CASE STUDY

Hospital intelligent medical waste construction based on wireless IOT with Bluetooth + LoRa: a Case Study

Zhiyuan Zhao[1], Muqing Niu[1]

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Corresponding Author:

Muqing Niu
First Affiliated Hospital, Henan University of Science and Technology, Vice President.
niumuqing@163.com

ABSTRACT

With the maturity of the Internet of Things technology, medical institutions have established a positioning and sensing wireless IoT platform for the entire medical institution by using technologies such as Bluetooth positioning beacons, LoRa communication base stations, positioning and map engines. The intelligent medical waste collection and transfer vehicle integrates the wireless Internet of Things platform in the hospital based on 4G/5G modules, Bluetooth positioning terminals, electronic weighing and other technologies. An information-based, intelligent, and visualized "smart medical waste" management system covering all aspects of medical waste generation, collection, temporary storage, transfer, and disposal has been established in medical institutions. This set of solutions can greatly reduce the number of communication base stations deployed in hospital indoor buildings, the number of weak current construction and access switches in hospitals, save a lot of unnecessary costs for weak current construction and access switches and meet the real-time needs of intelligent medical waste collection and transfer vehicles such as real-time positioning, real-time tracking, video linkage, trajectory playback, and transfer route deviation alarms, which have certain reference significance in the practice of intelligent medical waste construction technology in hospitals based on smart IoT.
The article describes one case of implementation of the technology in a university Hospital.

Authors' Affiliations:
[1] First Affiliated Hospital, Henan University of Science and Technology, Luoyang, Henan, China

What do we already know about this topic?

With the maturity of the Internet of Things technology, medical institutions have established a positioning and sensing wireless IoT platform for the entire medical institution by using technologies such as Bluetooth positioning beacons, LoRa communication base stations, positioning and map engines

What is the main contribution to Evidence-Based Practice from this article?

The article demonstrates how a intelligent medical waste collection and transfer vehicle integrates the wireless Internet of Things platform in the hospital based on 4G/5G modules, Bluetooth positioning terminals, electronic weighing and other technologies. An information-based, intelligent, and visualized "smart medical waste" management system covering all aspects of medical waste generation, collection, temporary storage, transfer, and disposal has been established in medical institutions

What are your research's implications towards theory, practice, or policy?

This set of solutions can greatly reduce the number of communication base stations deployed in hospital indoor buildings, the number of weak current construction and access switches in hospitals, save a lot of unnecessary costs for weak current construction and access switches and meet the real-time needs of intelligent medical waste collection and transfer vehicles such as real-time positioning, real-time tracking, video linkage, trajectory playback, and transfer route deviation alarms, which have certain reference significance in the practice of intelligent medical waste construction technology in hospitals based on smart IoT

At present, most medical institutions in China mainly adopt the traditional medical waste management model. These medical institutions use manual registration books for recording and handover throughout the process. At the same time, the property logistics personnel responsible for the transfer and handover of medical waste are generally of low professional quality and weak sense of responsibility. There are many problems, such as not following the prescribed route, and the loss of medical waste. The management of medical waste in medical institutions has become more difficult. At the beginning of 2020, ten departments in China, such as the National Health Commission and the Ministry of Ecology and Environment, jointly issued the "Notice on Printing and Distributing the Work Plan for Comprehensive Waste Management in Medical Institutions".

The plan clearly states that "through standardized classification and clear procedures, a waste management system of classified delivery, classified collection, classified storage, classified handover, and classified transfer will be formed in each medical institution. The disposal of medical waste is tracked and managed in a refined way, making full use of electronic tags, two-dimensional codes and other information technology methods to ensure that the wastes of medical institutions should be divided and traceable. " According to national requirements, in the past two years, some provinces have launched a battle to speed up smart medical waste. It requires pilot hospitals to take the lead and lead the area from point to point to realize the full coverage of information-based dynamic online supervision of the whole process of medical waste generation, transfer, temporary storage and handover, and realize a new closed-loop management model of traceability, traceability and early warning of medical

waste. Therefore, higher requirements are put forward for the construction of medical waste informatization in medical institutions.

1. Technology selection and construction ideas

1.1 Technology selection

At present, the commonly used wireless IoT technologies include LoRa, Bluetooth, active RFID, passive RFID, WIFI and so on. Different IoT technologies have different applicable scenarios and apply different IoT technologies. Various work scenarios in the hospital cannot be realized and completed using a certain Internet of Things technology. A medical IoT application can use one or more IoT technologies to achieve good results and experiences for the medical IoT application. After comprehensive comparison, Bluetooth Beacon positioning + LoRa low-power long-distance wireless transmission technology not only supports data transmission of positioning terminals, but also supports data transmission of sensing terminals, according to the characteristics of hospital medical waste business. Its positioning accuracy reaches 1-5 meters, and it can realize intra-hospital navigation through positioning and map engines. Moreover, the deployment of Bluetooth beacons and LoRa base stations has the advantages of low implementation cost, no need for a large number of wired deployments, little impact on hospital operations, and low cost of operation, maintenance and management in the later stage.

Based on the above technical features and advantages, it is recommended that medical institutions use Bluetooth + LoRa wireless positioning technology to establish a wireless Internet of Things platform for hospitals (see table 1 below).

1.2 Construction plan

Medical institutions should use Bluetooth positioning technology combined with the application of low-power and long-distance LoRa transmission technology, and adopt a converged, open, and wireless deployment strategy to build an efficient, high-precision, low-investment, and low-maintenance smart IoT platform. Bluetooth positioning terminals and sensing terminals should be installed on intelligent medical waste collection and transfer vehicles with functions such as electronic weighing, automatic counting, face recognition cameras, and QR code scanning. A four-in-one hospital intelligent medical waste management system, including smart IoT platform, smart medical waste vehicle, in-hospital monitoring, and medical waste management system, should be established through indoor positioning network, sensor network, wireless intranet, and in-hospital monitoring, etc.

The main technical architecture of the smart IoT platform is simple and highly scalable. It consists of iBeacon Bluetooth positioning beacon, Bluetooth positioning terminal, LoRa communication base station, positioning and map engine, deployment inspection + POI information management and calibration App, mobile app, server software, etc. The LoRa communication base station and the intelligent IoT platform software server equipment are directly connected to the POE communication switch through the network cable. The data interaction of the application platform is completed through the POE communication switch. In the whole system, only the LoRa

communication base station requires a very small amount of wiring, and the rest of the equipment can work as long as it is connected to the power supply, so the implementation degree of medical institution transformation is small.

1.3 Implementation method

The iBeacon Bluetooth beacon positioning node should be deployed in the indoor pipe gallery. It can emit Bluetooth signals as a positioning infrastructure network infrastructure. The intelligent medical waste collection and transfer vehicle is equipped with a Bluetooth positioning terminal tag. It receives iBeacon signals and communicates the signal measurement results with the LoRa communication base station through proprietary technology to transmit data back. The LoRa communication base station receives the data returned by the Bluetooth terminal tag, and sends the data back to the positioning and map engine server. By calculating the coordinate position of the Bluetooth terminal tag, it provides indoor map information, and provides services such as route inspection and indoor navigation for the intelligent medical waste collection and transfer vehicle.

2. Effects observed

The intelligent medical waste collection and transfer vehicle realizes the visual management and control of medical waste vehicles and terminal equipment by connecting to the intelligent IoT platform in the hospital. Its advantages are mainly reflected in the following four aspects:

2.1 Real-time positioning

The Bluetooth beacon of the medical waste collection and transfer vehicle has a real-time positioning function, so the real-time location of all medical waste collection and transfer vehicles can be visualized on the PDA and indoor electronic map. The real-time location of all medical waste collection and transfer vehicles can be known and queried at any time. If the transfer route of the medical waste collection and transfer vehicle deviates, the medical waste supervisor can receive the notification at the first time, so as to realize the real-time positioning monitoring of the medical waste collection and transfer vehicle.

2.2 Real-time tracking and video linkage

By connecting with the internal monitoring system of the medical institution, if necessary, the designated medical waste collection and transfer vehicle can be tracked in real time. The indoor electronic map will be identified and displayed with highlighted colors. Therefore, when it is necessary to view the real-time image of the nearest camera of the designated medical waste collection and transfer vehicle, the staff can link the camera to transmit the camera image closest to the designated location to the indoor electronic map interface in real time, which can satisfy the medical institution's video monitoring of the status of the medical waste collection and transfer vehicle, and also meet the unannounced inspection needs of the government supervision department.

2.3 Track playback

Through the real-time data returned to the positioning and map engine, it is possible to play back the trajectory of the indoor

electronic map for the designated medical waste garbage and the area where the transfer route passes and stays in a certain time period of a certain day. It can accurately restore the previous transfer route, residence time, etc., and help the medical waste management personnel to quickly analyze whether the medical waste is not in accordance with the specified transfer route during the collection and transfer process through the track playback function, resulting in the leakage of medical waste.

2.4 Transit route deviation warning

A message reminder mechanism is established. When the collection and transfer vehicle does not follow the prescribed route sequence or deviates significantly from the prescribed route to transport medical waste, the medical waste management personnel will be reminded in time according to the set alarm rules. The alarming function of the deviation of the transfer route is convenient for tracking the status and quantity changes of medical waste, dynamically monitoring the outflow of various links in the hospital, identifying problems and tracing the source in time, effectively controlling the illegal outflow of medical waste, and filling the supervision gap of in-hospital transfer and temporary storage points.

3 Conclusion

Through the establishment of advanced hospital smart Internet of Things, the use of artificial intelligence, cloud computing, big data and other advanced information technologies, combined with the medical waste disposal process of medical institutions, medical institutions have realized the information and intelligent management of medical waste circulation. This means that each bag of waste and medical waste collection and transfer vehicle can have its own unique identification code, the process of waste from generation to disposal is transparent and standardized, all data can be recorded and uploaded in real time. Therefore, medical waste can be intelligently collected, transported and disposed of, classified from the source, and its supervision process can be standardized to establish a traceable and accountable closed loop of medical waste supervision. Especially in the current background of strict prevention and control of new coronary pneumonia, the establishment of the hospital smart Internet of Things can significantly improve the level of refined management of medical waste in medical institutions, achieve comprehensive safety management and control of medical waste, and make positive contributions to joint prevention and control (see table 1 below).

Table 1 Comparison of Bluetooth + LoRa and commonly used active RFID

Indicator item	Bluetooth + LoRa	Active RFID
Project implementation costs (labor, network cables, access switches, etc.)	very low	very high
Does device deployment require a large number of external network cables?	very little	numerous
Does the device deployment require a large number of wired deployments?	none	numerous
Weak current construction	Very little network POE power supply and network communication	Requires a lot of weak current construction
Impact of construction on hospital operations	Wireless construction and no impact on hospital operations, basically	The antenna needs to be deployed in the ward, which has an impact on the structure of the ward and the operation of the hospital
The amount and difficulty of post-maintenance work	Small workload, basically wireless deployment, easy maintenance	Heavy workload, basically wired deployment, difficult maintenance
precision	1-3m (indoor) 3-5m (outdoor)	Interval level (five to ten of meters)
Geofencing functionality	High accuracy and high availability	Poor accuracy, difficult to use
Indoor navigation function	support	not support

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