Document Tracking using Internet-of-Things Devices for Fast Data Retrieval

Z Zainal Abidin1, N A Zakaria1, N Harum1, M S Suhaimi1, Z Abal Abas1, A Idris1, K Wan Mohd Ghazali1 and M H Abdul Hamid1

1Fakulti Teknologi Maklumat dan Komunikasi
Universiti Teknikal Malaysia Melaka 76100 Durian Tunggal Melaka Malaysia

Email: zaheera@utem.edu.my

Abstract. University is required to keep printed documents for a certain duration. Documents are evidence, for instance, student’s proof of payment or final exams script, which need to be stored in a safe place within five years or more. The creation of a physical or printed document follows the standard of the International Organization for Standardization (ISO) due to quality management and interrelation between universities for sharing information. However, an inventive way of ISO documentation for storing the evidence from loss and document misallocation is highly requested. Therefore, to overcome the document misallocation problem, an Internet-of-Things (IoT) based file tracking prototype is implemented. The prototype devices consist of Radio-frequency Identification (RFID) that has two parts, which are RFID reader and RFID tag, Arduino Uno, and mobile application (Android). RFID reader scans the information from the RFID tags located at the ISO document’s file. The RFID reader is integrated with Arduino to establish a connection to the network to communicate with mobile applications (Android). This method tracked the current location of the ISO document’s file. The result shows that the ISO document’s file is located in the respective area. Finally, the impact of this research brings efficiency in searching the ISO document’s file in the university.

Introduction
ISO develops a standard for i) quality documentation, ii) a quality report, iii) process control, iv) procedures and v) operations. The ISO documentation involves physical files, printed documents, receipts and logbooks [1]. These documents are important and need to be managed properly since they are evidence [2]. Furthermore, the document management system uses an ISO standard process of filing since physical documents are still in need based on requirements [3]. The person-in-charge checks whether the content in the document is complete, the document follows the template format and the document is arranged using colour label based on categories. Nonetheless, the worker finds the existing file or document is time-consuming and file misallocation, paper usage is wasted; and more spaces for storing the document files at premises [4]. Thus, the transformation of a paper-based document management system into the digitalization or electronic document management system (EDMS) is implemented [5], [6], [7]. The EDMS consists of a document tracking mechanism, which is a web-based file-tracking system [8], [9]. In the web-based file-tracking system, the user, dispatch, and administrator of the website need to register. The user requests for the physical document to be sent to the respective receiver by giving the name of the document, type of document and address. Then, the user needs to put the physical document at the office which the dispatch could collect and send it to the receiver based on the address given. Once the dispatch successfully delivered the physical document, the dispatch needs...
to update the status at the website so that the sender of the physical document acknowledged that the process of delivery has been done. Moreover, the web-based file-tracking system developed still involved in human interaction and not a fully autonomous system. Section II explains related works on web-based file-tracking system with additional device. Section III describes methods and Section IV shows the results and findings on the prototype. Section V concludes the study on ISO document files tracking.

**Related Works**
The technique used in web-based file-tracking with additional device for electronic document management system is explained in sections 2.1, 2.2, and 2.3.

1.1. Barcode based Electronic Document Management System
Barcode provides a series of lines and spaces that represent information about the physical document. The physical document could be a contract or memo. For instance, the physical document is a contract that is printed with a barcode to ensure the expiry date [10]. As the barcode is scanned with a barcode reader, the information is encoded and verified in the database for comparison. If the date is more than the due date, then the status of the contract is changed to “Finish” else “Active”. The system send alert to the person-in-charge through Short Message Service (SMS) and Email notification, which inform the action to be taken. The outcome of using EDMS with barcode is convenience data retrieval [10] and fast response. Moreover, barcode is a cheaper way of implementation but easily be copied [11] and bring to data theft.

1.2. RFID based Electronic Document Management System
Radio Frequency Identification (RFID) gives a mechanism to arrange documents filed in a low or high-frequency range and cost-effective device [12], [13]. For example, a book is borrowed by a student from a library, which has been labeled with the RFID Tag. The RFID reader scans the information of books with RFID Tag in real-time and updates the database on a planned schedule basis. As the book is approaching due date, an alarm is activated to inform the borrower through SMS or email that he or she has few days to return the book before being fined by the librarian [14]. RFID assists the librarian in the autonomous task but for a large scale of system implementation, a huge number of RFID tags are needed since each book is assigned to one RFID Tag that has a unique number [15].

1.3. Cloud based Electronic Document Management System
The cloud-based electronic document management system is a software for organizing and storing different types of document in digital storage solution [16]. It acts as a warehouse that gives accessibility anywhere and anytime [17]. For instance, the document can be updated by different users as long as the user registered to the same cloud. The registered user not only can update but also do synchronization and share other documents to another user to use. Moreover, the cloud is useful especially for companies at a remote distance that involve geographical area. Conversely, cloud solutions give a limited storage and security of the cloud is at the highest level of concern.

**Proposed Method**
The implementation of the study shows how the system work, user interface design, and architecture of the system. This new design shows the solution to the current problem. Figure 1 shows the conceptual diagram and figure 2 illustrated the physical design architecture. Moreover, figure 3 shows the integration of hardware and software of the proposed system. More explanation regarding RFID systems such as RFID Tags and RFID Readers, Arduino with Ethernet Shield and Android Application to track the document files are described in section 3.1, 3.2 and 3.3.
1.4. RFID Tags and RFID Reader
The MFRC522 based RFID Reader module and card integrates the reader or writer circuit for contactless communication at 13.56 MHz with the distance of reading is approximately in 3 cm.

1.5. Arduino UNO and Ethernet Shield
Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input or output pin, 6 analog inputs, 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. Meanwhile, the Ethernet Shield is a 5 voltage of operating, W5500 Ethernet Controller with internal 32K buffer and speed of 10 or 100Mb.

1.6. Mobile Application (Android)
Android studio is the official integrated development environment (IDE) for developing applications on the Android platform. It has an editor tool for developing creative emulators for different versions to test and simulate sensors without the actual devices.

Development Settings and Results
The development settings of the experiment conducted using combined hardware and software. The word A represents the device (laptop) that has been installed with an android installer, MYSQL (database), RFID and Arduino Uno that acts as a server. The letter B indicates the Arduino Uno with Ethernet Shield that is connected with the RFID module reader as labelled as letter C. The Ethernet Shield is important for Internet accessibility to send data to MySQL Database, which is connected through a PHP page. After the data have been inserted into MySQL, then the data is sent to the android application in a smartphone. The letter D indicates the RFID tag in the form of card and letter E is in the form of a key chain. Meanwhile, F is a smartphone that tracks the document through the use of mobile applications.
The result of the experiment conducted in figure 4 presents a mobile application-based file-tracking with additional devices for an electronic document management system. The devices used in this study are Arduino UNO with Ethernet Shield; and RFID Reader and RFID Tag. The configuration and development for RFID Reader, RFID Tag, Arduino UNO with Ethernet Shield are using python language. Based on the findings, the integration of the RFID circuit and the Arduino UNO with Ethernet Shield produces a better document file tracking. The reason is the shield provides a standard RJ45 ethernet jack that allows the circuit board to connect to the internet. When the board has the internet connection, thus, the frequency of the signal can be transmitted and data is retrieved or updated between the board, database and smartphone. Interestingly, the detection of the document file is faster, however still less than a 1-meter radius of coverage. The person-in-charge of the ISO committee or the user of the electronic document management system needs to download the ISO Files Tracking at the Apps Store and install it. Then, the user registers the Staff ID and Password to log in to the ISO Files Tracking. Once the RFID tag of the document file is detected, the notification about the status of the current location of the physical file is viewed at the user’s smartphone.

Conclusion
This study set out to determine an alert or notification to the user through a mobile application instead of SMS or Email. In this investigation, the implementation of mobile application-based file-tracking with RFID and Arduino with Ethernet Shield for an electronic document management system has been achieved. This study has found that the user no need to write their name at logbook anymore but just download the mobile application called ISO Files Tracking to locate the physical document file. It was also shown that the searching process is efficient and the resources are effectively managed. In summary, the tracking method using the Internet of Things (IoT) environment reduces the time of searching for the physical document ISO File and the allocation room for ISO file can be eliminated. It is
recommended that further research be undertaken in the application of devices of the Internet of Things (IoT) environment.

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