Smart library automation using face recognition

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Abstract: The Library Automation System is gaining more importance as the number of its users is increasing. Automation of libraries reduces the duplication of work, saves time, and brings accuracy and speed. It also increases efficiency in library services and boosts the quality of work. One such effective system is the Smart Library Automation System using Face Recognition. The Proposed system uses face recognition for entering and getting the details of an end user. Through this application, the book gets issued to the end-user by identifying the user with the help of face recognition and identifying the book using barcode capture. In our system, we are using dlib face recognition, which is 99.38% accurate. We have provided the validations on the user registration form so that we get the right information. The registration process captures the face of the user and book issue, and the book return process checks the details of the user. End-users of the application will be librarians, students, and teachers. Our project aims at making the tasks of the library easy and to make the book issuing and returning process more interactive and effortless for the user. Also, our system is responsible for preserving the details of book issue and return and paperless report generation.

Keywords: Book issue, Face recognition, Barcode detection, Library management

1. Introduction: Despite the increasing availability of digital books, many still choose to read physical books, and here comes the concept of borrowing a book from the library. Various manual tasks such as asking for a required book to librarian, checking if a book is available, keeping a record of newly added books and maintaining book copies record, collecting data into excel sheet for analysis, maintaining issue and return records along with fine calculation are all done by our system on a single click. The system aims to simplify the tasks and save the time of both the librarian and the user. For issuing and returning the book our system uses a face recognition model which helps to identify the registered user, and book barcode capture to identify the book name. This paper begins with a background analysis of this library automation idea, detailed problem statement and objectives. It contains our proposed solution, its approach, working methodology, and flow of the system. Finally, the actual implementation is described along with code snippets and screenshots.

1.1. Problem statement, and Objective:
The traditional academic library management system consists of a lot of repetitive work whenever a student comes to borrow the book; the librarian has to bring the book and then issue it to the student and have to maintain the record in a diary each time. Also, the students have to wait if there is a queue
for borrowing the book. Therefore, there is a need to automate this process to save time and avoid repetitive work. We have to make the book issuing and returning process more interactive and effortless for the user.

2. Background Study:

2.1. Library management:

2.1.1. Library management manually:
Manual library management puts pressure on people to be correct in all details of their work at all times, the problem is that all people are not perfect. With the use of manual systems, the level of dependency is increased concerning resources like manpower. It takes efforts and a lot of space to keep track of all the paper documents to seek out the knowledge and to keep the small print secure. When mistakes occur or corrections are required, the whole document needed to be check once more.

2.1.2. Computerized library management:
The computerized library management system is helpful for librarians because it makes it easier to manage daily activities in electronic format. It reduces the paperwork maintaining the reports or documents, etc. Library automation refers to the simplification of library operations mainly by using computerized systems. The system has advanced features like user login and a teacher login, which are not available in traditional library management systems. It also has an admin login facility through which it can monitor the whole system.

2.2. Existing Library Automation Systems:

2.2.1. Intelligent Library Based on RFID Technology:
This system is build using Radio Frequency Identification (RFID). It is a self-service borrowing system, and an intelligent security door system. One drawback of such systems is the user has to maintain the identity card for borrowing the book. [1]

2.2.2. Library Management System with Facial Biometric Authentication:
This type of system is generally used to authenticate the user to provide entry into the library. [2] It does not give information about available books in the library, and also does not help the librarian to handle the book database.

2.2.3 Library Management Using Real Time Face Recognition System:
It consists of a real-time attendance system based on human face recognition. This system helps to issue the book by recognizing the face of the user and maintains the database. The drawback of the system is the user cannot search for the available books and also the user interface is not much friendly.

3. Proposed Solution: To eliminate the drawbacks of the traditional system, we have added new features in our system like issuing the book using face recognition and automatic generation of a report. Our proposed system consists of face recognition and book barcode recognition system for automating the issuing and returning of the book. We aimed to develop the system for an academic library, so it consists of the following modules:

3.1. Librarian Module:
A librarian can add the books, search the books, update student and teacher record, and generate a report.

3.2. Student / Teacher Module:
Students and teachers have to complete the registration first by entering the details along with capturing the face. After registration, they can search whether the required book is available or not and can issue or return the books by holding it and standing in front of our system with a webcam.

Figure 1. System Architecture

The system architecture diagram given above represents how the system is structured to fulfill the needs of the user. During the process of issuing and returning the book, as the date of returning the book is already defined if the user exceeds the date then he/she has to pay the fine. The amount of fine will get notified to the user immediately after returning the book.

3.3. Salient features of the system:
   a. Automated book issue and return system using face recognition
   b. Preserve details of book issue and return
   c. Responsive interface for end users
   d. Eliminate the repetitive work of a librarian
   e. Paperless report generation

3.4. Advantages of the proposed system:
   3.4.1. Easy to Use: Automation in the process of issuing and borrowing the book provides the ease in doing this. Users need not maintain their login ID and password. Also, there is no need to bring the cards every time.
3.4.2. Increased Library Engagement: Avoid frustration and tediousness by providing students with their access to library resources. Library Management Software allows the librarian to maintain all types of books, and student and teacher events.

3.4.3. Fine Calculation: The calculation of fines turned out to be simple. The product automatically calculates fine utilizing due dates.

3.4.4. Time Saver: Previously librarian has to go and check whether the book is available or not and if available then how many copies are there. But this process was taking too much time and users had to wait for the issuing process. Therefore our system shows the number of available book copies when the user searches for it.

3.4.5. Productivity of library workers: Automating your day to day processes will increase productivity. A Library System ensures that the workers spend their time doing what is important.

4. System Design:

![System Design](image)

The aim of designing the system is to fulfill the requirements of end-users and provide an effective solution to the drawbacks of the existing system. Therefore, we came with the design which consists of the following functional components as User registration, Add Book, Book issue, Book Return, Search Book, Report generation, and fine payment. Figure 2 is showing the design of the system.

4.1. User Registration: This component takes the details of the student along with the face picture and stores it into the database. The System converts the face capture into face encoding array by extracting the features using python’s dlib library. Then the face encoding gets stored into the database for user identification at the time of issuing or returning the book. Face encoding process is depicted in Figure 3.

![Face encoding process](image)
4.2. **Add Book**: Librarian is responsible for adding the new book details and the copies of the book. This component lets the librarian add book copies by capturing the book barcode.

4.3. **Book Issue**: After registration, the user (student/teacher) can issue the book. This component provides the user interface for users where users can capture their faces and the book barcode. Then the system verifies users, identifies the book, and stores the book issue event into the database.

4.4. **Book Return**: This component has a similar user interface as the book issue. The user does the same process and the book return event gets stored into the database.

4.5. **Search Book**: Before issuing the book, the user can search if the book is available or not. This component gives all the details required such as how many copies are available and how many books are remaining.

4.6. **Report Generation**: Librarian can get the report of available book copies and report of book issue and return.

4.7. **Fine Payment**: Sometimes user returns the book after the expected book return date exceeds. At this time user has to pay the fine. This component calculates the fine and notifies the user.

5. **System Requirements**:

5.1 **Hardware Requirements**:

5.1.1. **Webcam**

5.1.2. **Computer**:

- Core i3 processor (5th Generation min.)
- RAM - 4GB
- Hard Disk - 1GB

5.2. **Software Requirements**:

- Frontend: HTML, CSS, Bootstrap, Angular 8, Node.js, JavaScript, and TypeScript
- Backend: Python, Flask REST API, and XAMPP
- Database: SQL

6. **Implementation Results**:

In this section, the proposed system implementations with the screen shots are briefed out.

6.1. **User Registration**: The registration window consists of input fields for entering the details of the user and the face capture module.
6.1 User Registration window

6.2 Form validation: The registration module consists of form validation. User should capture their face accurately.

6.3 User Identification: At the time of issuing and returning the book, the system does the verification of the user’s identity.
6.3 User identification

6.4. Book Issuing Process: After the identification of the user, system captures the book barcode and identifies the book. Then the book gets issued to the user.
6.4 Book identification and issuing book to the user

6.5. Book Returning Process: This process is similar to issuing the book. After the user and the book identification, the book gets returned and the event gets stored in the database.

6.5 Returning book

6.6. Add new book: To add the new book librarian can enter all the details as shown below

6.6 Add New Book
6.7. View, add and delete book copies: Librarian can add the multiple book copies by capturing the barcode on the book. Also can view the available number of book copies and delete the copies if required.

7. Conclusion: The traditional library system stores the book issue and returning data manually. Thus it is necessary to automate the existing library system to save the manpower as well as time. This project is developed based on more need for automating the library work and making the process of book issuing and returning more interactive and easeful for the users. The system consists of a face recognition model with high accuracy and can identify the user efficiently at the time of issuing and returning the book. Therefore, users need not carry identity cards and there is no need to remember the username and password every time. The system can be well suited for academic libraries, school libraries as well as public libraries.

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