Smart Library Management System using RFID

Dr.Annaraman[1], P. Thamarai*[2,] Dr. T.V.U. Kiran Kumar[3]

Assistant Professor, Dept. of ECE, Jerusalem College of Engineering, Chennai, Tamil Nadu, India[1]

Assistant Professor, Dept. of ECE, Bharath University, Chennai, Tamil Nadu, India[2]

Associate Professor, Dept. of ECE, Bharath University, Chennai, Tamil Nadu, India[3]

* Corresponding Author

ABSTRACT: Applicability of Radio Frequency Identification (RFID) system which is a new generation of Auto Identification and Data collection technology in a future Smart Library Management System is presented in this paper. It helps to automate business processes and allows identification of large number of tagged objects like books, using radio waves. In existing system barcode and token card system were used. Barcodes have no read/write capabilities; they do not contain any added information such as expiry date etc. and it needs line of sight, less security and it also can easily damaged. By using token card system, they are very labor intensive and work process for the librarians was more. By considering the above demerits in the existing systems, the proposed Smart RFID system , which is a wireless non-contact system that uses radio frequency to transfer data from a tag attached to an object, for the purpose of automatic identification and tracking. RFID doesn't need the line of sight, it remove manual book keeping of records, improved utilization of resources like manpower, infrastructure etc. Also less time consumption as line of sight and manual interactions are not needed for RFID Tag reading. RFID based Library Management system would helps to allow fast transaction flow for the library and will prove immediate and long term benefits to library in traceability and security.

KEYWORDS: RFID, library management, shelf management, book drop, self check in/out, wireless, smart

I. INTRODUCTION

1.1   Library Management System:

   A library management system (LMS) can be considered as an enterprise resource planning (ERP) system for a library. It is formed from a suite of integrated functions to manage a diverse range of processes within a library. These modules' typically include: cataloging (classifying and indexing materials), acquisitions (ordering, receiving, and invoicing materials), circulation (lending materials to users and receiving them back), serials (tracking journal, magazine and newspaper holdings), OPAC ('Online Public Access Catalogue'--the public interface for users).[5]

1.2   RFID:

   It is the wireless non contact system that uses radio frequency EM waves to transfer data from a tag attached to an object, for automatic identification and tracking. A Radio-Frequency Identification system has three parts that are –a scanning antenna ,a transceiver with a decoder to interpret the data, a transponder - the RFID tag - that has been programmed with information. The scanning antenna puts out radio-frequency signals in a relatively short range. The RF radiation provides a means of communicating with the transponder (the RFID tag) and provides the RFID tag with the energy to communicate (in the case of passive RFID tags).The scanning antennas can be permanently affixed to a surface, handheld antennas are also available. They can take whatever shape you need; for example, you could build them into a door frame to accept data from persons or objects passing through. When an RFID tag passes through the field of the scanning antenna, it detects the activation signal from the antenna. That "wakes up" the RFID chip, and it transmits the information on its microchip to be picked up by the scanning antenna. The RF low frequency range 120-150 KHz is used for the data transmission.

II. INTRODUCTION TO RFID SYSTEMS

A RFID system uses tags, or labels attached to the objects to be identified. Two-way radio transmitter-receivers called interrogators or readers send a signal to the tag and read its response. The readers generally transmit their observations to a computer system running RFID software or RFID middleware [1]. RFID tags can be either passive, active or battery assisted passive. An active tag has an on-board battery and periodically transmits its ID signal. A semi passive tag has a small battery on board and is activated when in the presence of a RFID reader. The tag's information is stored electronically in a non-volatile memory [2].

The RFID tag includes a small RF transmitter and receiver. An RFID reader transmits an encoded radio signal to interrogate the tag. The tag receives the message and responds with its identification information. This may be only a unique tag serial number, or may be product-related information such as a book number, student number, or other specific information. RFID tags contain at least two parts: an integrated circuit for storing and processing information, modulating and demodulating radio-frequency (RF) signal, collecting DC power from the incident reader signal, and other specialized functions; and an antenna for receiving and transmitting the signal [3-4].

Fixed readers are set up to create a specific interrogation zone which can be tightly controlled. This allows a highly defined reading area for when tags go in and out of the interrogation zone. Mobile readers may be hand-held or mounted on carts or vehicles. Data is transferred between a tag and a reader via low-power radio waves, which are tuned to the same frequency [5]. To obtain information from a tag, a transceiver must send a signal to the RFID tag, causing the tag to transmit its information to the transceiver. The transceiver then reads the signal, converts it to a digital format, and transmits it to a designated application such as a Library management system.

2.1 RFID Tags:
Tags are the heart of an RFID system, they stores the information that describes the object being tracked. Specific object information is stored in the memory of tags and is accessed via the radio signal of RFID readers. Tags may be active or passive, read-only, write-once, or read-write.[6]

2.1.1 Active Tags:
An active RFID tag is equipped with a power source for the tag's circuitry and antenna. The advantages of an active RFID tag includes readability from a distances of one hundred feet or more as well as capability to have other sensors that can use electricity for power. The major disadvantages of an active RFID tag are the limitations on the lifetime of the tag (5 years) [8]. They are more expensive and physically larger and they add to the maintenance cost if the batteries are replaced. Battery outages in an active tag can result in expensive misreads.

2.1.2 Passive Tags:
Passive RFID tag does not contain a power source; the power is supplied by the reader. The tag draws power from the inductive coupling with reader antenna. The major disadvantages of a passive tag are that the tag can be read only at very short distances, typically a few feet at most. However there are many advantages [9].The tag functions without a battery which increases the life time to more than 20 years. The tags are less expensive and much smaller. These tags have almost unlimited applications in consumer goods and other areas.

2.1.3 Semi-Passive Tags:
Like passive tags, semi-passive tags reflect (rather than transmit) RF energy back to the tag reader to send identification information. However, these tags also contain a battery that powers their ICs [10]. This allows for some interesting applications, such as when a sensor is included in the tag so it can transmit real-time attributes, such as temperature, humidity, and timestamp. By using the battery only to power a simple IC and sensor— and not including a transmitter—the semi-passive tags achieves a compromise between cost, size, and range.

2.2 RFID Readers:
RFID readers are devices that convert radio waves from RFID tags into a form that can be passed to middleware software [7]. An RFID tag reader uses antennas to communicate with the RFID chip. Applications will require multiple forms of readers to make a successful system. There are a variety of different reading systems and

technologies. These include: Handheld readers that act like a handheld bar code scanner, RFID readers embedded into mobile data collection devices, fixed readers, which are mounted to read tags automatically as items pass by or near them.

2.3 Middleware:

Middleware software or applications are needed to manage the flow of data from readers and send the data to back-end management systems [11]. RFID middleware assist with the following: Retrieving data from readers, Filtering data feeds to application software, Generating inventory movement notifications, Monitoring tag and reader network performance, Capturing history, Analyzing tag-read events for applications like tuning and optimization.

III. SMART LIBRARY MANAGEMENT SYSTEM

Library management system consists of various modules like acquisitions- ordering, receiving of books from the suppliers; cataloging-classifying and indexing materials (tagging); circulation – lending materials to patrons and receiving them back.

3.1 Tagging:

Tag 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. The role of the librarian is to classify the books into groups and paste the RFID tags on them. These paper-like tags helps in tracking the books within the range of the reader.

3.2 Check in/out service:

The counter station is a staff assisted station on services such as loan, return, tagging, sorting and etc. The patron approaches the counter to borrow or return the book. First the patron is supposed to identify themselves using the tags provided to them. The staff at the counter then uses a reader to read the tags to make an entry in the central database. In case of book return, the staff collects the book and reads the tag. If the book is returned beyond the due date, fine is collected from the patron.

3.3 Self check in/out service:

The system basically consists of a computer interfaced with a 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 RFID card- containing the patron details and their ID, the patron is asked to choose the next action (check-out or check in of one or more books). After choosing check-out , the patron puts the book(s) in front of the RFID reader and the display will show the book title, author name and its ID number (other optional information can be shown if desired) which have been checked out .It displays the date before which the book is to be returned. Where as in check in, the patron shows the book(s) in front of the RFID reader and the same will be displayed as in check out. Besides, if there are delays in the return of book(s), the fine amount will be displayed.

3.4 Shelf Management:

Shelf management includes locating and identifying items on the shelves as an easy task for librarians. It comprises basically of a scanner and a base station. The system is designed to cover three main requirements: Search for individual books requested, Inventory check of the whole library stock, Search for books which are miss-helved.

3.5 Book Drop:

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 anytime of the day, even when the library is closed. Patron has to place the book on the trays available for book drop. The reader reads the tags and acknowledges the patron of the successful return. The reader updates the backend system and allows loan cancellation.
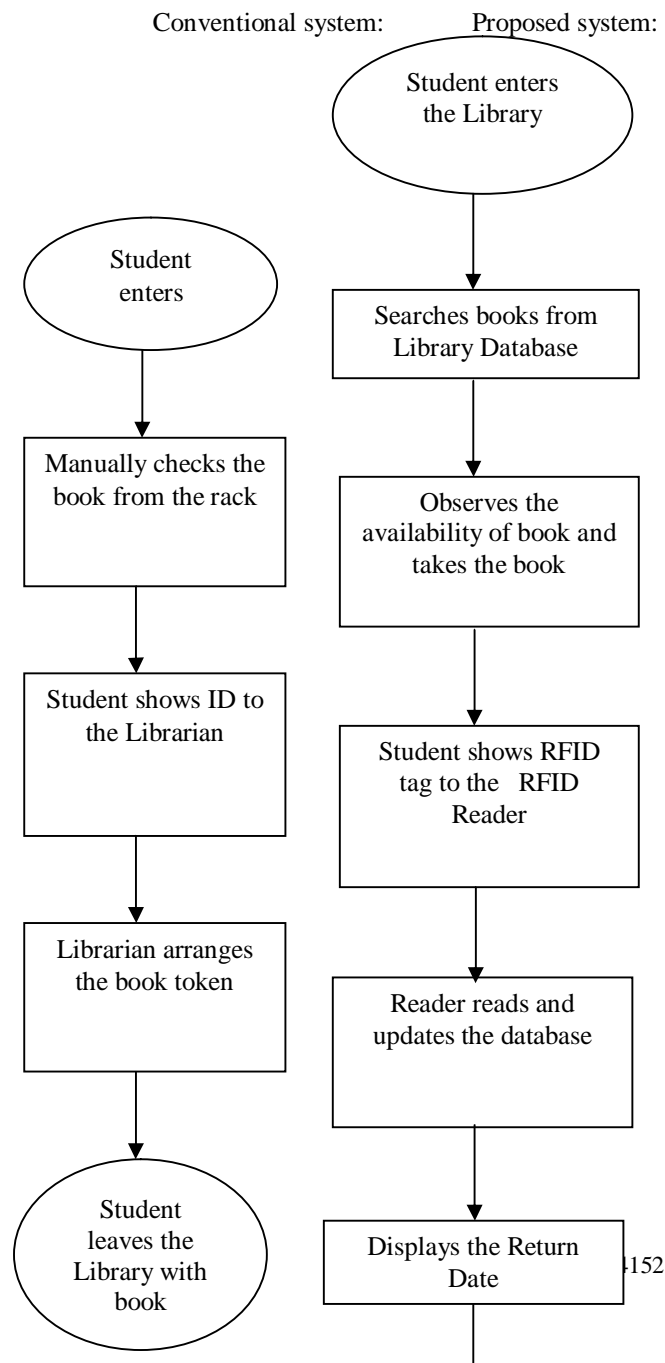
3.6 Anti-theft Detection:

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.

IV. EXPERIMENTAL VALIDATION

As explained in the above section, there are several modules in the existing library management system. But this paper focused only on three modules namely: Self Check in/out, Book drop and Shelf management.

a) Self check in/out:

The following flowchart describes the self check in/out modules in the existing and the proposed system.

b) Book Drop:

The book return module is explained by means of a flowchart to understand the difference between the conventional and the proposed system.

Conventional system: Proposed system:
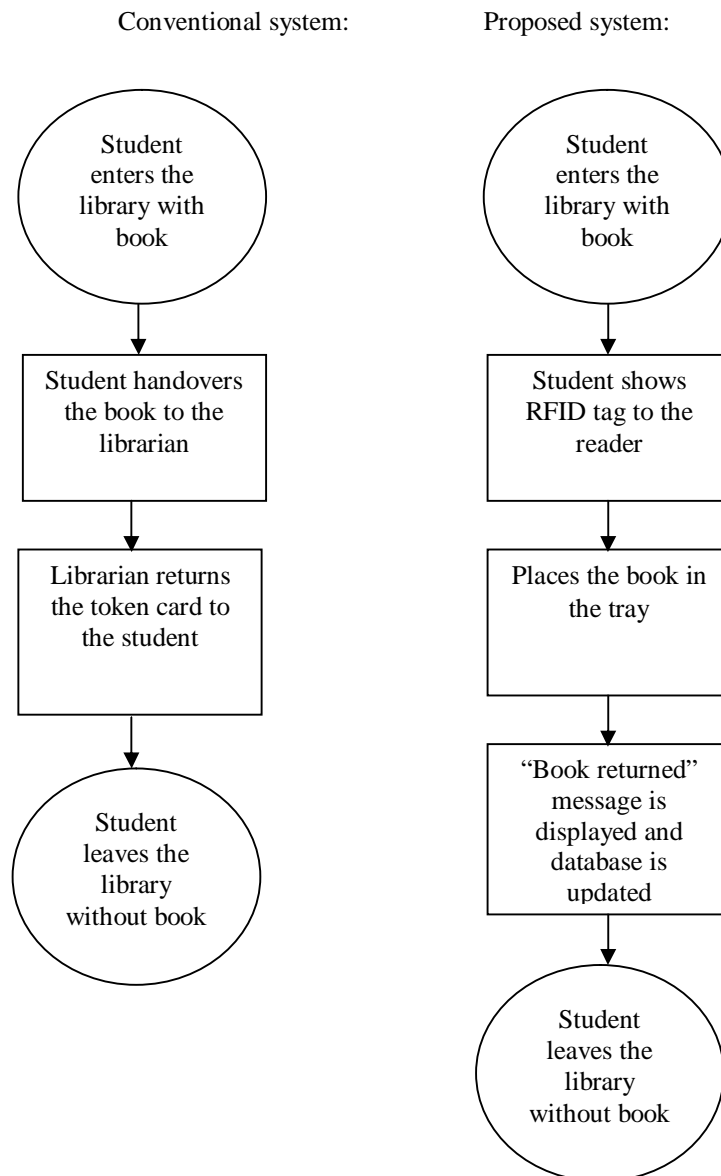
c) Shelf management:

Arranging the books in their respective locations in the racks is a tedious task done by the librarian. In order to overcome this drawback the proposed system consists of RFID reader to check for the misplacements of books. The following flowchart describes the shelf management in the conventional and the proposed system.
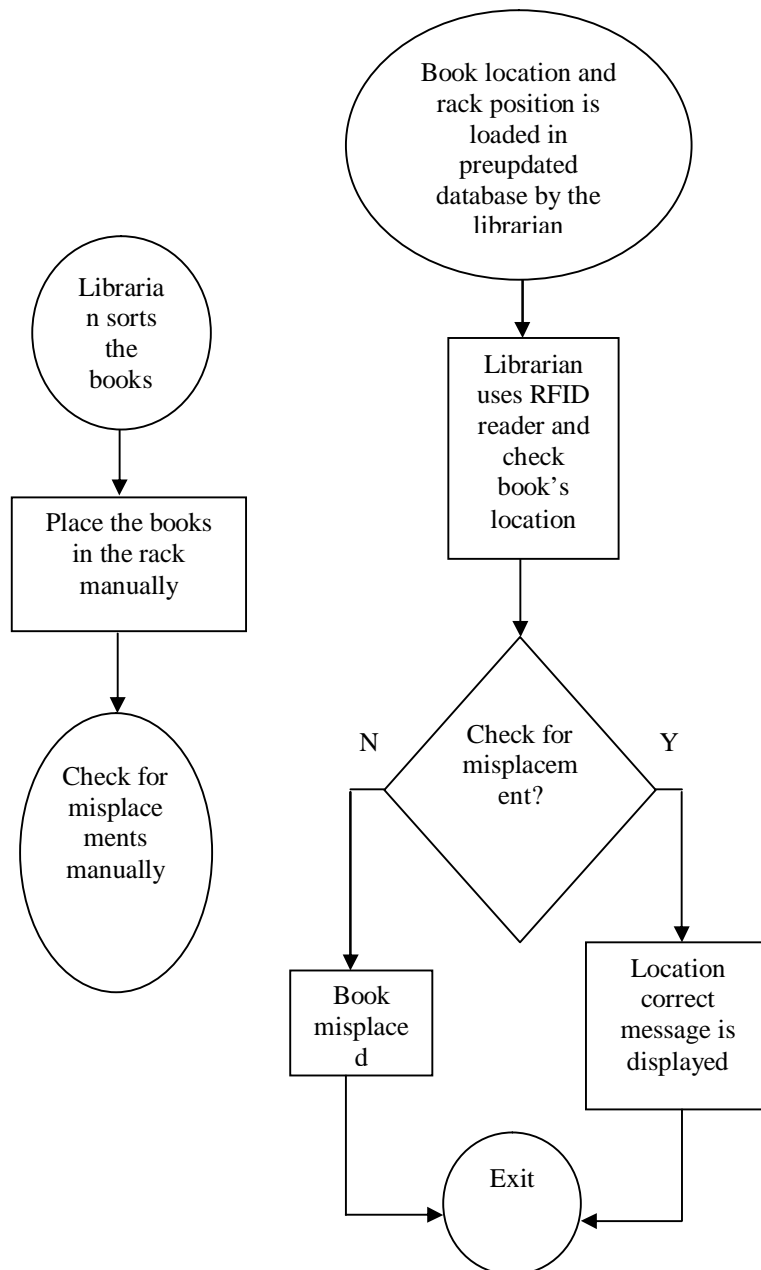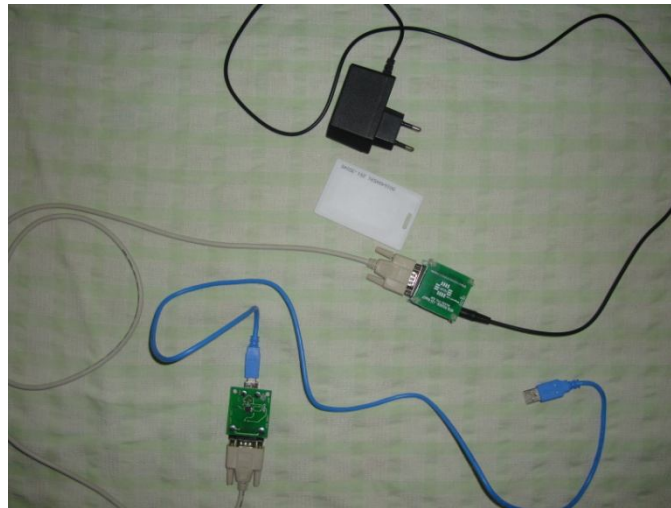
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Hardware Model:

Screenshots:

The results of execution of the Smart library management system are displayed below. Each module is executed and the screenshots of each module is displayed.
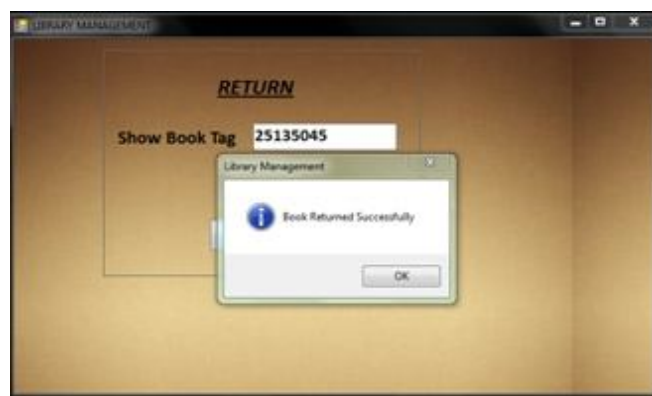
a) Self check in/out:

b) Book Drop:

c) Shelf management:

V. CONCLUSION

RFID implementation in libraries has been discussed. The whole system was designed to overcome the disadvantages of barcode systems and thus demonstrated. The entire project was planned to reduce the need of skilled librarians. Though the system is more expensive than the barcode systems, security is ensured and is more efficient. RFID technology is also applicable in various fields like: Asset tracking, people tracking, healthcare, animal tracking, document tracking, object tracking in stores, building access control, airline baggage tracking and toll collection at toll booths.

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