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AI-Powered Intelligent Library Management and Navigation System

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Abstract - There is a requirement for libraries to have reliable methods of managing books. This includes recording books, checking when books are available, issuing and returning books and helping users find the right book. This article provides a web based Smart Library Management System. Each book will have a unique identifier in the form of a QR code. This application was developed using Python and Django. It uses HTML, CSS, JavaScript and a database to manage the catalogue and transaction data. As an administrator you can manage books and students, whilst as a user/student you can search for books and view their locations. The application also allows issuing and returning books, calculating dates and fines for overdue books based on the library's rules. Emails can be sent if the SMTP settings are enabled and the workflow is set up. The QR code links the physical book to the digital version. Navigation around the shelves can be done using the location data stored in the database. In this paper we will discuss the architecture, methodology, implementation workflow, testing plan and advantages and disadvantages. Results from testing the application should be included.

Key Words: Library Management, QR Code, Django, Book Tracking, Shelf Navigation, Web Application.

1. INTRODUCTION

Libraries provide books, references and other study materials to the students and faculty members. In case of manual or partial computerization, the The employees will have to spend time searching for the book in the catalog, updating issuance and return logs, checking for availability and helping readers find the book. This can cause inconsistencies within the system as the records may not be updated in a timely manner.

This idea proposes developing a web based library system where a QR code containing the book's ID would be added to the record. Those with permissions would have access to the application via their browser. The application would display the information of the book, including its status of the transaction and where it is located on the shelf as set by the administrator. The key aim of developing this is to make the library easier to manage.

The system would be based on the software. While the identification number of the book would be revealed from the QR scan, there is no way to independently locate the exact place where the book stands.

2. LITERATURE REVIEW

1. "Integration of Web-Based and Mobile Application with QR Code Implementation for Library Management System" — A. Prathama (2025)

The focus of this paper is on using web based and mobile applications in combination with QR code technology to increase efficiency within Library Management. The web based system offers centralised access to library management by providing a platform for managing books, user records and library activities. The mobile application provides users with an easy way to interact with library services. QR codes allow an easy way to identify books and find information quickly. This can be used to help manage inventory, track books and provide efficient communication between users and the library system. This aims to increase ease of access, reduce tedious repetitive tasks and provide an easy way to manage library resources.

2. "A Smart QR-Based Library Management System" — P. K. Mishra (2024)

This paper proposes a new intelligent library management system using QR codes. Each book can be given its own unique QR code that will either store or be used to identify their corresponding records in the database. This will give access to information relating to a book when scanned which can be used in processes such as issuing and returning books. The authentication can give assurance that only authorised users have access. Using QR codes in conjunction with a central database will make information more accurate and reduce the paper work. It will also

make managing books and users much easier. Overall providing a foundation for automation to be added into library applications.

3. "QR Code Based Library Management System" — R. Patel (2024)

This paper presents a QR based Library Management System that can manage data and transactions within the library. Users have login access to the system, alongside book management and tracking. Scan QR codes to easily find books. This means that book details do not need to be manually entered into the library. An administrator can manage the availability of books. This solution will improve circulation of books efficiently. It will become easier to keep track of records and reduce errors in traditional paper based systems.

4. "QR Codes Making Smart and Effective Library Services" — L. Wang (2024)

This paper looks at how QR codes are being used in libraries to provide efficient modern library services. QR codes allow physical resources such as books and library resources to be connected to information on the internet. This makes it easier for users to locate the correct information by using their smartphone or scanning device. QR codes make information about books more accessible and easier to find resources within the library. QR codes will give users an easy way to access digital services. This will reduce the amount of work required to find the information they want. Overall this shows that QR codes can be used to help improve library services to make them more accessible, efficient and convenient.

3. METHODOLOGY

A. Problem Statement:

- Manual methods are often used in traditional systems. This can cause problems such as taking a lot of time and effort to do things like register books, search for books, issue books, return books and manage stock. Manual data entry can also cause issues with data accuracy, duplication and book information not being accurate. With more books and users in the library it can become difficult to keep the record up to date and accurate.
- Another issue is being able to find specific books. If students know what the title or topic is they may not know where to find it. This can become an issue if the library has many books split into sections. Time can be wasted looking for the right section and students might need employee help. A system that shows the location of the book can help make this easier.
- There are many issues when managing the book circulation process. This includes manual data entry such as recording issue dates, calculating due dates, checking if books are past their due date and calculating the fines. This can cause errors in calculations and cause delays within the process. Students will also often forget what date they should return the books by. A centralised system would help with this as it would keep a record of transactions and allow calculations and notifications to be done automatically.
- Security is also a factor to take into consideration. Features such as adding books, editing and viewing transaction history should only be accessible by authorised staff members. A good system would also have secure and accurate records. This would ensure that the administration features were safe to use. The system should also be easy to use for students and staff
- This system is designed to overcome these issues. It includes a QR code based library system which allows books to be identified, a web based library management system, database driven navigation of shelves, book circulation, calculation of overdue fines and email notifications. The application will help to reduce time spent on repetitive tasks, ensure accurate data and provide an easy way to access library services.

B. Objectives of the Proposed System

The major objectives of the proposed system are:

1. Django-based Web Application for a secure Library Management System.
2. To implement QR code generation and scanning for convenient book identification.
3. To maintain centralized records of books, students, and library transactions.
4. To automate book issuing, returning, due-date tracking, and overdue fine calculation.
5. To provide shelf, row, and column information to help users locate books.
6. To provide email notifications and reminders for relevant library activities.
7. To improve the efficiency of library administration and reduce manual record maintenance.
8. To provide an organized dashboard for monitoring book availability and transaction history.
9. To incorporate AI-based assistance where implemented, helping users interact with the library system and obtain relevant information.

C. Proposed System Architecture

The first step in this system is gathering all the relevant data about the books, students, and transactions. Information on the books could include unique IDs, title of the book, author, category, availability, and the physical position of the book in the library. Students' information will include their relevant identification and authentication credentials.

The gathered data will be placed into the database within the application. Each book will be given an ID so the data can be retrieved by the application without the user having to enter all the details of the book. The shelf data is stored by using pre set shelf, row and column data.

The database will contain circulation data such as issuance date, due date, return date, and fines applicable. This will enable the application to identify if the book is available, if it is issued, or if it is overdue.

D. Data Collection and Database Design

Information gathering starts from gathering the relevant information relating to the books, students, and transactions in the library. This information can include the ID of the book, its title, author, categorization, availability, and shelving details. Information relating to the students entails the details needed for identification.

The information is stored within the application database. Every book has a unique ID which the application can access the information using. Users don't have to type in any information as every book has an ID. The shelving information is fixed with specific shelf numbers, row numbers and column numbers.

There will be a circulation database that will contain information such as issue dates, due dates and fine amounts. This information will allow us to know if the book is available, on loan or overdue.

E. QR Code Generation and Book Identification

The QR code has been implemented so that when books are added by the administrator, a QR Code is created for that book based off the unique ID. This can be printed and attached to the relevant book.

After scanning the QR code via any scanning interface, the application will open that books entry. Depending on what permissions the user has, the application can show the title, author, category, availability status and shelf number.

This means that no manual input of book IDs is needed, which makes it much easier for users to get the information they need. The QR code acts as a link to the entry within the database. As a result, the QR code does not need to hold all the information about the book. Any changes to the information stored will automatically be accessed.

G. Book Issue and Return Management

The circulation module will manage the process of issuing and returning books from the library. When a book needs to be issued, it will check if its status is available and create a new transaction. The transaction may include data like the students ID, the books ID, the date issued and the return date.

When the issue process has been completed the books status will change to unavailable as it cannot be issued again. This stops any issues with the transactions.

When the book is returned the system will pull up the previous issue transaction and log when the book was returned. It will also change the status to available again based on the business rules. The transaction will still be logged into the database so that authorised staff can look at it.

H. Due-Date Tracking and Fine Calculation

As discussed earlier this system can be constructed so that there is a way to check when a book is due back and for calculating overdue fines. For every issue transaction the due date will be stored.

If the book is returned before the due date then no fine will apply. If it is returned after the due date then the total amount of days overdue will be calculated and the relevant fine charged per day.

I. Email Notification and Reminder System

Email alerts can be added to inform about library events. The app will include alerts to confirm that a book transaction has been completed and will notify when a book is approaching its return date.

When the alert is scheduled it will look for active transactions. It will then find any books which are approaching their return dates. If there are any matching transactions then it will create an alert email containing information about the book and return details.

Correct SMTP details will need to be put into the alert email settings. There also needs to be background tasks running. The app should not send duplicate alerts for the same transaction and reminder period.

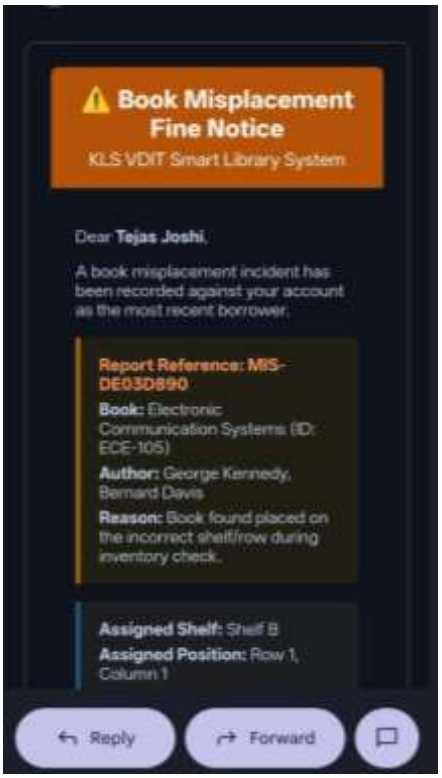
J. User Authentication and Access Control

Authentication will help distinguish between logged in users and those who are not. This will help us determine if the user is who they claim to be.

Role based authorisation could be used to separate the students and admin users. Students may have permission to search for books, look up book information and view transaction history. Admin users may have permission to add books to the database, manage records, view issued books and more.

These restrictions mean there will be no unauthorised changes made to the library records. The validations and permissions must be done on the server side.

K. AI-Based Assistance



The admin login feature can be used to access the library administration modules. This allows the admins to manage the library books, student details, QR Codes and transactions. The system could use an authorisation process to allow the admin to enter. This would involve the principals/authorities reviewing any applications. Only authorised users should be allowed to access this. The homepage is the main page of the Smart Library Management System. This helps to introduce the software and provides access to the main features of the library. Users can scroll through the options for searching for books and other information. The homepage is simple to use and will give users an easy understanding of the library system. This will help users get to the log in and register options. Making it easy for students and admins to access the modules.

L. Book Misplacement Reporting and Fine Notification

This feature allows the library admin to note any books that have been misplaced when being physically checked by them. They can also search for the book using its unique book ID and view the book details, allocated shelf positions and last person who borrowed it. Once they have confirmed that the book has been misplaced, they can submit the report. There will be a fixed fine of ₹100 added to their account for misplacing the book. A unique report reference number will then be created and the admin will receive an automatic email to their registered email address, with the details of the book, allocated shelf position, fine and report details. The details of the misplace book and whether they have paid will be stored in the database. This helps improve organisation within the library, keeping staff accountable and avoids having to manually record this information.

IMPLEMENTATION

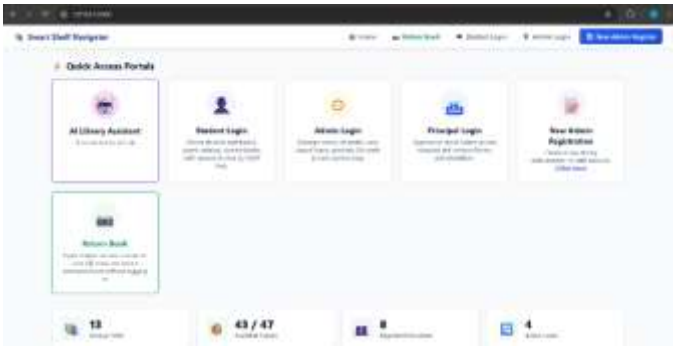


Fig:1- Home Page

The Administrator Login will allow access to the modules of the library administration. This will allow the administrator to manage books, student information, QR codes and transactions within the library. The system could also have an authentication process where a principal/authority figure will review applications. Only authorised people should be allowed access. The homepage is the main page of the Smart Library Management System. This page introduces what the software can do and provides access to key features. Users can navigate through to search for books and information. The homepage is designed to be user-friendly so that users can easily understand the library system. The homepage will give users access to the login and register areas, making it easier for students and administrators to access modules.



Fig:2- User Registration Page

Login module which provides access to the library administration. The registered administrator can manage books, student information, QR codes and transactions. The system can be designed in such a way that it requires the administrator to be approved by an approved

authority/Principal for them to be registered within the system. The registered administrator will only be able to utilise the administrator functions. This reduces the possibility of manipulating any library records.



Fig:3- Administrator Login and Approval

This module allows users to log in as an administrator. The administrator has control over library management functions including managing books, student information, QR code information and library transactions. When registering an administrator there is an option to enable an approval system so only a set principal/authority can approve any new logins. Only approved administrators should have access to restricted administrator functions.



Fig:4- Administrator Dashboard

The administrator's dashboard is a one-stop platform that gives an overview of what is happening within the library. It enables the administrator to access the various management tools using a single application. This can include information regarding the books, student details, books issued, and books that are still available. Additionally, there is provision of navigation to book registration, QR code generation, and transactions. This eliminates the need for using different applications. The dashboard helps to streamline administrative operations. It offers a convenient interface for library administration. The data presented is dependent on the data in the database.

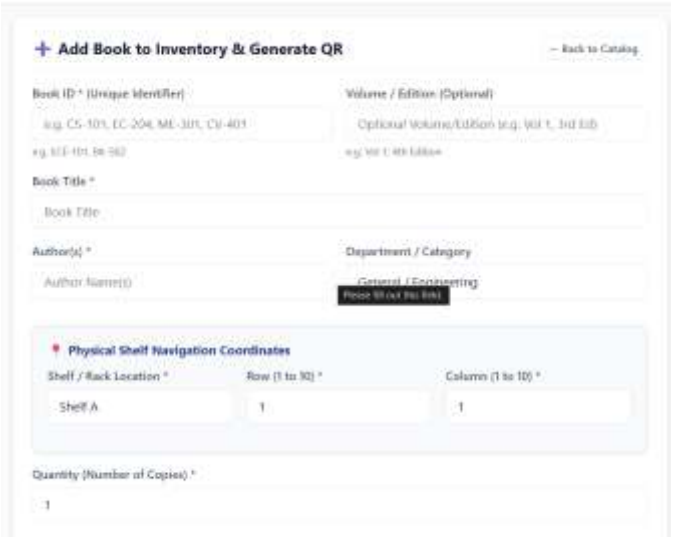


Fig:5- Add Book Module

Add Book module is used by the administrators to add new books in the database of the library. The administrator has to enter the book's ID number, its title, author, category, and other necessary information. Information about the shelf number, row number, and column number of the book is also maintained by this module. Once the registration process is successful, all the information entered by the administrator is saved by the application in the database. This information will be used by the Search and Circulation modules.



Fig:6- QR Code Generation

The QR Code Generation functionality produces a unique QR code corresponding to each registered book. The QR code is associated with the particular identifier of the book stored in the database. Administrators have the ability to generate and access QR codes for registered books. These codes may be printed out and affixed to the physical copies of the books. By scanning the QR code using the scanning interface that is provided, the corresponding book can be retrieved. The necessity to input book identification information manually will be reduced.

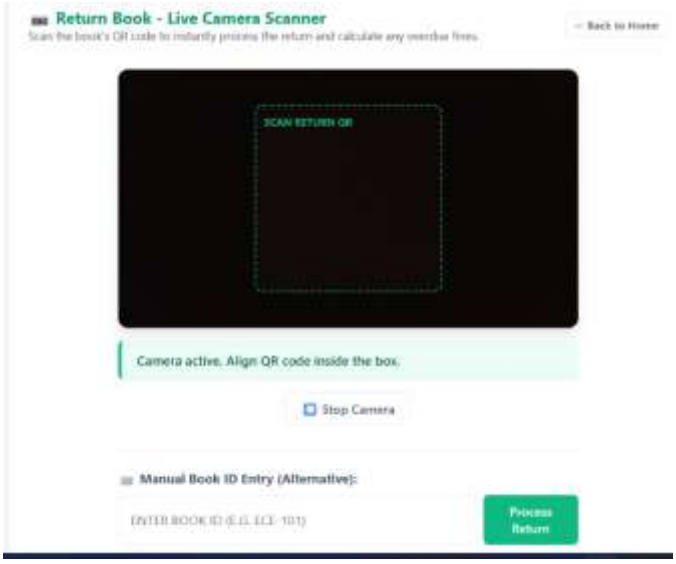


Fig:7- Book Return Module

The This module will handle returning the books. When returning a book within the application, an issue transaction will be retrieved and the return date added. Once the transaction has been completed, the availability of the book will be updated. The system can also calculate if the book was returned late by comparing the return date against the due date and calculate any fines. The transactions will be stored within the database for tracking.

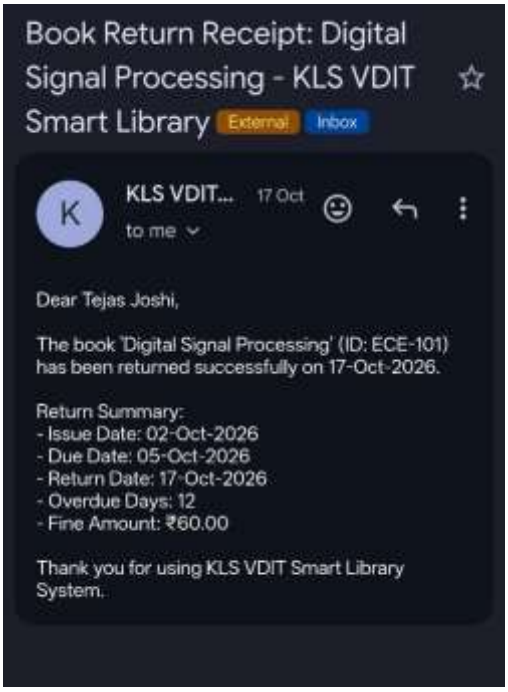


Fig:8- Fine Calculation Module

This section of the program is used to calculate late penalties for returned books. It looks at the date the book was returned and compares it to the date it should have been returned. From this information and using the daily penalty set it calculates the total amount of penalty that should be paid. This helps to eliminate any human error when calculating penalties and can help to manage penalties systematically within the library.

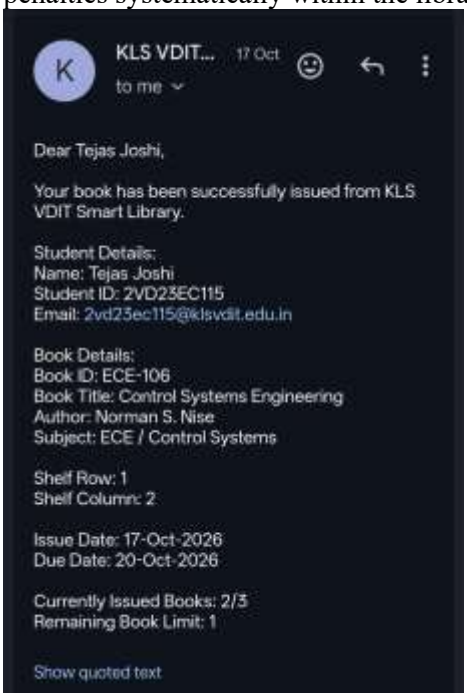


Fig:9- Book Taken Email

The email notification module provides a means of communication between the library and its users. This allows confirmation emails to be sent if an action was successfully completed within the library. It can also be programmed to send reminder emails to the user a few days before their books are due to be returned, for example 2 days before. Using the users email address the notifications ensure they are kept up to date with when they have to return their books.

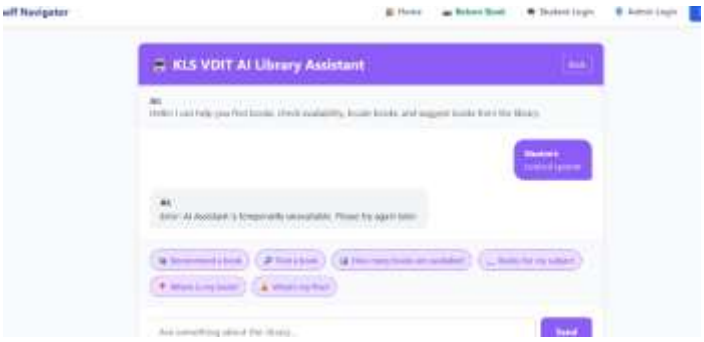


Fig:8- AI Chatbot / Assistant

The chatbot uses AI to create an alternative way to interact with the library application. Users can ask questions relating to the library services and receive answers from the integrated AI service. This will help users to understand how to search for books in the library, what functions the library has and how to use the library. This allows users to communicate using natural language. The AI service is integrated using an API. It operates based on its features.

5. CONCLUSIONS

This AI-Powered Smart Library Management and Shelf Navigation System allows you to have an efficient way to manage library activities using a web-based system. This system contains many functions such as QR-code based book recognition, managing a database, searching for books, issuing and returning books and navigating to the correct shelf. It can also automatically manage due dates, calculate any fines for late books and send emails.

The software allows you to reduce the amount of paper work you have to do, increase the accuracy of your library activities and easily view book data. The shelf navigation feature will allow you to see what shelf number, row number and column number the selected book is registered under. Using the admin authentication and access control will keep your library activities secure.

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