Monitoring Method of Internet of Things for Classified Recovery of Medical Waste

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Abstract. In order to overcome the shortcomings of the existing technology and hit the medical waste disposal of black industry chain, this paper provides an IoT monitoring method for medical waste treatment, which can strictly monitor medical waste from the source, processing by digital, back in any link problems, the use of big data to find abnormal problems, guide the development of medical enterprise, to ensure the safety of people's life.

1. Introduction

With the rapid development of China's economy, people's lives have been greatly enriched and improved. While human beings have enjoyed all the conveniences brought by the development of science and technology, they have ignored the many disadvantages that accompany them. For example, in recent years, the booming health and medical services meet human demand for health care, medical institutions have also generated more and more varieties, and complex components and properties of medical waste [1-3] as shown in Figure 1.

![Figure 1. China's Medical Waste Generation and Growth from 2010 to 2018](image)

From Figure 1, we can see that although the year-on-year growth rate of medical waste has shown a declining trend since 2012, it shows that the standardized management of medical waste has made some achievements in the process of continuous improvement of the management system of medical waste in our country. But from a long-term point of view, the amount of medical waste produced in our country is increasing, which poses a severe challenge to the management of medical waste.

Medical waste is more harmful to the environment than general domestic waste. It is extremely infectious, biologically toxic and corrosive [4-7]. These medical wastes carry a large number of germs. If these wastes are not properly managed and handled, they will cause pollution to the soil, air, water, etc. in the natural environment, and will also cause damage to the ecological environment in the area, and can also lead to the ecological environment of the area, what is more, some illegal businessmen,
simply to deal with medical waste, will once again be put into use. These wastes are mainly concentrated in "three-none" hospitals, it has become a key source of pollution for the spread of infectious diseases, endangering the life safety of Chinese people [8-10].

In short, in order to overcome the shortcomings of the existing technology, and crack down on the black industry chain of medical waste treatment, and guide the development of medical undertakings, and guarantee the safety of people's lives, this article this paper provides an Internet of things monitoring method that based on an intelligent device for sorting and recycling medical waste treatment. Networked monitoring methods. It can solve the problem that the intelligence level and monitoring intensity of medical waste collection devices are generally low, the lack of effective management and problem feedback mechanisms in the collection and processing process, and the useful information generated in each link is not fully digitized [10-12]. It is helpful to achieve efficient classified collection and strict monitoring of medical waste from the source, and is beneficial to problem tracing, finding anomalies, and beneficial information from big data mining [13].

2. Innovation of Monitoring Methods
As shown in Figure 2, the monitoring method is divided into three levels of monitoring. The hospital information monitoring center, the professional transportation company information monitoring center, and the medical waste treatment company information monitoring center are the first level monitoring. The three different monitoring centers are all municipal medical waste. The processing information monitoring center is supervised throughout the process. This is the second level monitoring. The monitoring centers in each urban area are supervised by the provincial medical waste processing information monitoring center. This is the third level monitoring. Special responsibility and management.

![Figure 2. Schematic of IoT monitoring method for medical waste treatment](image)

When an abnormal situation occurs during the monitoring process, the system will feed back the abnormal information to the monitoring center of each link in time. The monitoring center in the problem link is responsible for processing the abnormal information, but if the abnormal information generated by the above process has not been processed for a long time, it will The Municipal Medical Waste Disposal Information Monitoring Center focused on anomalous information and contacted the responsible person to handle it, thereby establishing a sound problem feedback and treatment mechanism.
When there is a problem in a certain link, the relevant personnel of the hospital, the company and the government have the right to trace back, openly find the cause of the problem, hold the person responsible, and also use big data to study these data characteristics, find abnormal problems, and guide the development of the medical cause.

3. Description of the Entire Process of Monitoring Method Operation

3.1 Basic Process of IOT Monitoring Method

In order to be able to strengthen the classification, treatment and transportation monitoring of medical waste and to overcome the existing technical problems, this article discloses a method of monitoring the Internet of Things for medical waste treatment including the following steps:

Step S1: Obtain a medical waste treatment barrel \( x_{ijk} \), \( i \in N^* \), where \( j \) is the type of medical waste, \( j = 1, 2, 3, 4, \ldots N \); \( k = 1, 2, 3, 4, \ldots N \) \( k \) is the number of corresponding medical waste treatment barrels set in hospital \( i \); in this example, it is preferable to set the existing types of medical waste to five, that is, the value of \( j \) ranges from 1-5;

Step S2: Acquire information of a correspondingly set caster and corresponding garbage type of the medical waste processing barrel \( x_{ijk} \) of the hospital \( i \);

Step S3: Obtain the load of the medical waste treatment bucket \( x_{ijk} \) of the hospital \( i \) and the current first treatment time value of the corresponding medical waste treatment bucket \( x_{ijk} \). If the first time value is not greater than \( T1 \), judge the \( kth \) class of the \( i \) hospital \( j \) \( x_{ijk} \) load of medical waste processing bucket; when the \( x_{ijk} \) load of the \( kth \) medical waste processing bucket of type \( i \) in hospital \( i \) reaches the first threshold, the collection instruction of medical waste processing bucket is triggered; if the first time value is greater than \( T1 \), the medical waste processing bucket is automatically triggered Collection instructions; based on the statistical limit on the processing time and load of \( j \)-type garbage stored in the medical waste processing bucket \( x_{ijk} \), the expiration treatment and full load treatment of the garbage can be timely performed for the medical waste processing bucket \( x_{ijk} \). The processing flow is shown in Figure 3 Shown.

The first library is the temporary storage warehouse of the \( i \) hospital. After obtaining the medical waste disposal bucket collection instruction triggered by the medical waste disposal bucket \( x_{ijk} \), the relevant personnel transfer the trash bin of the \( j \)-type garbage that triggers the alarm of the target medical waste disposal bucket \( x_{ijk} \). Avoid environmental pollution caused by the medical waste garbage loaded in the waste treatment bucket due to the uncleaned or full load in \( T1 \) time; Preferably, \( T1 \) in the embodiment of the present invention is 12h;

Step S4: Obtain a second time value from the corresponding type (\( j \)-type) of medical waste in the first library to the last centralized processing of the corresponding type of garbage. If the second time value is greater than \( T2 \), trigger the instruction for the collection and transfer of medical waste in the first library;

The second library is a sorted storage library. After obtaining the garbage transfer instruction from the first library (temporary storage in the \( i \) hospital), the garbage placed in the first library with a valid time exceeding \( T2 \) will be transferred by transportation equipment;

It is specifically stated here that \( j \) is the type of medical waste garbage, and its corresponding type \( j \) of medical waste garbage stored in the first library has different effective storage time, so the specific value of \( T2 \) depends on the type \( j \) corresponding medical treatment. The actual number of days that the waste is kept in the sorting repository;

Step S5: Obtain all types of medical waste garbage from all hospitals in the second library, and sort and store the medical waste garbage from all hospitals according to the type of medical waste garbage;

Step S6: Obtain the storage volume of the corresponding type (\( j \)-type) medical waste in the second library and the third time value of the last time of the corresponding type of medical waste: if the third time value is not greater than \( T3 \), it is judged that the classification processing has been completed The amount of \( j \)-type garbage storage; when the amount of \( j \)-type garbage that has completed classification processing reaches the second threshold, the corresponding type (\( j \)-type) medical waste disposal
instruction is triggered; if the third time value is greater than T3, the corresponding trigger is triggered Type (type j) medical waste disposal instructions.

Figure 3. Time judgment process

3.2 Weight Judgment Conditions
For any type j medical waste that has been packaged, obtain the weight of the type j medical waste corresponding to the package, and store the weight data in the corresponding cloud of the striped code on the package:

If the difference between the weight of the j-type garbage corresponding to any number of transfers obtained in the cloud and the weight of the j-type garbage to be transferred next corresponding to the number of transfers does not exceed Δm, perform next storage location transfer of the j-type garbage;

If the difference between the weight of type j garbage corresponding to any number of transfers obtained in the cloud and the weight of type j garbage to be transferred next corresponding to the number of transfers exceeds Δm, record the current operation information and trigger a fifth alert;

Specifically, medical waste garbage is a mixture of any kind, which includes solid, liquid, or gaseous mixtures. During storage or transportation, the quality of medical waste garbage may change, such as the kth medical waste in hospital i Handle j-type garbage stored in buckets, and in the first weighing (When the load of \( x_{ijk} \) of the k-th medical waste treatment bucket of type j in hospital i reaches the first threshold, or the first time value is greater than T1), the corresponding mass is \( m_1 \). The mass of medical waste in the j-th medical waste disposal bucket \( x_{ij} \) in the hospital j is collected and processed in the first library. The corresponding mass is \( m_2 \). If |\( m_1 - m_2 \)|≤Δm, the medical waste is collected and processed in the first library; otherwise, the current operation information is recorded, a fifth alert is triggered, and the abnormal weighing information is synchronized to the cloud server. The cloud server performs the result processing of the weighing information, compares and analyzes the collected images through the report and the weighing site, generates the analysis and processing results, and stores them in the cloud server. The relevant management personnel close the alarm based on the cloud server. In the embodiment of the present invention, the alarm instruction can be pushed by the cloud server administrator through the cloud server, and specifically can be pushed in the form of information, phone or email; the quality of the medical waste garbage at any number of transfers and the number of the transfer times The difference analysis of the quality of the medical waste to be transferred next time facilitates the monitoring of the implementation effect of the medical
waste transfer process, avoids illegal transfer or resale of medical waste by unrelated persons, and ensures the effective transportation and treatment of medical waste.

3.3 Alarm Response Process
As shown in Figure 4, after receiving the first alert, a collection instruction is sent based on the alarm information, and the actual position of the medical waste disposal bucket is obtained through the positioning display of the medical waste disposal bucket triggered by the first alert in the GIS system. The first centralized collection and treatment of medical waste in the barrel is performed in the first library; the alarm notification is performed through the contact information bound by the corresponding management personnel associated with the first alert.

| Alert   | Instruction                                      |
|---------|--------------------------------------------------|
| First   | Send the collection instruction, obtain the actual location, and collect the transfer centrally |
| Second  | Send a transfer instruction to get the first library of garbage storage for garbage sorting storage |
| Third   | Send processing instructions to get the second library of garbage storage for recycling or destruction |
| Fourth  | Send reminder instruction                        |
| Fifth   | Obtain the triggered alarm of the abnormal weighing and corresponding historical weighing information |
| Sixth   | Send query instructions to get the location of transportation equipment |

**Figure 4.** Schematic diagram of the alarm response process of the IoT monitoring method
After receiving the second alert, a transfer instruction is sent based on the alarm information, and the corresponding type of garbage is transferred to the second library based on the actual location of the first library triggering the second alert; the corresponding management personnel associated with the second alert are tied Fixed contact information for alarm notification.

After receiving the third alert, send a processing instruction based on the alarm information, and then recycle or destroy the corresponding type of garbage by triggering the actual location of the second library of the third alert; bind the corresponding manager through the third alert Contact information for alarm notification.

After receiving the fourth alert, send a reminder instruction based on the alarm information; use the contact information of the corresponding management personnel associated with the fourth alert to notify the alarm.

After receiving the fifth alert, the operation record information that triggers the fifth alert is obtained, and the historical weighing record information of the j-type medical waste corresponding to the stripe code is obtained based on the record information. Contact for alarm notification.

After the sixth alert is obtained, a query instruction is sent based on the alarm information, and the actual position of the transportation device is obtained through the positioning display of the transportation device that triggers the sixth alert in the GIS system. Contact for alarm notification.

4. Conclusion
At present, China is aware of the harm caused by medical waste, and relevant national laws and regulations have stipulated the production, transportation, storage, and treatment of medical waste. At the same time, local governments and civilians have also combined existing scientific and
Some useful improvements have been made to the medical waste collection device and treatment method, but the following problems still exist:

1. The intelligence level and monitoring intensity of the collection device are generally low, and it is impossible to achieve efficient separated collection and strict monitoring of medical waste from the source;
2. Classification, collection, transportation, storage, and processing are lacking effective management and problem feedback and processing mechanisms;
3. The useful information generated during the collection and treatment of medical waste is not digitized, which is not conducive to big data mining for problem tracing, finding anomalies and useful information.

Facing the necessary and severe forms of medical waste management, the practice of the legal system is indispensable, but the update and improvement of technical equipment and methods provide the most powerful means to solve the problem. The intelligent device for the classification and recycling of medical waste designed for this purpose, and the monitoring method of the Internet of Things, help to realize the efficient separate collection and strict monitoring of medical waste from the source to the final recycling treatment, which is helpful for problem tracing, finding abnormalities and large Data mining beneficial information also helps to standardize the management of medical waste, which has played a good role in reducing the economic cost of medical institutions' treatment of medical waste, reducing the government's economic burden, and saving environmental resources, and has made social, economic, and environmental benefits common. Win, has broad market application prospects.

Finally, thanks for the supports of Plan of Talent Introduction and Cultivation of Youth Innovation for Colleges and Universities of Shandong Province (No:2019189) and Jining Intelligent Manufacturing and Industrial Robot Technology Innovation Platform Project (No :201904).

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