

# Using Internet of Things (IoT) Technique to Improve the Management of Medical Equipment

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**Abstract**—As we've continued to explore Internet of Things (IoT) in its various applications, there has been no shortage of innovation. From medical quality to patient safety applications use in the healthcare industry, IoT has shown its worth across the board. Just as it's helped organizations in healthcare industry thrive, the power of IoT could also mean big things for the management of medical equipment. That is to say, connected equipment's sensors could pave the way for a fundamental change in the depth and quality of service medical equipment is able to provide. In our study, we constructed the life cycle of gastroendoscope, is used to look inside the oesophagus (gullet), stomach and first part of the small intestine (duodenum). From the procurement of equipment, the use of management to investment efficiency tracking can be applied through IoT to improve the efficiency of management. For example, we can use IoT unique identification function to carry out the inventory management, retirement and other operations. In addition, it can also be used in the management of the medical equipment to track the location, use of records, cleaning records and maintenance management. Finally, we can extract the above information to analyze the investment to evaluate the efficiency of the medical equipment. In summary, we use IoT technique in the different stages of the medical equipment life cycle, because it can provide a more accurate management model, so that users can more efficiently manage the use of equipment to improve its investment efficiency. The internet of things will improve the management of medical equipment that can go a long way in not only increasing equipment efficiency, but medical quality as well.

**Index Terms**—Internet of Things (IoT), Medical Equipment, Gastro endoscope, Investment Efficiency.

## I. INTRODUCTION

Physicians or technicians in hospital rely on medical equipment to work accurately on a daily basis, and equipment managers are always on the lookout for ways to make their machines more efficient and reliable. With this need for constant improvement, the healthcare industry has a lot to gain by utilizing the ability to connect with Internet of things (IoT) technique. There are sensors imbedded in equipment could serve as unique identification and reliability. With the variety of wireless monitoring services now available, medical equipment can work together to create a comprehensive information network. For example, sensors could be connected to heart rate, blood pressure, ultrasound, or any number of equipment that could automatically relay the information it collects to healthcare professionals. It will make equipment more effective by allowing real time monitoring of patient health.

When equipment can gather data on their own, it removes the limitations that human error can cause. Automation reduces the risk of error, and fewer errors can mean increased efficiency, lower costs, and improvements in quality. With so many benefits of medical equipment connectivity, we can look forward to seeing more and more of these IoT connected equipment populate in hospital. Here are just a few of the benefits medical equipment will realize with possibilities of connected sensors and equipment:

### A. Monitor Both Machine and Patient Health

While connected patient medical equipment can provide excellent access to individual health, with connected equipment, technicians in hospital can also monitor the health of the machines of which they're in charge. This is especially helpful for those must-have machines that are imperative for patient care. Having this kind 24/7 automatic monitoring can give piece of mind to those organizations in charge of keeping medical equipment up and running.

### B. Ensure Equipment is Spread Equally Across Machines

Keeping equipment running is the main concern for hospitals, but making sure it's used effectively can also help to see tremendous benefits. IoT sensors have the ability to reveal how long, how often, and how well machines are being used. This means that if one piece of equipment is continually overused, while is rarely used, hospitals can make adjustments so they receive equal wear. Similarly, scheduling times for equipment use can be made easier by updating reservations through cloud based software.

### C. Understand Where to Implement Equipment Improvements

With an endless flow of data from device to manufacturer, hospitals receive insights into how equipment can be modified or upgraded. For example, if particular equipment tends to use resources too large or efficiency too low, equipment managers can change the specification in the next generation of the equipment when the original equipment has been retired. Useful data about the efficiency or performance of the equipment can make the medical process more efficient, and by relation, healthcare as well.

## II. LITERATURE REVIEW

### A. Internet of Things (IoT)

Internet of Things (IoT) is a network that consists of millions of private, public, academic, business, and government networks, of local to global scope, that are linked by a broad array of electronic, wireless and optical networking technologies [1]. Internet of Things is maturing and continues to be the latest, most hyped concept in the IT

world. Over the last decade the term Internet of Things (IoT) has attracted attention by projecting the vision of a global infrastructure of networked physical objects, enabling anytime, anyplace connectivity for anything and not only for any one [2]. The Internet of Things can also be considered as a global network which allows the communication between human-to-human, human-to-things and things-to-things, which is anything in the world by providing unique identity to each and every object [3].

The Internet of Things was initially inspired by members of the RFID community, who referred to the possibility of discovering information about a tagged object by browsing an internet address or database entry that corresponds to a particular RFID or Near Field Communication technologies [4]. The included key technologies of IoT are RFID, the sensor technology, nano technology and intelligence embedded technology. Among them, RFID is the foundation and networking core of the construction of Internet of Things [5]. The Internet of Things (IoT) enabled users to bring physical objects into the sphere of cyber world. This was made possible by different tagging technologies like NFC, RFID and 2D barcode which allowed physical objects to be identified and referred over the internet [6].

IoT, which is integrated with Sensor Technology and Radio Frequency Technology, is the ubiquitous network based on the omnipresent hardware resources of Internet, is the Internet contents objects together. It is also a new wave of IT industry since the application of computing fields, communication network and global roaming technology had been applied. It involves in addition to sophisticated technologies of computer and communication network outside, still including many new supporting technologies of Internet of Things, such as collecting Information Technology, Remote Communication Technology, Remote Information Transmission Technology, Sea Measures Information Intelligence Analyzes and Controlling Technology etc [7].

### B. Healthcare Applications of the Internet of Things (IoT)

The reliance of healthcare on IoT is increasing by the day to improve access to care, increase the quality of care and most importantly reduce the cost of care [8]. Based on an individual's unique biological, behavioral, social and cultural characteristics, the integrated practice of well-being, healthcare and patient support is termed as personalized healthcare. This empowers each and every individual by following the basic healthcare principle of "the right care for the right person at the right time", which leads to better outcomes and improvement in satisfaction thus making healthcare cost-effective. A sustainable service focuses on the prevention, early pathology detection, and homecare instead of the expensive clinical one, and checks the overall well-being to anticipate needs and ensure compliance to healthcare plans. Internet of Things promises to manage the personalization of care services and can maintain a digital identity for every person. Different equipment is used in healthcare, to communicate and to make the ubiquitous system-of-system. The classifications of IoT based personalized healthcare systems are Clinical care and remote monitoring [9].

### 1) Clinical Care

IoT-driven, noninvasive monitoring systems are used for hospitalized patients whose physiological status requires constant close attention. These monitoring systems employ sensors to collect physiological information which is analyzed and stored using gateways and the cloud. This information is then sent wirelessly to caregivers for further analysis and review hence, rendering a health professional having to check the patients' vital signs after regular intervals unnecessary. Instead, it provides a continuous automated flow of information. Thus, the quality of care is improved through constant attention which in turn lowers the cost of care and eliminates the need for a caregiver to actively engage in data collection and analysis [8].

### 2) Remote Monitoring

Lack of ready access to effective health monitoring systems may lead to many health risks go undetected, which is a problem being faced all over the world. But small, powerful wireless solutions connected via the IoT make it possible for monitoring to come to patients instead of vice-versa. Patient health data can be securely captured using these solutions. A variety of sensors and complex algorithms are used to analyze the data and then share it through wireless connectivity. The medical professionals can then make appropriate health recommendations remotely.

## III. APPROACH METHODS

### A. The Life Cycle of Medical Equipment

We constructed the life cycle of gastroendoscope, is used to look inside the oesophagus (gullet), stomach and first part of the small intestine (duodenum), to analyze the IoT can be used in those stages. The Stages and operations are shown in Fig.1. The explanation is as follows:

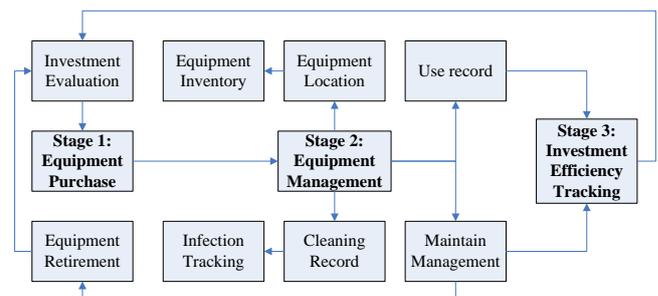


Fig. 1. The Life Cycle of Gastroendoscope

### 1) Stage 1: Equipment Purchase

When the original equipment will be scrapped or there is a need for new operations, new medical equipment purchases may be necessary. Before the procurement of equipment, investment must be assessed. If the first purchase of equipment because there is no historical data can refer to, can only be used to assess the estimated data. But if it is already in use we can use the data, are use records in the past, maintenance records etc., as the source of the analysis of information.

### 2) Stage 2: Equipment Management

This stage is the longest life cycle of equipment, therefore equipment need to take the most rigorous and accurate

management. As the gastroendoscope can be moved, so it may be used in different examination rooms, cleaning machines may also be inside the cleaning operation, the use of micro-location for equipment, users can easily find the equipment he wants to use, without the same as before, must be a one between the examination room to find. And the equipment inventory, you can quickly complete the inventory and confirm the equipment.

Each gastroendoscope is manipulated by those physicians or technicians, and used inpatients, these data of examination must be recorded. We can through the unique identification function, when the gastroendoscope and endoscopic center connection, at the same time will start using the time and the end time was recorded. In this way, we can track when the gastroendoscope was used, who was used and who used the patient.

Because medical equipment is re-used in patients, there is a risk of cross-infection. So we have to be able to track which equipment was cleaned and used in those which patients. Finally, we can record the past maintenance records to each medical equipment to understand how to repair and maintain these medical equipment.

### 3) Stage 3: Investment Efficiency Tracking

Equipment usage and maintenance records are an important source of information for tracking investment returns. If we can correctly and immediately obtain the information for investment efficiency tracking is very helpful.

## B. Technological Framework

Diverse architectures constitute the mutually non-interoperable application specific solutions that shape the market requirements for health monitoring devices. The links between the many applications in health monitoring are:

- The process of gathering data from sensors. (WSNs-Wireless sensor networks)
- Support for standard user interfaces and displays.
- Network connectivity for access to infrastructural services.
- In-use requirements such as low power, robustness, durability, accuracy and reliability [10].

Wireless Sensor Network (WSN) is an important enabling technology of IoT. It connects a number of sensor and actuator nodes into a network through wireless communication. This integrates the network into a higher level system through a network gateway[11].

Ubiquitous Sensor Network (USN) is an extension of the WSN integrated with an application system of the IoT. Gateways are information hubs which collect sensor data, analyze it and then communicate it to the cloud through Wide Area Network (WAN) technologies. Gateways can be designed for clinical or home settings. In home settings, they may be part of larger connectivity resource that also manages energy, entertainment and other systems.

Sensors measure physical data of the parameter to be monitored. The sensor nodes are normally lightweight, inexpensive, easy to deploy and maintain. A drawback though is that, the capability and functionality are limited by resources like sensor accuracy, processors, memories, energy sources, etc. As wireless sensor nodes are typically

very small electronic devices, they can only be equipped with a limited power source of less than 0.5-2 ampere-hour and 1.2-3.7 volts.

Connecting WSNs to the Internet is possible in three main approaches. The first proposed approach consists of connecting both independent WSN and the Internet through a single gateway. This approach is currently adopted by most of the WSNs accessing the Internet, and presents the highest abstraction between networks. The second approach forms a hybrid network which shows an increasing integration degree. It is composed of both, a considered network structure which remains independent and a few dual sensor nodes who can access the internet. In the last approach, multiple sensor nodes can join the Internet in one hop [12].

## IV. RESULTS

In order to achieve the management of the whole lifecycle of the equipment, we plan to build a equipment tracking system (ETS) for management the medical equipment in our hospital. At ETS core, equipment tracking works by performing three main functions — documenting equipment attributes, location identification, and tracking movement. There's other activities that take place such as taking pictures, capturing signatures when items move, scheduling maintenance events, performing maintenance events, depreciation calculations, and many more. The act of performing physical inventory on the equipment and items is another input to an asset tracking system that allows it to accurately manage the shared resources.

An equipment tracking system combines desktop software, RFID readers, RFID tags, and mobile devices to streamline the tracking of equipment from acquisition to retirement in our hospital. The EST applications include IT equipment tracking, check-in and check-out, take asset pictures with smartphone, overdue alert, perform physical inventory, warranty expiration alert, Create, run, schedule, and share reports...and so on.

The starting point to knowing what we have is to uniquely identify each and every item. Most electronic equipment have a unique identifier already such as their serial number. But they don't always have an easily scannable barcode of the serial number. So in ETS we replace barcode with RFID to quickly and correctly identify the serial number. Once we've got a method for identifying everything then we're well on the way to knowing what we have.

Locating equipment is a critical task for many hospitals. Typically, hospital-owned resources are stored and then shared throughout a department or spread out to multiple locations. The equipment is moved when needed by individuals or to be made available for different treatments. The challenging part is keeping track of all the movement and changes of possession over time.

With an ETS we can look on mobile pc to quickly find out where the equipment is located and see who the assigned custodian is. Furthermore, if an item has been checked out or reserved for a period of time, we can find out when it will be returned, shipped back, or made available again.

Over time equipment age and need to be fixed or maintained. These services are needed to ensure assets retain

value and remain usable to the hospital. Keeping track of equipment value throughout its lifecycle is important to the many hospital because of the effect on financial statements and outcomes.

Managing equipment with the ETS allows we to log purchase order info, planned maintenance activities, and the details of the services performed in a digital database. We can even create alerts that are automatically sent when the dates are approaching. Calculating each asset's value can be done in the software at any time, with our choice of depreciation method.

## V. CONCLUSION

Because a traditional equipment management system is the logical leap forward from using spreadsheets or paper-based log sheets to manage assets. The ETS provide a comprehensive solution for hospitals that need help taking physical inventory, maintaining accountability, and controlling physical equipment both on and off-site. It is very easy to lose track of the resources if our hospital still relies on outdated forms of equipment management, especially when dealing with hundreds of medical equipment.

We use IoT technique in the different stages of the medical equipment life cycle, because it can provide a more accurate management model, so that users can more efficiently manage the use of equipment to improve it's investment efficiency. The Internet of Things will improve the management of medical equipment that can go a long way in not only increasing equipment efficiency, but medical quality as well.

The Internet of Things will change our society, and will bring seamless "anytime & anywhere" personalized healthcare and monitoring over fast reliable and secure networks. Today, the most widely adapted technology for the Internet is the standard web services. Wireless identifiable embedded healthcare systems at the edge of the network need to have and utilize similar functionalities and this will prove to be a challenge in the future for the internet [13]. These billions of components produce consume and process information in different healthcare environments such as hospitals, households and nursing homes as well as in the work and everyday lives of people.

As the examples in this paper make clear, the long predicted IoT revolution in healthcare is already underway. And, as new use cases are emerging, they continue to address the urgent need for affordable, accessible care. Meanwhile, the IoT building blocks of automation and machine-to-machine communication continue to be established. The addition of the service layer forms the

complete IoT infrastructure. This revolution is characterized by providing end-to-end processing and connectivity solutions for IoT-driven healthcare [11].

IT equipment are purchased and then deployed or implemented at work stations across multiple locations. Then hospital needs and personnel change, which scramble the IT setup. This common sequence of events is incredibly difficult to track because of the speed and unpredictability of which it occurs. Monitoring the costs, usage, product details, and locations of the assets accurately is a critical challenge. In order to stay ahead of this potential liability, asset control solutions such as Passport help streamline tracking efforts and reduce associated expenses.

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