A SMART LIBRARY INVENTORY SYSTEM BASED ON BOOK PINE TEXT RECOGNITION

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ABSTRACT
Efficient management of library resources is essential for educational institutions, research centers, and public libraries. Traditional library inventory systems rely heavily on manual verification or barcode scanning techniques, which require significant human effort and time. Although technologies such as RFID have improved automation, their implementation cost remains high for many institutions. This research proposes a smart library inventory system that uses computer vision and optical character recognition (OCR) techniques to identify books directly from the text printed on their spines. The system captures images of bookshelves using a camera, detects book spines from the image, and extracts textual information such as book titles and author names. The extracted text is the matched with a digital library database to verify the presence and location of books. This automated approach minimizes manual effort, improves inventory accuracy, and speeds up the library management process. The proposed system demonstrates how artificial intelligence and image processing can be integrated into library management systems to enhance efficiency and reliability. The study also discusses system design, implementation methods, challenges, and potential improvements for future research.
Keywords: Library Automation, Computer Vision, Book Spine Recognition, Optical Character Recognition, Smart Inventory Management.

1. INTRODUCTION

Libraries play a vital role in providing knowledge and information resources to students, researchers, and the general public. Managing a large number of books and ensuring their proper organization is one of the primary responsibilities of library staff. Inventory management is particularly important because it helps libraries keep track of available, borrowed, and misplaced books.

Traditionally, librarians perform inventory checks by manually examining shelves and comparing books with the library database [1]. This process can be extremely time-consuming, particularly in large libraries where thousands of books are arranged across multiple shelves. Manual checking may also lead to human errors, such as overlooking misplaced books or incorrectly updating records [2].

To improve efficiency, many libraries introduced barcode-based systems. In these systems, each book is assigned a barcode that can be scanned during borrowing and returning processes [3]. While barcode systems make circulation management easier, they still require each book to be physically handled and scanned individually during inventory checks.

With recent advancements in computer vision and machine learning technologies, it has become possible to automate many tasks that previously required manual effort. By using image processing and OCR techniques, books can be identified directly from their spine text without removing them from the shelf. This study explores the development of a smart inventory system that uses these technologies to simplify and automate library management tasks.

2. LITERATURE SURVEY

Several research studies have explored the use of computer vision and text recognition techniques for improving library management systems. Traditional library inventory systems rely heavily on manual cataloging and barcode scanning, which can be time-consuming and require significant human effort [4-6]. To overcome these limitations, researchers have investigated automated approaches that use image processing and Optical Character Recognition (OCR) to identify books directly from their visual features, particularly the text printed on book spines [7].

Earlier studies focused on basic image processing techniques to detect book spines from shelf images. These approaches used edge detection, segmentation, and contour detection methods to identify the vertical regions corresponding to book spines [8-9]. Once the spine regions were detected, the images were processed to enhance text visibility. Although these methods were able to detect book regions successfully, they sometimes struggled with variations in lighting conditions, text orientation, and overlapping books [10].

Recent research has incorporated OCR technology to extract textual information from book spine images. OCR engines such as Tesseract have been widely used to convert printed characters into machine-readable text [11-13]. By extracting metadata such as book titles, authors, and publisher

information, these systems can automatically match the recognized text with library database records [14]. This approach significantly reduces the need for manual data entry and improves the efficiency of inventory management.

In addition to OCR-based methods, some researchers have explored machine learning and deep learning techniques to improve text detection and recognition accuracy [15]. Convolutional Neural Networks (CNNs) and other deep learning models can learn complex visual patterns and perform better in challenging conditions such as rotated text, low image quality, or partially visible book spines [16]. These advanced techniques have shown promising results in improving the reliability of automated book recognition systems.

Overall, the literature indicates that combining image processing, OCR, and intelligent recognition methods can greatly enhance library inventory management [17-18]. These technologies enable libraries to automate the process of identifying and tracking books on shelves, reducing manual effort and improving accuracy [19]. The proposed smart library inventory system builds upon these existing research contributions by integrating book spine detection and text recognition techniques to create a more efficient and practical inventory management solution.

3. PROPOSED METHODOLOGY

i. User Interface

The User Interface (UI) module provides a simple and interactive platform that allows librarians or users to interact with the smart library inventory system. Through this interface, users can upload or capture images of bookshelves, view the detected book spine regions, and check the text extracted by the OCR system. The interface also displays important information such as book titles, authors, and inventory status retrieved from the database. Additionally, it allows users to review recognition results, identify missing or misplaced books, and generate inventory reports. A user-friendly interface helps library staff operate the system easily and manage library records more efficiently.

ii. Image Acquisition

The Image Acquisition module is responsible for capturing images of bookshelves using a digital camera, webcam, or mobile device. These images contain the visible spines of books placed on library shelves. The captured images act as the primary input to the system and are important for accurate recognition. Proper lighting and clear image resolution help improve the visibility of the book spine text, which increases the effectiveness of the recognition process.

iii. Book Spine Detection

The Book Spine Detection module identifies and separates individual book spines from the captured bookshelf image. Image processing techniques such as edge detection, contour detection, and segmentation are used to locate the vertical regions representing book spines. This step is important because it isolates the relevant parts of the image where the text is present. Once detected, the spine regions are extracted and prepared for text recognition in the next stage.

iv. OCR & Metadata Extraction

The OCR and Metadata Extraction module reads the text printed on the detected book spines using Optical Character Recognition (OCR) technology. The OCR engine analyzes the spine images and converts the printed characters into digital text. This text usually includes important metadata such as the book title, author name, or publisher information. The extracted data is cleaned and formatted before being used to identify the book in the system.

4. ARCHITECTURE

The architecture of the smart library inventory system describes how different components of the system interact to identify books from shelf images and update the library inventory. The system begins with the image acquisition component, where a camera or mobile device captures images of bookshelves. These images serve as the primary input to the system and contain the visible spines of books arranged on the shelves.

After the images are captured, they are sent to the image processing and book spine detection module. In this stage, image preprocessing techniques such as resizing, noise removal, and contrast adjustment are applied to improve image quality. Edge detection and segmentation techniques are then used to identify the regions that contain individual book spines. This step ensures that only the relevant portions of the image are processed for text recognition.

The detected spine regions are passed to the OCR and metadata extraction module. Optical Character Recognition technology reads the text printed on the book spines and converts it into machine-readable format. The extracted text usually includes information such as the book title, author name, or publisher details. This textual information is cleaned and prepared for comparison with the library database. Finally, the processed text is sent to the library inventory management module, which matches the extracted metadata with records stored in the database. If the system finds a match, it confirms the presence of the book and updates its status in the inventory. The results are then displayed through the user interface, where librarians can view recognized books, detect missing items, and generate inventory reports.

5. RESULT

The implementation of the smart library inventory system demonstrated that book identification using spine text recognition is both practical and efficient. The system was able to capture images of bookshelves and successfully detect book spine regions using image processing techniques. After detecting the spine areas, the OCR module extracted textual information such as book titles and author names. The extracted text was then matched with the library database to identify the corresponding books. The results showed that the system could correctly recognize most books when the images were clear and the text on the spines was visible.

During testing, the system processed multiple bookshelf images containing several books placed close to each other. The image preprocessing steps such as noise reduction and contrast adjustment significantly improved the quality of the images, which helped the OCR engine recognize text more accurately. The recognition accuracy was higher when the lighting conditions were adequate and the book titles were clearly printed. In many cases, the system successfully identified books without requiring any manual intervention.

The results also showed that the proposed system reduced the time required for library inventory verification. Instead of manually scanning each book using a barcode scanner, librarians could capture images of shelves and allow the system to analyze them automatically.

This process made it easier to identify missing or misplaced books quickly. As a result, the overall efficiency of inventory management improved significantly compared to traditional methods.

6. CONCLUSION & FUTURE SCOPE

The Smart Library Inventory System based on book spine text recognition provides an efficient and automated approach to managing library collections. Traditional inventory management in libraries often involves manual checking of books on shelves, which is time-consuming and may lead to errors. The proposed system addresses this problem by using image processing and Optical Character Recognition (OCR) to identify books directly from images of their spines. By capturing shelf images, detecting book spine regions, and extracting textual information such as titles and authors, the system can automatically compare this data with the library database.

This process helps librarians quickly identify available, missing, or misplaced books and significantly reduces the time and effort required for inventory management. Overall, the system demonstrates how computer vision and text recognition technologies can improve the efficiency and accuracy of library operations.

In the future, the system can be further improved by integrating advanced deep learning techniques to enhance text detection and recognition accuracy, especially in challenging conditions such as low lighting, rotated books, or partially visible spines. A mobile application could also be developed to allow librarians to scan bookshelves using smartphones, making the system more flexible and convenient. Additionally, integrating the system with cloud platforms would enable centralized inventory management across multiple libraries.

Combining spine recognition with other technologies such as RFID or barcode scanning could further improve reliability and performance. These enhancements would make the system more scalable, intelligent, and suitable for modern digital library environments.

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