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Radio Detection System for Information Handling

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Abstract

In near future, libraries will operate with such simplicity that staff will receive pre-sorted materials for shelving. Shelves will be instantly scanned for setting in some specific order. Library users will be able to check materials in and out of the library all by themselves without a librarian processing them and would find what they want almost instantly without bothering for classification system or arrangement. All this will leave library staff with more time to give personal attention to the user that is most desired and to plan and launch new programmes to support research and development activities of the organisation. All this can be activated by using a new emerging technology known as Radio Frequency Identification (RFID) technology.

1. INTRODUCTION

A Radio Frequency Identification (RFID) system is a flexible technology that is convenient, easy to use and well suited for automatic operation. It combines advantages not available with other identification technologies. RFID does not require contact or line of sight to operate, can function under a variety of environmental conditions, and provides a high level of data integrity. In addition, since the technology is difficult to counterfeit, RFID provides a high level of security.

2. ISSUES FACED BY LIBRARIES

Nowadays libraries are facing the following issues:

- Rising labour costs
- Need to improve customer service
- Increased material handling time/cost
- Increasing theft of CDs, DVDs and books
- Mis-shelved books
- Poor inventory accuracy
- Lack of security arrangements.

3. COMPONENTS OF RFID SYSTEM

A basic RFID system consists of the following physical components:

- An RFID device (transponder or tag) that contains data about an item/book
- Antennae or sensors used to transmit the RF signals between the reader (server) and the RFID device
- A reader (server) to receive and decode the information, and to communicate with automated library system.

3.1 Transponder/Tag

Historically an RFID device that did not actively transmit to a reader was known as a tag. An RFID device that actively transmitted information to a reader was known as a transponder (TRANSmitter + resPONDER). However, it has become common within the industry to interchange the terminology and refer to these devices as either tags or transponders. The tags are programmed with data that identifies the item to which the tag is attached. Tags can be read only, volatile

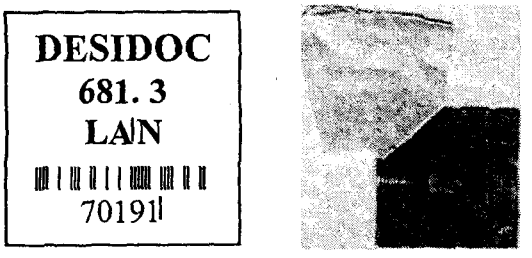
read/write, or write once/read many (WORM) and can be either active or passive. RFID tags come in variety of shapes and sizes.

The active RFID tags are powered by an internal battery and are typically read/write, i.e., tag data can be rewritten and/or modified. An active tag's memory size varies according to application requirements; some systems operate with upto 1 MB of memory.

Tag has three memory components:

- Item identification (bar code) number
- Security bit that is turned off and on as items are checked out and checked in
- Variable memory that can be used for sorting.

In a typical read/write RFID work-in-process system, a tag might give a machine a set of instructions, and the machine would then report its performance to the tag. This enclosed data would then become part of tagged part's history. The battery-supplied power of an active tag generally gives it a longer read range. Figure 1 shows the front view and back view of an RFID tag.



Front view of RFID tag

Back view of RFID tag (Sticked out)

Figure 1. RFID Tag

Passive RFID tags operate without a separate external power source and obtain operating power generated from the reader. Passive tags are consequently much lighter than active tags, less expensive, and offer virtually unlimited operational lifetime.

Each passive thin tag contains a microchip with a capacity of at least 96 bits. The tags can be permanently activated or they can be read/write. In the former case, the tag usually contains only a unique identifier for the item. With read/write tags other information can be added upto the capacity of the tag. For example, a library might add an identification code for each branch. That information can be changed.

3.2 Antennas

A typical RFID system includes several different kinds of antennas, also known as sensors, interrogators or readers. These are radio frequency devices designed to detect and read intelligent tags to obtain the information stored thereon. The antenna generates a field of power to read the tags within range. Each tag generates its own signal to provide its unique data to the antenna. The antennae can be used for circulation desk check-out, book return check-in, and long-range walk through devices to detect and interrogate an RFID tag passage for purposes of determining whether it is a checked (authorized/no alarm) or unchecked (non-authorized alarm) event. It is also possible to read a group of items on the shelves for purposes of locating missing and misplaced items using a portable device that consists of a hand-held scanning gun.

Circulation desk checkout units (equipment to charge and discharge the tags) can be placed on the circulation counter or built-in. Discharging can be done on the same units, or on one or more dedicated units away from the service counter. Check-in is particularly rapid because the materials can be moved over the unit without regard to the orientation (vertical or horizontal) of the material.

3.3 Server

The server is the heart of a comprehensive RFID system. It is the communications gateway among the various components. It receives the information from the antennae and exchanges information with the circulation database. Its software should include the applications programming interface necessary to link it with the automated library system. The server should typically include a transaction database so that reports can be produced.

4. USE OF RFID SYSTEM

The RFID system reduces the amount of time required to perform circulation operations. The most significant time savings are attributable to the fact that several items in the stack can be grabbed at the same time. The system allows an entire stack to be charged or discharged during circulation. The one problem that remains is for the books, on which the tags are not pasted properly, or information on the tags are not clearly filled.

The other time saving realised by circulation staff are modest unless the RFID tags replace both the electromagnetic or RF tags (used in older theft detection systems) and barcodes used by automated library system. The RFID system is a comprehensive system which combines circulation and security applications. Security gate with exit control, work as interface to the circulation system that can identify the items moving out of the library.

The greatest advantage of RFID tracking system is their ability to scan books on the shelves without tipping them out or removing them. A hand held inventory recorder (scanner) can be moved rapidly across the shelf of books to collect all of the unique identification information from the tags. Using wireless technology, it is possible not only to update the inventory, but also to identify items, which are out of order. With the coming up of better detectors, it would be possible to locate the exact position of the book inside the library by sitting at the circulation desk and thus guide the user to it or to retrieve the same through a robotic book pick-up arm integrated with a conveyor system. This can in a way, overcome the problem of depth classification and shelving of the books by call number in a library system as the book could be easily traced from a large collection of documents and can be automatically sorted, shelved and retrieved, as and when desired.

5. RFID SYSTEM IN LIBRARIES

The RFID system in libraries can have three components:

(a) Labels and hard tags—electronic sensors that are attached to the document

(b) Equipments/gadget to deactivate and detach—used at circulation desk to electronically deactivate labels as books are issued or detach tags if needed; and

(c) Detectors that create a surveillance zone at exits or checkout aisles.

The surveillance begins by attaching labels or hard tags to documents. When a book is issued, the label is deactivated. However, if document with an active label or hard tag is carried past the detector security gate, an alarm sounds.

5.1 Tag Functionality

Some tags can only be 'written to' once. That is, once the tag is programmed, the information stored in the tag's memory cannot be changed. Alternatively, information stored in the memory of read/write tags can be updated as required, and these are the tags suitable for library usage for regular automated circulation job pooled with security. Almost all RFID tags of the recent times in the library market are also available with the feature of anti-collision i.e., the reader has the ability to read several tags simultaneously. However, the performance of tags varies depending upon speed at which this can be performed by server, and the total number of tags that can be read.

5.2 Electronic Document Surveillance Mechanism

As mentioned, RFID system can be used to prevent theft in the library. The security mechanism may be integrated into the chip itself, or security gates may be linked to a separate server, which interrogates the database to conclude whether an alarm needs to be triggered. Electronic document surveillance is a system that protects books, CDs, microfilms, etc., from undesirable social activities, such as theft, hiding of books, or dislocation from their proper shelves.

The physics of a particular tag and resultant surveillance technology determines which frequency range is used to create the surveillance area. The systems range from

very low frequencies through the radio frequency range. Similarly, these different frequencies play a key role in establishing the features that affect operation.

6. RFID CYCLE AT LIBRARY

☐ Step 1: Tagging in Book

The RFID tag is stick on the book and scanned by the equipment at tagging station which in turn captures the data about the book from the library database and security will automatically be activated. Then the book is placed on the shelf.

☐ Step 2: Check Out by Staff

The books can also be issued by library staff just by putting the book on the equipment that will deactivate the tags. Tags security bit will be deactivated and database will be updated automatically.

☐ Step 3: Circulation Station

If there is no one available on the circulation counter to issue the books/material there can be an optional device 'self check out station', on which library materials placed in any orientation may be checked out one at a time or books stacked upto 6" high may be checked out all at the same time. Database gets automatically updated. Tag's security bit is deactivated.

☐ Step 4: Security Gates

For theft detection security gates will sound an alarm if any smart tag is not deactivated and passed through it, security system does not require a link to the central database.

☐ Step 5: Material Return

To return a book, if the staff is not available at the circulation counter the book can be just dropped in the drop box equipment which will activate the security bit of tag, and the database will be automatically updated.

☐ Step 6: Stock Verification

For verifying the books in library, a lightweight handheld device (scanner) can read tags embedded on books just as they are on shelves at a rate of 12 per second. The server attached with the scanner can be programmed to search for missing book. Figure 2 shows the RFID Cycle at a library.

7. COMPARISON WITH BAR-CODE

The RFID system is similar in concept to bar coding. Bar code systems use a reader and coded labels that are attached to an item, whereas RFID uses a reader and special RFID device/tag which is attached to an item. Bar code uses optical signals to transfer information from the label to the reader; RFID uses RF signals to transfer information from the RFID device to the reader/server.

Since RFID does not require line-of-sight between the transponder and the reader, these systems overcome the limitations of other automatic identification approaches, such as bar coding. The RFID systems work effectively in environments where excessive

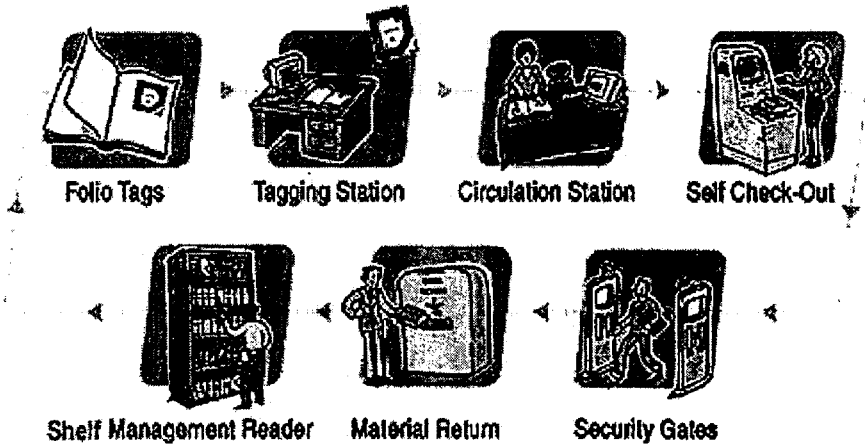


Figure 2. RFID cycle at library

dirt, dust, moisture and/or poor visibility would normally hamper rapid identification. One outstanding benefit of RFID is its ability to read through these environments at remarkable speeds - responding in less than 100 milliseconds in most cases. Furthermore, RFID is completely automatic and transparent, eliminating the need to scan an object manually or activate a magnetic stripe, reader, or other contact ID technology.

The advantages of the RFID over traditional bar codes are shown in table 1.

wider reading ranges, and faster processing. The technology has the potential to ultimately replace barcode. Even though with inevitable reduction in raw materials coupled with economics of scale, the integrated circuit in an RF tag will never be as cost effective as barcode label but the overall benefits achieved from an RFID will definitely outscore a barcode system. The RFID will continue to grow in its established niches where barcode or other optical technologies are not effective and the spin off benefits from the RFID system is immense.

Table1. Advantages of the RFID

Characteristics	Bar Code	RFID
Line of sight	Required	Not required
Orientation	Specific	Any
While moving	Not supported	Possible
Several at a time	Not possible	Possible
Distances	In cms.	In mtrs.
Scanning	Done manually	Automatic
Data entry	Can be automatic	Automatic
Scan speed	Fast	Faster than barcode

The RFID system improves library workflow, staff productivity and customer service with these attributes. However, the ability to conduct inventory counts without removing a single book from the shelf is what really separates RFID from preceding technologies such as barcodes.

CONCLUSION

Developments in RFID technology continue to yield larger memory capacities,

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