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TECHNOLOGICAL ADVANCEMENTS IN LIBRARIES: RFID (RADIO FREQUENCY IDENTIFICATION)

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ABSTRACT

Neeraj Tanwar and Sunder Singh TanwarThe main aim of the libraries is to provide an open and free access to its resources to all the users without any discrimination. The growth of new technology has also affected the resources of libraries. Most of the libraries now use modern techniques and online resources for searching and lending books to the users. These technologies enhance the efficiency of a library to bestow its services. One such technology is Barcode technology which is being used by libraries all over the world. To replace this a new and improved technology was introduced in late 1990s which is known as Radio Frequency Identification (RFID). RFIDs are small chip based devices uses radio waves andthat can store data which can be used to automatically identify individual items uniquely. RFID technology is adopted widely in many areas. Primarily RFID was used to identify and track the objects in industries. But today, RFID technology is used in tracking assets in companies, access control, inventory management etc. With its increasing usage its security and privacy risks need to be addressed at both organizational level and individual level.

KEYWORDS:*RFID, RFID in libraries, RFID components, RFID applications, implementation issues.*

INTRODUCTION :

Libraries are considered at the highest level for gaining knowledge in our today's society. Libraries have been identified as one of the key elements for open access to information. Social values of libraries are although intangible but are crucial to democratic information society development. Libraries preserve social or organizational knowledge and provide it for usage by the society. Libraries have a free flowing nature. The main aim of the libraries is to provide an open and free access to its resources to all the users without any discrimination. All the activities and functions of the library revolve around this objective only. So libraries have been looking for the technological support to advance their services and management of resources as well.

The growth of new technology has also affected the resources of libraries. There has been an enormous growth in the variety of resources available in the libraries. Today people rely on internet as a primary source of information. Users need not to go in library to borrow a particular book. The genesis of internet technologies have made it possible for users to access books and journals online. Even libraries are provided computer education to enhance the skills of people who are not familiar to computers. With other services libraries also provide internet services to those who do not have internet access at their home. Libraries also allot space to computer facilities for general public interest. Most of the libraries now use modern techniques and online resources for searching and lending

books to the users. These technologies enhance the efficiency of a library to bestow its services. One such technology is Barcode technology which is being used by libraries all over the world. To replace this a new and improved technology was introduced in late 1990s which is known as Radio Frequency Identification (RFID).

RFID

RFID is an acronym for Radio Frequency Identification. RFIDs are small chip based devices uses radio waves andthat can store data which can be used to automatically identify individual items uniquely. RFID system carries data in a transponder known as tag and receive data through sensors according to needs of specific application. RFID is a dedicated short range communication (DSRC) technology. RFID is one of the technologies which are grouped under a class named Automatic Identification (Auto-ID). Auto-ID technologies are used to identify objects, anytime, anywhere by using low-cost smart tags, readers, and unique object-identification schemes(Repanovici & Cristea, 2011). These technologies include barcodes, magnetic inks, optical character recognition, voice recognition, touch memory, smart cards, and biometrics etc.

RFID technology is similar to the Barcode technology for identification. (Mulla & Chandrashekara, 2006) state that RFID is future of Barcoding. The barcode technology is slowly getting replaced by the RFID technology.RFID have many advantages over barcodes. It can store more data than barcodes. Barcodes can store only identification number whereas RFID tags can store data such as stack number, accession number, book number, author information etc. The stored data can be changed during processing which is helpful in the environment where barcodes are not effective. The libraries across the globe have started to use RFID to speed up the self-check-in/out processes, to control the theft and to ease the inventory control in library(Dhanalakshmi & Mamatha, 2009).

Flashback on RFID

The foundation of Radio Frequency Identification (RFID) technology was laid during 1940s. The British used radars to identify their aircrafts and aircrafts of enemies during World War II. This system was known as 'Identification: Friend or Foe' (IFF) systems. RFID was developed out of the radar experiments and development. It was followed by decades of experimentation and development. Era of 1950s saw an exploration of the technical developments in RFID technology. Scientists discovered the possibilities of evolving Radio Frequency Identification during this era.In 1960s, US government started the implementation of RFID tags for monitoring radioactive and other hazardous materials. Use of RFID by developers, inventors, companies, academic institutions and government laboratories started in 1970s. In 1972, Los Alamos Scientific laboratories started using RFID in public sector which further motivated other organizations also to use RFID. Full implementation of RFID was witnessed in decade of 1980s. RFID was used for commercial purpose in 1980 for cattle tracking applications. 1990s saw a wide scale deployment of RFID all over the world. Today, RFID is used for many applications of day to day activities such as security, access control, toll collection, object tracking in shops, hospitals, libraries, etc.(Anuragi, 2014).

Whyuse RFID

RFID can be used because of following reasons:

• Objects can be identified through wireless medium without Line-of-Sight: Line-of-Sight is a mode of wireless communication technology in which the object should be in a straight line with the reader. As in barcode technology, if laser cannot see the objects it cannot identify them i.e. if objectis not in a straight line of sight with the laser of the reader, then it won't be read. Rather than adjusting objects to computing devices it would be feasible if objects can be identified regardless of their position to the reader. RFID provides this feature. Objects need not be in line of sight. Normal human gestures and movement of objects can also be identified by using RFID.

• It can store small amount of information and also the information can be dynamically changed: RFID tags can store up to 512 bits of information that can be read in less than 5 milliseconds time. RFID tags provide versatility. It allows to change data in no time.

• RFID can be used to provide security: Bar-coded products have visible signatures as barcodes can be identified through line-of-sight of the reader. But if you don't want to reveal the ID of objects, RFID helps provide this feature. RFID tags can be embedded in the object itself and can easily be read.

• UHF (Ultra High Frequency) RFID can provide identification of objects from far away: One of the noteworthy advantages of UHF RFID is that the tags can be read from a distance also. Passive UHF tags can be read across a room whereas Battery-Assisted-Passive Tags and Active Tags can be read across buildings.

Components of RFID System

An RFID System has four major components(Pandey & Mahajan, 2010):

a.RFID Tag (Transponder)
b.RFID Reader (Interrogator)
c.Antenna
d.Server

Other components of the system are:

e.RFID Label Printer
f.Handheld Reader
g.Self-Check Unit
h.Staff and Conversion Station

a. RFID Tag (Transponder)

RFID tag is the main component of the system. The tag is equipped with a programmable chip and an integrated antenna. It is a paper-thin smart label which can be programmed electronically to contain the unique information about the object. It can be embedded in the object itself.These tags are also available as labels with adhesive at the back. Tags are also available in the form of reel which can be printed through a label printer which can be used as labels for books and documents in a library.

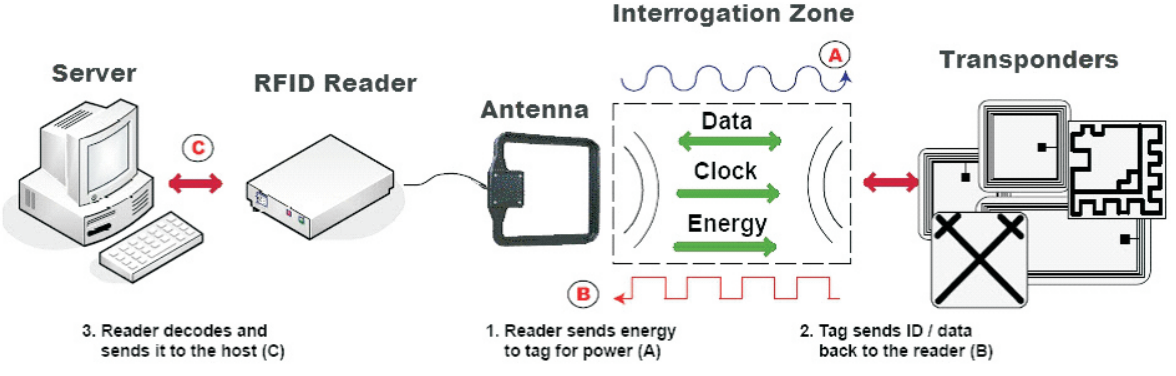

Figure 1: Components of RFID System

There are two types of RFID tags:

• Active Tags
• Passive Tags

Active tags have their own transmitter and a power source.Usually, the power source is a battery. These have a long range of more than tens of meters and large memory than the passive tags. Active tags can also store some extra information during the communication process. Size of an active tag is similar to a coin. The power of battery of active tags can last up to several years.

Passive tags, on the other hand, do not have any power supply unit. So the size of the device is comparatively small. Range of the passive tags is also less which can vary from 10 mm to 5 meters(Vasishta, 2009).

Another type of tag is Battery Assisted Passive (BAP) tag. It is a type of passive tag have crucial feature of an active tag. It uses an integrated power source (usually a battery) to power on the chip but it do not have their own transmitter like an active tag.

Depending upon the requirement of applications and local radio frequency regulations, tags of RFID system can operate under a number of nominated frequencies:

- Low Frequency (125kHz);
- High Frequency (13.56MHz);
- Ultra-High Frequency (860-960MHz);
- Microwave (2.45GHz)

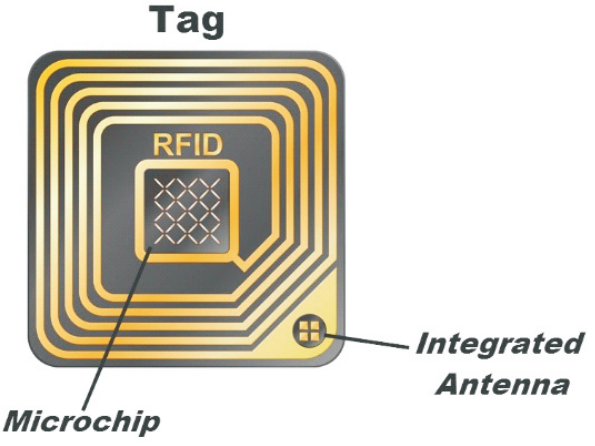

Figure 2: RFID Tag

b. RFID Reader (Interrogator)

An RFID reader is a device which detects the signal as soon it enters into its radio range and decodes the signal. It consist of a transmitter, a receiver, an antenna and a decoder. When a tag comes in the radio range, it communicates with the tag, identify it and receive the data stored on the tag. It offers an optimum reading performance which captures the data stored on a tag instantly. The reading time of a reader is less than 100 microseconds. For a reader to identify the object, it needs not to be in the line-of-sight. It provides a contact less communication. A typical RFID system can have four different types of readers. These are also called as the sensors or scanners. The devices which are used inside the building are called as “readers” and the ones which are used on the entry or exit of the buildings are called as the “sensors” (Pandey & Mahajan, 2010). Readers used in libraries can read up to 15 tags at a time even when there is no direct contact between the reader and the tag. Books can be read even when carried in the bags(Vimalraj, Sameera, & Saranya, 2015).

c. Antenna

An antenna is a device which is connected to the reader. It helps in the process of identification of the objects. Besides identification it can activate or deactivate tags simultaneously for the function of anti-theft. Use of additional antenna can increase the capacity of reader to read number of items simultaneously.

d. Server

A server is another vitalcomponent of the RFID system. It is a computer system which contains a database. This database consists of the information related to the objects for which RFID system is

implemented(Grover & Ahuja, 2010). It acts as the communication gateway among different components of the system. It is connected to the reader by means of a connecting cable. When an object embedded with the tag comes in juxtaposition to the reader, the server receives this information and exchange it with the circulation database. Along with the database it includes the SIP/SIP2 (Session Initiation Protocol), APIs (Application Programming Interface), NCIP (NISO Circulation Interchange Protocol) or SLNP (Service Level Negotiation Protocol)which is required to interface it with Library Management Softwares(Pandey & Mahajan, 2010).

APPLICATIONS OF RFID

Some of the real world applications of RFID systems are:

• **Logistics and Supply Chain Visibility –** Visibility provided by RFID in supply chains increase the efficiency and reduce the errors by providing real time data on the status of individual items.

• **Item Level Inventory Tracking –** Item level tracking of the assets is beneficial for industries. A well-designed inventory control system can share the data across all units of business providing management with a data to take proper action.Another benefit of RFID in industries is that store employees can count inventory easily with the help of a handheld RFID reader and thereby saving a lot of time.

• **Race Timing –** One of the most popular use of RFID is for timing marathons and races.

•Attendee Tracking – RFID technology is used in large conferences to keep the flow of traffic moving at a steady pace. Its usage eliminate the need for registration lines at entrances.

• **Materials Management –** RFID based system Jovix is used on large job sites for tracking construction and other related materials.

• **Access Control –** RFID access control systems provide access to the authorized personnel only in the areas which require an expected security level such as parking lots, doors etc.

• **IT Assets Tracking –**ITassets such as server blades, laptops, tablets, and other peripherals which are costly investment of the company and also have information of high value to the companywhich can be detrimental if in the wrong hands. RFID tags for IT assets allow quick inventory count and easy tracking.

• **Tool Tracking–**RFID tool tracking systems which track the large variety of tools, fasteners, and other items depending on the level of complexity of the industry.

• **Kiosks–**Kiosksuse RFID to either manage resources or interact with users where an embedded RFID reader interrogates badges or cards.

• **Library Systems -**Use of RFID in Library Management Softwares can improve the efficiency of operations of a library. RFID tags can be helpful performing the checkout and check-in process significantly faster. Its usage can simplify the process of inventory control of books on the shelves while increasing its speed.

• **Laundry Management -**Large companies like casinos use RFID laundry management system which can track which uniforms were assigned to specific employees, the age of uniforms, the number of times washed, and identify missing uniforms.

• **Interactive Marketing** -RFID in marketing, unlike traditional advertising campaigns, brings a certain level of interaction to campaigns which invite the consumer to engage with the brand.

• **RTLS (Real Time Location System)–** RFID systemsprovide facility to track the real-time location of assets, employees, or customers.

RFID in Library

Primarily RFID was used to identify and track the objects in industries. But today, RFID technology is used in tracking assets in companies, access control, inventory management etc. RFID is also having its technological applications in libraries. RFID (Radio Frequency Identification) is one of the latest technologies used in libraries. Its usage in libraries automatizes library operations and thereby saves time of library staff. The main purpose of using RFID in libraries is anti-theft systems. RFID based security systems have moved far beyond the traditional security systems such as EM (Electro-Mechanical) based systems. RFID security systems provide more efficient security as they provide tracking of library material.

Figure 3: Library Management System Using RFID

Usage of RFID in libraries has made it easy and increased the paceof library operations. A RFID based Library Management System saves the time of a reader which would be wasted if he have to wait in queue for his turn for getting a book issued or returned. For this purpose, RFID system can automatize the operations having self-check-in/out module. It can also provide readers, a unique personal identification number, allowing him to manage his account as a library user. For library staff, RFID system provide operations such as inventory control, material management etc. RFID also provide cost effective solution to major issues in libraries such as searching of specific books, automated issue and return of library resources, library memberships, annual stock verifications, misplaced books etc.

Applications of RFID Library Management System

• **Tagging:** A tag is the most important part in the RFID system. It is paper thin and of size approximately 2x2 inches and can be wedged tothe book cover. It can store a specific amount of information related to the book which in turn is used for its identification, location in library and for anti-theft. Special tags are designed for the multimedia in library such as CDs, DVDs etc. RFID tags have been earlier discussed in this article.

• **Library Counter:** It is provided for imparting services, such as loan, return, tagging etc., to the readers. It is a staff assisted station. Library user can approach to this counter to borrow or return books. Library users are also provided RFID identification number/card. The staff member at the counter uses a reader to read the tags of books for issue and return. If book is delayed its due return date, user can be charged with a feasible amount of fine.

• **Self-Check-In/Out Service:** It consists of a computer system with RFID reader, also having a user friendly interface. It also consists of an Identification software for identification of users, books and other media. System can identify a user through an RFID based identity card which contains user information. User is provided with an option of check-in or check-out to choose. After choosing an option, user have to put the book(s) in front of the reader. Reader reads information of book(s) through tag(s). In user choose check-out, the information of book(s) is added in the list of books issued by the user and user is provided with a return date. Whereas, if user choose check-in option, RFID reader reads books information, checks the due date of the book. If book is delayed in return, then fine amount is displayed accordingly(Annaraman, Thamarai, & Kumar, 2015).

• **Shelf Management:** Shelf management system is used to locate and identify items on the shelves. It consist of

the two components i.e. a hand held scanner and a base station. There are three main functions fulfilled by this system. First is to locate the book requested by users on the shelves. Another important function is stock verification. This system makes the task much easier. Library users misplace the books in library after reading. Which creates difficulty for other users who want to use the same book. This system also helps in finding books which are miss-shelved. Shelf Management system makes it easier for the library staff to locate and identify the documents on the shelves.

• **Book Drop:** This system offers an exceptional flexibility to the users for returning the library items. These can be located outside the library so that users can return books even when library is not open. Users can place the books in drop trays where reader automatically reads the tags and user is acknowledged for returning book successfully.

• **Anti-Theft System:** Another important module of RFID Library Management System is security gate/ EAS (Electronic Article Surveillance).It is used for both item identification and theft detection. Each lane of the gate can track the item in range of one meter. If a non-borrowed item or improperly checked-out item is passed through them, it triggers an alarm system with flash lights to notify the security personnel.

ADVANTAGES OF RFID SYSTEM IN LIBRARIES

Usage of RFID technology in libraries can be summarized as:

• RFID system is durable. It helps to manage the library expanses for a long time.
• Library staff becomes familiar to the latest technology and hence enhance their technical and professional working skills.
• It helps in finding misplaced books in library.
• Unlike barcode technology, more than one items can be processed simultaneously and hence saving time of user as well as staff.
• Tags have a long life and hence are more economic.
• It increases the speed of circulation process.
• It makes self-charging /discharging easy.
• It increases the speed of process of inventory control.
• It is more reliable than the traditional methods of libraries.
• It automates the operations in libraries such as material handling, issue/return, sorting of books returned by users, instant update of the databases.
• It makes stock verification easier.
• It improves the security of library resources.

RFID Implementation Issues and Challenges

Implementation issues related to RFID can be classified into three major categories(Nagalakshmi, 2011) viz.
1. Technical issues
2. Privacy and Ethical issues
3. Security issues

1. Technical issues

a.Non-availability of globally recognized standards: There are no globally accepted standards for RFID. There are only a set of allotted frequency bands. Every institution, organization or even country implement RFID in their own different ways. Each country has different operational standards and regulations. Global standards are still being worked on.Two major groups of standards EPC (Electronic Product Code) and ISO (International Standards Organization) are competing for RFID standards. EPC is created by Auto-Id center of MIT (Massachusetts Institute of Technology).

b.Open to easy disrupt: RFID systems can be easily jammed by using right frequency spectrum because electromagnetic spectrum is used in RFID systems. This can cause problems to the environment where RFID is used at high level such as hospitals, military equipment etc.

c.RFID reader collision / Interference: When a tag is unable to respond to multiple queries simultaneously due to overlapping of signals of two or more readers, this situation is called as Reader Collision. To avoid this situation, RFID system must be set up carefully so that signals of different readers do not overlap. One method to handle reader collision is use of Anti-Collision protocol. Such protocol enable tags to handle multiple reader signals in time sharing manner.

d.RFID tag collision / Interference: When many tags are present in a small area and respond simultaneously, it is called as Tag Collision. This problem is occurs when a large volume of tags are read together in the same RF (Radio Frequency) field. The reader is gets confused and is unable to differentiate these signals.To overcome this problem different systems have been developed to isolate individual tags.

e.Cost: Besides several benefits, RFID implementation involves high costs. RFID implementation costs include costs of tags, security gates, staff work station, installing and commissioning costs of RFID system, application software costs, server/docking station, self-station, book-drop kiosks, portable RFID reader etc. Such high cost of implementation is the main reason of less use of RFID systems in libraries.

2.Privacy and ethical issues

a.Tags can be read at greater distance with a high gain antenna: Although, to avoid tag collision RFID systems are designed to keep minimum required distance to read tags but tags can be read by high gain antennas from much farther away which causes privacy problem.

b.Contents of an RFID tags can be read after the item leaves the premises: One of the important issue with the RFID technology is that the tags can be read by any appropriate scanner. A tag cannot tell the difference between two readers. It can be read even when object leaves the premises of the implemented system. It is a concern of privacy. One solution to this problem is the "Zombie Tags". It is a tag which can be deactivated temporarily. When the object embedded with tag leaves the premise through security gates, it sends special "die" signal to the RFID tag and tag becomes unreadable. When zombie element again enters the premise it "re-animates" the tag and makes it readable again in the premises.

c.RFID tags are difficult to remove: It is difficult for consumers to remove RFID tags due to size of tags. Some tags are very small that consumer cannot locate them on the objects. Sometimes tags are embedded inside the objects where consumers cannot even see them. New technology such as Printing of RFID tags with Magic Ink print tags right on the objects which are not removable at all.

3. Security issues

RFID technology is adopted widely in many areas. With its increasing usage its security and privacy risks need to be addressed at both organizational level and individual level. RFID tags are also referred to a category of "Dumb" devices as they can only receive a read signal and respond(Knospe & Pohl, 2004). It does not matter who is reading. This gives rise to the risks such as unauthorised access and modification of tag data. Problems which can rise due to this are (Shih, Lin, & Lin, 2005):

- Eavesdropping
- Individual information leakage
- Industrial espionage
- Traceability
- Spoofing

- Theft
- Counterfeiting
- Industrial sabotage
- Physical attacks
- Denial-of-Service
- Traffic analysis etc.

CONCLUSION

RFID (Radio Frequency Identification) is one of the most effective and convenient technologies emerging in the field of libraries. It has replaced the traditional bar-code system for identification of library resources. Unlike barcode system which contains only identification number, RFID tags can store more information about books such as classification number, ISBN, author information etc. Besides containing such information it can be used for activities such as self-checkout, inventory control, theft control etc. which ease the work of library staff, enhance reader services reduce book theft and can also be helpful in updating the information of new library collection. It can not only identify books but can also be used for user identification. RFID has emerged as the reliable security systems in libraries replacing the traditional electromagnetic security strip.

Small RFID tags has brought a big change in our society. RFID technology is changing our world. It has potential to make our lives easy and convenient. While its usage has increased in day-to-day lives, it is also necessary to state the issues related with it. Although libraries have started using RFID, but there are still there are libraries which have not implemented RFID systems. Every new technology need to be paid with a cost associated with it. It is necessary to reduce such costs in favor of our society. Therefore, more work has to be done in direction of standardization of RFID technology and security and privacy issues need to be tackled so that such a helpful technology can be fully adopted.

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