RFID Technology: Mechanism and usage in Library

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Abstract - *A Radio Frequency Identification (RFID) tag is an electronic device that holds data. Typically these tags are attached to an item and contain a serial number or other data associated with that item. We will focus on passive RFID technology, in which the tag carries no power source, but is instead powered by a radio signal from a separate RFID reader.More recently, RFID systems have begun to find greater use in automatic identification applications. RFID systems consist of Radio Frequency (RF) tags, or transponders, and RF tag readers, or transceivers. The transponders themselves typically consist of integrated circuits connected to an antenna.*

Keywords: RFID, Radio-frequency identification, RFID Technology, Usage of RFID in Library, User Studies

1.1 Introduction:

RFID (Radio Frequency IDentification) was invented in 1969, patented in 1973, first usedin Harsh Industrial Environment in 1980s', and standards presented in 2001, is thelatest addition of technology to be used in the libraries for a combination ofautomation and security activities in the well maintenance of documents either insidethe library or goes out-of library. RFID uses wireless radio communications to uniquelyidentify objects or people, and is one of the fastest growing automatic data collection (ADC)technologies, which is comprising one or more reader/interrogators and RF transpondersin which data transfer is achieved by means of suitably modulated inductive orradiating electro-magnetic carriers. In addition it can be used as a data carrier, withinformation being written and updated to the tag on the fly. RFID systems carry data insuitable transponders, generally known as tags, and retrieve data, by machine-readablemeans, at a suitable time and place to satisfy particular application needs.

1.2 RFID:

"Radio Frequency identification is a technology that uses radio waves to transfer data between a reader and an electronic tag which is attached to a particular object. Typical uses are for object identification and tracking". According to Harrod's Librarians' Glossary and Reference Book, "Radio Frequency Identification, an alternative to the Bar Code that uses tiny microchips in tags to hold and transmit detailed data about the item tagged. RFID has advantages over bar codes such as the ability to hold more data, the ability to change the stored data as processing occurs, it does not require line-of-sight to transfer data and is very effective in harsh environments where bar code labels may not work"[1]. RFID, thus is a generic term for technologies that use radio waves to automatically identify people or objects.

1.3 Components of RFID:

1.3.1 RFID Tag

An RFID tag is a tiny radio device that is also referred to as transponder, smart tag, smart label, or radio barcode. There are two main components present in the RFID tag. Firstly, a small silicon chip or integrated circuit which contains a unique identification number (ID). Secondly, an antenna that sends and receives radio waves. The antenna consists of a flat, metallic conductive coil and the chip which is less than half a millimetre.[2]

1.3.2 Readers and Antenna

The second component in a basic RFID system is the interrogator or reader. Technically, reader units are transceivers (i.e., a combination of transmitter and receiver) and their usual role is to query a tag and receive data from it. RFID reader converts radio waves from RFID tags into a form that can be passed to middleware software. An RFID tag reader use antennas to communicate with the RFID chip. It can read information stored in the RFID tag and also update RFID tag with the new information. Hence, RFID reader accomplishes two tasks: it receives commands from the application software and communicates with tags.[3]

1.3.3 Middleware

Both middleware and software applications are required in an RFID environment. Middleware manages the flow of information between the readers and the backend. In addition to extracting data from the RFID tags and managing data flow to the backend, middleware perform functions such as basic filtering and reader integration and control. RFID middleware assist with retrieving data from readers, filtering data feeds to application software, generating inventory movement notifications, monitoring tag and reader network performance, capturing history and analysing tag-read events for application tuning and optimization.[4]

1.3.4 Server

A server may be configured with an RFID system. It is a communication gateway among the various components. It receives the information from one or more readers and checks the information against its own database or exchanges information with the circulation database of the library integrated management system. The server typically includes a transaction database so that the reports can be produced.[5]

1.4 RFID technology in Library:

The concept of RFID can be simplified to that of an electronic barcode and can be used to identify, track, sort or detect library holdings at the circulation desk and in the daily stock maintenance. This system, consist of smart RFID labels, hardware and software, provides libraries with more effective way of managing their collections while providing greater customer service to their patrons. The technology works through flexible, paper-thin smart labels, approximately “2X2”in size, which allows it to be placed inconspicuously on the inside cover of each book in a library’s collection.

The tag consists of an etched antenna and a tiny chip which stores vital bibliographic data including a unique Accession number to identify each item. This contrasts with a barcode

label, which does not store any information, but merely points to a database. These smart labels are applied directly on library books and can be read with an RFID interrogator/scanner. Line of sight is not essential for reading the tags with the scanner, therefore, the books require much less human handling to be read and processed. A middleware or Savant software integrates the reader hardware with the existing Library Automation Software for seamless functioning of circulation. The information contained on microchips in the tags affixed to library materials is read using radio frequency technology regardless of item orientation or alignment. It provides a contact less data link, without need for line of sight, for example, the documents in the shelves or cardboard boxes can be checked without removing or opening.

RFID has no concerns about harsh environments that restrict other auto ID technologies such as bar codes. Tags have a discrete memory capacity that varies from96 bits to 2kbytes. In addition to tags, an RFID system requires a means for reading or "interrogating" the tags to obtain the stored data and then some means of communicating this tag data to library information system. RFID-based systems have been implemented for efficient document tracking purpose throughout the libraries that combine, easier and faster charging and discharging of documents, security of materials, inventorying, stock verification and shelf handling. RFID tag's transponder listen for a radio query from the reader and respond by transmitting their unique ID code. Most RFID tags have no batteries, they use the power from the initial radio signal to transmit their response.

1.5 Components of RFID System:

Radio Frequency-Identification technology (RFID) involves a tag affixed to a product which identifies and tracks the product via radio waves. These tags can carry up to 2,000 bytes of data. This technology has three parts: a scanning antenna, a transceiver with a decoder to interpret the data and a transponder (RFID tag) pre-set with information. The scanning antenna sends out a radio-frequency signal providing a means of communication with the RFID tag. When the RFID tag passes through the frequency field of the scanning antenna; it detects the activation signal and can transfer the information data in holds to be picked up by the scanning antenna.

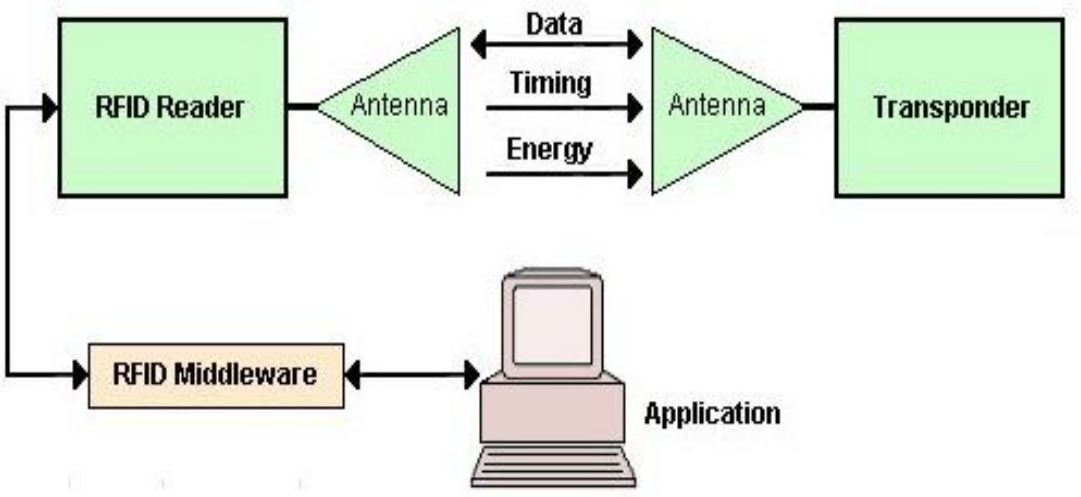

Figure 1: Components of RFID System[6]

1.6 How RFID works in Library:

The RFID technology works through flexible, paper-thin RFID tags, which can be placed inside the cover of each and every document. Complete information about each document is entered into the Library Management Software. Whenever a user brings a document for issue-return purpose, the RFID reader from the tag reads the information pertaining to that book and transmits the data into the software and document is issued in a few seconds without the assistance of the library staff. As the user takes the document outside the library, the antenna placed at the exit gate automatically reads the information contained on the RFID tag to verify whether the document is properly issued or not. In case, it is not issued to the user as per library norms or it is being stolen from the library, the antenna senses it and gives an instant alert. Thus, it results in successful theft reduction of documents. RFID technology is not only being used for circulation purpose in the libraries, it is also used for stock taking purpose.[7]

Figure: 2 Library Management Using RFID Technology[8]

1.7 Advantages of RFID in Library:

Due to the low cost of the barcode technology, most of the libraries around the world are using it for circulation management. However, the main constraints related to barcode technology are that it always requires a line-of-sight, does not provide security of library collection, does not offer any benefit for collection management and is becoming very difficult for the libraries to satisfy the increasing demands of the users.[9] Hence, a need was felt to have a better technology that can improve the circulation management, inventory and security of library collections. Some of the advantages of RFID in libraries include issuing multiple books at a time; simplified self-charging/discharging; reduction in queue at circulation desk /counter; more hours of circulation; saving time of the library staff while issue/return of document; allow library staff to provide other users' centric service; reduction of staff at circulation desk; increased issue/return of library documents; security of library collection, etc.

Advantages

- RFID tags can read from a greater distance than barcodes.
- RFID tags don't need to be positioned in a line of sight with the scanner.
- RFID tags can be read at a faster rate than barcodes; as approximately 40 RFID tags can be read at the same time.

- RFID tags can work within much greater distances; information can be read from a tag at up to 300 ft.
- RFID tags are read/write devices.
- RFID contain high levels of security; data can be encrypted, password protected or set to include a 'kill' feature to remove data permanently.
- RFID tags carry large data capabilities such as product maintenance, shipping histories and expiry dates; which can all be programmed to the tag.
- Once these are set up; it can be run with minimal human participation.
- RFID tags are more reusable and rugged as they are protected by a plastic cover.

Disadvantages:

- RFID involves assembling and inserting a computerized chip; which works out to be more expensive.
- RFID readers struggle picking up information when passing through metal or liquid.
- Reader collision can occur where two signals from different readers overlap and the tag is unable to respond to both.
- Tag collision can occur when numerous tags in the same area respond at the same time.
- RFID still has two separate chips (read only and readable/writable), which cannot be read by the same machine.[10]

1.8 Conclusion:

Libraries are a fast growing application of RFID; the technology promises to relieve repetitive strain injury, speed patron self-checkout, and make possible comprehensive inventory. Unlike supply-chain RFID, library RFID requires item-level tagging, thereby raising immediate patron privacy issues.

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