via LoRa. When the management system obtains the corresponding information, it will give an alarm prompt [8].

3.5 Analysis of the Use Efficiency of Equipment

The positioning & energy consumption tag hardware integrates an energy metering chip, which performs current sampling and voltage sampling. And upload current, voltage, active power and other data through LoRa. After obtaining the corresponding information, the management system judges whether the device is in a standby, working or shutdown state, so as to realize the management of the efficiency of the use of the equipment.

4. Conclusion

This solution also has certain shortcomings, and data cannot be sent quickly and frequently. Due to LoRa's own protocol limitations, it cannot be sent frequently and frequently, mainly because of the long transmission time of LoRa messages. The protocol itself uses the Aloha conflict model, and two receiving windows need to be opened after sending. Considering that the requirements for the management of high-asset instruments and equipment in colleges and universities are not very high, it can fully meet the needs [9].

LoRa, as a narrow-band IoT technology, is characterized by long coverage distance and low power consumption. It has inherent advantages over RFID technology in the backhaul of IoT data (low data transmission volume and low frequency), which is great in college equipment management scenarios Reduced the number of deployments and construction costs. In addition, in this solution, the adjustment of the coverage distance of 125kHz RFID locator can be remotely managed and configured through Ethernet in the later period, which reduces the complexity of construction and later optimization. Therefore, this solution has great practical value in practical applications. Due to the difference in the number of high-asset equipment for practical training in various universities, the concurrent bearer performance of LoRa base stations needs to be considered in the actual scheme design [10].

5. Acknowledgment

School-level key topic: “Wireless Sensor Network Construction and Communication Research” topic number JSJM19024.

This work is supported by Distinguished Youth Foundation of Jiangsu Vocational Institute of Commerce

References

[1] Ou Xiaoou. Application Analysis of Radio Frequency Identification Technology RFID in Internet of Things. Communication World, no. 02, 2018.

[2] Research on secret-related asset supervision system based on Internet of Things technology. Qin Chao, Zhang Jingyan, Wang Cheng. Communication World. No. 08, 2019.

[3] The application of RFID technology in the management of fixed assets in colleges and universities. Wu Zhongyun. Enterprise Technology and Development. no.11, 2018

[4] Wang Peng, Liu Zhijie, Zheng Xin. Research on LoRa wireless network technology and application status Information Communication Technology, no.5, pp. 65-70, 2017.

[5] Zhao Sihai. New multi-function energy meter based on LoRa technology. Information and Communication, no. 5, pp. 288-289, 2017.

[6] Lin Shengwei, Zhao Wenju, Zheng Kan. Implementation and performance analysis of low-power wide-coverage LoRa system. China Science and Technology Thesis Online Excellent Paper, vol. 12, no.3, pp. 457-464, 2019.

[7] Nan Jingchang, Bao Xiaowei, Guo Yingyan. Design and implementation of high precision RFID positioning system based on low frequency trigger. Journal of Engineering Design, vol. 24, no.2, pp. 225-231, 2017.s

[8] Zhang Fan, Chen Diancheng, Yang Jie. Comparative research on indoor positioning technology and system. Guangdong Communication Technology, no.11, pp. 73-79, 2012.

[9] Zhuang Kaikai, He Anping, Yuan Lei, Feng Zhihua, Wu Jingzhao. Design of LoRa-based underground parking vehicle positioning system. Computer Measurement and Control. no.2, 2019.