Automation of Library Management System Using RFID

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ABSTRACT
Radio Frequency Identification (RFID) is one of the pillars of Internet of Things (IOT). This is an advanced technology which uses RFID sensors to retrieve data from the RFID tags which store information. This Library Management System uses tags attached to books in the library as source of information and the sensors attached on the ceiling are used to sense the information and analyse data. The base idea of this project is that, a RFID tag will contain information of the book to which it is attached. The Ultra High Frequency (UHF) Scanners or RFID readers attached on the roof of the library activate signals to read the information from the tags based on the user input. The end user of this system would have an android application which would connect him with the library server. Whenever he would search for a book, the sensors would get activated and user would be able to get the location of the book in the library. Also, books which customer may be interested in would be recommended to him.

General Terms

Keywords
RFID, IOT, UHF readers, active RFID, passive RFID, collaborative filtering, jaccard index, RSSI, recommendation, navigation

1. INTRODUCTION
RFID is a wireless technology in which objects having RFID tags attached to them can be identified using scanners to read the data from the tags. RFID is high speed and reliable system which is different from the barcode and QR in the following ways:
1) It does not require line-of-sight
2) It provides a unique identification to all objects
3) It can read the information through opaque objects

a.) Comparing Different RFID Tags
RFID technology provides tags which have an unique identification number, different for each tag. This helps in identifying a specific object from a collection. The tags work at particular frequency which are read with help of RFID scanners. The RFID is categorized into 2 types:

1. Passive RFID Tag
Passive tags are cheap in cost, about 7-8 INR per tag. As the name implies, passive, it waits for the signal from the reader. Once it receives signal, connection is established and data from the tag can be retrieved. A passive RFID tag attached to an object can be read from a range of 15-20 feet. Passive RFID tags do not contain an external battery attached to it. The lifetime of these tags are about 2 to 3 years.

2. Active RFID Tag
Active tags on the other hand, are expensive, about 75-80 INR per tag. These tags have a battery connection which keeps them charged. Unlike passive RFID, these tags continuously transmit signal for the readers to understand their presence. The lifetime of these tags is until the battery supply is good enough to keep them charged.
b) RFID Sensors And Connection Establishment

RFID middleware is a term associated with the connection establishment. RFID middleware helps in messaging, interaction between two machines and message passing. RFID middleware can be related with the following operations:

i. Retrieve data from users
ii. Capturing history
iii. Notifying user based on trends
iv. Navigate user to selected book
v. Inventory management

A RFID reader consists of a scanner and antennas to transmit as well as receive signals. It is connected with a microcontroller of processor to control the reader input and process the data. RFID readers are used to keep track of the individual objects, in this case, books in the library. RFID sensors are also categorized into 2 types:--- Active and Passive

Generally for a complete system and to offer high level automation, active sensors are used which have battery support throughout their lifespan. These keep on transmitting signals till one of the RFID tag catches it and responds. This response is then recorded and data is processed.

2. PROBLEM STATEMENT AND MOTIVATION

Library Management specifies details of books in the Library depending upon several categories like Author-name, Publication, Sales, etc. Manual Library management thus becomes a hectic task for the administrator as he is required to update all the details of the borrower, dates of issue and receipt manually. This manual management system may lead to errors in updations or deletions in the Library Database, thus decreasing the quality. Automation in library management will lead to less manual intervention, more accuracy in library operations and good quality product for the customer as well as the administrator. Traditional Library Management requires manual intervention at each and every stage. From borrowing a book to returning, administrator has to update the library database every time. This may increase the risks of more erroneous database entries and updates. Also, user friendliness gets hampered in traditional library systems as user has to search for the book own his own, thus increasing time constraint. The user may also not find the best book always. Consider the scenario:-

User finds a particular book in traditional library system, but there are higher rated and new versions of the book available in library which the user is unaware of.

3. METHODOLOGY

Passive RFID tags will be attached to all the books in the library. Active RFID tags will be attached to the shelves in the library. RFID readers will be installed on the ceiling and exit door. Customer will have an android application installed on his smartphone. When user logs into the application, he will get connected to the library server. The GUI will contain a catalogue of the books and also a search option for selecting a book. When user searches for a book, he will get recommended similar books on the basis of genre, author, past issued books, current purchase-trend, etc. Also, he will get the location of the book in the library. At the same time, RFID readers will look for the shelf containing the searched book. Accordingly, a path will be provided to the customer using RSSI technology. Thus, he will be guided to the book thus making the system more user-friendly and easy for customer. While exiting from library, RFID reader will scan the book and match with that entry in the database. Accordingly the alarm bell gets activated in case of theft. Customer will also get notified about the new books available in the library. Also, he will get notified about dates of return of the books, his issued books at current time, etc, thus making the system automatic with minimum manual intervention as possible.

➢ Fig 1 shows the high-level system implementation and connectivity.
Fig 1 High level view of system

- Fig 2 depicts flow diagram for issuing a book from library

Fig 2. Issue Book From Library

- Fig 3 shows flow diagram for returning a book to library

Fig 3. Return Book To Library
Fig 3. Return Book To Library

Fig 4 shows the high-level view of the system

Fig 4. High-Level View Of The System
4. ALGORITHMS AND IMPLEMENTATION TECHNIQUES

1) Collaborative Filtering
Collaborative Filtering is a technique of making automatic predictions based on the current searches been carried out in real-time. Using this technique in the library management system, we can predict what type of book user would be looking for and accordingly he would be recommended. Also, this algorithm will take into account the past history and searches of the user, thus making it predict user’s choice more accurately.

2) Jaccard Index Coefficient Of Similarity
Jaccard Indexing is a prediction technique which is based upon the intersection of two entity sets, and the outcome set is recommended. In our system, one set can be considered as the past history or the wishlist of the user. This is user’s personal interests, what types of books he reads, what current scenario is going in the market, etc. The second set is the current real-time purchases going on. This may change according to different seasons (include exam time, new literatures made available, etc). Fig 4 shows the intersection set based on Jaccard Indexing technique.

3) Relative Received Signal Strength
RSSI technique is a shortest distance finding technique taking into consideration multiple base points, thus giving the shortest route which user may take to reach to his destination. In our system, the scanners installed on the ceilings act as different base points. When user searches for a book, the scanners gets enables and the centroid from all the base points is calculated. The base point nearest to the centroid is considered and specific route gets enabled and user is navigated to the shelf containing the book. Fig 5 shows the shortest distance calculations for locating a book using RSSI technique.
5. FEASIBILITY AND SCOPE OF THE SYSTEM

The system we are implementing is an one-time investment. Once RFID scanners are installed, then they are quite resistant to wear and tear, thus don't need replacement soon. RFID tags are also cheap and thus can be easily attached to new books in the library. This system is beneficial for all stakeholders involved because there is a profit in long term. Hence, cost is a negligible factor looking in the long term. Thus taking the above aspects in consideration, we can say that this problem solvable in polynomial time. Deterministic techniques and algorithms are used to tackle this problem and arrive to a solution in polynomial time.

6. CONCLUSION

Automation of library not only helps the customer finding a book, but also the administrator of the library. He can monitor the activities without much intervention. Also high level of customer satisfaction is obtained as he will get the best book available. Customer finding the book at it’s exact location saves his precious time, thus becoming user-friendly and less hectic. Application provides notifications and past issued books can help customer ponder upon his choice of book. He gets notified about new versions of books available and also the return dates which help in easy transaction between him and the administrator.

7. FUTURE SCOPE

This system can be further extended to a level wherein the administrator can monitor user movements in and around the library. Also additional facilities and functionalities can be added to the application such as suggestion of an e-book download for an unavailable book in the library, etc. Exact positioning of the book and the customer can be obtained using high-frequency active RFID tags and readers. Thus, if cost is not an issue, then such systems can be implemented in future.

REFERENCES


