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Retraction

Retracted: Construction and Application of SPD Automated Management Module for Interventional High-Value Consumables Based on RFID Sensors

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] J. Cheng, C. Wen, S. Jiang, L. Zhang, X. Zhu, and W. Qian, "Construction and Application of SPD Automated Management Module for Interventional High-Value Consumables Based on RFID Sensors," *Journal of Sensors*, vol. 2022, Article ID 2184694, 7 pages, 2022.

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Research Article

Construction and Application of SPD Automated Management Module for Interventional High-Value Consumables Based on RFID Sensors

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In order to discuss the construction and application of the SPD automated management module for interventional high-value consumables based on RFID sensors, a high-value medical consumables management information system based on radio frequency identification (RFID) technology is designed and implemented in this paper. It not only realizes the scientific, effective, and full-process monitoring of high-value medical consumables management but also provides managers with scientific and efficient management methods, combined with HIS and SPD's "Unified Receiving Platform" system and barcode technology, to achieve drug barcode acceptance. The experimental results show that the goal of zero inventory management of high value medical consumables is realized and the whole tracking management of use, warehousing, billing, and payment, the high value consumables can be traced back to suppliers and manufacturers and patients, and the inventory, accounting, and payment status can be checked at any time. It proves the effectiveness of RFID technology in the construction and application of SPD automatic management module for high-value consumables.

1. Introduction

With the rapid development of science and technology and hospital business, new materials and new technologies continue to emerge. The government-led and provincial-level online centralized procurement of high-value medical consumables continues to advance, and high-value medical consumables are more and more widely used, which effectively improves the medical level of the hospital [1]. As shown in Figure 1, due to the high price and variety of high-value medical consumables, it is particularly important to carry out strict, scientific, efficient, and traceable management on the procurement, storage, distribution, use registration, and waste disposal of high-value medical consumables. In particular, when some high-value medical consumables are implanted into the human body for a long time, product quality problems and medical device adverse events have become the main contradiction between doctors and patients [2]. The fine management system of the whole process of medical high-value consumables is aimed at realizing the fine information visual management of the whole process of medical high-value consumables and implementing real-time two-way traceability closed-loop management of consumables to ensure the safety and quality of consumables. The system realizes the information fine management of the whole process of medical high-value consumables application, approval, procurement, acceptance, warehousing, inventory management, and warehousing use. At the same time, it can identify consumables information instantly and carry out batch warehousing operation, which is convenient and fast operation, effectively reducing clinical workload and improving work efficiency.

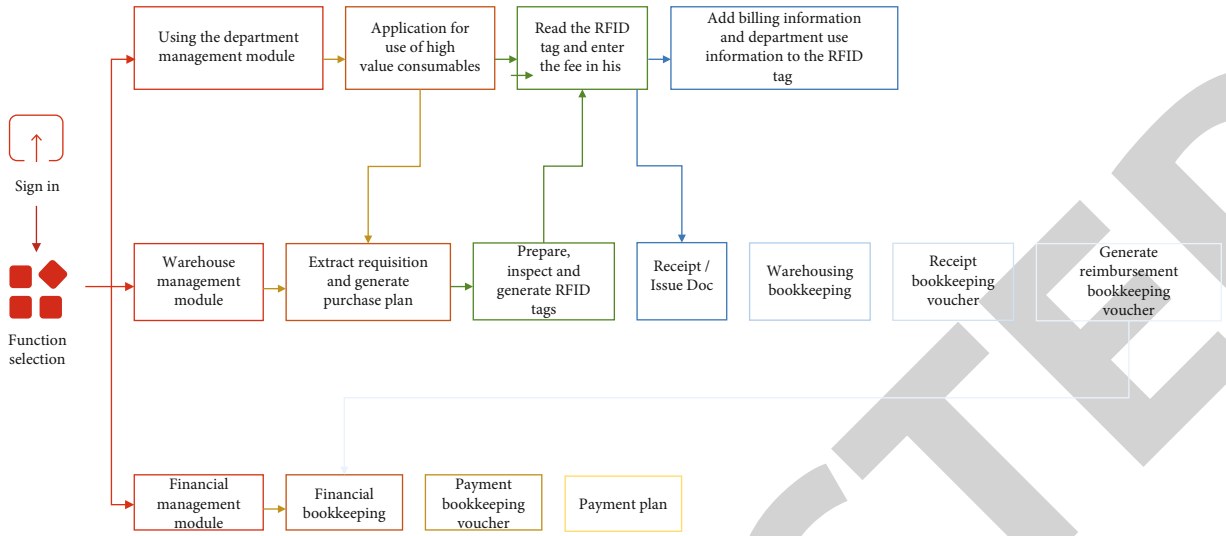

Figure 1: Software flowchart.

2. Literature Review

Estler et al. used radio frequency identification (RFID) technology in logistics distribution and warehousing, mainly to identify and locate products, cargo spaces, boxes, pallets, workers, and other objects, and attached RFID electronic tags to the corresponding target objects to realize real-time tracking of the location of finished products in the warehouse and real-time understanding of the quantity, location, and entry and exit conditions of finished products in the warehouse [3]. RFID technology can improve the supply chain and achieve efficient management by reducing inventory losses. Justinvil et al. proposed the optimization management of RFID-based three-dimensional storage, picking, and distribution in the clothing supply chain. By designing the deployment of RFID technology and the application of RFID electronic tag, the three-dimensional storage center under the application of RFID, and the optimal management of outbound distribution picking path was put forward, so as to improve the efficiency and accuracy of warehousing picking and distribution [4]. Kul'ga combined with SAINT ANGELO to develop a production and logistics management system based on RFID technology and a distribution management system. Through the production management system, it monitors the production progress in real time. It also has production data processing technology, which can effectively process a large amount of data transmitted by RFID system. The use of RFID technology in the warehousing and distribution process can effectively improve the management efficiency of warehousing and distribution. The path of using RFID technology in warehousing is shown in Figure 2 [5].

Xin et al. used RFID to carry out inventory. In the past, it usually took 1 h to complete the inventory of the goods in the store. Now it only takes 10 minutes to complete the reading of RFID electronic tags of all goods, which greatly improves the efficiency of inventory. The data collected by the reader is transmitted to the web server, and the company can quickly complete replenishment and delivery through the data. The tracking management of the production line mainly uses RFID technology to track the position of the product in real time, speed up the sewing workflow, and avoid the occurrence of out of stock. It is mainly through the reader to read the RFID electronic tag attached to the product to track the location. The tag is the only identification during the entire production process, which are used to quickly locate and process the work-in-progress [6]. Zhang and others proposed an RFID-based suit production order tracking management system for the problems of isolated and disordered data collected on the garment production site, low real-time performance, and difficulty in tracking production orders. Combined with the actual production of enterprises, it shows that the management ability in the production process is improved and the tracking of production orders is realized. According to the actual situation of a company, Gao combined the concept of lean production and RFID technology to strengthen the intensity of production management, while optimizing the layout of clothing production equipment and balancing the production line [7]. Sekiguchi et al. proposed the use of RFID technology in the production process of denim and the use of RFID electronic tags for positioning in the production process of denim. Through data analysis on the assembly line, they proposed an improvement method for the production process of denim [8]. Schulze et al. proposed a real-time production tracking system based on RFID, which fully embodies the concept of lean production [9]. Decker et al. believe that hospitals must choose a more cost-effective drug management and storage mode, prepare drugs scientifically and reasonably, and improve drug management efficiency, so as to not only greatly reduce drug storage costs but also ensure the clinical use of drugs in our hospital, so as to effectively solve the problem of inventory management [10]. Romero and Rozano believed at the beginning of the project, it takes some time for the staff of the drug store to familiarize themselves with the scanning gun, the related application

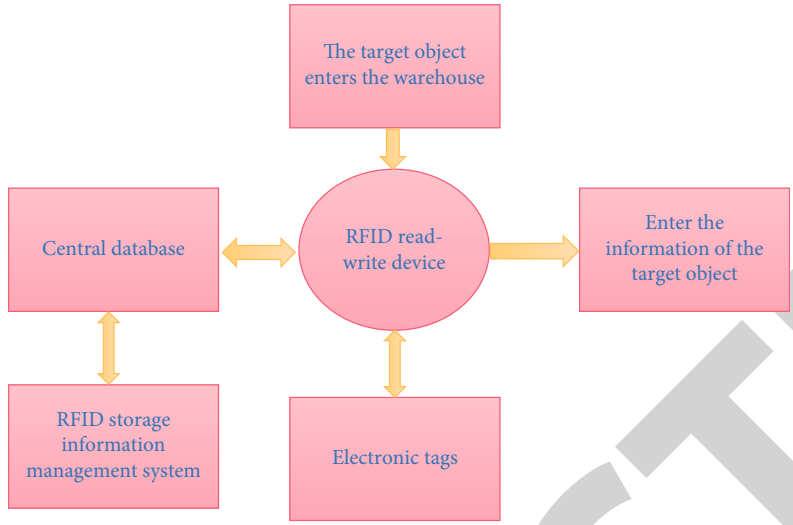

Figure 2: Application path diagram of RFID technology in warehousing.

systems in the tablet computer, and their operation methods. And during the acceptance process, sometimes the network speed is slow or the scanning gun malfunctions, so it is necessary to use traditional acceptance methods to accept drugs, which affects the acceptance rate [11]. Hilburn believed after more than one year of operation with the decline of the system failure rate and the more skilled operation of the drug warehouse staff, the work efficiency has increased significantly [12].

On the basis of current research, this paper designs and implements a high-value medical consumables management information system based on radio frequency identification (RFID) technology, which not only realizes the scientific, effective, and whole-process monitoring and management of high-value medical consumables but also provides managers with scientific and efficient management means and HIS. With SPD's "Unified Receipt Platform" system and bar code technology, drug bar code acceptance is realized.

3. Cooperative Application of SPD and RFID

The definition of SPD in supply chain management is Supply-Processing-Distribution. The SPD model manages medical consumables as a whole by linking core members of the internal and external supply chains of medical consumables to improve management efficiency. The SPD model comprehensively considers the operation rules, characteristics, and interlinkages of each management link of medical consumables in the hospital. Under the support of supply chain management theory and information technology, the traditional management method of medical consumables is optimized and improved. Consumables management mode is suitable for current social and medical background. RFID is an acronym for radio frequency identification. The principle is the noncontact data communication between the reader and the tag to achieve the purpose of identifying the target. The application of RFID is very wide; typical applications are animal chip, car chip immobilizer, access control, parking lot control, production line automation, and material management.

3.1. The Basic Working Principle of RFID. Install the RFID tag on the identified object (sticking, inserting, wearing, implanting, etc.); when the identified object enters the magnetic field, a wireless communication link is established between the tag and the reader. The tag sends the product information stored in the chip to the reader. The reader receives and decodes the information and transmits it to the information system for data processing. At present, there is no global organization to uniformly manage the standards used in RFID. The two popular tags in China are ISO14443 close-coupled IC card and ISO15693 loose-coupled IC card. The system developed in this paper will use ISO15693 loose-coupled IC card. The advantage of this type of card is that it has a large amount of stored data and can better support simultaneous reading of multiple cards, which is in line with the use of high-value medical consumables [13].

3.2. SPD Application. The first is to establish a "Unified Receiving Platform" system, which applies barcode technology to achieve drug barcode inspection and acceptance. Then, by setting up a drug fixed quantity package in the "Unified Receiving Platform" system and scanning the fixed quantity card on the outer packaging of the drug, the automatic entry and exit of drugs the automatic generation of purchase plan can be realized. Finally, the purchase plan is optimized with the help of the fixed quantity package function to realize the scientific management of the drug library inventory [14].

3.2.1. Establish a "Unified Receiving Platform" System. The "Unified Receiving Platform" system is a set of "smart chain" platform independently developed by Sinopharm Holding Co., Ltd., which can realize the functions of drug barcode receipt, electronic drug sales invoice, mobile Internet application, and anywhere acceptance.

3.2.2. Changes in the Inspection and Acceptance of Medicines in the Pharmacy. After the pharmacy staff of this hospital sends the drug order to the third-party drug procurement platform in Guangdong Province based on the drug inventory, the drug distribution company (a delivery company with barcode technology) will log in to the procurement platform to obtain the drug order and print the drug sales order (invoice). After the stock is prepared, the drug order data is synchronously transmitted to the "Unified Receiving Platform" system, and then, the drugs are distributed to the hospital pharmacy, and the pharmacy accepts the drugs.

3.3. Implementation of Server Layer. If you need to add other types of readers or return other types of tags, you need to design corresponding processing methods based on the previous design framework. In the specific implementation process, it is mainly necessary to design the classes required by the following types of sensors to implement the corresponding operations [15].

(1) Sensor session class: the sensor session class generates a connection to the sensor and collects data from this connection. A sensor session corresponds to a sensor object. Once the sensor session is created, it cannot be changed. The sensor session is the most important part, which is mainly composed of three parts:

   (i) Connection logic: the sensor session contains the logic required to connect to the sensor and maintain this connection. When a sensor disconnects and tries to connect again, the sensor session can be detected [16]

   (ii) Execution of orders: the sensor session needs to ensure that the commands assigned to the sensor can be executed in a thread-safe manner

   (iii) Agreement analysis: the sensor session needs to analyze the acquired information according to the protocol used by the sensor. Therefore, some common problems in sensor session can be dealt with according to some extensible classes provided by API, such as TCP/IP, a typical protocol usually used to connect readers. API provides an abstract class to handle the TCP/IP protocol soundly

In our design, there are two kinds of commands used to interact with the sensor: single-shot command is used to execute only-once and repeated command is used to execute repeatedly according to regulations. Each command will use the following three classes:

(1) Command class: the command class is an executable class, executed by a session. This command requires fast execution, which means that sleep and long running cycles need to be avoided [17]

(2) Command configuration class: the command configuration class is used to generate commands. It has various attributes needed to generate commands and has an ID for OSGi command line identification

(3) Command configuration factory class: the command configuration factory class is a factory that generates command configuration. Each type of command configuration corresponds to a command configuration factory

4. Study and Application of Asset Management System

4.1. Design of Asset Management System. The design of RFID asset management system is shown in Figure 3.

The system is divided into RFID electronic tags, fixed card readers, handhelds, and database systems [18].

4.1.1. RFID Electronic Tag. The electronic tag is fixed on the substation equipment or asset, and the unique ID and related information of each equipment asset are stored in the tag.

4.1.2. Fixed Card Reader. RFID fixed card reader is mainly composed of three modules (coupling, send and receive, and control) and interface unit. The card reader provides timing and energy to the electronic tag through the coupling module and performs half-duplex information interaction between the send and receive and control module and the electronic tag. The control unit is used to receive data and perform encryption and decryption algorithms on the data. The interface unit is connected with the control unit for communication between the control unit and the upper computer [19].

4.1.3. Handheld. The scan results can be uploaded in real time via Wi-Fi, or after the scan is completed, the results can be uploaded to the asset management background system via wired transmission and stored in the database.

4.1.4. Database System. The database system is mainly composed of database and management software, which can realize the functions of storage, maintenance, query, and statistics of intelligent building asset data and manage user information, parameter information, maintenance records, and other information [20].

4.2. Asset Management System. When there are two or more electronic tags within the range of the card reader sending information at the same time, the card reader may have a data conflict (that is, data collision), which will lead to a short-term failure of the receiving module of the card reader; the data cannot be received in a timely and accurate manner, which will reduce the performance and efficiency of the system. In order to solve this problem and ensure that each tag can be read correctly, a tag anticollision algorithm is needed [21].

Assuming that N RFID tags are in a specific area, the frame size is L. P_c, P_s, and P_i, respectively, represent possible collision, success, and idleness, and then, calculate P_c according to

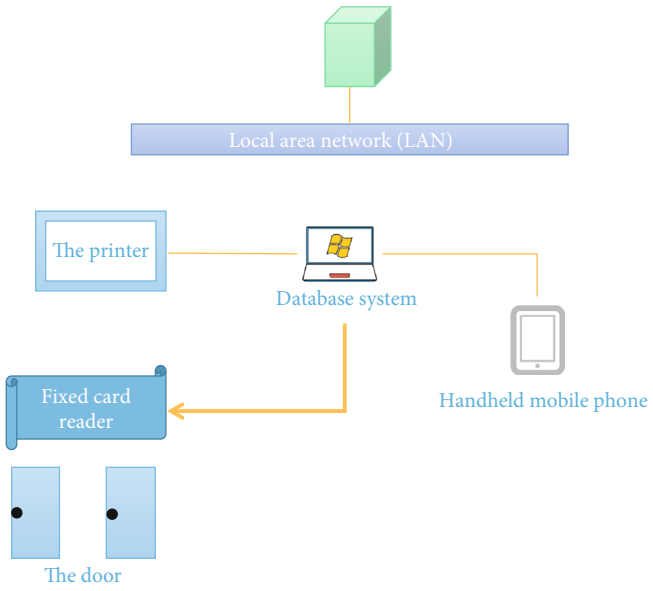

Figure 3: Design of RFID asset management system.

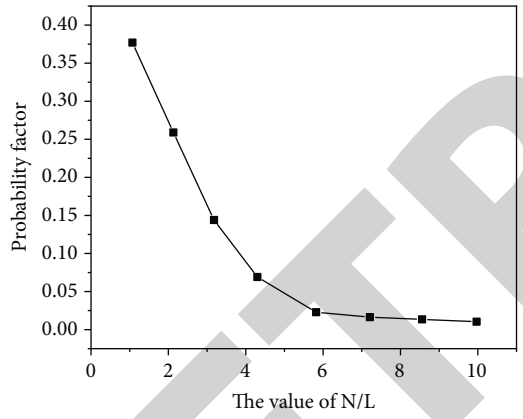

Figure 4: Collision position of P_s.

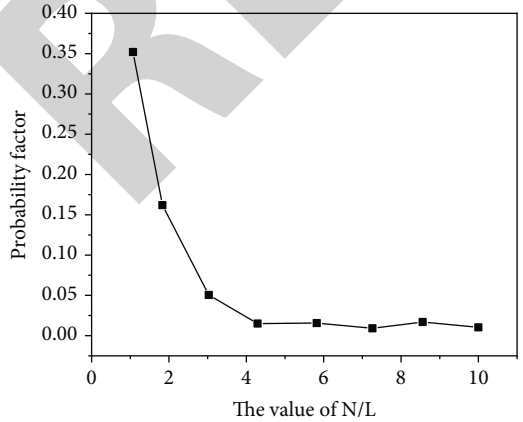

Figure 5: Collision position of P_i.

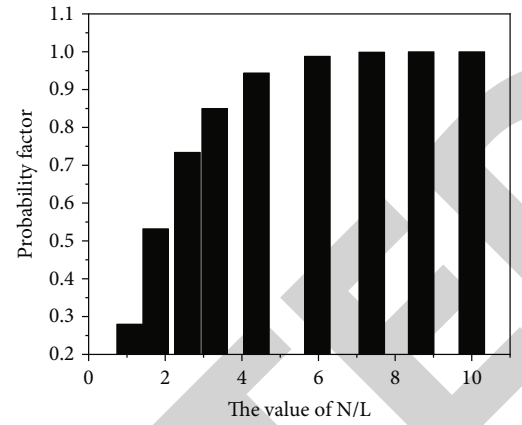

Figure 6: Collision position of P_c.

Table 1: The specific configuration of the handheld in the asset management system.

Item	Configuration
Operating system	Windows CE
Development platform	VS2005
Development language	C#
Class library	Net Compact Framework
Call function	API function

$$P_s = \frac{N}{L}\left(1 - \frac{1}{L}\right)^{N-1}, \tag{1}$$

$$P_i = \left(1 - \frac{1}{L}\right)^{N}, \tag{2}$$

$$P_c = 1 - (P_s + P_i). \tag{3}$$

When N and L are close to the appropriate value, the number of tags tried in each time slot is a Poisson distribution, and the collision position is shown in Figures 4–6, and an appropriate size is selected for the solution.

4.3. Asset Inventory Query Management System. The asset inventory query system sends the inventory task to the handheld terminal (handheld computer) in the form of a task list during the asset inventory query. Scan to complete information recording, quantity registration, difference comparison, etc. Finally, upload the collected information through Wi-Fi, or upload the data cable to the system database through wired means for automatic verification and recording. The asset inventory query management system can also export Excel tables or XML reports [22]. The system can provide a variety of data query methods, such as single condition query and multiple conditions combination queries, and the query results can be browsed in the form of a list. The specific query conditions are asset classification, asset name, use department, presence, use status, maintenance cycle, etc. [23]. See Table 1 for the specific configuration of the handheld in the asset management system.

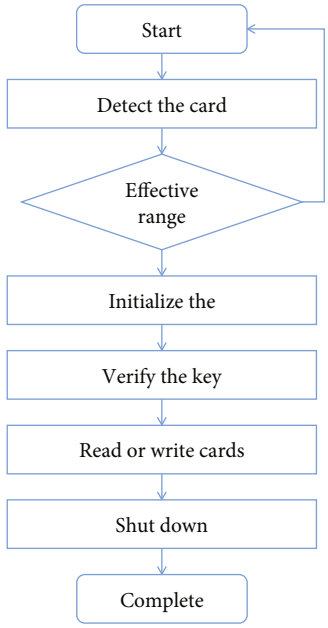

Figure 7: Handheld workflow.

The workflow of the handheld is shown in Figure 7.

5. Conclusion

In the early stage of the project, it takes a period of time for the staff of the drugstore to familiarize themselves with the scanning gun and the related application systems in the tablet computer and their operation methods. In the acceptance process, sometimes the network speed is slow or the scanning gun malfunctions, so the traditional acceptance method needs to be used to accept drugs, which will affect the acceptance rate. Therefore, in the early stage of the project, it has little improvement in work efficiency and faces many difficulties. The compliance of drug warehouse staff in using scanning gun to accept drugs is poor. However, through repeated operations, familiarization with the process, timely reporting to the engineers of the Information Section and Sinopharm Zhongshan when the system fails, actively cooperating with the engineers to feedback the content of the failure and assist in solving the problem, therefore, after more than one year of operation of this project, with the decline of the system failure rate and the more skilled operation of the staff of the drug store, the work efficiency has been improved significantly.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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