Design and implement of mobile equipment management system based on QRcode

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Abstract. A mobile equipment management system based on QRcode is proposed for remote and convenient device management. Unlike conventional systems, the system here makes managers accessible to real-time information with smart phones. Compared with the conventional method, which can only be operated with specific devices, this lightweight and efficient tele management mode is conducive to the asset management in multiple scenario**s.**

1. Introduction

With the rising variety of equipment in various fields, the need for equipment management is becoming increasingly intense. In the traditional way, the use of manpower and paper for the equipment management is a waste of resources [1]. Most of the current equipment management systems use specific device to operate and manage, for instance card [2] [3] and RFID [4] [5] Reader. Lars el al. had presented the architecture of medical equipment service management and details of integration to develop a service program which is not a web service [6]. Hu Bin had developed a laboratory equipments management system in university which uses a RF-SIM card Reader to identify the RFID tags on the equipment [7]. S. Nutdanai had developed a medical equipment management in hospital which uses a bar code reader device to recognize the bar code on the medical equipment [8] [9]. They all have significant contributions to the equipment management in specific scenarios.

However, if using the smart phone for telemanagement, the system will enhance the user experience and broaden the application scenario. This paper develops a mobile equipment management system (MEMS) using the telemanagement mode based on mobile internet. In this system the user operates and manages only requiring to scan the QRcode on the equipment with a smart phone. This lightweight and efficient system is conductive to the asset management in multiple scenarios.

The rest of paper is organized as follow: Section II describes the design of the system. Section III details the implementation of the system. In section IV, the system operation and evaluation results are demonstrated. Section V concludes the paper.

2. System Design

2.1. System User Scenario

The user scenario of the MEMS is shown in Figure 1. Every equipment is affixed with a unique label made by the QRcode printer. Then the user can send a request of borrowing or returning to the cloud server after scanning the QRcode. Meanwhile, the web server makes manager accessible to real-time request information. Once the manager has made a check, the information will be fed back to the user and recorded in the database.

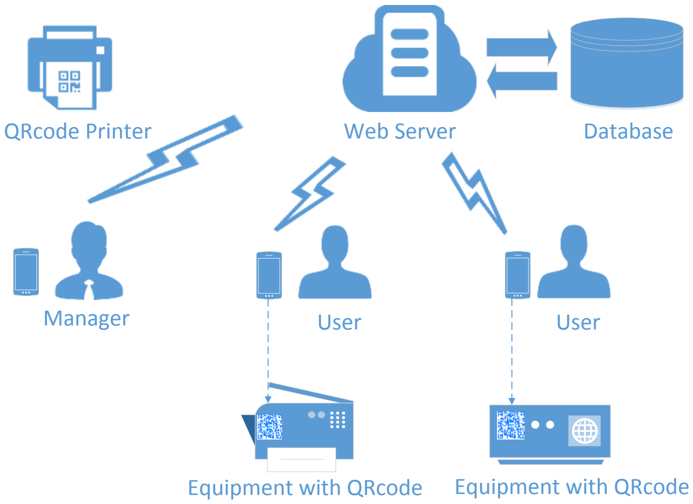

Figure 1. The user scenario of MEMS. The user borrows equipment through scanning QRcode. The web server makes manager accessible to real-time request and synchronize database information.

2.2. System Function Design

Figure 2 shows the block diagram of system functions. The function of the MEMS is divided into two main parts, namely user management and the equipment management. Two parts are subdivided into seven specific functions. They are detailed as follow:

- User Query: The manager can query user information, such as the history, current status, telephone, etc.
- User Remind: Once the user borrows or returns equipments, the system will remind the manager of the audit via SMS. In addition, the user can also be reminded to return the equipment on schedule.
- Equipment Registration: After the identity authentication, the manager is able to register the equipment with a smart phone.
- Equipment Borrowing: After the manager passes the audit, the user can borrow the equipment
- Equipment Returning: The user can return the equipment after the manager has audited.
- Equipment Query: According to the equipment name or the equipment ID, the manager can query the information of equipment, such as the history, status, images and etc.
- Equipment Inventory: The manager can investigate the equipment by scanning the QRcode on the equipment.

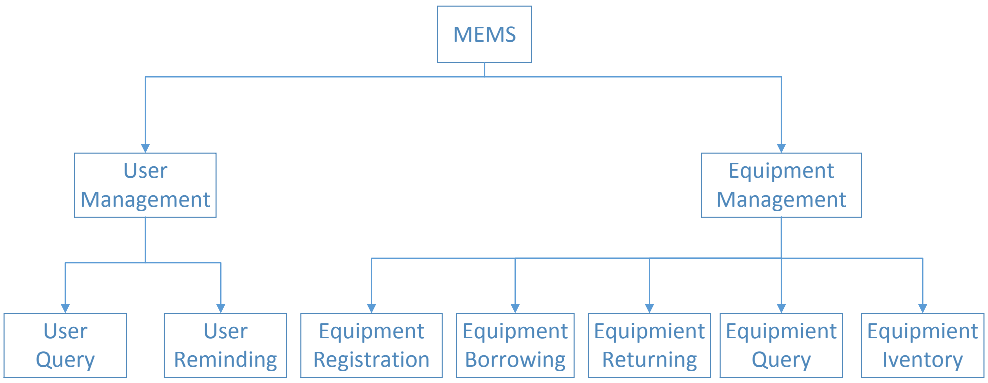

Figure 2. The block diagram of MEMS functions. The system function is divided into two main parts,user and equipment management. They are subdivided into seven specific functions such as equipment registration, borrowing, query and etc.

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2.3. System Architecture Design

Based on the user scenario and function, we designed the system architecture. It can be seen from Figure 3 that the MEMS is web-based system. The developing environment is based on LAMP [10] (Apache + MySQL + PHP under Linux), and the server uses the MVC framework [11], which separates the input, processing procedure and output [12]. This framework eases the management and development procedure.

In our system, the user's smart phone communicates with the web server via http protocol in real time. The browser sends the request to the Controller, then the Controller updates the Model in line with requests. Hereafter, the Model modifies the data, synchronizes to database and responses the Controller. Finally, the Controller renews the View, then the View feeds the updated the interface and information to the browser.

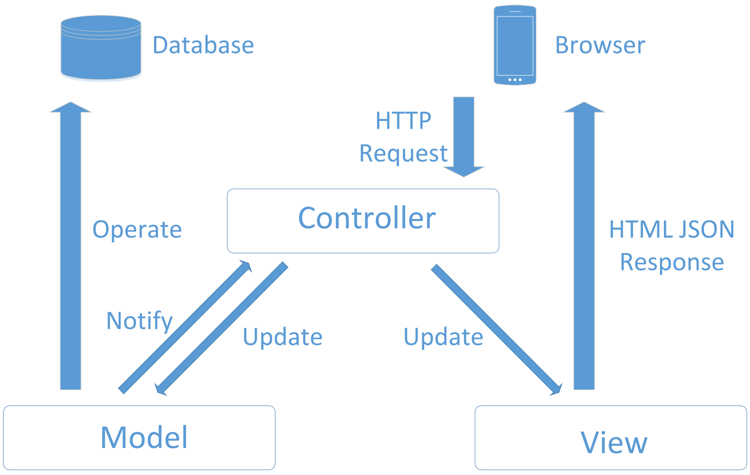

Figure 3. The MEMS architecture. The system uses MVC framework. The Controller receives requests from browser, then updates the Model and the View. The Model synchronizes database information. The View displays interfaces.

3. System Implementation

3.1. System Function Implementation

The system functions have been implemented according to the system functional design. We condense the function into three pivotal parts, namely the equipment registration, the equipment borrowing and the information query.

- The equipment registration is premised. The process is shown in Figure 4. Initially, manager enters the system through scanning QRcode, meanwhile interface sends request to server for details. Then the server retrieves information in the database. Once finding the corresponding data, the server will return data and update pages. Next, the manager photographs equipment and himself. Finally, the manager sends registration request. The server updates data and return results.

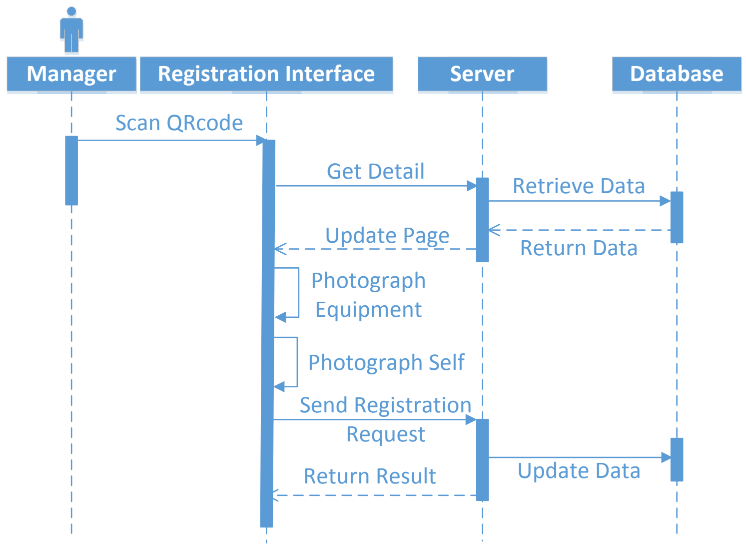

Figure 4. Sequence diagram of equipment registration. The manager registers equipments through scanning QRcode, photographing equopemnt and self, send registration requests.

- Only the equipment has been registered, the user can borrow. The process of equipment borrowing is illustrated in Figure 5. Firstly, the user scans QRcode and then enters the borrow interface. Then the server updates information and page. After photographing the equipment and self, the user sends request to the server for borrowing. When receiving the request, the server calls API to remind the manager of check via SMS. Once the manager has made feedback, the server will update data and return results.

The process of equipment returning is the same as above.

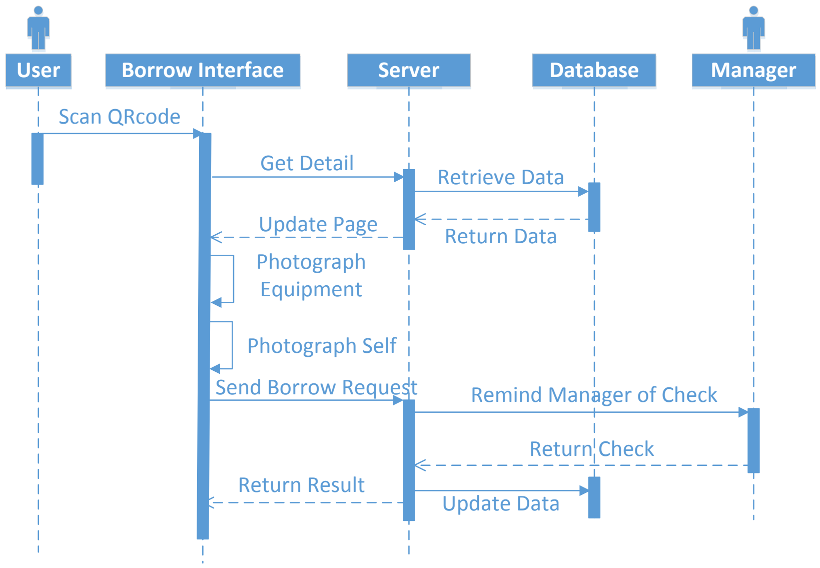

Figure 5. Sequence diagram of equipment borrowing. User borrows equipment through five steps, namely scanning QRcode, photographing equipment and self, sending borrow request.

- The information query can be operated at any time. As is shown in Figure 6, the manager logs in the background management interface after verifying identity. Then the manager can query the current state and history of users and equipments. If necessary, the manager can also export the data.

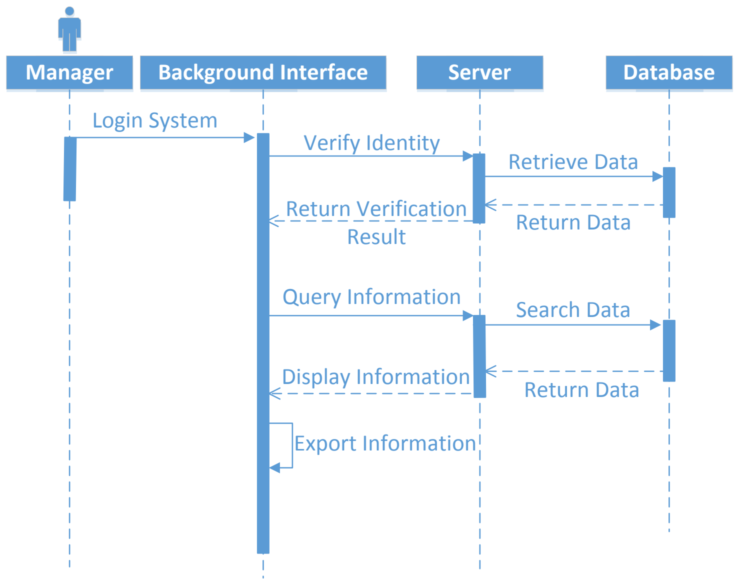

Figure 6. Sequence diagram of information query. After the authentication, the manager can query and export information in the background interface.

3.2. Database Creation

The background database of the MEMS stores various types of data and related parameters, such as the basic information and parameters of equipment, user's parameter and record of operation. According to system needs, we create database and tables. Data tables are linked to others and some of tables are built by users during the operation. Part of the table structure and field information is shown in Fig. 7 as follow.

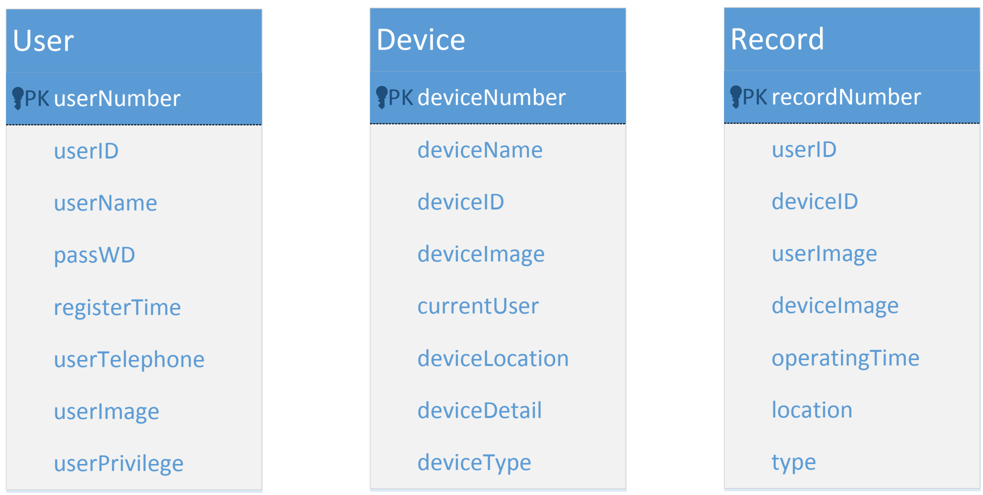

Figure 7. Part of the database structure. The user and device table stores basical information and parameters. The record table stores operation history

4. System Results

According to the user scenario, we built a test environment. As is shown in Figure 8, the system includes a QRcode printer (GPRINTER GP-3150TIN), an oscilloscope used as an example (RIGOL DS1052E), a user mobile device (iPhone 6) for borrowing or returning, a manager mobile device (iPhone 5S) for checking requests and a management software based on a PC browser (MacBook Pro).

In addition, the mobile browser is Safari and the PC browser is Chrome. Then we tested the system from two aspects.

Figure 8. The test environment. a: The QRcode printer generates label. b: The oscilloscope with QRcode label is used as an example of the equipment. c: The user mobile for borrowing. d: The manager mobile for check. e: The management software based on a PC browser

4.1. Test Procedure

The system procedure is tested according to the system function sequence diagram. Firstly, the QRcode printer generates a QRcode shown in Fig. 9 for the equipment. Next, the manager scans the QRcode and registers the equipment. Then the user sends a request for borrowing and the manager checks the information. This part corresponds to the Figure 10. In addition, all of the above information can be queried and exported in the background management interface.

Figure 9. The label generated by QRcode printer. Every equipment has a specific QRcode label.

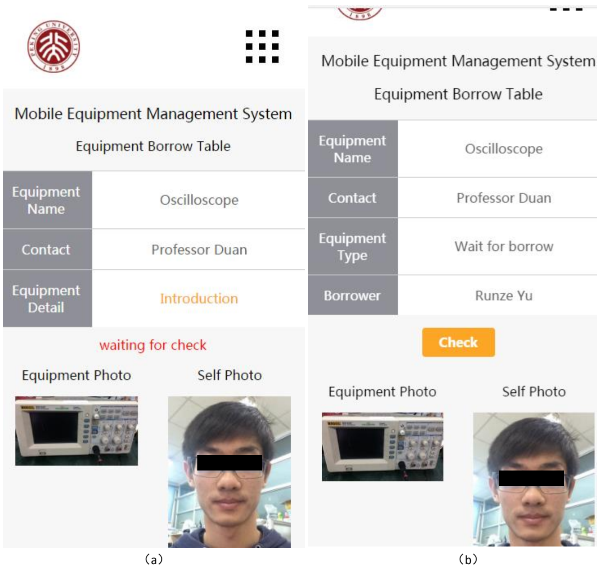

Figure 10. The actual system interface. (a) The user sends request for borrowing and waits for check. (b) The manager checks the borrow request.

4.2. Test Performance
The transmission delay of information is mainly due to the size of photo. In order to reduce the delay, we compress the files before transmission. Next we measure transmission delay of information 50 times through the data capture package method. The average delay is about 47ms.

5. Conclusion
In this paper, we designed and implemented the MEMS, which can receive requests, process data and display information in real time. Moreover, the system can be remotely operated and monitored based on mobile Internet. The system assessment contains robustness and latency. Practical application results show the MEMS is a promising solution for lightweight and high-confident asset management.

6. Acknowledgment
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7. References
[1] Liu Yajing, Tian Guie, “Design and Implement of University Laboratory Equipment Network Management Platform Based on C/S and B/S Model”, Industrial Control and Electronics Engineering (ICICEE), 2012 International Conference, 23-25 Aug. 2012

[2] Bao-Xun He, Ke-Jun Zhuang, "Research on the Intelligent Information System for the Multimedia Teaching Equipment Management", Information System and Artificial Intelligence (ISAI), 2016 International Conference, 24-26 June 2016

[3] N. Saleh, S. Rosati, A. Sharawi, M. Abde, G. Balestra, "Application of quality function deployment and genetic algorithm for replacement of medical equipment", Biomedical Engineering Conference (CIBEC) 2014 Cairo International, 11-13 Dec. 2014.

[4] Jingyu Wang, Sumei Li, Chungui Liu, "Design and Implementation of Smart Equipment Management System Based on RFID", Wireless Communications, Networking and Mobile Computing (WiCOM), 2011 7th International Conference, 23-25 Sept. 2011

[5] Yinghui Huang, Guanyu Li, "Descriptive models for Internet of Things", Intelligent Control and Information Processing (ICICIP), 2010 International Conference, 13-15 Aug. 2010

[6] L. Lars, T Mario, B. Thomas, S. Oliver, "Integration of medical equipment into SOA — Enabling technology for efficient workflow management", Emerging Technologies & Factory Automation (ETFA) 2011 IEEE 16th Conference, 5-9 Sept. 2011.

IOP Conf. Series: Journal of Physics: Conf. Series **887** (2017) 012036 doi:10.1088/1742-6596/887/1/012036

[7] Hu bin, “The Design and Implementation of Laboratory Equipments Management System in University Based on Internet of Things”, Industrial Control and Electronics Engineering (ICICEE), 2012 International Conference, 23-25 Aug. 2012
[8] S. Nutdanai, A. Sanpanich, “A development of medical equipment registration and spare part module in WepMEt system for medical equipment management in Thai hospital”, Biomedical Engineering International Conference (BMEiCON), 2014 7th, 26-28 Nov. 2014
[9] S. Nutdanai L. Pornthip A. Sanpanich, “Development of an information system for medical equipment management in hospitals” Biomedical Engineering International Conference (BMEiCON), 2016 9th, 7-9 Dec. 2016
[10] S.-J. S. Tsai, C. C. Luo, "Synchronized Power-Quality Measurement Network With LAMP", IEEE Transactions on Power Delivery, Volume: 24, Issue: 1, Jan. 2009 , pp. 484-485, doi: 10.1109/TPWRD.2008.2005361
[11] Edward Curry, Paul Grace, "Flexible Self-Management Using the Model-View-Controller Pattern", IEEE Software, Volume: 25, Issue: 3, May-June 2008, pp. 84-90, doi: 10.1109/MS.2008.60
[12] Badurowicz Marcin, "MVC architectural pattern in mobile web applications", Actual Problems of Economics, vol. 6, no. 120, pp. 305, January 2011.