Application of RFID Technology in Sardar Vallabhbhai National Institute of Technology (SVNIT), Surat.

By

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Abstract

RFID (Radio Frequency Identification) is the latest technology to be used in different industries for security and theft detection. In this paper the concept of RFID is defined. Components of RFID Systems used by the SVNIT library are discussed. Advantages, shortcomings and remedies of RFID systems, financial implications are explained with special reference to SVNIT library, Surat.

1. Introduction

RFID (Radio Frequency Identification) is the latest technology to be used in different industries for security and theft detection. Now a day this technology is widely used in the library. In the library RFID based systems move beyond security to become tracking systems that combine security with more efficient tracking of materials through out the library, including easier and faster charge and discharge, inventory, and materials handling. The application of this technology not only able to reduced the theft of books but also reduce the manpower due to its self-check out and check in facility.

2. Definition

RFID is a means of identifying a person or object using a radio frequency transmission. These wireless automatic identification data capture system allows for non-contact reading or writing of data and are highly effective in environments where barcode labels can not survive. **"RFID is a combination of radio frequency based and microchip technology. The information contained on microchips in the tags affix to the library materials is read using radio frequency technology."** [1]

This technology is similar in theory to bar code identification. With RFID, the electromagnetic or electrostatic coupling in the Radio Frequency portion of the electromagnetic spectrum is used to transmit signals. An RFID system consists of an

antenna and a transceiver, which read the radio frequency and transfer the information to a processing device, and a transponder, or tag, which is an integrated circuit containing the Radio Frequency circuitry and information to be transmitted.

3. Use of RFID in Libraries

Recently the use of RFID tags to track books, videotapes, CD-ROMs and other library collection, components has risen in popularity. Libraries are finding that RFID technology holds many advantages over traditional barcodes and antitheft tags and contributes to realize considerable labour and cost savings. **"**The task of receiving, transporting, sorting and shelving materials has exploded in recent years. Library staff size remains constant at best while circulation and materials management continues to grow. RFID provides a solution to automate much of these handling and return staff to the business of customer service.**"**[1]

4. How the Technology Works

An RFID system has two units, a transponder and a reader. The transponder is attached to the object or person to identify, whereas the reader is stationary in most cases. Both units contain an antenna and a computer chip to send and receive radio waves and process the information, which is behind the signals.

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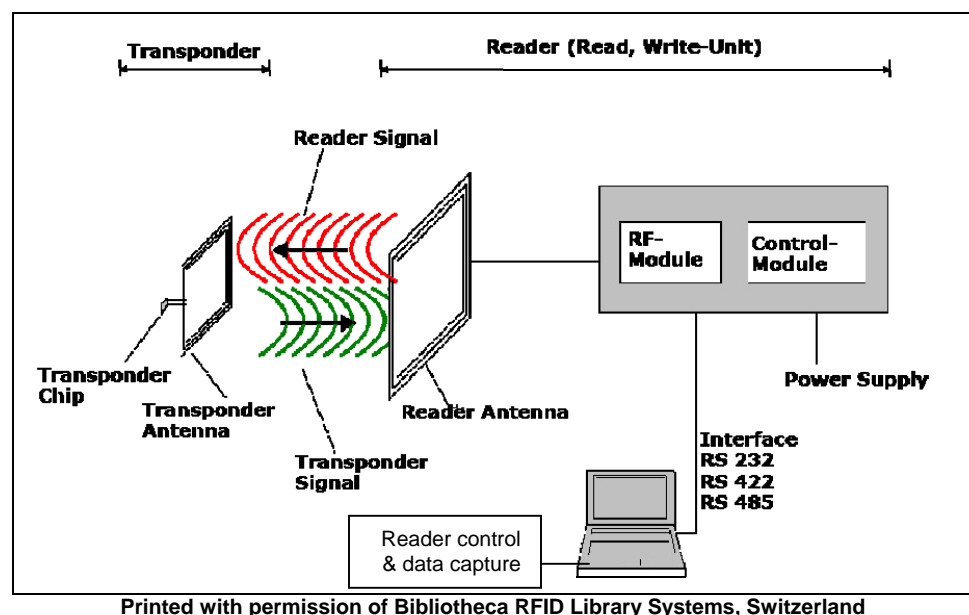
The reader unit is connected to a computer and power supply. The signals from the transponder are sent at a frequency of 13.56 MHz. This frequency is approved worldwide for RFID systems. The transponder does not contain a battery, using induction to receive energy. This is important to make it useable for a long-term application, a feature that makes it possible to use it in books and other material. For the use in libraries the transponder is designed as an RFID label, which has four elements: the chip, the antenna on a foil, the cover paper or plastic label and the silicon liner. [2]

5. Application of RFID Technology in SVNIT Library

Sardar Vallabhbhai Regional College of Engineering and Technology, Surat was established in 1961 with 3 branches of engineering i.e. Civil, Mechanical and Electrical. In 2004 it is converted to National Institute of Technology. It consists of 7 Undergraduate 18 Postgraduate branches. All major branches are conducting Ph.D. Studies. The SVNIT library is providing services to its 2500 students including PG and Ph.D., 300 faculties and supporting staff. In addition to teaching the institute has been providing consultancy services and undertaking research projects from time to time. The central Library of SVNIT, Surat is trying to satisfy the needs of its users with 92526 number of collection including back volumes, standards, technical reports and 180 current journals. The number of volumes faculties, branches of study, students have been increasing years after years but Library staff size remains constant as it was in 1968 while circulation and materials management continues to grow and the necessity application of RFID is felt.

The total Library RFID Management Systems in SVNIT library can be divided in following 6 Units:

- Tagging in programming Station
- Circulation Station
- Self Checkout/in Kiosk
- RFID Security Gate for antitheft detection
- Book Drop
- Shelf Management

5.1 Tagging and Programming Station

The programming station is used to programme RFID tags affixed to library materials. Using a standard scanner, the barcode is read and its data is automatically

programmed in the tag of the book placed on the programming station. Alternatively the self adhesive RFID tag is pasted on the book and the book is placed on the programming station attached to the PC and the accession number is entered through keyboard and the book data is programmed in the tag in case the book is not bar-coded.

RFID Programming Station is made up of RFID Reader and an Antenna. It can read information stored in the RFID tag and also update this RFID tag with new information. It generally holds application software "Lsmart" specifically designed for the required task.

5.2 RFID Circulation Station

The circulation counter consists of a RFID Reader and antenna attached to the PC and printer. It can identify 4 to 8 books within a second and up to 16 books by adding an additional antenna. This circulation station is a staff RFID station enabling librarians to simultaneously checkout and check-in several items. Each item must be equipped with an RFID tag. This station will identify the entire items place in a stack, onto the designated area, while activating or de-activating the antitheft function of the tags at the same time.

RFID circulation station is easy to integrate into or under existing circulation counter. Item identification and security management are performed in one single operation, making for very efficient station. RFID patron card can also be used at this station to identify the borrower.

5.3 Self Checkout / in Kiosk

The design of this self-check out and check-in kiosk is similar to ATM machine in bank. It consists of one RFID Reader, one Antenna with multiple Read/Write facility ISO15693 & ISO 18000 compliant. LCD 15" touch screen monitor with P4 CPU (256 MB RAM, HDD and WinXP operating system), Epson TMT 88 III auto cutter thermal printer and kiosk cell along with check-in cart (receiving cart). The SVNIT Library is presently using barcoded borrowers ticket in self checkout and check-in system instead of Smart Card to minimize the expenditure in first phase. In second phase there is a provision for Smart Card.

Self-check in & checkout Kiosk

Touch screen & Menu

Scanner: Scanning the borrower's Ticket

Printer: getting issue slip

Reader: reading the book data

The photograph is as it is in the SVNIT Library

5.4 RFID Security /Sensor Gate for Antitheft Detection

The sensor gate is designed for the detection and reading of information from RFID tags, which are carried through a door. The gate consists of two parts;

1. Pedestal, includes an antenna set for large detection field
2. Electronic unit (controller) for each pedestal

Each pedestal is standalone and plug and play to the main power, and does not require equipment to operate. Existing gate is made of 2 pedestals. In near future additional pedestals may be added in a row for increasing detection surface. Being a standalone solution, this security gate needs not to be linked to the library database, and therefore, they can still operate when the library network is down. The existing security system uses a single tag for both identification and security. The detection rage and pedestal spacing is 914 mm (36 inches).

5.5 Book Drop System

At present Book Drop system does not exist in the SVNIT Library. Order of one unit of Book Drop System and an additional unit of self-checkout and check-in kiosk is to be placed

within a short period as the RFID technology become very popular among the users. The details of the Book Drop system that is expected to be received are explained with figure. This unit will be placed at convenient locations in the organization's premises perform easy, one-step checks-in of multiple items. As books are returned through Book Drop facility located suitably in library the RFID tags are automatically read and LSmart software will immediately update both patron record and LibSys database. The Book Drop system consists of the following components:

- RFID Reader and Antenna with Multiple Read/Write facility
- Book Drop [Teak Wooden Enclosure]
- Imported Receiving cart
- 17" Touch Screen LCD
- Thermal Slip Printer
- Branded CPU
- LSmart Client Software

5.6 Shelf Management / Inventory

The shelf management system consists of the following components:
- RFID Reader
- Network adopter
- Pocket PC
- Antenna connected to RFID Reader
- Wand

RFID antenna is unique in its shape and functionally and enables librarians to easily identify items on the shelves. This RFID reader has been designed to perform fast and accurate inventory checks and also to search for specific items (re-shelving, weeding, on-hold management etc). This system is useful stock verification and to find out wrongly (intentionally by students) shelved books.

6.0 Software

The SVNIT Library has been using LIBSYS software since 1997 and for application of RFID system Lsmart software developed by the Libsys Corporation is used and in all RFID subsystems i.e. tagging, circulation, self checkout and check-in, inventory control etc Lsmart client is used.

7.0 Main Components of RFID Technology

All the units of RFID system described above are controlled by the following major components:

- Tag
- Reader
- Antenna
- Pedestal
- RFID Inventory Component

7.1 RFID Tag

It consists of a chip attached to an antenna. Tags are developed using a frequency according to the needs of the system including read range and the environment in which the tag will be read. Generally two types are used in the library one for books and other for CD/DVD. The design of two types of tag are shown below:
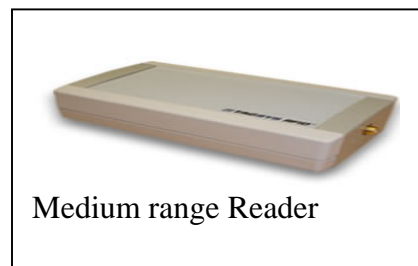

Tag used in CD

Tag used in books

7.2 RFID Reader

An RFID Reader can be fixed or handheld, and usually connected to MIS or PC. The Reader handles the communication between the information system and RFID Tag. Different types of readers are used depending on the requirement. Example of two typs of reader is shown below.

Long range Reader

Medium range Reader

The RFID Antenna connected to the RFID Reader, can be varying size and structure, depending on the communication distance required for a given system performance The antenna activates the RFID tag and transfer data by emitting wireless pulses. Sample of an antenna is given below:

This is a desktop antenna typically used with long-range RFID readers. This flat antenna offers a large read area to rapidly detect the RFID tags affixed to books and CDs.

7.4 RFID Pedestal (part of security gate)

Each pedestal is standalone and plug and play to the main power featuring an advanced digital signal processing technology and does not require additional equipment to operate. Two pedestals is required for one security gate and additional pedestal can be added to in a row for increased detection surface.

7.5 RFID Inventory Component

Inventory Reader features a unique design and functionality. Through fast-read performance, the handheld RFID reader simultaneously interrogates multiple items (between 15 and 20 items per second). Data is transmitted via WiFi to the library's host PC or to a PDA, avoiding the hassles of cables and providing freedom of movement. Featuring a lightweight, ergonomic design, the reader can be conveniently carried with a shoulder belt strap. A patented, flexible antenna allows easy access to items (books, periodicals, CDs, DVDs, documents and other media) on upper and lower shelves without the need to bend or reach.

RFID Inventory Component

Wireless Antenna

Reader

Wand

Pocket PC

8 Advantages of RFID Technology

RFID technology is a boon to the librarian as well as its users. The RFID technology makes the work of librarian easier, fast tracking of documents and save the time of the users. It has following advantages:

- Rapid Check out / check-in
- Self Check out / check-in
- Increase the circulation
- Minimize the time of the users as well as library staff
- Minimize the expenditure incurred on counter and inventory staff
- High reliability
- High speed inventorying
- Automated material handling (Presently it is not used in SVNIT Library)
- Long life of RFID Tag in comparison to Barcode slip

9 Limitation of RFID Technology

Though the RFID technology is having enormous advantages it has also many disadvantages as stated below:

- High cost

- Possible to block the radio signal by any metallic content by the users

- Easy to remove the tags from the book

- Exit sensor problems: exit sensor may create problem if there is power failure or if the book passes through the side of the pedestal, which is out of the range of he antenna.

10 Documentation and Financial Implication of RFID in SVNIT

Though the RFID technology has many disadvantages but considering the self-checkout and self check-in system the application of RFID in SVNIT Library was proposed at the end of 2004. During 2005 it was discussed in the Library Committee several times. Discussion was held with Dr. Venkadesan, Librarian, IISc, Bangalore, Dr. Harischandra, Librarian, IIT, Madras and Dr. Jagadish Arora, IIT Delhi and proposal was submitted to the NPIU (National Project Implementation Unit) for getting fund from World Bank under TEQIP (Technical Quality Improvement Programme). At the end of July 2006 the tagging work was started by the Libsys Corporation on contractual basis but it was stopped on 7th August 2006 due to severe flood in Surat. Entire tagging work was completed in November 2006. It takes near about 2 months to complete tagging work of 50,000 books. The RFID gate was installed and kept it for continuous testing the environment. i.e. how the gate is working, whether antenna is properly catching the tagged books, to adjust the frequency of the antenna and adjustment of the pedestal etc. In April 2007 the self-checkout and check-in kiosk was installed and tested the same up to July and from the month of August 2007 the full-fledged is introduced.

10.1 Financial Implications

Total approximate financial involvement is Rs.27.70 lacs except book drop system, smart card and job works. Book drop system and smart card is under process in

second phase. An overview of approximate budgetary estimate with minimum requirement of RFID system in library is shown in the following table:

Approximate Budgetary Estimate with Minimum Requirement of RFID

Sl	Item description	Qty	Approx. Amount (Rs in lacs)
@01	RFID Tags for Books 9with locking facility. Folio370 self adhesive label: size 50x45 mm, 1024 bits including theft bit	50000	11.30
02	RFID Gate (2 Pedestals)	01	5.90
03	Library Programming Station	02	1.20
@04	Self Checkout/Check-in Station comprising of RFID Reader + one Antenna with multiple read/write facility (to handle 4 books) ISO 15693 & ISO 1800 compliant. LCD 15" touch screen monitor with P4 CPU + 256 MB RAM+HDD. Epson TMT 88-III Auto Cutter Thermal Printer and Kiosk Shell with fitting along with Check-in Cart	01	3.85
05	Shelf Management Reader to enable stock checking, re-shelving of books, locating a specific book etc including compatible Pocket PC (HP iPAQ 64 MB)	01	2.05
06	Library Server Interface for Integration/Upgradation of Libsys server	01	2.00
@07	Transportation & Insurance on item no. 1, 4, & 7		0.90
08	Installation & Commissioning		0.50
			27.70

@ Item no. 1, 4, & 7 are imported from France

11 Problem faced in initial stage and remedies

11.1 Online keyboard on touch screen

Initially online keyboard was installed on touch screen in place of smart card to avoid a huge expenditure on smart card, smart card reader, smart card printer etc. But it was not succeed as it takes more time to enter user ID and password of the user and while the users are standing in queue are able to identify the password of others. To solve this

problem as well as to minimize the expenditure a fixed scanner is installed in the kiosk in the place of smart card and bar-coded ID is used in lieu of smart card.

11.2 Problem of pasting of RFID tag

Initially RFID tag was pasted on the back cover of book but distance between spine and the tag was not properly maintained and as a result while scanning the books in shelf management reader and wand the data of the book was not capturing for identification of location of book books. Initially only one hundred books was selected for testing and again the distance between spine and the tag was changed and make it uniform i.e. 2.5 cm from spine and 2.5 cm from the bottom.

11.3 Problem of RFID Gate

During the period of testing it was found that the gate was unable to identify some books. After minute checking the system it was found that the frequency of RFID gate was not properly adjusted and distance between two pedestals was not proper. The gate was reinstalled and the distance between two pedestals was adjusted.

11.4 Problems of the software

When the self checkout / check in was opened for all the users it was found that in case of overdue books the system is indicating fine amount but allowing the book for renewal and other small problems were faced. Finally the software was customized and the system is running in full swing.

12 Reputed vendors

There are many vendors of RFID components all over the world and now a days India is also producing RFID components. Name address of reputed vendors are stated below for information of the other institutions those are willing to apply RFID technology. The list includes only those vendors to whom the author has contacted and this is only for primary information.

1. **Tagsys,** 180, Chemin de Saint Lambert. F-13821 La Penne Sur Huveaune, France. Tel: +33 (0) 4 91 27 57 00, Fax: +33 (0) 4 91 27 57 01. Web: http://www.tagsysrfid.com

2. **Bibliotheca RFID Library Systems,** Hinterbergstrasse 17, CH-6330 Cham, Switzerland. Contact Person: Mr. Matthias Joos, Chief Executive Officer, Tel: +41(41) 7269940 Fax:+41 (41) 7269956, Mob:+41 (79) 2500123, Email: matthias.joos@bibliotheca-rfid.com, Web: www.bibliotheca-rfid.com.

3. **Asia Smart Tag Co., Ltd** ,No.268 , Sec. 3 , Wucyuan W. Rd., Nantun District , Taichung City 408 , Taiwan (R.O.C.), TEL: 886-4-23509778 , 23503615 FAX: 886-4-23506783 E-Mail astag@astag.com

4. **Gemini TRAZE RFID Pvt. Ltd.** # 1, Dr. Ranga Road, Alwarpet, Chennai - 600 018 INDIA   Tel : +91-44 - 2466 0570 / 71 Fax: +91-44-2499 5062 E-Mail: info@traze.in URL: www.traze.in

Near about 47 vendors are there all over the world and who have taken part in recent Taiwan International RFID Applications Conference 2007 (Oct 9-13), Taipei. Details of the vendors are available at http://www.rfidtaiwan.com.tw/visitors/exhibitor_list.shtml

13 Conclusion

Libraries have become a driving force in the development of RFID for the mass market. This technology was first used in other sectors, such as logistics, airline luggage automation and parcel distribution. The leading role for libraries is understandable, since libraries share their knowledge in the development of these systems. Also, the benefits have been greatest in the library community. It is also very interesting these systems are becoming popular in India, Korea, and Singapore.

In first instance it is found that the system is more costly and some demerits also, but as an user of RFID technology the author is having strong opinion that RFID technology is accurate, cost saving and minimize the manpower. For example initially two number of manpower in the counter is reduced after application of RFID and there is certain chances to reduce more manpower in near future. If we initially calculate the salary, DA, Medical allowances, LTC etc and compare the amount with the expenditure involved in RFID system definitely it cheaper. It may reduce more manpower engaged in

materials handling after full-fledged application of RFID. On the other hand if budget does not permit to introduce complete system at a time, it may be divided in to two or three phases.

Finally it is concluded that the librarians in 21st century should go ahead and compromise with the development of advanced technology.

14. Acknowledgement

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