A DESIGN OF A BOOK RENTAL SYSTEM BY USING RFID TRANCEIVER FOR 13.56 MHZ FREQUENCY RANGE

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Dedicated to my parents, Hj. Mizuar Udin and Halijah Abd. Rahman, my whole family members and my supervisor, Dr. Yosza Dasril.

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ABSTRACT

The Design of a Book Rental System by Using RFID Tranceiver for 13.56 MHz Frequency Range is a systematic and efficient library management system using RFID technology. This device will enable user to borrow the books by just pass through the gate which is integrated with RFID reader or detector. The system will reduce the amount of time required to perform the book rental process in the library. This system will show the information of the books and the borrower. At the same time, it will store the information such as the book borrowing date and date of return into the central database. The device used low frequency RFID reader to interrogate the user ID RFID card and RFID tag that is stamped on the books. The Microsoft Visual Basic .NET is used to design the graphical user interface for this system and Microsoft Office Access for the database. The software will control the hardware and decodes the responses from the RFID tag. The result shown that this device can work properly based on the test that was conducted in laboratory. This system make the borrower of the book do not need to go to the library counter for the process of borrowing the book, in such way can reduce time and minimize the number of librarian. This system also enables the librarian to search, update and delete book information easily.

ABSTRAK

The Design of a Book Rental System by Using RFID Tranceiver for 13.56 MHz Frequency Range adalah sebuah sistem pengurusan perpustakaan yang sistematik serta cekap yang menggunakan teknologi RFID. Alat ini akan membolehkan pengguna untuk meminjam buku dengan hanya melalui pintu keluar perpustakaan yang disepadukan dengan pembaca atau pengesan RFID. Sistem ini akan mengurangkan jumlah masa yang diperlukan untuk melakukan proses pinjaman buku di perpustakaan. Sistem ini akan memaparkan maklumat tentang buku-buku dan peminjam. Pada masa yang sama, ia akan menyimpan maklumat seperti tarikh meminjam buku dan tarikh pemulangan ke pangkalan data pusat. Alat ini menggunakan pembaca RFID berfrekuensi rendah untuk mengesan kad ID pengguna dan tag RFID yang dilekat pada buku. Microsoft Visual Basic. NET digunakan untuk membina perantaramuka grafik untuk pengguna sistem ini dan Microsoft Office Access digunakan untuk pangkalan data. Perisian ini akan mengawal alat ini dan menyahkodkan isyarat dari tag RFID. Keputusan kajian menunjukkan bahawa Alat ini boleh berfungsi dengan baik berdasarkan ujian yang dilakukan di makmal. Sistem ini membuat peminjam buku tidak perlu pergi ke kaunter perpustakaan untuk proses pinjaman buku, dengan cara seperti itu dapat mengurangkan masa dan meminimumkan jumlah pustakawan. Sistem ini juga membolehkan pustakawan untuk mencari, mengemas kini dan memadam maklumat buku dengan mudah.

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CD	-	Compact Disc
DVD	-	Digital Video Disc
RFID	-	Radio Frequency Identification
HF	-	High Frequency
API	-	Application Programming Interface
IC	-	Integrated Circuit
SMA	-	Sub Miniature Version A
JTAG	-	Joint Test Action Group
EEPROM	-	Electrically Erasable Programmable Read-Only Memory
USB	-	Universal Serial Bus
GUI	-	Graphic User Interface

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CHAPTER 1

INTRODUCTION

1.1   Background of Project

Library is a spot that most people visit especially students. Library has diverse functions like to study, to do research, to borrow books, place to make a discussion and such. But the most important function of a library is for people to get the book or other material that they can have access to and borrow.

Recent growth of libraries in Malaysia carries a lot of new challenges to the library management process. Especially, the operation cost is beyond the limit in several libraries. Core of the difficulty is the allocation of labors for book check out and returns. This problem is particularly clear in small as well as large libraries such as elementary and junior-high school libraries, where dedicating someone for such responsibilities is impractical. Up until this moment, bar-code based library management system has been prevailing.

By using barcodes, a library management system can keep records of lending, borrowing and shelving status of items such as books, audio or video tapes, CDs and DVDs [7]. But barcodes have their limitations. They are slow to read and are prone to

sabotaging by thieves. All these lead to irreparable loss to a library and its valuable inventory stock. This is where RFID technology can come to the aid of library managers and users. Many libraries are switching over to RFID application [6]. But borrowers still need to take the book up and queue to the front desk or to the self check-in/check-out station.

There are a lot of profit or advantages of RFID system compared to the old technology which is bar code system. The advantages are:

    i.   Faster scanning of the data stored on the RFID tag.

    ii.   Straightforward and easy way for borrower to self-checking for material and returns.

    iii.   Greater detection rates.

    iv.   High speed inventory hence reducing time for item placement and further inventory activities by staff.

    v.   Automatic return of materials therefore speeds up materials sorting and re-shelving for the next borrower to access.

    vi.   A longer lifecycle than a barcode.

Many libraries are switching over to RFID applications. Radio-frequency identification (RFID) is the use of an object incorporated into a product, animal, or person for the purpose of identification and tracking using radio waves [1]. They can be read from several meters away and beyond the line of sight of the reader. Using barcodes, a library management system can keep status of item but they are slow to read [4]. There are three main components consist in an RFID system.

Tags – An RFID tags or transponders are the identification device attached to the items that need to be tracked. The microchips on the RFID tags can be programmed electronically. Similarly a reader (technically known as an interrogator) has to be programmed to send and receive correct information from a tag. There are three types of

tags which are read only tag, write once tag and full read and write tag. Every RFID tags used in libraries are passive types of tags which in general stores item id, theft bit, shelving information as well as date of circulation, on the tags.

Readers – An RFID reader or interrogator is a device that can identify the presence of RFID tags as well as read the information stored on them. It has an antenna that sends and receives signals. An RFID reader will generates an RF field so that as soon as a tag passes all the way through the field, the information stored on the chip in the tag is decoded by the reader and it will sent to the server. The same as tags, readers appear in a wide range of sizes and offer different features. Different frequency bands carry different characteristics. One must examine their characteristics when constructing an RFID application.

Today's library RFIDs mostly operate in the high-frequency (HF) 13.56 MHz band which is the most commonly used of the RFID HF bands for the reason that it is the universal standard frequency for contact-less smart labels. These tags have a read range of 1 meter or about 3 feet. In general, as the band goes higher, the longer the reading distance it can handle. However, the cost increases as the band goes up [10]. Table 1.1 summarizes characteristics of different radio bands used for RFID.

Table 1.1: Various Frequency bands for RFID

Frequency band	Characteristics
135 KHz	Read Range: Under 45cm Price Range: Low Description: The first band ever used. No anti-collision mechanism. Mostly used for gate-keeping, animal tagging, and automobile locks.
13.56 MHz	Read Range: Under 1m Price Range: Moderate Description: The same band with smart cards. Support read and writes and up to 20 simultaneous tags can per reading.

860MHz - 960 MHz	Read Range: 2m - 5m
	Price Range: High
	Description: Longer read range although using shorter antenna. Used for transportation vehicle identification, large item management and supply chain.
2.45GHz - 5.8GHz	Read Range: 1m - 1.5m
	Price Range: High
	Description: Standard frequency band for toll collection. Similar to UHF band but the tag size is much smaller.

Middleware – An RFID middleware is a software layer that connects information coming in from tags attached on the library items and readers, to the library management system. Middleware provides a consistent and secure interface linking RFID hardware operations and flow of data elements like membership number, catalogue number, author and such into the library database. RFID middleware solutions offer messaging, routing, and connectivity features necessary to integrate the RFID tag information into the accessible library management system. The applications software would have the Applications Programming Interface or the API which is needed to interface the RFID system with the server so as to reach the automated library system.

This project is about to develop a book rental system by using RFID. Since the usage of RFID is very wide nowadays, it can be implemented to the process of borrowing the books in the library. The security, efficiency as well as the productivity can be enhanced by the usage of RFID in the system. This is how the conventional method of borrowing books in a library.

Scan borrowers' card ➡ Receive books ➡ Scan RFID tag or barcode ➡ Deactivate security ➡ Return books ➡ Date due receipt

Figure 1.1: Conventional method of borrowing books.

It is a six step process and it is very tedious and time-consuming. If these processes are made by conventional methods, it will capture a lot of time and lead to inefficiencies and unsatisfactory services to the borrowers. This will results the borrowers need to suffer a long queue at the library counter. This will also burden the librarian for doing a tedious and repetitive process every time.

The Book Rental System by Using RFID Tranceiver for 13.56 MHz Frequency Range is a system that can reduces the amount of time required to perform the book rental process in the library and free the librarian from doing repetitive and physically stressful tasks. It consist of a RFID tag that stamped on the back of the books, RFID card, RFID reader to interrogating the RFID tag and card, and software to controlling the hardware and decoding the responses from RFID tag and card. The borrowers will pass through the RFID reader and it will read the RFID tag attached to the books and send the data to the library software [8]. The software will change the status of the book and the book's borrower data will be stored in the database. The RFID tags that were used in this project are a passive type with the frequency of 13.56 MHz and the reader is High Frequency type which is also operated at the frequency of 13.56MHz.

1.2   Problem Statement

Current library management system used barcode and technology to keep records of lending, borrowing and shelving status of items such as books, audio or video tapes, CDs and DVDs.

Barcodes limitations:

    i.   They are slow to read.

    ii.   Prone to sabotaging by thieves.

    iii. Irreparable loss to a library and its valuable inventory stock.

By using RFID

    i.   Save time.

    ii.   Read more than one item at a time.

Current RFID limitation:

    i.   Borrowers still need to take the book up and queue.

1.3   Objectives of Project

The objectives of this project are:

1. To design and develop a book rental system by using RFID transceiver for 13.56 MHz frequency range by using appropriate hardware and software.
2. To develop the interface between the software and hardware detection system.
3. To test the suitability, reliability and efficiency of the prototype.