Application of RFID Technology in Library Automation

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Abstracts
A Library is a growing organism. As it grows in size, the problems associated with the maintenance and security of the documents also grows. To solve the problems of arranging documents, problems of searching documents & problem of space and time, there is need of Radio Frequency Identification (RFID) technology is needed to provide right information to right user at right time. RFID is a rapidly emerging technology, which allows productivity and convenience. This paper proposes RFID-based Library Management System that would allow fast transaction flow and will make it easy to handle the issue and return of book keeping which benefits by adding properties of traceability and security.

Keywords: *RFID, Library Security, Radio waves, Security System, Tag, Theft detection*

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INTRODUCTION

RFID (Radio Frequency Identification) invented in 1969, patented in 1973, first used in harsh industrial environment in 1980s. RFID is a technology used for tracking and identification of objects in many areas of commerce, shipping, manufacturing, and, beginning in the late 1990s, in the circulation, inventory and security processes of libraries.

RFID uses wireless radio communications uniquely to identify objects or people, and is one of the fastest growing automatic data collection (ADC) technologies. RFID allows an item, for example a library book, to be tracked and communicated with by radio waves. There are several methods of identification, but the most common is to store a serial number that identifies a person or object, and perhaps other information, on a microchip that is attached to an antenna.

The antenna enables the chip to transmit the identification information to a reader. The reader converts the radio waves reflected back from the RFID tag into digital information that can then be passed on to computers that can make use of it. RFID-based systems have been implemented for efficient document tracking out the libraries that combine, easier and faster charging and discharging of documents, security of materials, inventorying, stock verification and shelf handling [1].

RFID LIBRARY MANAGEMENT SYSTEM

Using RFID in libraries saves library staff's time by automatizing their tasks. An establishment that uses RFID library management saves a book reader, precious time that he would have been spent, waiting for his turn in a queue for borrowing or returning a book [2].

Taking care of books and making them available to the book readers are important tasks. Most of the library staff's time is spent in recording information of incoming and outgoing books. Borrowing and returning of books can be fully automatized with the help of self check-in/out systems. This system involves installation of special software.

A person using this system to borrow books is presented with options on a computer screen. The person has to identify himself with a code, which is preferably a personal identification number, or any form of unique identity code.

Books selected by the person are identified by the system's built-in RFID reader. In addition, the surveillance bit in the book's tag is deactivated by the system. When a book is returned, the check-in/out system activates the surveillance bit (Figure 1).
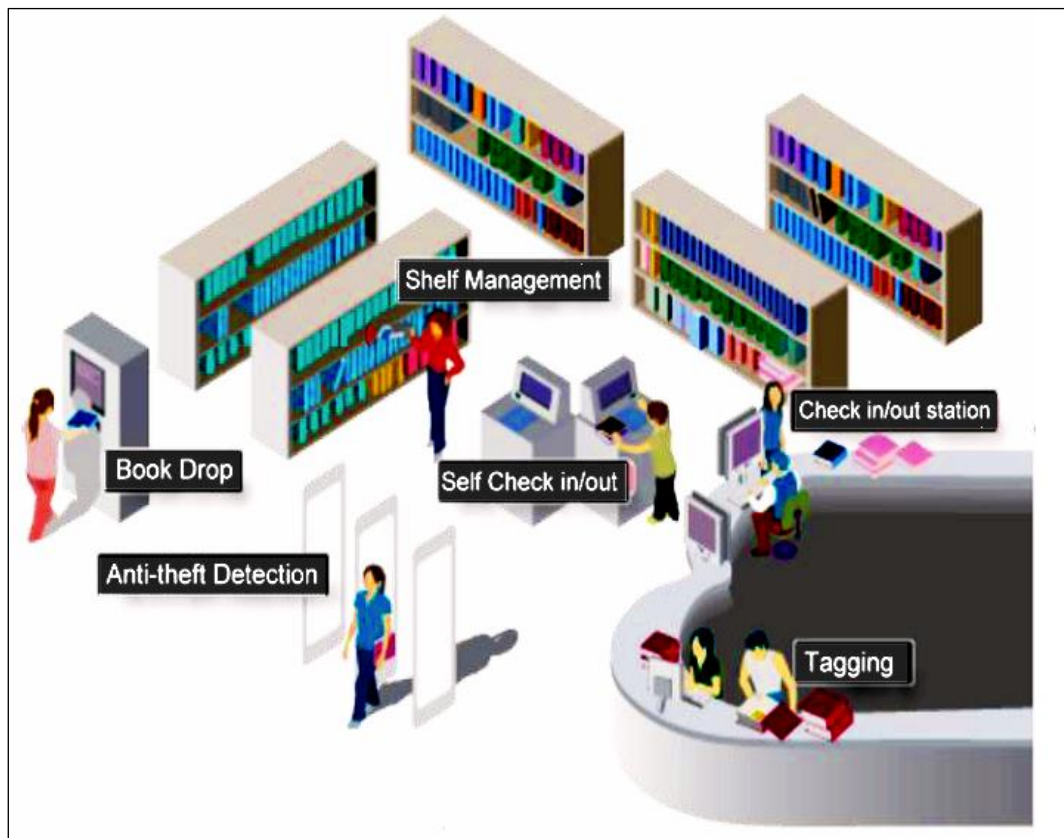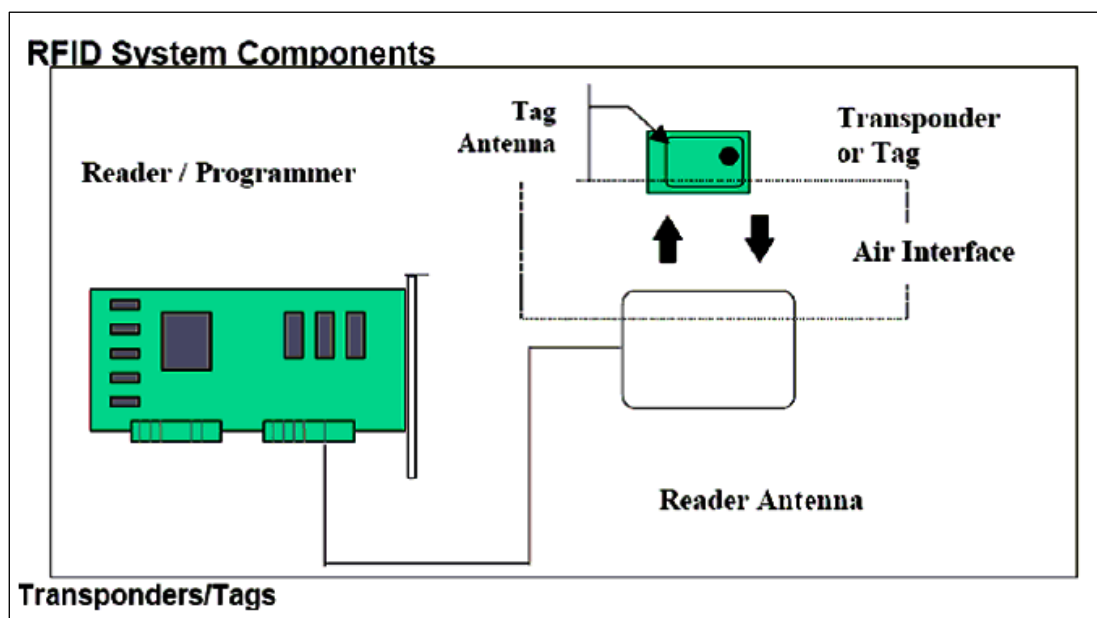
***Fig. 1:** RFID Library Management System.*

***Fig. 2:** RFID System Components.*

Components of an RFID System
A comprehensive RFID system has four components (Figure 2):
1. RFID tags that are electronically programmed with unique information
2. Readers or sensors to query the tags
3. Antenna

4. Server on which the software that interfaces with the integrated library software is loaded.

Tags
The heart of the system is the RFID tag, which can be fixed inside a book's back cover or

directly onto CDs and videos. This tag is equipped with a programmable chip and an antenna. Each paper-thin tag contains an engraved antenna and a microchip with a capacity of at least 64 bits. There are three types of tags: "read only", "WORM", and "read/write" (Boss 2003). "Tags" are "read only" if the identification is encoded at the time of manufacture and not rewritable. "WORM" (Write-Once-Read-Many) tags are programmed by the using organization, but without the ability to rewrite them later. "Read/write tags", which are chosen by most libraries, can have information changed or added [3]. In libraries that use RFID, it is common to have part of the read/write tag secured against rewriting, e.g., the identification number of the item [4].

Readers
RFID readers or receivers are composed of a radio frequency module, a control unit and an antenna to interrogate electronic tags via radio frequency (RF) communication (Sarma et al. 2002). The reader powers an antenna to generate an RF field. When a tag passes through the field, the information stored on the chip in the tag is interpreted by the reader and sent to the server, which, in turn, communicates with the integrated library system when the RFID system is interfaced with it (Boss 2004).

RFID exit gate sensors (readers) at exits are basically two types. One type reads the information on the tag(s) going by and communicates that information to a server. The server, after checking the circulation database, turns on an alarm if the material is not properly checked out. Another type relies on a "theft" byte in the tag that is turned on or off to show that the item has been charged or not, making it unnecessary to communicate with the circulation database [5].

Readers in RFID library are used in the following ways:
- Conversion station: where library data is written to the tag
- Staff workstation at circulation: used to charge and discharge library materials
- Self check-out station: used to check-out library materials without staff assistance

- Self check-in station: used to check-in library materials without staff assistance
- Exit sensors: to verify that all material leaving the library has been checked out
- Book-drop reader: used to automatically discharge library materials and reactivate security
- Sorter and conveyor: automated system for returning material to proper area of library
- Handheld reader: used for inventorying and verifying that material is shelved correctly.

Antenna
The antenna produces radio signals to activate the tag and read and write data to it. Antennas are the channels between the tag and the reader, which controls the system's data acquisitions and communication. The electromagnetic field produced by an antenna can be constantly present when multiple tags are expected continually. Antennas can be built into a doorframe to receive tag data from person's things passing through the door [6].

Server
The server is the heart of some comprehensive RFID systems. It is the communications gateway among the various components (Boss, 2004). It receives the information from one or more of the readers and exchanges information with the circulation database.

Optional Components
Optional RFID system includes the following three components (Bibliotheca 2003):
1. RFID Label Printer
2. Handheld Reader
3. External Book Return
4. RFID label Printer

An RFID printer is used to print the labels with an individual barcode, library logo, etc. When the print is applied, it simultaneously programs the data in to the chip. After this process, the RFID label is taken from the printer and applied to the book.

Application in RFID Library Management System
1. **Book Drops**: The Book Drops can be located anywhere, within or outside the library. Possible remote locations outside the library include MRT/train stations,

shopping centers, schools, etc. This offers unprecedented flexibility and convenience of returning library items at any time of the day, even when the library is closed.

2. **RFID Transponder or Tagging:** It is the most important link in any RFID system. It has the ability to store information relating to the specific item to which they are attached, rewrite again without any requirement for contact or line of sight. Data within a tag may provide identification for an item, proof of ownership, original storage location, loan status and history. RFID tags have been specifically designed to be affixed into library media, including books, CDs, DVDs and tapes.

3. **Counter Station** is a staff assisted station on services such as loan, return, tagging, sorting and etc. It is loaded with arming/disarming module, tagging module and sorting module. Arming/Disarming module allows EAS (Electronic Article Surveillance) bit inside the tag of the library material to be set/reset so as to trigger/not trigger the alarm of the EAS gate.

4. **The Patron Self Check-out Station:** It is basically a computer with a touch screen and a built-in RFID reader, plus special software for personal identification, book and other media handling and circulation. After identifying the patron with a library ID card, a barcode card, or his personal ID number (PIN), the patron is asked to choose the next action (check-out of one or several books). After choosing check-out, the patron puts the book(s) in front of the screen on the RFID reader and the display will show the book title and its ID number (other optional information can be shown if desired) which have been checked out [7].

5. **Shelf Management:** This solution makes locating and identifying items on the shelves an easy task for librarians. It comprises basically of a portable scanner and a base station. The solution is designed to cover three main requirements:
1. Search for individual books requested
2. Inventory check of the whole library stock
3. Search for books which are miss-helved

6. **Anti-theft Detection:** RFID EAS Gates is the anti-theft part of the Library RFID Management System using the same RFID tags embedded in the library items. Each lane is able to track items of about 1 meter and would trigger the alarm system when an un-borrowed item passed through them. The alarm will sound and lights on the gate will flash as patron passes through with the un-borrowed library material.

Important Points Based on RFID Library Management System
1. RFID tags replace both the EM security strips and Barcode.
2. Simplify patron self-check-out/check-in.
3. Ability to handle material without exception for video and audio tapes.
4. Radio Frequency anti-theft detection is innovative and safe.
5. High-speed inventory and identify items which are out of proper order.
6. Long-term development guarantee when using Open Standard.

BENEFITS OF RFID USE IN LIBRARY
1. RFID improves library workflow by reducing non-value added work processes
2. Improves staff productivity
3. Improves customer service
4. Assist inventory check with ease
5. Easy book identification for shelving process
6. Assist traceability of book allocation
7. Enhance book return processes by full automation of check-in, EAS activation and system updates completed simultaneously in the self-return chute
8. Allow better accuracy in book collection management, resulting in reduced book purchase
9. More than one item can be checked out or checked in at the same time
10. Items can be placed on reader without careful placement that it is required for line of sight system (bar code scanner)
11. Faster inventory process
12. Ability to locate specific items.

ADVANTAGES OF RFID IN LIBRARIES
The use of RFID reduces the amount of time required to perform circulation operations. The

most significant time saving with bootable to the fact that information can be read from RFID tags much faster than form barcodes and that served items in the stack can be read at the same time. Some basic commonly advantages of RFID over Libraries are as follows: Simplified Patron Self charging and discharging, High Reliability, Streamlined Inventory Management, Faster Circulation Operation, Reduction in workplace injuries, Automated materials handling, Easy stock verification, Theft reduction, High level of security, Mis-shelf easy identification, External Book Return, Improved tracking of high value items, Reduce Shrinkage errors, Technology standards to drive down cost, Reduce materials cost and handling, Automated issue/return, Automated sorting of books on return, Inventory visibility accuracy and efficiency, and Improved Production planning [8].

RFID tags are very simple to install/inject inside the body of animals, thus helping to keep a track on them. RFID technology is better than bar codes as it cannot be easily replicated and therefore, it increases the security of the product. Barcode scanners have repeatedly failed in providing security to books and journals in libraries. But nowadays, RFID tags are placed inside the books and an alarm is installed at the exit doors, The RFID tags can store data up to 2 KB whereas, the bar code has the ability to read just 10-12 digits.

Some basic technologies, which compare Barcode to RFID, are as follows-
1. RFID can be Read & Write both, whereas BARCODE only Read.
2. Multiples items can be read simultaneously by RFID, but in BARCODE scan only single item.
3. In RFID, Stock Verification made easier as no need of taking the books out from the shelf, but from BARCODE stock verification takes some because of the fact that each book has to be take out from the shelf and then scanned with scanner.

DISADVANTAGES OF RFID IN LIBRARIES
High Cost, Frequency Block, Chances of removal of exposed tags exit gate sensor problems, User Privacy concern, Reader collision, Tag collision, Interoperability, etc.

ROLE OF LIBRARIAN
RFID technology introduces an ethical dilemma for librarians. The technology allows for greatly improved services for patrons especially in the area of self check-out; it allows for more efficient use of professional staff and may reduce repetitive stress injuries for library workers. Yet, the technology introduces the threat of hot listing and tracking library patrons. Library use of RFID technology serves to legitimize the technology in the eyes of the community. Therefore, it is incumbent on the library community to ensure that the technology is developed in concert with established privacy principles and that any library use of RFID follows best practices guidelines consistent with library values.

CONCLUSIONS
RFID technology is not only emerging but also more effective, convenient and cost efficient technology in library security. This technology has slowly begun to replace the traditional barcode on library items. "RFID is increasing in popularity among libraries, as the early adopters of this technology have shown that, it makes good economic sense, both for large & small libraries". The RFID tag can contain identifying information such as a book's title or material type, without having to be pointed to a separate. The information is read by an RFID reader, which replaces the standard barcode reader commonly found at a library's circulation desk. The RFID tag found on library materials. It may replace or be added to the barcode, offering a different means of inventory management by the staff and self-service by the borrowed. It can also act as a security device, taking the place of the traditional electromagnetic security strip. In addition, not only the books, but also the membership cards could be fitted with an RFID tag. The cost of the technology is main constraint.

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