NITTE (Deemed to be University) | NMAM INSTITUTE OF TECHNOLOGY

Internet of Things Laboratory (EC2601-1)

A Project report on

BOOK SMART: INTELLIGENT LIBRARY SEAT & BOOK MANAGEMENT

Submitted By

Shraddha Upadhyaya	NNM22EC158
Spoorthi Bhat K.	NNM22EC171
Sushmitha	NNM22EC185

DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

May 2025

NITTE (Deemed to be University) | NMAM INSTITUTE OF TECHNOLOGY

Department of Electronics and Communication Engineering

CERTIFICATE

This is to certify that **Shraddha Upadhyaya (NNM22EC158), Spoorthi Bhat K. (NNM22EC171), Sushmitha (NNM22EC185),** bonafide students of N.M.A.M. Institute of Technology, Nitte have submitted the report for the project entitled "**BOOK SMART: INTELLIGENT LIBRARY SEAT & BOOK MANAGEMENT"** in partial fulfillment of the requirements for the Internet of Things Laboratory (EC2601-1) during the year 2024-2025

Project Evaluation

Name of the Examiners	Signature with date
1. Dr. Ananta R. Shastri	
2. Mr. Chandra Sys	

ABSTRACT

The growing demand for intelligent, user-friendly library systems has driven the need to integrate modern technologies into traditional library environments. **Book Smart: Intelligent Library Seat & Book Management** is an IoT-based solution designed to automate and streamline the processes of book tracking and seat reservation. By using motion sensors for seating areas and RFID tags for books the system enables real-time monitoring of seat and book availability respectively. Users can reserve seats and check availability remotely through a website, while seat status is instantly updates in the website.

The system is powered by a cloud-based backend using Firebase, which stores and synchronizes all data, allowing for seamless communication between users, devices, and administrators. Librarians are provided with a centralized dashboard monitor activity and manage reservations. This integration of IoT, automation, and cloud services not only reduces manual effort but also enhances transparency, optimizes space utilization, and improves user satisfaction. Book Smart represents a significant step towards the development of smart, future-ready libraries.

TABLE OF CONTENTS

List of Figures

Abbreviations:

- **ESP32** – Espressif Systems Protocol 32-bit Microcontroller
- **RFID** – Radio Frequency Identification
- **Wi-Fi** – Wireless Fidelity
- **ID** – Identification (implied in RFID Tags)
- **IoT** – Internet of Things
- **PIR** – Passive Infrared (Sensor)
- **HTTP** - Hypertext Transfer Protocol

CHAPTER 1

INTRODUCTION

In the era of digital transformation, libraries must adopt modern technologies to improve efficiency and user satisfaction. Traditional methods of managing seating and tracking resources manually are often prone to delays and inconvenience. To overcome these challenges, **Book Smart: Intelligent Library Seat & Book Management** introduces an IoT-based system that primarily focuses on real-time seat occupancy detection and web-based seat booking. Using pressure sensors or motion sensors, the system detects whether a seat is occupied and updates the status on a Firebase-backed website, allowing users to view and reserve seats remotely. This web platform enables seamless, real-time interaction, enhancing convenience for users and reducing the workload for administrators.

As an optional and low-priority extension, the system also integrates RFID technology to support book availability tracking. Each book can be tagged with an RFID, allowing users to check its availability in the website. All data, including seat status and (optionally) book tracking, is managed through Firebase, ensuring real-time synchronization. This intelligent approach enhances the overall library experience, promotes smarter resource utilization, and supports the evolution of traditional libraries into more efficient, tech-enabled environments.

1.1 OBJECTIVES

- To detect seat occupancy using PIR motion sensor or pressure sensor for real-time status updates and enable users to reserve seats remotely through a website.
- To utilize Firebase for centralized data management to enable real-time synchronization of seat status and user reservations between hardware and website interface.
- To develop a dedicated web-based admin dashboard for librarians to monitor usage, manage seat reservations, and oversee system performance.
- To integrate RFID tags on books and use RFID readers to track book availability as a future enhancement to reduce manual inventory checking.

CHAPTER 2

METHODOLOGY

The system is designed to monitor seat occupancy in a library using IoT-based motion sensors. Each seat is equipped with a motion sensors that detects whether it is occupied. When a user sits, the sensor sends data to a microcontroller, which then updates the seat status to the Firebase real-time database. This information is accessed through a web-based interface, allowing users to view available seats and reserve them remotely. Firebase ensures live synchronization of data, so all seat status changes are reflected instantly on the website.

An admin dashboard is available on the same website, enabling librarians to monitor activity, manage bookings, and overrides reservations when necessary. The entire system operates efficiently through cloud connectivity, providing a seamless experience for both users and administrators. RFID tags are attached to books to enable real-time availability checks through RFID scanning, with data stored and updated in firebase real-time Database. Users can check the details of available and total copies of each book on the website.

2.1 BLOCK DIAGRAM

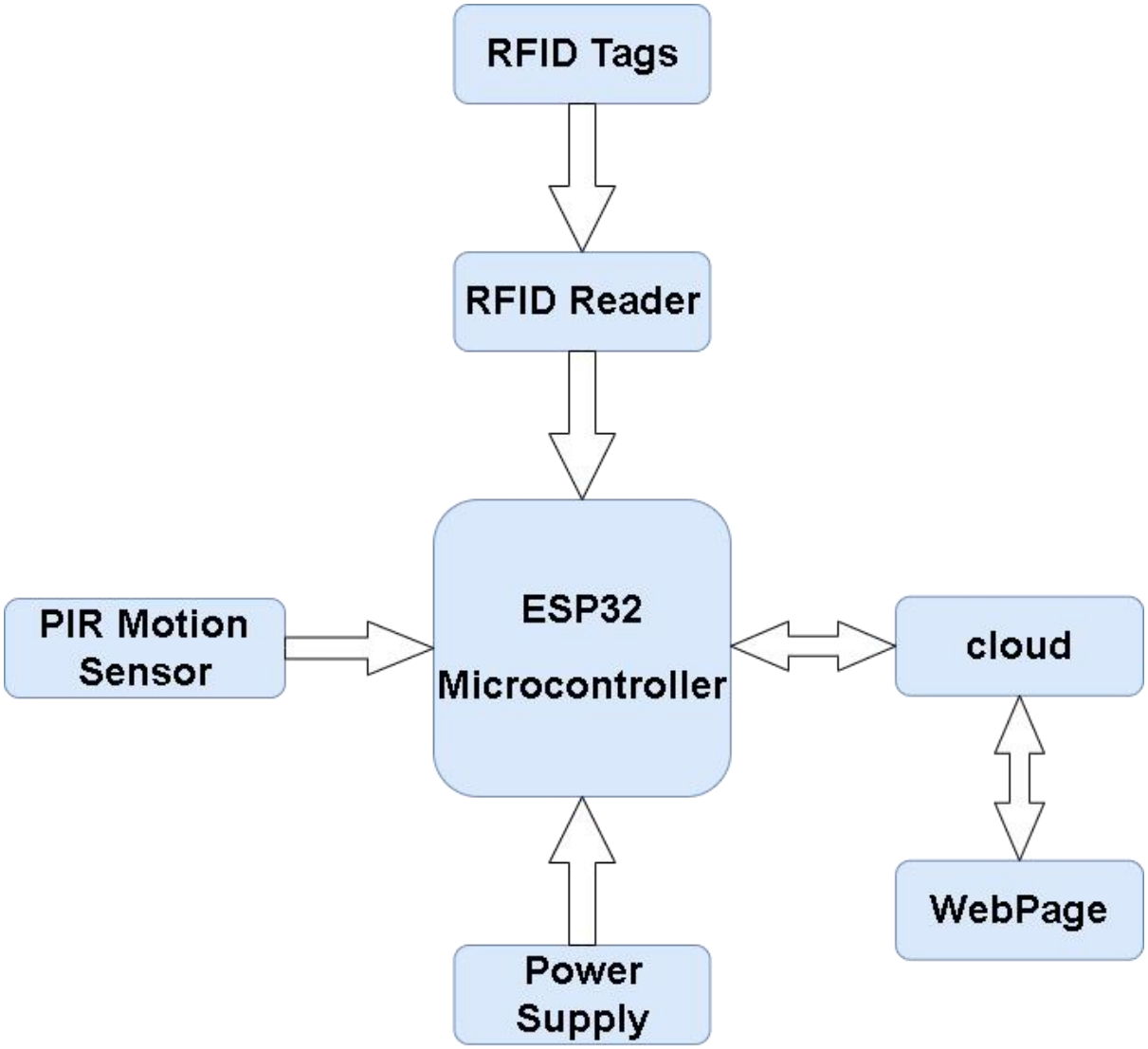

Figure 1.1. Block Diagram of the Book Smart : Intelligent Library Seat & Book management

CHAPTER 3

HARDWARE AND SOFTWARE REQUIREMENTS

3.1 HARDWARE REQUIREMENTS

- **Microcontroller (ESP32):** The ESP32 is a powerful microcontroller with built-in Wi-Fi and Bluetooth, making it ideal for IoT applications. It processes data from the RFID reader and motion sensors, handles logic for seat management, and communicates with the Firebase cloud platform. Its dual-core processor supports real-time operations and wireless connectivity.
- **Motion Sensor (**PIR)**:** The Passive Infrared (PIR) sensor detects human movement by sensing infrared radiation from body heat. It is installed on or near seating areas to determine occupancy. When motion is detected, the sensor sends a signal to the microcontroller to update the seat's availability status.
- **RFID Reader Module:** The RFID reader module is responsible for scanning passive RFID tags attached to books. It reads the unique identifier of each book and sends the data to the microcontroller for processing and status updating. This enables real-time availability within the library.
- **RFID Tags (Passive):** Passive RFID tags are small, battery-less devices that store a unique ID used to identify books. When a tag comes in proximity to the RFID reader, it transmits its stored data using electromagnetic fields.
- **Power Supply (5V/12V Adapter, Battery):** A regulated power supply is essential for the reliable operation of all hardware components. Depending on the configuration, a 5V or 12V adapter or rechargeable battery is used to ensure uninterrupted power. Proper power management helps maintain consistent sensor readings and data transmission.
- **Connecting Wires:** These are standard jumper wires used to connect sensors, displays, and the microcontroller on the breadboard. They facilitate the transmission of data and power throughout the system. Proper wiring ensures stable and noise-free communication between components.

3.2 SOFTWARE REQUIREMENTS

- **VS Code:** Visual Studio Code (VS Code) is used for developing both the website and ESP32 microcontroller code. It supports multiple languages including HTML, CSS, JavaScript, and C/C++, and offers extensions for Firebase integration and PlatformIO for embedded development. VS Code also provides live server previews and built-in terminal support for efficient testing and debugging.

- **Firebase (Realtime Database / Firestore):** Firebase provides a scalable, cloud-based backend that enables real-time data storage, retrieval, and synchronization. It connects website, microcontroller, and administrator dashboard, ensuring all components access up-to-date information. The platform also supports real-time notifications, user authentication, and analytics.

- **HTTP Protocol:** HTTP (Hypertext Transfer Protocol) is a communication protocol used to transfer data between a client and a server in a request-response manner. In our project, HTTP is used for accessing the web interface and for communication between the ESP32 and Firebase, allowing the exchange of data such as seat availability and RFID status. This protocol is lightweight, stateless, and ideal for real-time updates.

CHAPTER 4

RESULTS AND DISCUSSIONS

- The system successfully detects seat occupancy using motion sensors and reflects real-time seat status on the website, enabling users to reserve available seats remotely with minimal delay.
- Firebase Real-time Database ensures seamless synchronization between hardware and the web interface, providing accurate and real-time updates of seat availability and reservations.

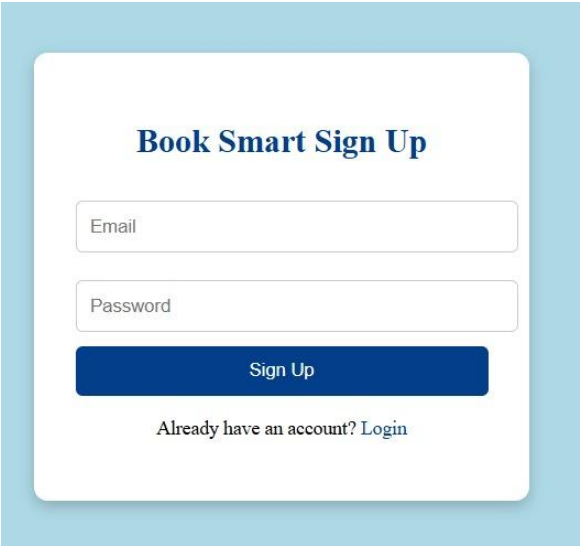

Fig 2.1 Book Smart Sign Up Page Screenshot

Fig 2.2 Book Smart Login Page Screenshot

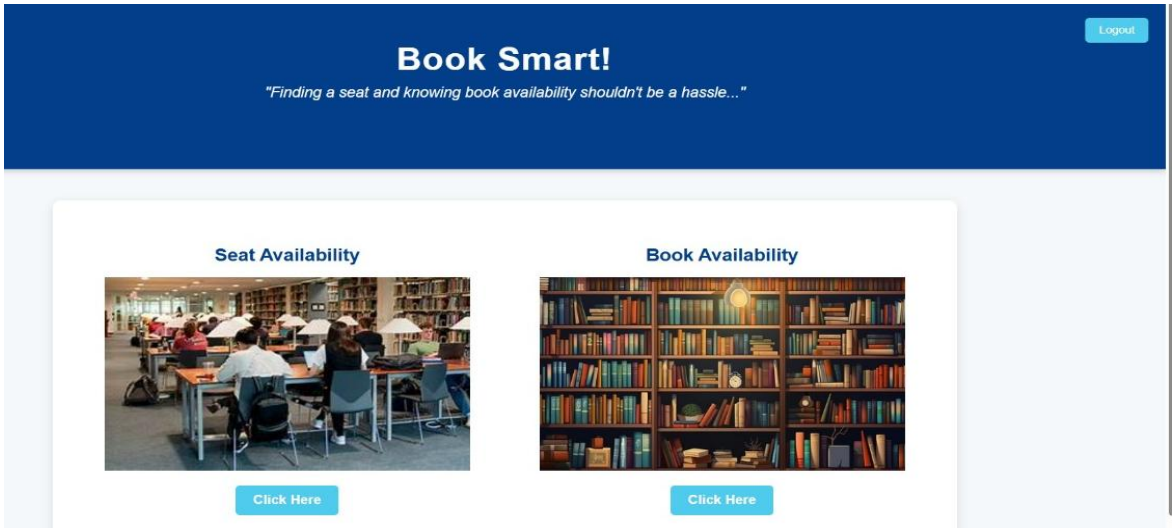

Fig 2.3 Book Smart Home Page Screenshot

Fig 2.4 Book Smart Firebase Books Screenshot

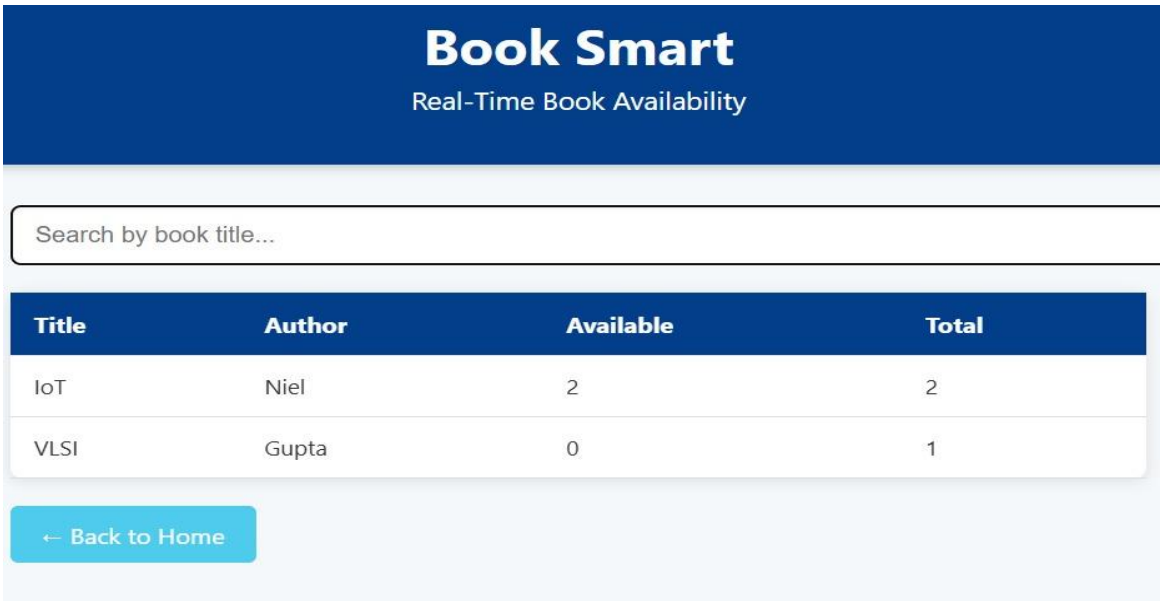

Fig 2.5 Book Smart Book availability Page Screenshot

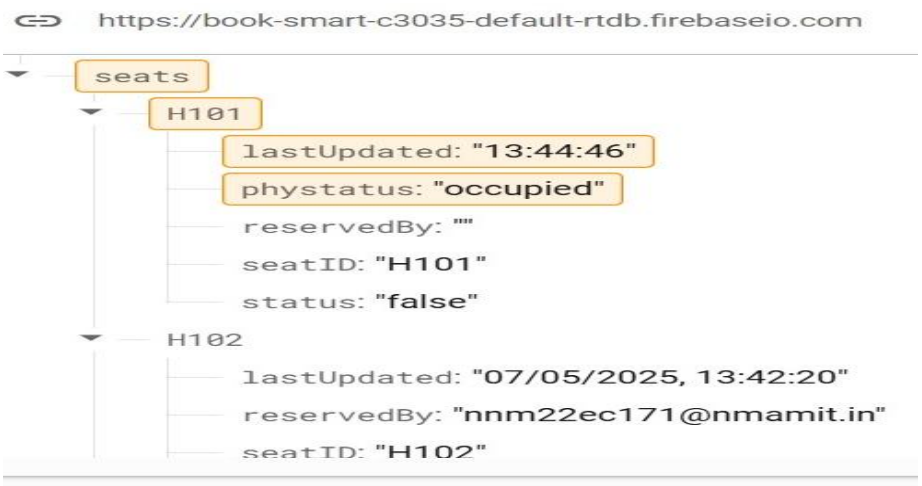

Fig 2.6 Book Smart Firebase Seats Screenshot

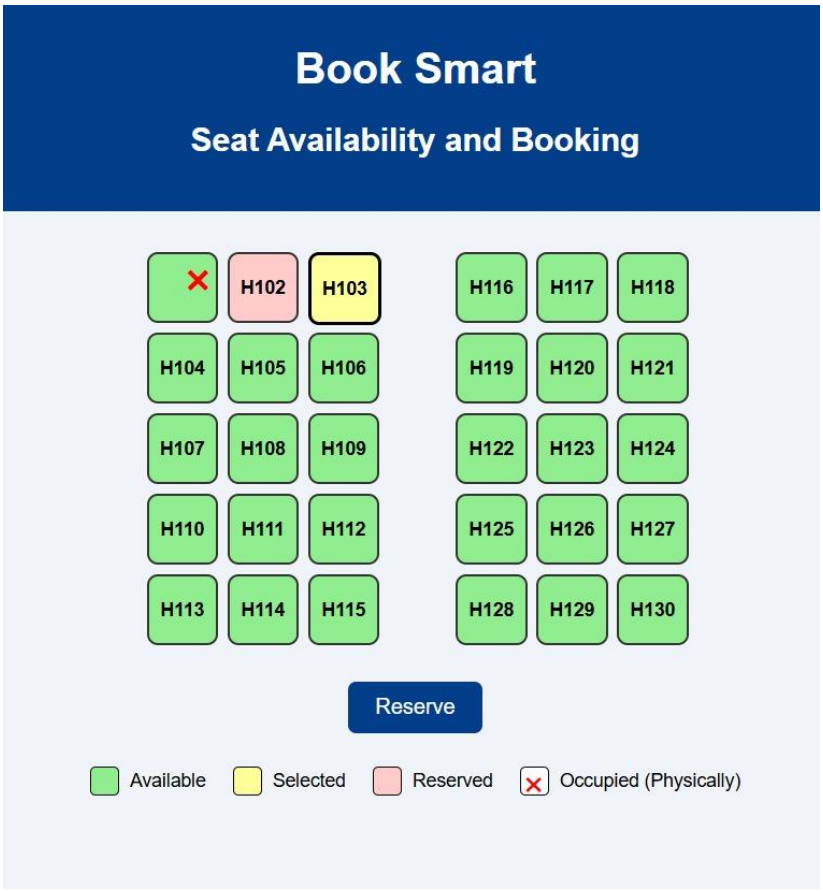

Fig 2.7 Book Smart Seat Availability and Booing Page Screenshot

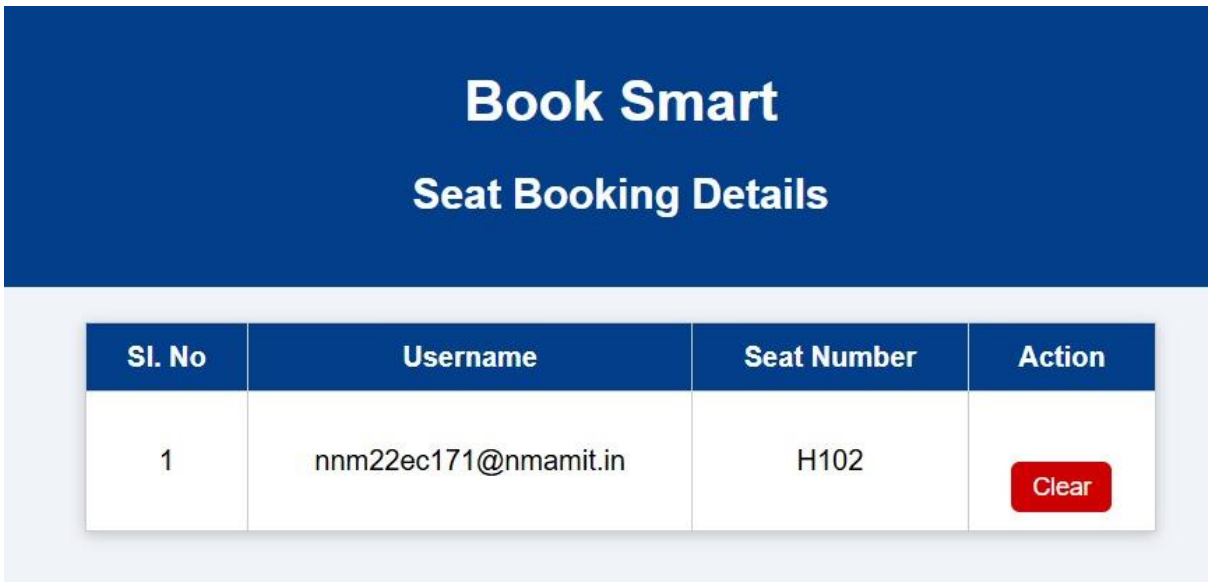

Fig 2.8 Book Smart Firebase Seats Screenshot

```
RFID Reader Initialized
Connecting to WiFi...
Connected to WiFi
Welcome
Firebase seat status updated to: occupied
Firebase seat status updated to: vacant
Welcome
Firebase seat status updated to: occupied
Firebase seat status updated to: vacant
Welcome
Firebase seat status updated to: occupied
Firebase seat status updated to: vacant
Seat Reserved
```

Fig 2.9 Book Smart VS Code Serial Monitor Screenshot

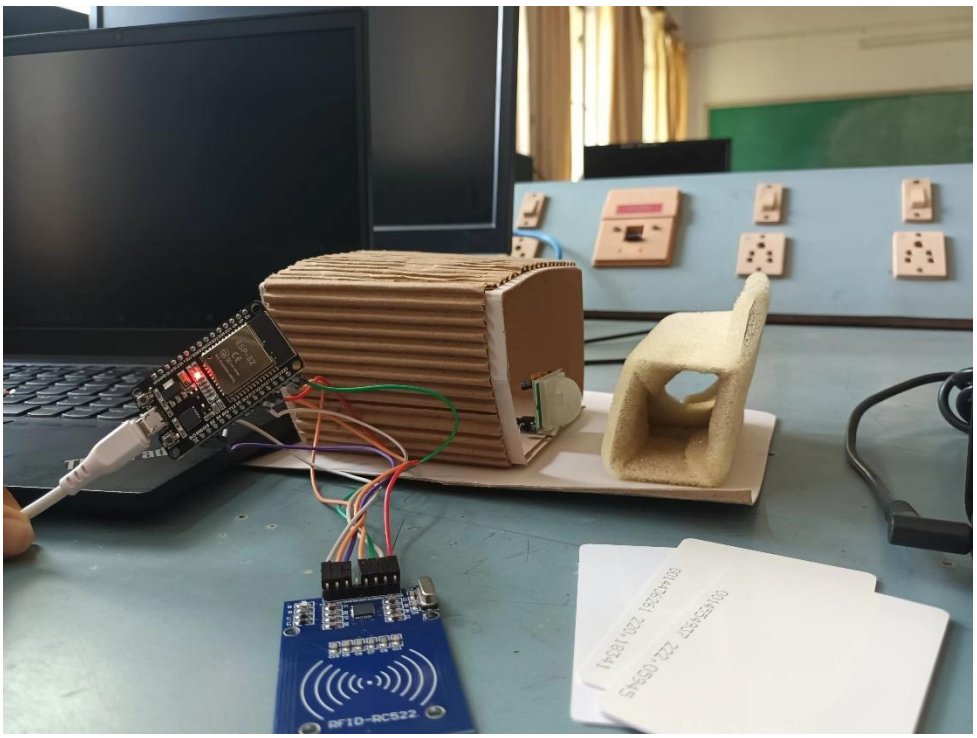

Fig 2.10 Book Smart Hardware

CONCLUSION

The proposed system, Book Smart: Intelligent Library Seat & Book Management, presents an effective and modern solution to the challenges of manual seat allocation in libraries. By integrating IoT-based motion sensors, cloud-based data management using Firebase, and a web interface for user interaction, the project enables real-time seat monitoring, remote reservations, and streamlined library operations. The automation of these functions reduces human error, ensures fair access to resources, and enhances the overall experience for both users and librarians.

Although the current implementation emphasizes seat occupancy and booking functionality, the system is designed with scalability and future-readiness in mind. A modular structure allows for easy upgrades, including the optional integration of RFID-based book availability tracking. This forward-looking approach positions the solution as a reliable foundation for smart library systems in educational institutions and public facilities, promoting digital transformation, operational efficiency, and user satisfaction.

REFERENCES

[1] S. Jadhav, A. Mahajan, and P. Patil, “IoT Based Smart Library Management System,” International Journal of Engineering Research & Technology (IJERT), vol. 9, no. 6, 2020.

[2] Firebase Documentation. “Firebase Realtime Database.” Google. https://firebase.google.com/docs/database

[3] PIR Motion Sensor Datasheet from Adafruit.

https://cdn-learn.adafruit.com/assets/assets/000/018/232/original/PIRsensor.pdf