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IoT System of Prescription Drugs' Discard and Dispense

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Abstract

Though IoT has been regarded as a powerful impetus for global development, people's horizon on IoT needs to be widened and IoT technology demands further development. Until today, IoT has been greatly promoted and employed in all fields of people's life and industry. With sensors, RFID, GPS and other technologies, a network that covers everything can be built. The network makes everything around people obtainable, trackable, interoperable, connectable, and controllable automatically, saving people's efforts. IoT has also been employed in services for patients and achieved great results while drugs are still managed manually in low efficiency and poor accuracy. If a more intelligent system with higher efficiency can be applied to drug management, the system will be greatly promoted.

Keywords

IoT system; Nearly expired drug; Drug recovery; Drug dispense.

1. INTRODUCTION

With the significant development of modern science, our medical technology has been greatly promoted, but it is still hard and inconvenient for patients to get efficient, secure and low-price prescription drugs. Research shows that 3% of all the surplus drugs were destroyed today, and nearly 8.1 billion dollars' worth of drugs become waste. At the same time, there are people who need these medications, and they usually spend the majority of their income on these inelastic products if they don't have medical insurance, which means there are 44 million Americans facing the same problem. [2] [5] What's more, today's management in pharmacies is still completed by men and it is an impossible task to identify the history of a tablet. If the tablets can be tracked, the quality and security of the drugs can be monitored.

The Internet of things can achieve the connection between objects and objects and between objects and people. It means that the network can cover everything and realize the communications among objects without manual operations. With various technologies of information perception, like the RFID, sensors, GPS, and means of communication, any object, process, and data can be acquired, tracked, monitored, connected and controlled. When the environment around us is more intelligent, our life quality can be improved with more convenience and higher efficiency. Advances of IoT in ubiquitous communications can provide relevant data and information to users, no matter where they are. [3] Also with the development of technology, the cost of building an IoT system can be greatly reduced and the IoT can be popularized to people's daily life.

With all the advantages that IoT can bring to drug management, every pill and packages in use can be identified and tracked. A network that covers every tablet can be built and all the

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information like where it comes from and which patient brought it can all be stored. Then the recovery of unused drugs from patients and the management of drugs in pharmacies can be achieved with the technology and network provided by IoT.

This paper is going to discuss the use case scenarios of recovery and dispense system of prescription drugs based on IoT in section II, its system architecture in section III functions of the IoT system in section IV, and conclusion in section V.

2. USE CASE SCENARIO

The system designed in the paper can be used to minimize the human effort and maximize automation related to prescription drug recovery and dispensing processes.

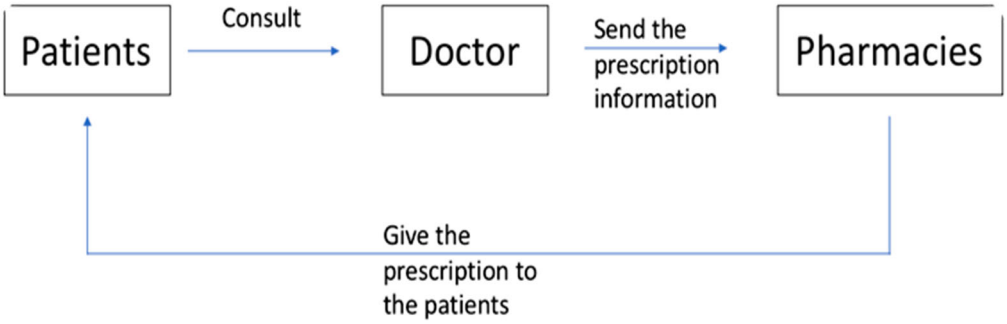

Figure 1. Structure of drug recovery and dispensing system

The pharmacies described in the figure above can either be physical or online. If it is physical, it would require the patients to pick their prescriptions up in person at the pharmacy. In the other case, if the pharmacy is online, the system will automatically search in their database and utilize an algorithm that considers location, expiration date, and amount of drugs needed. Then from a hub, these medications will be delivered to the patients as quickly as possible by trackable packages. People in the US get prescription drugs in both of the ways.

With the existing system of prescription drugs, patients pick up their prescription drugs issued by the doctors from local pharmacies. And in most cases, patients recover from illness before they consume all the medications. Since prescription drugs are issued to the patients by the doctors for onetime usage, they can easily become medical waste in every household. A system for the recovery of unused drugs is proposed in this paper. Pharmacies can then either properly discard or dispense, employing the idea of IoT to efficiently utilize these prescription drugs.

RFID tags are widely used by pharmaceutical companies today. They are attached to packages of manufactured drugs as an anti-counterfeit measure, whereas some other firms are working on placing identification code on each pill to digitalize its information such as name, descriptions, expiration date, purchase record, etc. With this development in mind, the level of automation for pharmacies can be maximized and human intervention can be decreased to its minimum.

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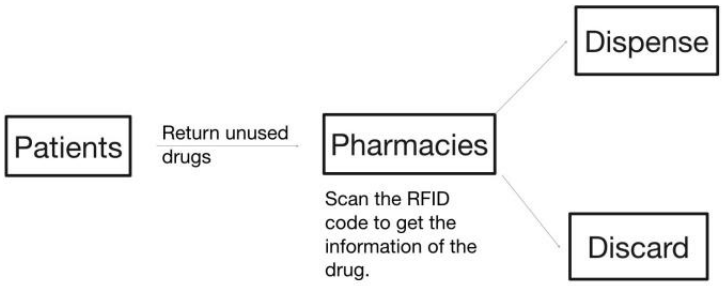

Figure 2. Process of returning unused drugs

With our designed system, patients can return their household unused drugs to any pharmacies in the US. The pharmacy will then use RFID scanner to gain access to the information of the drugs.

The design of the system is the key component. Pharmacy will have the system in which will command the pharmacy to make the choice either to dispense the medical drugs because the drugs still have value left in them or to discard them through environmental friendly methods. This system will reduce the workload of the pharmacies significantly. RFID technology not only has a long scanning range, but it also has the ability to scan multiple items simultaneously and rapidly [16]. The RFID system will give instructions to the pharmacies based on the data stored in the database of the drugs. This way, pharmacies can then follow the current system to resell or to donate some drugs to the needy people.

Cybersecurity is also a topic that will be brought up during the discussion of the IoT system and every system that has something related to the internet. We admit that our system cannot guarantee that our data won't be stolen or accessed in any kind. But we will have programs and algorithms to secure the privacy of both the patients and the pharmacies. In our case, the benefit of our system clearly outweighs the concerns of cybersecurity as well.

3. SYSTEM ARCHITECTURE

The scattered drugs are collected, integrated, and sold in an authenticated and efficient manner with being tracked by a drug recovery system. The recovery and utilization of scattered drugs are improving, and the waste of drugs is reducing. The three layers contributing to the system architecture are:

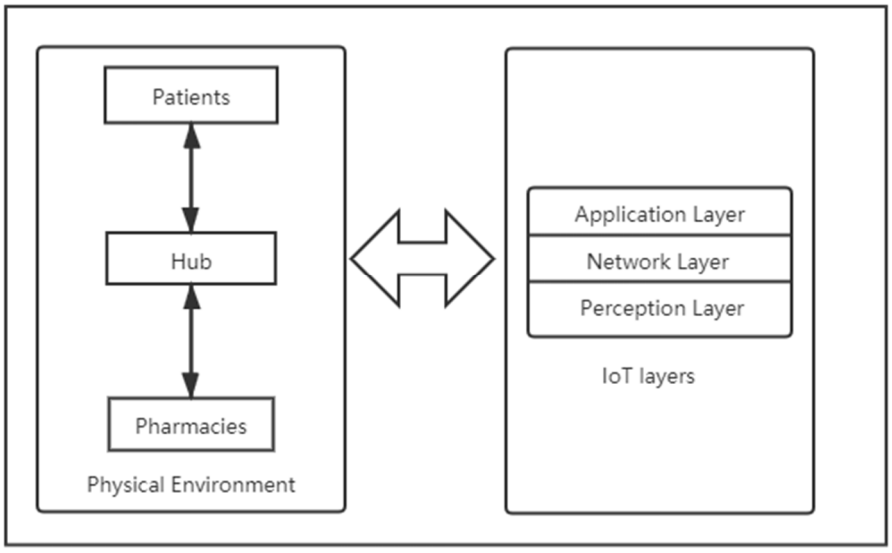

Figure 3. The system architecture

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The perception layer is the main source of information and the information of the physical world such as drug details, user data, location, etc. are sensed, scanned, and collected. [6] It is necessary with the help of technologies, such as RFID system, Electronic Data Interchange (EDI), and others. The RFID system is based on RFID tag, RFID reader, RFID middleware, and scanning camera. The details of the RFID system will be introduced in the next section. Besides, EDI is the computer-to-computer exchange of business documents in a standard electronic format between business partners which are patients, hub, and pharmacies in this system.

The network layer provides transparent data transmission capabilities, and provides an efficient, reliable, and trusted network infrastructure platform with the help of technology between the device layer and the application layer of wireless transmission technologies such as local area network (LAN) and Wi-Fi [7]. In the drug data collected by the RFID reader on the device, the layer is uploaded to the database on the upper-level by the network layer.

The application layer is also called the service layer [6]. The information obtained by the perception layer is processed, and specific applications are realized which are visualized on the terminal. The application layer is including the application support sub-layer and application service sub-layer [6]. The application support sub-layer is a middleware of data management which provides data processing such as combining, restructuring, cleaning [8]. And the application support sub-layer provides information search services, and drug order management through service-oriented architecture (SOA) based on web service and cloud computing technologies and so on [8-9]. The application services sub-layer is a centralized processing of the system's service logic. The application service layer connects the application support sub-layer with the user interface. [13] The application services sub-layer provides the functions of operation and visualization such as drug information retrieval, drug demand distribution and online payment in the user interface.

4. FUNCTIONAL DESCRIPTION

4.1. Pill Identification

Today, all Prescription drugs, over-the-counter drugs, and oral drugs in the U.S. are required by the Food and Drug Administration (FDA) to have a unique imprint. Pills with imprint codes can be identified by their codes, colors, and shapes. [14]

Based on the mature technology of conductive inks, it is possible to develop a new way of imprinting pills with some special inks to identify them more efficiently.

4.2. RFID Tags

Drugs produced by pharmaceutical companies are assumed to be affixed with RFID tags on their boxes. The tags should take the information such as the drug's name, producer and number. As a result, the process of manual checkup can be simplified as scanning the RFID tags with the RFID readers and importing the data into the database of the pharmacy. [16] The RFID tags can be installed with chips or printed with conductive carbon inks. The conductive ink is considered to be environmentally friendly and can reduce the cost of RFID tags. The chips can be recycled to the producers to contain new information and be used again. [11]

4.3. RFID Readers

The hand-held broadcast frequency identifier is suitable for the pharmacy staff who moves frequently to register medicines quickly. The identified drug data is uploaded by the reader to the database of the pharmacy via Wi-Fi.

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4.4. RFID Middleware

The RFID middleware is to collect the data acquired by scanning, manage equipment, process all the data and give a standardized output to the database. The middleware can hide the difference between readers and terminal equipment, which can improve the system's openness. With the middleware, building a terminal application can be much easier without the consideration of the underlying hardware. [15]

4.5. Website

A website with a database is applied for the interaction between users and pharmacies. The database is an important component to realize the functions of the dispensing center and is shared by all pharmacies. The website provides a separate account for each pharmacy. The main functions of the web page are uploading drug information, retrieving drug information, online orders, and online payments. The pharmacy account is used when uploading drug information. The address information of the pharmacy account can be automatically linked to the uploaded medicines, which simplifies the information input steps and improves the efficiency of input operations.

5. CONCLUSION

This report presents the IoT use case scenario for the recovery and dispense of prescription drugs. This system can realize the automatic management and reuse of nearly expired prescription drugs and bring benefits to patients, economy, and environment. The IoT system mainly based on the pill's identification, RFID, and webpages, though some technologies need further development. From this paper, the great potential of IoT is shown. It not only makes the management of drugs become automatic and intelligent, but also can be applied into other fields like food, medical facilities. More use case scenarios and enabling technologies can be developed to make a better world in the future.

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