

Enhancing Library Services through Smart Automation Systems: A Comprehensive Review

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Abstract: This paper presents the overview of smart library automation, in order to better understand how library services have evolved. The integration of cutting-edge technologies with traditional library services is known as smart library automation. It provides a holistic solution that adapts to the changing needs of customers in the digital age. The review delves into the fundamental ideas behind smart library automation. The work establishes the foundation for next studies and real-world application in the creation of smart library systems by methodically examining design factors and implementation techniques. This introduction sets the stage for later design and application of smart library automation solutions by offering a conceptual framework and examining new trends.

Keyword: Library, Virtual, System, e-library, Smart Library

INTRODUCTION

BACKGROUND ON TRADITIONAL LIBRARY SYSTEMS AND THEIR LIMITATIONS

Virtual library services refer to services delivered through specific websites accessible on the internet, offering integrated access to various databases. According to Gavit (2019), Web Based Library Services are primarily provided through the library portal, which is a unique kind of gateway to web-based library resources. It offers integrated access to the metadata of a library's numerous databases. The terms "Digital Library Services," "Web Based Library Services," and "Electronic Library Services" are interchangeable for Virtual Library Services.

The idea of virtual library systems represents a significant shift in how libraries provide access to information and services. The progression of technology has exposed the shortcomings of brick-and-mortar libraries, resulting in the creation of digital library platforms. These programs strive to surpass geographic limitations, amplify user satisfaction and furnish unparalleled access to a diverse array of materials.

Physical libraries have been a fundamental part of education and research for a long time. However, they have inherent limitations such as restricted opening hours, limited physical space for collections, and the requirement for users to be physically present. These limitations have restricted widespread access to resources, especially for remote or distance learners.

According to Araya and Mengteab (2020), the physical library has often faced a number of challenges as a result of the ineffective management of the library, most errors in record keeping are caused by human mistake, such as lost or destroyed manually written documents from inefficient use, even if it causes chaos and takes time, the effort put into finding books that can be deemed inadequate in terms of book management is an issue in the manual library. Moreover, the rapid growth of digital information and the internet emphasized the need for libraries to embrace technology to remain relevant and effective in the digital age.

THE NEED FOR MODERNIZATION AND DIGITIZATION

Dande, et al. (2023) uphold the validity of this quote even today, acknowledging libraries as a long-standing source of knowledge since ancient times. However, their effectiveness is often undermined by manual processes such as inventory management, book tracking and shelving alignment which impedes

seamless operations. To counter these issues effectively we have proposed an integrated Library Management System (LMS) that automates every operation in the library efficiently. The LMS employs RFID tags equipped with all books combined with RFID readers operated by librarians to easily manage all aspects including cataloging new entries, issuing/collecting books etc., without any hassles or complications. The software interface provided for users designed intuitively fosters user convenience aimed at streamlining essential hardware functionality ensuring smooth operations across varied platforms. Database stored securely on our local MySQL server ensures data safety while maintaining data integrity accuracy. Our primary goal focuses upon prioritising cost-effectiveness backed up firmly behind enhanced operational efficiency - ultimately facilitating hassle-free borrowing and returning process empowering more modernisation throughout diverse library settings enhancing its overall utility value from contemporary perspectives.

In the realm of library management systems, the integration of RFID (Radio Frequency Identification) technology has emerged as a promising solution for enhancing efficiency and accuracy. This literature review explores the technological advancements and benefits offered by RFID-based smart library management systems, as highlighted in various scholarly works.

LITERATURE REVIEW

OVERVIEW OF VIRTUAL AND DIGITAL LIBRARY SYSTEMS

Virtual library systems emerged as a response to these challenges, driven by technological progress. These systems utilize digital platforms to offer users access to extensive collections of resources without being constrained by physical space. Virtual libraries encompass digital books, scholarly articles, multimedia content, and more, all accessible from anywhere with an internet connection.

Mageto (2021), define an e-library system, commonly called a virtual library, utilizes ICT to offer services and house documents electronically. Utilizing digital technologies for retrieving, preserving, archiving and delivering available materials online is now possible with this platform. The management of such tasks as bookings or payment processing are conducted through secure communication channels which make the process cost-effective yet reliable enough to guarantee efficient library service delivery.

Virtual library services refer to services delivered through specific websites accessible on the Internet, offering integrated access to various databases. According to Gavit (2019), Web Based Library Services are primarily provided through the library portal, which is a unique kind of gateway to web-based library resources. It offers integrated access to the metadata of a library's numerous databases. Virtual Library Services can be referred to as Digital Library Services, Web Based Library Services or Electronic Library services.

Gbaje's (2007) article highlights the negative impact of inadequate information resources on education, research, and development in Nigerian academic libraries. In response to this issue, the government has taken steps towards improvement through initiatives such as National Virtual Library programs and policies promoting access to current information for teaching and learning. The implementation of a virtual library enables online accessibility to vast amounts of scholarly content while also providing valuable solutions across higher educational institutions.

He goes on to say that a virtual library's digital collections—which are more than just a haphazard collection of digital items or a unified resource locator (URL) for free web resources—are its fundamental components. In addition to information and web technology abilities, building digital collections involves traditional library competencies. The steps in creating a virtual library are as follows:

DIGITIZATION

Digitization refers to the process of making non-digitally created materials accessible in a digital format. One of the initial tasks that librarians undertook during digitization was converting printed library cards into computer-readable catalogues. The entire digitization procedure involves selecting relevant material from collections, scanning and transcribing it whilst producing markup and an index, creating metadata,

conducting quality checks by topic specialists as well as processing photographs before entering them into Digital Asset Management software (DAM). Various Software including DSpace Eprints Fedora Greenstone are used for managing digital assets; organizing indexes while providing access via locally or remotely available databases consisting primarily of Metadata records with search options across all platforms.

ACQUISITIONS AND DEVELOPMENT OF COLLECTIONS

Purchasing and obtaining ownership of digital resources including databases, e-books, and journals is known as acquisition. After authentication and authorization, the vendor's remote server hosting subscribed electronic resources makes it available to a target community.

According to Araya and Mengteab (2020), the physical library frequently encounters obstacles due to poor management practices. Many inaccuracies in record keeping arise from human error, including misplacing or damaging hand-written documentation caused by inefficient handling processes. Such inadequacies can lead to confusion and waste time when searching for books that may not have been correctly managed within the manual system. Furthermore, with the exponential growth of digital information available via the internet, libraries must adopt technological advancements to keep pace with these demands if they are to remain effective in this era.

COMPARISON BETWEEN PHYSICAL AND VIRTUAL LIBRARIES

- Virtual libraries differ from physical ones in that they primarily feature electronic resources like e-books, e-magazines, online newspapers and reports as well as multimedia content such as videos, audios and animations. In contrast to this digital world of information carriers stand traditional libraries with their collections comprised mainly of hard copy books and printed works including magazines or monographs.
- While physical libraries face the challenge of limited space that is tough to increase, virtual libraries encounter a confined space issue (determined by the scalability of their IT infrastructure) that can be easily addressed.
- In a physical library, an item can be accessed through an issue and borrow system with a limited number of available copies, whereas in a virtual library, an item can be accessed any number of times by any number of users.
- Physical libraries are based on physical spaces, while virtual libraries are created in virtual spaces, such as data centers, the cloud, and servers.
- Physical libraries use rack-based search and indexing, while virtual libraries provide web/interface-based search and indexing.
- The main drawback of physical libraries is the degradation, mutilation, and loss of materials over time, whereas virtual libraries offer digital preservation and long-term archival of content.

SMART LIBRARY TECHNOLOGIES

After Aittola, et al. (2003) groundbreaking trial garnered interest from librarians, numerous IoT- and AI-driven strategies have been integrated into various facets of the field. In particular, essential IoT technologies wield a significant influence over daily library management and operation; we will primarily focus on outlining their fundamental principles in this discussion for ease of comprehension.

- **RFID:** With over 70 years of history within the Internet of Things, RFID has become a popular technology. Thanks to progress in integrated circuits manufacturing, applications using RFID have decreased in cost (Khadka, et al. 2022). Arguably one useful instance utilizing this smart tech is that libraries can successfully implement access controls and self-borrowing/return bins along with intelligent shelving by adopting it (Ali, et al., 2022)
- **Wi-Fi:** The IEEE 802.11 standard has facilitated the extensive use of Wi-Fi in numerous indoor settings, such as libraries (Yang & Shao, 2015). The vast coverage and formidable networking

capabilities of Wi-Fi-based localization technology have resulted in its popularity (Chen, Li, Zhou, Liu, Wu, and Dudek, 2022), while smart libraries utilize it for navigation purposes (Jarawan, et al., 2022).

- **BLE:** The authors Jeon, et al., (2018) note that BLE, a fresh iteration of Bluetooth technology, presents desirable features such as efficient energy usage and extensive range capabilities. Ji, et al. research (2022) highlights the predominant applications of BLE within intelligent libraries to be centered around navigation functionality and fostering social connections amongst students.

LIBRARY MANAGEMENT SYSTEMS

The development of library management systems has been significantly impacted by technological advancements, and one prominent example of this progress is the KOHA Library Management System. The name KOHA comes from a Māori term for a gift or donation. According to Koha (2023), the implementation of its system signifies a major advancement from conventional library management techniques towards cutting-edge, technology-based approaches that revolutionize how libraries function and cater to their patrons.

The KOHA system is an integrated library solution available to all types and sizes of libraries. It's open-source, first developed in 1999 by Katipo Communications for the Horowhenua Library Trust in New Zealand. The core principle driving KOHA is promoting free information access and making library services more democratic. It has since gained worldwide recognition and adoption due to its flexibility, customization capabilities, and community-driven development model (Koha, 2023).

KOHA became a feasible and adaptable solution for libraries of all types when the influential Zebra indexing engine was incorporated into its 3.0 version launch in 2005.

Niranjana, et al. (2020), in their study "Implementation of KOHA Integrated Library Management System in Wollega University Main Library, Nekemte, Ethiopia" investigate the technical setup, Koha library software installation, customization process, and data migration process in the Wollega University Library. The library began implementing all of Koha's modules, including cataloguing, serial control, OPAC, and others, in May 2017. In September 2019, the KOHA version 17.05 was updated to KOHA 19.05 and the new functionality "email notification to users" was included.

In data mining, data classification algorithms are commonly used to separate data into distinct groups. The goal of machine learning is to teach a computer to learn from a variety of training and testing datasets, determining its own outcomes in each scenario without the need for explicit programming. Decision Trees are one machine learning technique. Decision Tree algorithms are employed in a variety of industries and applications. These algorithms can be utilised in search engines, medical certified fields, text extraction, and replacement statistical techniques to find data. Various decision tree algorithms have been developed based on the accuracy and effectiveness cost.

According to Patel and Prajapati (2018) in their paper, studied and analyze the ID3, C4.5, and CART decision tree algorithms. Classification is defined as the process of assigning objects to groups that have a wide range of potential uses. They concluded that CART executes algorithms in 0.5 seconds, ID3 in 0.02 seconds, and C4.5 in 0.06 seconds. CART has the slowest execution rate, while ID3 has the fastest.

While CART is the slowest algorithm—it takes far longer than the others—it has the best accuracy and produces results that are far more exact than those of ID3 and C4.5. It leads to the conclusion that, after comparing the three algorithms, the CART is the best option. Priyam, et al. (2013), in their investigation of three decision tree algorithms that are currently in use (ID3, C4.5, and CART) and applied to educational data in order to forecast exam success. In order to forecast a student's performance on the final exam, all algorithms are applied to the student's internal assessment data. The accuracy and time required to derive the tree can be used to compare the relative efficiency of different decision tree algorithms. The tutor has been able to identify the weaker students and help them do better thanks to the system's forecasts. Of the three methods, C4.5 offers the most accuracy and efficiency, making it the ideal choice for small datasets. When the training data is big, the serial decision tree algorithm's (ID3,

C4.5, and CART) primary drawback is its poor classification accuracy. However, all of these are limited to tiny datasets and necessitate the permanent storage of all or part of the dataset in memory. Their use for mining over big databases is thus limited.

RESEARCH GAP

Smart library automation and monitoring systems have revolutionized traditional library operations, offering enhanced efficiency, accessibility, and user experience. After reviewing other literatures, the current literature predominantly focuses on the features and implementation of existing systems, there exists a significant research gap in exploring the integration of emerging technologies and innovative approaches to enhance the functionality and effectiveness of smart library automation systems.

Despite the emphasis on user-centric design in smart library systems, there remains a gap in understanding and implementing advanced personalization techniques based on user preferences, behavior, and context as well as methods of cataloging. This research aims to find approaches to personalized content recommendations, adaptive user interfaces, as well as using Classification tree for cataloging of library materials within smart library automation systems to improve user engagement and satisfaction.

CONCLUSION

The research successfully designed and implemented a “Smart Library Automation and Monitoring System”, will emphasize the importance of web-based virtual libraries. The system will address challenges associated with traditional libraries, such as limited physical space, high costs, and accessibility issues. By creating a user-friendly interface and leveraging digital technology, the study contributes to enhancing information access for students and staff.

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