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RFID-Based Inventory and Security System

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Abstract
During the last decades, the technology of Radio Frequency Identification (hereafter RFID) has been widely used for practical functions in different disciples including; air industry, military, library services, health services, sports, security and many other fields. Within the industry, RFID has been utilized for various functions such as: storing security, personnel and vehicle access/tracking, production and inventory tracking, bagging, delivery and logistics. In this research, a prototype of inventory and security system for the devices and equipment in university labs is implemented. The system uses RFID technology, which is a form of wireless communication that is used to identify tagged objects by a reader. Both hardware and software implementation of the system are described in this paper.
Keywords: RFID, Inventory system, RFID Implementation

1. Introduction

It could be argued that the manual system and the bar code identification technique are the most commonly-used inventory systems by different types of organizations, including companies, universities, and public entities. Efficiency and effectiveness of the manual system are questionable due to a high probability of human error and time consumption. On the same vein, the bar code identification technique requires line of sight reading and it can read only one object with each scanning. Such disadvantages could be overcome by using RFID technology. RFID system is defined as a contactless radio frequency identification system that transfers data and power between an electronic data-carrying device (transponder or tag) and its reader (interrogator). The history, principles, and applications of RFID were addressed in previous studies (see for example, [1-7]).

RFID Technology has a wide spectrum of application areas. One of these areas is the inventory systems. Based on a model, researchers in [8] examined how different error sources lead to inventory discrepancies and how RFID technology could eliminate some errors. Numerous studies show how RFID is used for inventory management in several fields such as libraries [9], semiconductor industry [10], tobacco industry [11], supply chain [12], fashion industry [13], and retail sector [14]. The studies [15, 16] deal with the laboratory equipment inventory system that uses a passive low frequency RFID device for small coverage. Both studies did not specify type of the used passive RFID device. Regarding the software being utilized, the first study used Microsoft Access and Microsoft Visual Studio, while Visual Basic 6 was utilized in the second study for the client-side application and the Active Server Pages (ASP) for scripting for the server-side application in addition to Microsoft Access and Dreamweaver.

2. System Design

University labs are usually equipped with a large number of devices, equipment and materials. Evidently, tracking inventory through classical manual approach needs more time with probability of human error. In addition, there are a large number of students, and in some times workers, have an access into these labs and hence, the probability of losing some of these devices will increase. To solve these problems, a prototype of an RFID inventory and security system is implemented, where a passive RFID reader is connected to a PC through an Arduino microcontroller. Each device and equipment in the lab is attached with a passive tag which in turn, is communicated with the reader. Every tag has a unique identification number, which means that each device or equipment is uniquely identified. The tags are powered by the radio frequency energy transferred from the reader in proximity of the tag. The system uses two modes. The first mode is activated for security purposes. In this case the RFID reader is placed at the entrance door of the lab. If the reader senses any tagged object (device or equipment) within its range, the system triggers an alarm to notify the supervisor of the lab about an illegal attempt of moving an object out of the lab. The second mode is used whenever there is a need to make an inventory counting of the devices and equipments in the lab. Such inventory checking is usually performed once or twice per year or when there is any doubt about losing a device or equipment. In this case, the responsible person could move the RFID reader away from the entrance door and walk through the tagged objects to verify existence of the inventory. Undoubtfully, this approach will increase efficiency of the inventory system through minimizing the time of items' checking and reducing human error. In the following sections, the hardware and software implementation of the system are described.

3. Implementation

3.1 Hardware Implementation

The passive RFID reader used in the system is Innovations ID-12 that comes with internal antenna. It operates with 125 kHz and has read range of 12 cm. The circuit diagram of the reader is shown in Figure (1) [17].

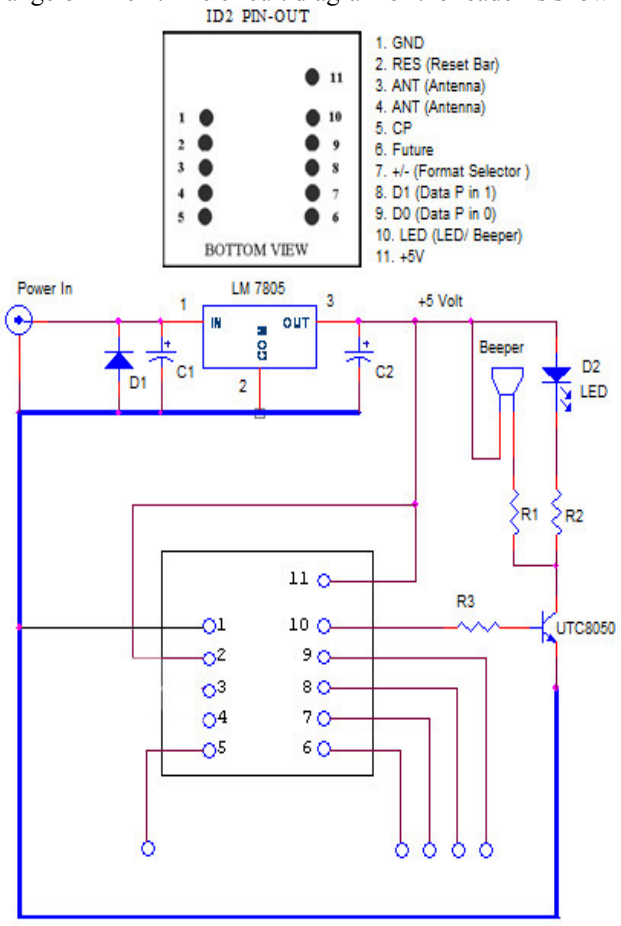

Figure 1. Circuit Diagram of ID-12 Reader

The reader is connected to PC via Arduino Uno as shown in Figure (2). Arduino Uno is a microcontroller board based on ATmega328 [18].

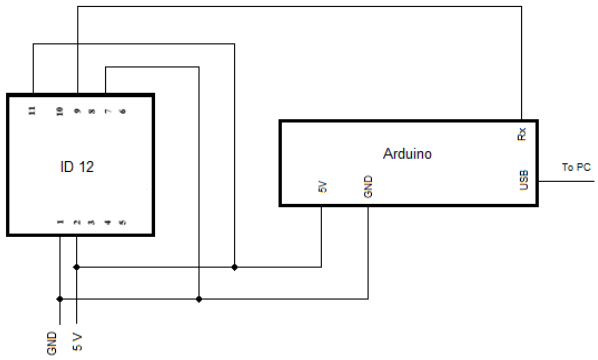

Figure 2. Reader – Arduino – PC Connection

The reader uses a 9600 baud serial connection with the Arduino, which is programmed with the Arduino software (Arduino 1.0.5). The serial communication code is shown in Figure (3).

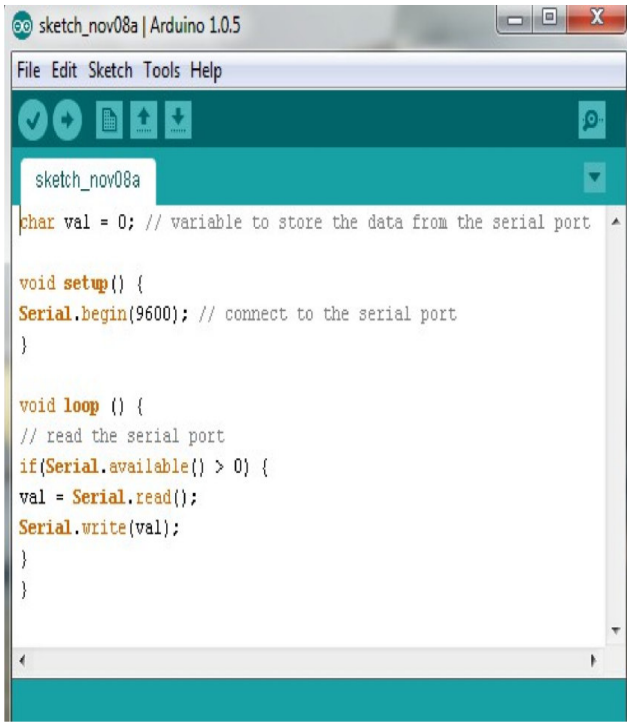

Figure 3. Serial Communication Code

3.2 Software Implementation

In this section, server-side and client-side development are described. The server-side development utilizes programming languages and web databases operating on a web server. Within the system being developed, XAMPP for windows is used as local testing server. It provides users with an Apache, MySQL, and PHP where Apache is the actual web server application, PHP is the server-side scripting language, and MySQL is the database management system. The client-side development manipulates and displays the content requested from the server. For the system being developed, Adobe Flash Professional and its programming language Action Script 3 (AS3) are used.

Monitoring new items and security-mode flowcharts are shown in Figures (4) and (5), respectively.

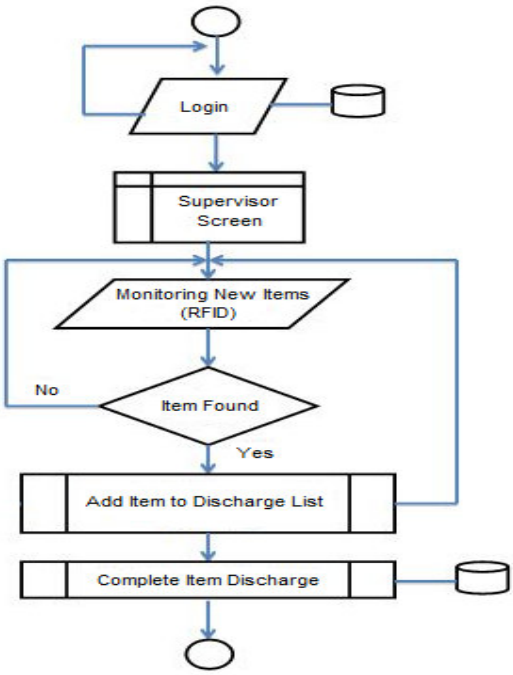

Figure 4. Monitoring New Items Flowchart

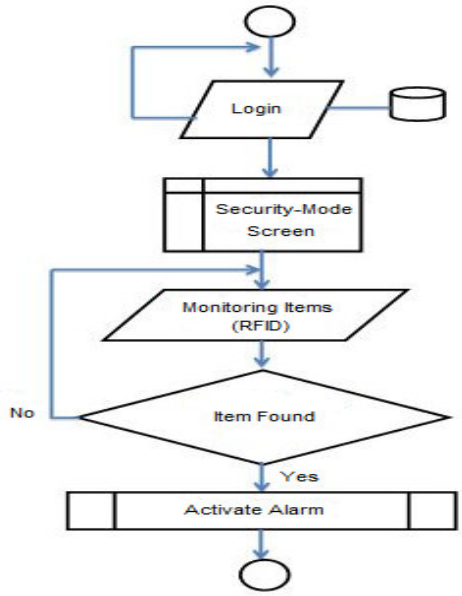

Figure 5. Security-Mode Flowchart

4. The Results

The main window that will appear after login to the system is shown in Figure (6). While the reader detecting a tag (which has an ID previously stored on the database), this item will appear on the right side window of Figure (6). In case of no stored data for this ID were found in the database, the window in Figure (7) will appear; where information of a new item could be added to the database.

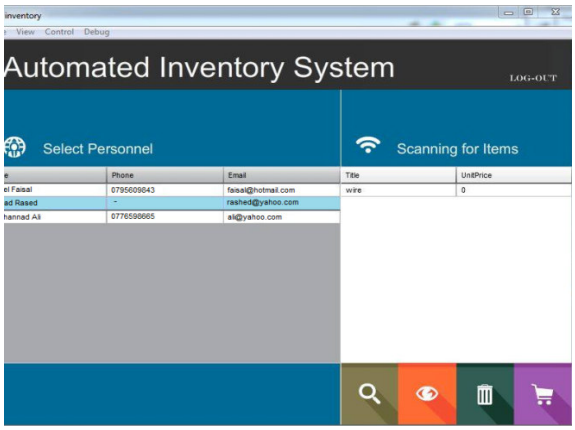

Figure 6. Main Window of the Inventory Tracking System

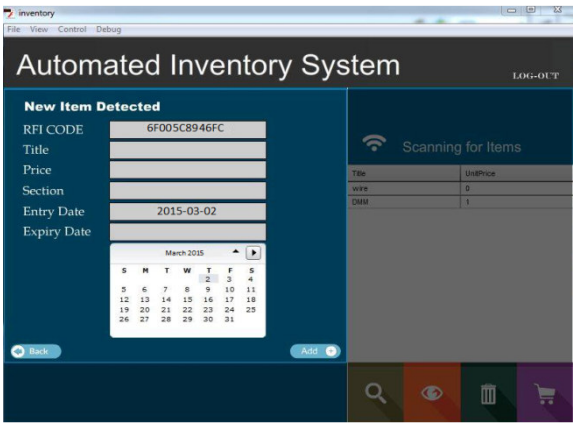

Figure 7. Window for Adding New Items

On the bottom right side of the window in Figure (6), four icons appear. The first one from right is for

scanning purpose as described previously. The second icon is designed for deleting a selected item from the database, while the third icon is used to switch the system to security mode, as shown in Figure (8). In this mode, if any stored ID is sensed by the reader, the system triggers warning sound. The fourth icon is for advance searching, which is represented by the window in Figure (9), where a certain item name could be entered and the system will display the information about that item and the total number of items that match the search query.

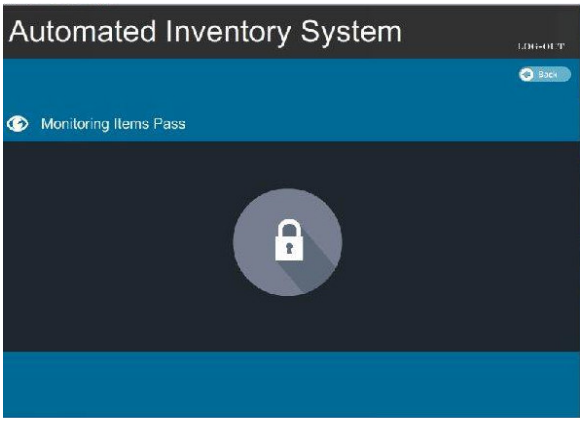

Figure 8. Security Mode Window

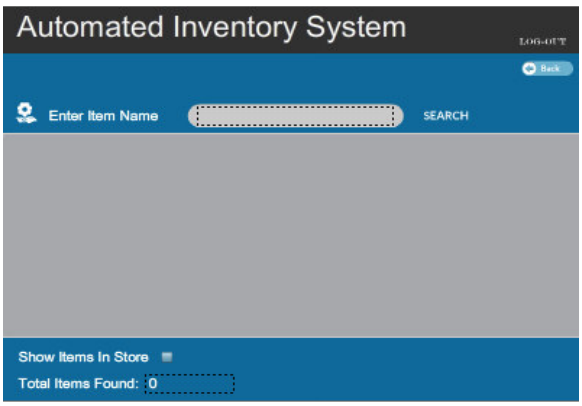

Figure 9. Advance Searching Window

Further to the functions mentioned above, the database could be accessed and edited by opening an internet browser with a certain address that causes the window shown in Figure (10) to be appearing.

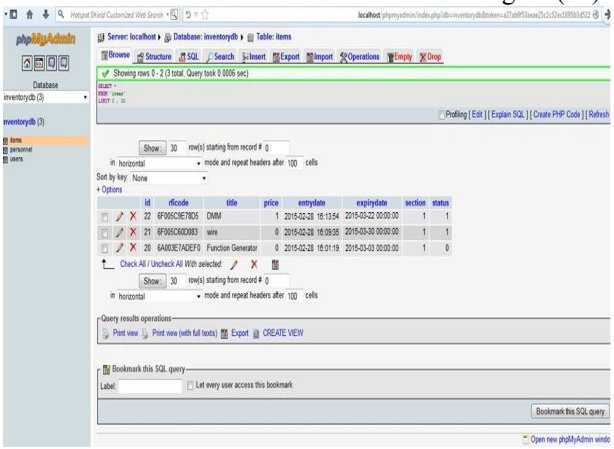

Figure 10. Accessing Database through the Internet Browser

5. Conclusion

A RFID technology has been used to implement a two-mode system for university labs. The first mode is for security purposes and the second one is for examining devices and equipment inventory in the lab. The implemented system utilized a passive RFID reader connected to a PC via Arduino. The software implementation of this system is also described. The system could be improved by using the facilities of Arduino for communicating with another Arduino or microcontrollers. Also, the used reader, which has a small read range,

could be replaced with an active reader with a greater range. Furthermore, the security function of the system could be enhanced by using GSM technology to alert the responsible persons with SMS in their mobile phones or by triggering a camera connected to the system, in case that the reader senses any stored tag's ID in its range when the security mode is activated.

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