International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 10 Issue: 10 | Oct - 2026 SJIF Rating: 8.659 ISSN: 2582-3930

AI-Based Digital Library Assistant

1.Prof. J. S. Kavathekar, 2.Anushka A. Budhe,3. Shreya V. Chavan

Assistant professor ,Student member,Student member of

DR.ASHOK GUJAR TECHNICAL INSTITUTE'S

DR.DAULTRAO AHER COLLEGE OF ENGINEERING, KARAD

Department of Electronics and Telecommunication Engineering

Shivaji University,Kolhapur

Abstract -Managing a library by hand is slow: finding a title, recording a loan, chasing overdue items and guarding the stock all depend on staff time and attention. This paper describes the design of a voice-enabled Digital Library Assistant that brings Artificial Intelligence (AI), the Internet of Things (IoT) and Radio Frequency Identification (RFID) together on a low-cost ESP32 platform. A reader can ask for a book by speaking; the system looks the title up in a cloud database and replies by voice and on a display with its availability and shelf position. RFID tags on cards and books let issue and return happen without manual entry, a companion mobile application keeps digital records and sends due-date reminders, and an exit gate with an alarm warns when a book leaves without being issued. A servo-driven return box and a librarian dashboard complete the design. The prototype is planned for testing in a college library setting and is expected to cut routine effort, speed up retrieval and improve security, in line with the Smart Library concept and the Digital India mission.

Key Words: Smart Library, Artificial Intelligence, Internet of Things, RFID, ESP32, Voice Recognition.

1. INTRODUCTION

A library is only as useful as the speed with which a reader can reach the right book. In many institutions this still depends on catalogue cards or basic software, a staff member at the desk to record every loan, and periodic stock checks by hand. These routines are slow, easy to get wrong, and become harder to sustain as collections and membership grow.

Several technologies are now cheap and mature enough to take over this work. RFID gives every book and member a machine-readable identity, low-power microcontrollers with built-in Wi-Fi connect devices to the cloud, and speech recognition lets people interact in natural language. Used together they allow a library that finds books on request, records transactions by itself, reminds borrowers and notices when something is taken away without permission. Such a library also fits the national push towards digital, citizen-friendly services under the Digital India programme.

In this paper we present the design of a Digital Library Assistant that combines these elements around one ESP32 controller. Section 2 surveys earlier work, Section 3 explains the shortcomings of conventional libraries, Section 4 sets out our aims and scope, Section 5 describes the architecture and its working, Section 6 lists the hardware, Section 7 describes the expected prototype, and Section 8 concludes.

2. LITERATURE REVIEW

The literature on library automation shows a steady move from stand-alone catalogue software towards connected systems that use AI, IoT, RFID, machine learning and cloud services. Across these studies the common goals are less manual work, dependable book tracking, quicker retrieval and a better experience for readers [1]-[4].

built a smart library management system on IoT, RFID and a Raspberry Pi. It handles issuing, returning, reservation, stock control and theft prevention, and adds AI-driven recommendation and prediction. Their results suggest that most routine staff intervention can be removed.

Achary and Rathnakar examined how RFID and IoT-based library systems perform in practice. They link the library's local network to the Internet and to cloud servers, use RFID for book identification, and analyse the factors that influence the performance of RFID readers and tags. Related IEEE studies of RFID smart shelves and smart bookshelves show that tagged books can be located and tracked automatically on the shelf.

A separate line of work applies machine learning to recommendation. Studies of university libraries propose personalized suggestions based on a reader's interests and borrowing history, and other work applies natural language processing to make book retrieval in an AI library assistant more flexible [3], [4]. These studies mostly address one function, such as tracking, recommendation or search. The present work instead places voice interaction, RFID transactions, mobile alerts and security on a single inexpensive controller.

3. PROBLEM IDENTIFICATION

Conventional libraries suffer from a set of linked problems. Recording loans and returns by hand takes time and invites mistakes, and finding a particular title in a large collection can take longer than reading it. Catalogue tools seldom offer spoken interaction, so readers who are visually impaired or in a hurry gain little from them.

Overdue reminders depend on someone noticing and writing to the borrower, so they arrive late or not at all. Books can leave the building unnoticed when there is no electronic check at the exit. Even a correctly catalogued book is hard to find if the reader is not told which shelf holds it, and the

librarian's time is largely spent on repetitive clerical tasks instead of helping users.

4. OBJECTIVES AND SCOPE

The main aim is to build an automated, intelligent library assistant that reduces clerical effort and improves the reader's experience. In particular, the work sets out to:

(i) identify members and books with RFID so that issue and return need no manual entry; (ii) accept spoken queries and answer with the title's availability and shelf location by voice and on a screen; (iii) keep records in a cloud database, expose them through a mobile application and send automatic due-date alerts; and (iv) detect unauthorized removal of books at an exit gate and receive returned books through a servo-controlled return box, then test the assembled prototype.

The design targets college and research libraries as well as public ones, where a modest number of tagged items and a Wi-Fi connection are enough to run it. Later versions could add personalized recommendations, richer mobile features, more extensive cloud storage and analytics on usage patterns.

5. PROPOSED SYSTEM

The architecture is centred on an ESP32 microcontroller, which gathers sensor inputs, interprets commands, drives the outputs and communicates over Wi-Fi. Input devices (microphone, RFID reader, IR sensor and push buttons) feed the controller, while the display, speaker, buzzer and LEDs present the results. The overall arrangement is given in Fig -1.

5.1 Voice search

The reader speaks a title or request into the microphone. A speech-to-text stage converts it into text, which the ESP32 turns into a query against the cloud (Firebase) database holding the catalogue, member data, transactions and due dates. The reply, containing the book name, whether a copy is in, and its shelf position, is shown on the OLED/LCD screen and in the mobile application and is spoken through the amplifier and speaker.

5.2 Issue and return with RFID

Each member card and book carries an RFID tag. Presenting a card and a book to the RC522 reader lets the controller recognise both, confirm eligibility in the database, and log the loan together with a return date. Three push buttons (issue, return, voice search) allow manual control, and LEDs report the state of the system. When a book is dropped into the return box, an IR sensor detects it, the reader identifies it, and a servo mechanism secures it, so the record is closed without staff action.

5.3 Reminders and mobile application

Since every transaction is stored with its due date, the system can compare these dates with the current date and push reminders to the borrower's phone. Through the same application, readers can search the catalogue and see availability and shelf location without visiting the library, and the application and database stay synchronized in both directions.

5.4 Security and administration

At the exit, an anti-theft gate checks the tag of every book that passes. If the book has not been issued, the controller sounds the buzzer and raises an alert. Staff use a librarian dashboard to maintain the catalogue, manage members, view transactions and produce reports.

5.5 Comparison with a conventional library

Table -1 summarizes how the proposed assistant differs from manual operation for the tasks identified in Section 3.

Table -1: Conventional library versus proposed assistant

Task	Conventional	Proposed
Finding a book	Manual catalogue search	Voice query with shelf location
Issue / return	Entered by staff	RFID, automatic
Overdue notice	Manual follow-up	Automatic mobile alert
Theft control	Visual check	Exit gate with buzzer
Records	Registers / local files	Cloud database, dashboard

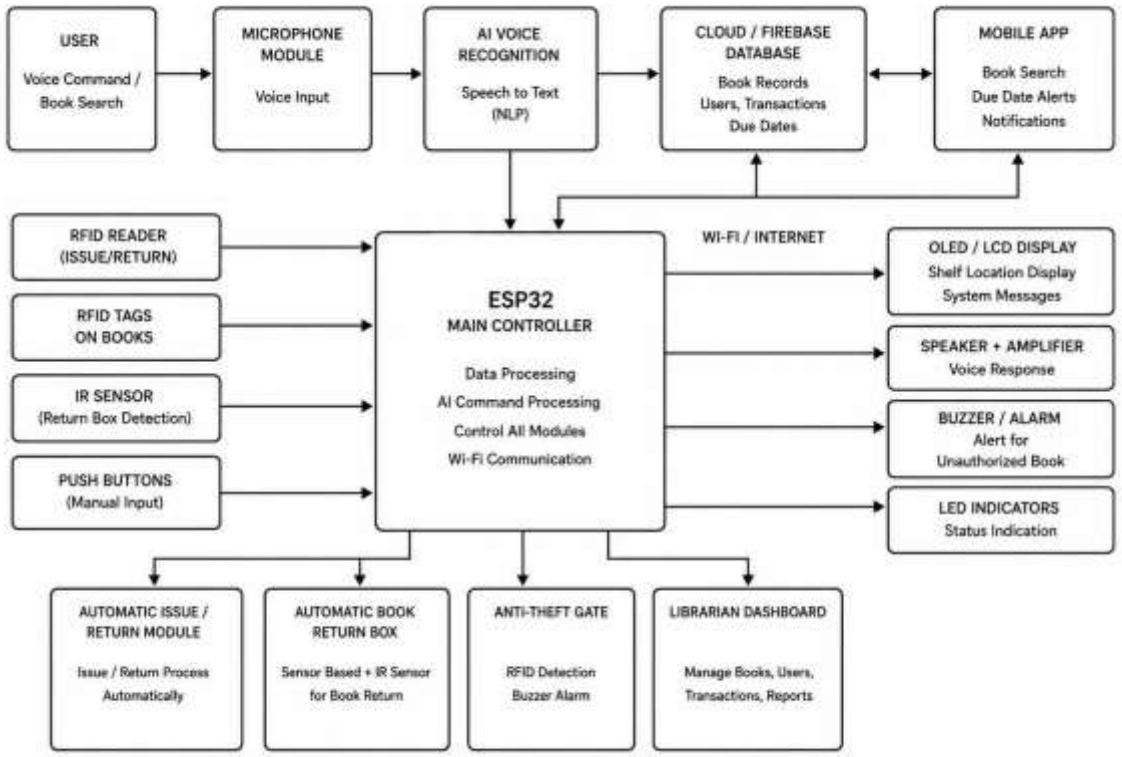


Fig -1: Block diagram of the Digital Library Assistant

6. HARDWARE SETUP

The prototype uses the ESP32 controller, a microphone and speech recognition stage, the cloud database with its mobile application, RFID reader and tags, IR sensors, push buttons, an OLED/LCD display, a speaker with amplifier, a buzzer, LED indicators, the return box and anti-theft gate, and a Wi-Fi link. The principal parts, with their approximate cost, are listed in Table -2.

Table -2: Major components and approximate cost

Sr. No.	Component	Qty.	Price (Rs.)
1	ESP32 DevKit	1	350-650
2	RC522 RFID reader	2	120
3	RFID cards/tags	20	25
4	0.96" OLED I2C display	2	200
5	IR obstacle/proximity sensors	4	50
6	2-channel relay module	2	200
7	Servo motor	2	150
8	12V electronic/solenoid lock	1	450
9	Buzzer	2	40
10	LEDs + 220/330 ohm resistors	1 set	50
11	Push buttons	4-6	40
12	Breadboard	2	150
13	Jumper wires	1 set	150
14	5V/12V power supplies	1	400
15	Connecting/USB cables	1 set	150
16	Project enclosure/acrylic model	1	700

Fig -2: Expected prototype of the Digital Library Assistant

The total outlay is estimated at about Rs. 6000, which is low enough for a student project and for small institutions to adopt

7. CONCLUSIONS

A Digital Library Assistant based on an ESP32 controller, RFID, cloud storage and speech recognition has been designed to address the slow search, manual transactions, late reminders and weak security of conventional libraries. Its low cost and modular structure make it suitable for colleges, research centers and public libraries. The next steps are to build and test the prototype, then to add recommendation features, extend the mobile application and cloud services, and use analytics to improve the service.

ACKNOWLEDGEMENT

The authors are grateful to the project guide, Prof. J. S. Kavathekar, and to the Head of the Department, Prof. R. K. Gurav, Department of Electronics & Telecommunication Engineering, Dr. Daulatrao Aher College of Engineering, Karad, for their guidance and encouragement.

REFERENCES

[1] Available: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=6384718
[2] Available: https://ieeexplore.ieee.org/document/10932399
[3] "Impact of AI on Library Management and the Future of Library Automation," ResearchGate. Available: https://www.researchgate.net/publication/390329464_IMPACT_OF_AI_ON_LIBRARY_MANAGEMENT_AND_THE_FUTURE_OF_LIBRARY_AUTOMATION
[4] "Developing an AI-Based Library Assistant: Enhancing Book Retrieval with Natural Language Processing and Machine Learning," ResearchGate. Available: https://www.researchgate.net/publication/390221494_Developing_an_AI-Based_Library_Assistant_Enhancing_Book_Retrieval_with_Natural_Language_Processing_and_Machine_Learning