Towards a context-aware smart library management system

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Abstract- This paper proposes a context-aware smart library management system. The proposed work comprises a web application developed using MEAN stack that provides context-aware interface for library management. The interface can be used to perform different library management operations, such as managing members, keeping book records, search a book, issue or return a book and track a book location; based on the current context of user. There is a server module that uses k-means clustering technique to enable user to search data based on his preferences and current context. RFID tags are embedded on library books that enable tracking of books. The server has a GSM modem installed that sends SMS to users who have borrowed the books and the last date of returning books has expired.

Keywords- context-aware system, library management system, RFID, automation;

I. INTRODUCTION

Information and Communication Technology (ICT) can play a very vital role in education sector. It is a combination of computer and communication infrastructure used together to assist in automation of various human tasks. For instance, it can be used for home and office automation, e-governance, health care, agriculture management and e-commerce applications. In the domain of education, it can be used to reach remote areas, providing education at nominal or zero cost, regulating the education system and distance learning etc. The need for ICT based systems are increasing and those who don’t opt for automation are bound to lose due to the competition and efficiency brought in by ICT base systems [1]. In this research paper, a smart library management system has been proposed. The proposed system makes use of ICT technology to make it convenient for a library user to obtain books, magazines and journals of its interests.

The system has been proposed for Indus University, Pakistan (http://www.indus.edu.pk). The university library currently comprises 5000 books, along with hundreds of magazines and journals. There is no library management system currently available for the university. The active users of the library are around 1500 in numbers. In the current scenario, all the library management tasks are performed manually. The librarian at Indus University currently faces following challenge:

- **Managing book records:** It becomes very cumbersome to manage book records. Most of the library record is maintained in Excel sheets, making it difficult to manage and is prone to loss. In case of new arrival, it is very difficult to inform students and faculty about new books of their particular interests.

- **Searching a book:** It becomes very difficult to locate a book or literature. This requires manually maintaining location of books in excel sheets and searching in those sheets for a particular book.

- **Issuance of books:** The issuance of book is managed by hand. The librarian has to enter the book details in excel sheets to issue a book.

- **Late arrivals:** Late arrivals are also managed herself by the librarian. There is no mechanism to automatically contact or inform the defaulter in case of getting late.

Considering that most of the library tasks are performed by hand, it is felt that a library management system is desired. This paper proposed a library management system. The main contributions of this work are:

- **Automation of library management system:** It provides a smart and convenient approach to automate library management at Indus University. Different tasks such as Add book, issue book, late return, book tracking etc. are automated using RFID tags.

- **Context awareness:** The user’s past history is logged in the form of session records. A clustering algorithm is applied on the user’s history to determine his preferences and interests. Using the preferences, the system helps the end user to accurately get the information they desire.

- **Tracking:** The library books are identified with RFID tags. It helps in tracking the current location of books in the library i.e. where the books are located.

- **Alerts:** The system keeps end users updated about the new arrivals in library based on their preferences determined using clustering algorithm.
**Book return:** With the help of database triggers, the current system keeps track of the books that have not been returned on time or whose return date is about to expire. An automated SMS is generated to alert the end user. This approach facilitates end users in returning the books on time.

II. **LITERATURE REVIEW**

There has been several library management system proposed in literature. Jibia et al. [1] proposed a web-based library management system for Cavendish University, Uganda. Kumar et al. [2] discussed how cloud computing can be used for improving library management. In some of the studies, semantic web technology has been incorporated for assisting user in seeking desired information. In this direction, Seker [3] has developed a Turkish language interface for querying a library ontology. First, lexical and syntactic analyses are performed on user queries, which are then semantically analyzed using C language code. Similarly, Banu et al. [4] have developed a wrapper for library management system that translates semantic queries in RDF format to SQL. Saranya [5] has proposed a context aware smart library management system based on RFID technology for identification and furnishing information to library users on smart phone. An RFID based smart library management system has been proposed in [6]. An agent based mobile augmented reality solution for library management has been proposed in [7]. Using Internet of Things (IoT), a library management system has been proposed in [8].

In this paper, a novel library management system is proposed. The novelty of proposed work is that it provides complete automation of library management system, context aware searching and tracking of library books.

III. **PROPOSED LIBRARY MANAGEMENT SYSTEM**

Figure 1 shows the proposed library management system. It is an N-Tier application, comprising a client side interface and server side comprising different tiers. The client comprises interface for managing library members and books, issue a book and search books etc. All the requests of clients are handled by web server. The web server processes each requests of clients and interacts with other module at server end to furnish end user’s requests. All of the user’s searches for a particular book are stored in a log database which is then analyzed to determine preferences of users. The clustering algorithm is used to classify user’s searches into different categories. User searches can be performed based on his preferences. The database contains the complete information about the library books and users in the form of document databases. The GSM module is used for generating SMS to contact library users. The users can be contacted in case of becoming late in returning a book or a new book of user’s interests has arrived in the library.

IV. **DETAILS OF PROPOSED APPROACH**

This section discusses the proposed approach in detail. In particular, the various components of proposed approach are discussed.

A. **Client Side**

![Figure 1. Block diagram of proposed library management system](image)

The client side is used by end users to use library management service. It provides an easy to use interface that can be implemented using a mobile application, Java applet, WPF application or web browser. The client side connects with the server using HTTPS. The client side comprises interfaces for login, managing books, issuance of book, tracking
late users and generating reports etc. Each of the requests of client is handled by web-server using Model View Controller (MVC) architecture. The web application interacts with other modules (such as database, GSM modem, clustering component) at the server end to process client’s request. The web application can be implemented as Servlets, Java Server Pages (JSP), Java Server Faces (JSF), Active Server Pages .NET (ASP. NET), Professional Home Pages (PHP) or NodeJS.

C. Database

The database stores the information about library management system in the form of document databases. This includes documents such as:

- **Books**: Complete details about books
- **Members**: The active members of library
- **Transactions**: Books issued to members
- **Archive**: Books that have been archived
- **BookShelf**: The book shelves in the library where the books will be placed

Database triggers are installed to generate SMS to users in case of getting late in submission of records.

D. Managing Books

Every book has an RFID tag storing the complete information about the book such as title, author, year of publication, publisher and edition etc. Any new book that enters into the premises of library will get automatically registered in the database. Once the new arrivals have been registered in library records, the profiles of the user are searched for their preferences. For every book, all the users whose profile reflects that user is interested in this book are informed via GSM module.

E. Clustering

All of the user’s activity is logged into a log. These logs are then grouped into k different categories. Using k-means clustering algorithm [9], all the user’s searches stored in log are clustered into k groups. A particular user’s interests are then mapped onto one of these groups. A user’s search result is then ranked based on how closely it maps to user’s preferences.

V. DISCUSSIONS ON IMPLEMENTATION

For the implementation of proposed approach, MEAN stack (MongoDB, Express, AngularJs and NodeJs) [10] is proposed. Currently, the web based graphical user interface has been implemented and the rest of the work is under
Using k-mean clustering, the queries of current user is logged and analyzed to determine the likely searches. The clustering algorithm is used to assist the user in profile driven/preference based searching. Every book has an RFID tag containing complete information about the books along. The server comprises NodeJS server that uses clustering to assist user in searching based on its preferences. The client queries server for books and can issues books etc. At the server end, MongoDB [11] is used as a document database to store information about issued books and details of the books available in library. Using database triggers, server can inquire the list of users who have not returned books and can alert them to return the book. For this purpose, Modem.js API [12] is used to send SMS using GSM mobile phone.

VI. CONCLUSION

This work proposes a context-aware library management system and discussed how the proposed approach can be implemented. It will help in automation of library management task, thus saving manpower and time. It will improve end user searching capability, help in automatic tracking of books, keeps user updated about new arrivals, promotion and current status of books. Marketing techniques can be employed to advertise for a sponsor while sending SMS to user. This will also generate revenue for the university.

REFERENCES

Basic Context System Architecture. Context-aware systems can be described as sensors embedded in a device (middleware) which the application makes use of. Each of the components is inter-dependent with the other. Basic Local Context System Architecture. It is difficult for a context-aware system to authenticate information before utilizing it because sensors only detect changes in context. Whether the change is genuine or not, sensors cannot verify. Practice for certification success with the Skillset library of over 100,000 practice test questions. We analyze your responses and can determine when you are ready to sit for the test. Along your journey to exam readiness, we will