ALANYA ALAADDİN KEYKUBAT ÜNİVERSİTESİ
RAFET KAYIŞ MÜHENDİSLİK FAKÜLTESİ

LİSANS TEZİ

COMPUTER LABORATORY INFORMATION SYSTEM

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TEZ ONAYI

Bünyamin Yavuz ve Ömer Aygün tarafından hazırlanan " Computer Laboratory Information System " adlı tez çalışması 16/05/2025 tarihinde aşağıdaki jüri tarafından oy birliği/oy çokluğu ile Alanya Alaaddin Keykubat Üniversitesi Rafet Kayış Mühendislik Fakültesi Bilgisayar Mühendisliği Bölümünde LİSANS TEZİ olarak kabul edilmiştir.

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ETİK

Alanya Alaaddin Keykubat Üniversitesi Rafet Kayış Mühendislik Fakültesi tez yazım kurallarına uygun olarak hazırladığım bu tez içindeki bütün bilgilerin doğru ve tam olduğunu, bilgilerin üretilmesi aşamasında bilimsel etiğe uygun davranıldığı, yararlandığım bütün kaynakları atıf yaparak belirttiğimi beyan ederim.

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Bünyamin Yavuz Ömer Aygün
Alanya Aladdin Keykubat Üniversitesi

ÖZET

Lisans Tezi

BİLGİSAYAR LABARATUVAR BİLGİ SİSTEMİ

Bünyamin YAVUZ

Ömer AYGÜN

Alanya Alaaddin Keykubat Üniversitesi
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Geleneksel eğitim yöntemlerinin evrimi, yeni teknolojilere uyum sağlama gerekliliğini ortaya koymaktadır. Bu proje, eğitim sektöründe giriş-çıkış yönetimini ve bilgisayar laboratuvarı kullanımını otomatikleştirerek verimliliği artırmayı amaçlamaktadır. Kağıt tabanlı sistemlerde yaşanan zaman kaybı, doğruluk sorunları ve operasyonel karmaşıklıkları ortadan kaldırmak için, Bilgisayar Laboratuvarı Bilgi Sistemi (CLIS) geliştirilmiştir.Bu sistem, RFID ve Raspberry Pi teknolojisini kullanarak öğrenci giriş ve çıkışlarını otomatik olarak takip eder, laboratuvar içindeki bilgisayarların kullanım durumunu anlık olarak görüntüler ve adminlerin detaylı raporlar oluşturmasını sağlar. Öğrenciler, laboratuvarın müsaitlik durumunu görüntüleyebilirken, operatörler öğrencilere bilgisayar ataması yaparak laboratuvar kullanımını düzenleyebilir. Yönetici paneli sayesinde adminler operatörleri yönetebilir, sistem genelindeki duyuruları yapabilir ve kullanım verilerini analiz edebilir.Bu proje, üniversite laboratuvarlarındaki giriş-çıkış süreçlerini dijitalleştirerek daha güvenli, verimli ve kullanıcı dostu bir ortam sunmayı hedeflemektedir. Gelecekte yeni laboratuvar ve kullanıcıların sisteme kolayca entegre edilebilmesi için ölçeklenebilir bir yapı ile tasarlanmıştır. CLIS, eğitim alanında otomasyonun önemini vurgulayan bir çözüm sunarak hem öğrenciler hem de yöneticiler için daha düzenli ve etkin bir öğrenme deneyimi sağlamayı amaçlamaktadır.

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Anahtar Kelimeler: *Otomasyon, RFID, Laboratuvar Yönetimi, Bilgisayar Atama, Giriş-Çıkış Takibi, Kullanıcı Yönetimi, Web Panel, Yetkilendirme, Rol Tabanlı Erişim Kontrolü, Gerçek Zamanlı İzleme, Entegrasyon, Veritabanı Yönetimi, Güvenlik, Ölçeklenebilirlik, Kullanıcı Dostu Arayüz, Raporlama, Operatör Yönetimi, Öğrenci Takibi, Kağıtsız Sistem, Veri Şifreleme, Eğitim Teknolojileri*

ABSTRACT

Undergraduate Thesis

COMPUTER LABORATORY INFORMATION SYSTEM

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The evolution of traditional educational methods highlights the necessity of adapting to new technologies. This project aims to enhance efficiency in the education sector by automating entry-exit management and computer lab usage. To eliminate issues such as time loss, accuracy problems, and operational complexities associated with paper-based systems, the Computer Laboratory Information System (CLIS) has been developed. Utilizing RFID and Raspberry Pi technology, the system automatically tracks student entries and exits, provides real-time monitoring of computer usage within the lab, and enables administrators to generate detailed reports. Students can check lab availability, while operators manage computer assignments to optimize lab utilization. Through the admin panel, administrators can oversee operators, make system-wide announcements, and analyze usage data.This project aims to create a more secure, efficient, and user-friendly environment by digitizing entry-exit processes in university laboratories. Designed with scalability in mind, CLIS ensures easy integration of new labs and users in the future. By emphasizing the role of automation in education, CLIS provides a structured and efficient learning experience for both students and administrators.

Keywords: *Automation, RFID, Lab Management, Computer Assignment, Entry-Exit Tracking, User Management, Web Panel, Authorization, Role-Based Access Control, Real-Time Monitoring, Integration, Database Management, Security, Scalability, User-Friendly Interface, Reporting, Operator Management, Student Tracking, Paperless System, Data Encryption, Educational Technologies.*

İÇİNDEKİLER

TABLE OF FIGURES

1. INTRODUCTION

Education plays a crucial role in the development of individuals and the progress of societies. Ensuring a well-structured and efficient learning environment is essential for both students and educators. However, traditional attendance tracking methods, which rely on paper-based systems and manual data entry, are prone to inefficiencies, inaccuracies, and administrative burdens. These outdated approaches not only consume valuable class time but also increase the risk of attendance fraud and management difficulties.

To address these challenges, the Computer Lab Information System (CLIS) has been developed, aiming to automate and enhance the management of computer lab access and usage. The primary objective of this project is to provide a seamless and secure authentication process using RFID card scanning integrated with Raspberry Pi, ensuring that only authorized users can access lab resources while maintaining accurate attendance records in real time.

The CLIS project introduces a web-based management panel that allows administrators to monitor lab activities, manage user access, and generate detailed reports. Through RFID authentication, students and faculty can securely enter the lab, and their usage history is automatically recorded. Additionally, the system incorporates an entry-exit tracking mechanism, ensuring that lab access is efficiently controlled and unauthorized usage is prevented.

This project offers a significant transformation compared to conventional lab management approaches. Unlike traditional methods that rely on manual attendance tracking, CLIS automates the process with RFID-based authentication and Raspberry Pi integration. Furthermore, the system features a role-based access control mechanism, distinguishing between students, faculty, and administrators to improve security and efficiency.

By implementing CLIS, the project aims to:

- Automate the lab entry and exit process, reducing reliance on manual attendance tracking.
- Enhance security through RFID-based authentication.

- Provide real-time monitoring and reporting for lab administrators.
- Minimize human errors and administrative workload in managing lab activities.

This report provides an in-depth analysis of the Computer Lab Information System, detailing its core functionalities, technological advancements, and the benefits it brings to educational institutions. By revolutionizing lab management with automation, RFID authentication, and a user-friendly interface, CLIS aims to establish a more secure, efficient, and transparent computer lab environment for students and faculty alike.

2. LITERATURE REVIEW

Over the past decade, various systems have been developed to address the challenges of managing computer lab access and attendance. Earlier approaches incorporated technologies such as card reading, RFID, NFC, IoT, and even biometric methods. However, the current Computer Laboratory Information System (CLIS) project has shifted its focus away from facial recognition and biometric systems, instead emphasizing a robust, RFID-based access control mechanism integrated with Raspberry Pi devices and a centralized database for real-time data management.

Several universities have implemented RFID-based systems to control and monitor lab access. These systems typically allow students to enter labs by scanning RFID-enabled student cards, automatically logging entry and exit times, and ensuring that only authorized users can access lab resources. While many institutions benefit from the simplicity and reliability of RFID systems, common challenges include limited real-time tracking, insufficient data analytics, and underdeveloped reporting features.

The table below summarizes examples from up to 20 universities that have deployed RFID or similar access control systems, outlining key aspects, strengths, and weaknesses:

University	Description	Strengths	Weaknesses
Middle East Technical University (METU)	Uses an RFID card system to manage lab access.	User-friendly interface; secure entry control.	Lacks detailed session tracking and comprehensive reporting.
Istanbul Technical University (ITU)	Implements a web-based lab management system with secure student logins.	Secure login and clear usage guidelines.	Limited real-time monitoring and data analytics.
Bogazici University	Employs an RFID-based system for lab access control.	High security with RFID authentication.	Centralized data integration and detailed reporting are minimal.
Ankara University	Uses RFID readers to log student entries and exits in computer labs.	Efficient entry control reducing unauthorized access.	Lacks advanced real-time tracking and detailed reports.
Kadir Has University	Utilizes RFID card readers to control lab access.	Ensures authorized access with a simple system.	Does not store usage data in a centralized database.
Hacettepe University	Offers a web portal with lab schedules and rules.	Easily accessible lab information.	Minimal user authentication and tracking capabilities.

University	Description	Strengths	Weaknesses
Yıldız Technical University (YTU)	Provides lab information online without RFID integration.	Accessible lab schedules and policies.	Lacks secure access control and real-time monitoring.
Izmir Institute of Technology (IZTECH)	Maintains a web-based system for lab policies and scheduling.	Offers clear information on lab availability.	Limited functionality, missing RFID and detailed tracking.
Dokuz Eylul University	Hosts a basic online portal for lab schedules and rules.	Simple interface for accessing lab policies.	No secure access control or session tracking.
Ege University	Displays lab guidelines and usage policies via a website.	Straightforward access to lab policies.	Lacks real-time tracking and RFID-based authentication.
Selçuk University	Provides basic scheduling and policy information online.	Easy access to lab rules and schedules.	No advanced access control or detailed session logging.
Marmara University	Offers lab hours and usage rules on a dedicated website.	Clear guidelines and simple interface.	Minimal security measures and real-time monitoring.
Gazi University	Presents lab hours and policies in an informational online format.	Accessible lab guidelines.	Lacks comprehensive tracking and data analytics features.
Sakarya University	Shares lab rules and schedules online.	Straightforward access to lab policies.	Limited security features and no user tracking.
Pamukkale University	Provides a basic informational portal for lab rules and hours.	Simple web page for accessing lab policies.	No RFID integration or session tracking for enhanced security.
Uludag University	Implements a web-based lab access system with RFID integration for secure entry.	Secure and reliable RFID entry control.	Limited real-time monitoring and detailed reporting features.
Cukurova University	Uses RFID card systems combined with an online portal to manage lab access.	Provides clear lab access guidelines and secure entry.	Insufficient data analytics and lack of comprehensive tracking.

University	Description	Strengths	Weaknesses
Atatürk University	Offers an RFID-based lab management system that logs entry/exit times.	Ensures authorized access with simple automated logging.	Minimal integration with advanced monitoring tools.
Akdeniz University	Deploys RFID readers and a centralized database for lab access control.	Reliable and secure system ensuring authorized access.	Lacks robust session tracking and advanced reporting features.
Karadeniz Technical University (KTU)	Utilizes an RFID-based access control system in computer labs.	High security with efficient RFID scanning.	Limited real-time synchronization and inadequate data reporting.

Conclusion:
The review of existing literature and systems reveals that while RFID-based access control is widely adopted for managing lab entry and exit, many systems suffer from shortcomings such as inadequate real-time monitoring, limited analytics, and poor reporting capabilities. The CLIS project is designed to overcome these issues by integrating RFID technology with Raspberry Pi for reliable data capture, a centralized database for efficient data management, and a user-friendly web application that offers detailed real-time lab status and comprehensive reporting features. This approach aims to provide a secure, efficient, and scalable solution for modern computer lab management.

References for these findings are drawn from multiple academic and technical sources that discuss RFID applications in educational settings, as well as from analyses of existing university lab management systems.

3. MATERIAL METHOD

In this section, we outline the technologies, tools, and integration strategies used in the Computer Laboratory Information System (CLIS) project to automate lab management and student tracking.

3.1 Database and Integration

A robust and centralized database is essential for efficiently storing and managing the diverse data generated by the CLIS project. Our system employs a cloud-based MongoDB database to securely store and retrieve critical information such as student records, operator profiles, lab usage logs, computer assignments, and system settings. This approach ensures real-time data synchronization and supports rapid updates that are crucial for effective lab monitoring.

3.1.1 Database

The CLIS project's database is designed with scalability and reliability in mind. Key data categories include:
• **Student Information:** Names, unique student IDs, and other pertinent details.
• **Operator and Admin Information:** User credentials, roles, and activity logs.
• **Lab and Computer Usage Data:** Real-time records of lab entries and exits, computer assignment details, and session logs.

This structure enables fast data retrieval and continuous updates, facilitating accurate and timely reporting for administrators.

3.1.2 Integration Requirements

The system integrates hardware and software components to automate lab access and management:
• **RFID Integration:** Students gain lab access by scanning RFID cards. RFID readers installed in the labs capture student card data, which is then processed by Raspberry Pi devices.
• **Raspberry Pi Integration:** These devices interface with the RFID readers and act as intermediaries that transmit scan data to the central Node.js backend, ensuring that student entries and exits are logged in real time.
• **Web-Based Interface:** A dynamic web application, built using Node.js, EJS, HTML, and CSS, provides distinct panels for students, operators, and administrators. This interface displays current lab statuses, facilitates computer assignments, and enables report generation.

Real-time communication between the RFID hardware, Raspberry Pi devices, and the MongoDB database ensures that lab operations are monitored continuously and accurately.

3.2 Scenario

At the start of a lab session, a student taps their RFID card on a reader connected to a Raspberry Pi. The Raspberry Pi processes the card data and communicates it to the Node.js backend, where the student's entry is recorded immediately in the database. Operators can then assign available computers to the student via the web interface. When the student leaves, another RFID scan logs their exit, updating the lab status in real time. Administrators have access to comprehensive reports and system management tools, ensuring efficient oversight of lab activities.

3.3 Tools, Services, and Frameworks

The following technologies form the backbone of the CLIS project:
• **Node.js:** Powers the backend, efficiently handling multiple RFID scans and enabling real-time data updates.
• **EJS, HTML, and CSS:** Create responsive, user-friendly web interfaces tailored to the needs of students, operators, and administrators.
• **MongoDB and Mongoose:** Provide a scalable, cloud-based database solution for secure and organized data storage.
• **RFID Readers and Raspberry Pi:** Facilitate automated student entry and exit logging, ensuring secure lab access.
• **Role-Based Access Control:** Ensures that only authorized users can access specific functionalities, maintaining system security and operational efficiency.

By seamlessly integrating these technologies, the CLIS project delivers a reliable, secure, and efficient solution for managing computer laboratory environments in educational institutions.

4. FUNCTIONAL REQUIREMENTS

• **Student Requirements:**
The system must provide a user-friendly interface accessible via a web and/or mobile application for students to view lab availability, check their entry/exit logs, and verify their attendance records based on RFID scans.

• **Operator Requirements:**
Operators should be able to monitor lab activities in real time. They must have an intuitive dashboard that displays student entries and computer usage, allowing them to assign and unassign computers as needed when students check in and out via RFID.

• **Admin Requirements:**
Administrators must have full system control through a dedicated panel. This includes managing user accounts (operators and students), configuring system settings, and generating detailed reports on lab activities, computer assignments, and attendance records.

• **RFID-Based Attendance and Lab Access:**
The system shall record each student's entry and exit by processing RFID card scans through Raspberry Pi devices. Every scan should automatically log the student's ID, timestamp, and relevant lab information in the centralized database.

• **Mobile and Web Application Integration:**
Both students and operators should be able to access real-time lab data and attendance information through a mobile application and/or web interface, ensuring a seamless and efficient user experience.

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5. NON-FUNCTIONAL REQUIREMENTS

• **Data Security:**
All user data must be securely stored and encrypted using industry-standard protocols. Role-based access control should be implemented to ensure that only authorized users can access specific data, protecting sensitive information in accordance with data protection laws.

• **Real-Time Data Synchronization:**
The system should update lab statuses and attendance logs in real time. Utilizing Node.js and MongoDB's capabilities, the system must ensure that any change such as an RFID scan is immediately reflected across all interfaces.

• **Performance:**
The system must handle multiple simultaneous RFID scans without delays. Both the web and mobile applications should provide a smooth, responsive experience, even during peak usage times.

• **Scalability:**
The system must be designed to easily accommodate additional labs, users, and increasing data loads in the future, ensuring long-term reliability and performance.

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6. SYSTEM EFFICIENCY

• **RFID Reader Control:**
The system should ensure that each RFID reader is dedicated to a specific lab session, preventing conflicting scans. Once a reader is active for a given session, it must exclusively process the relevant entries and exits until the session concludes.

• **Troubleshooting and Data Updates:**
Students and operators should have the ability to report discrepancies or issues with attendance records via the mobile or web interface. Administrators and operators must be able to manually resolve these issues and update the data as necessary to maintain system accuracy.

• **Technology Utilization:**
The system leverages a robust technology stack Node.js for backend processing, MongoDB for data storage, and Raspberry Pi devices for RFID integration to deliver real-time, secure, and automated lab access management.

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7. LEGISLATIVE REGULATIONS

• **Consent and Data Protection:**
The collection and processing of student data via RFID must comply with applicable data protection regulations, such as the Personal Data Protection Law (KVKK). Explicit permissions for data collection, storage, and processing must be obtained, ensuring that data is used solely for managing lab access and attendance.

• **Usage Limitations:**
The system is strictly intended for managing lab entry and computer usage. Any form of unauthorized monitoring or data usage beyond the defined scope is prohibited, ensuring compliance with privacy regulations and safeguarding student rights.

This comprehensive requirements specification ensures that the CLIS project will provide a secure, efficient, and user-friendly environment for managing computer lab access and attendance in educational institutions.

8.DIAGRAMS

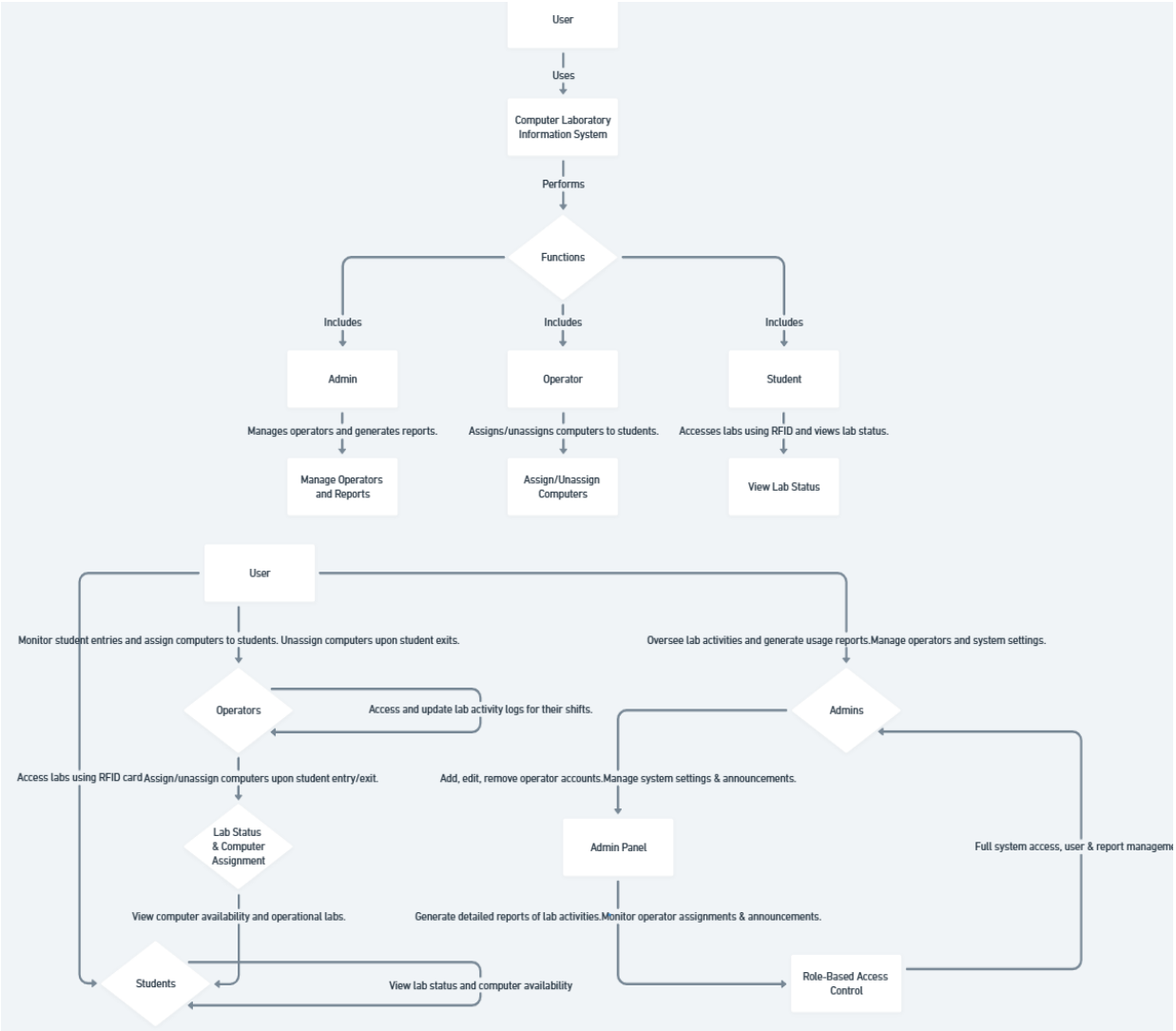

Figure 1: Usecase Diagram

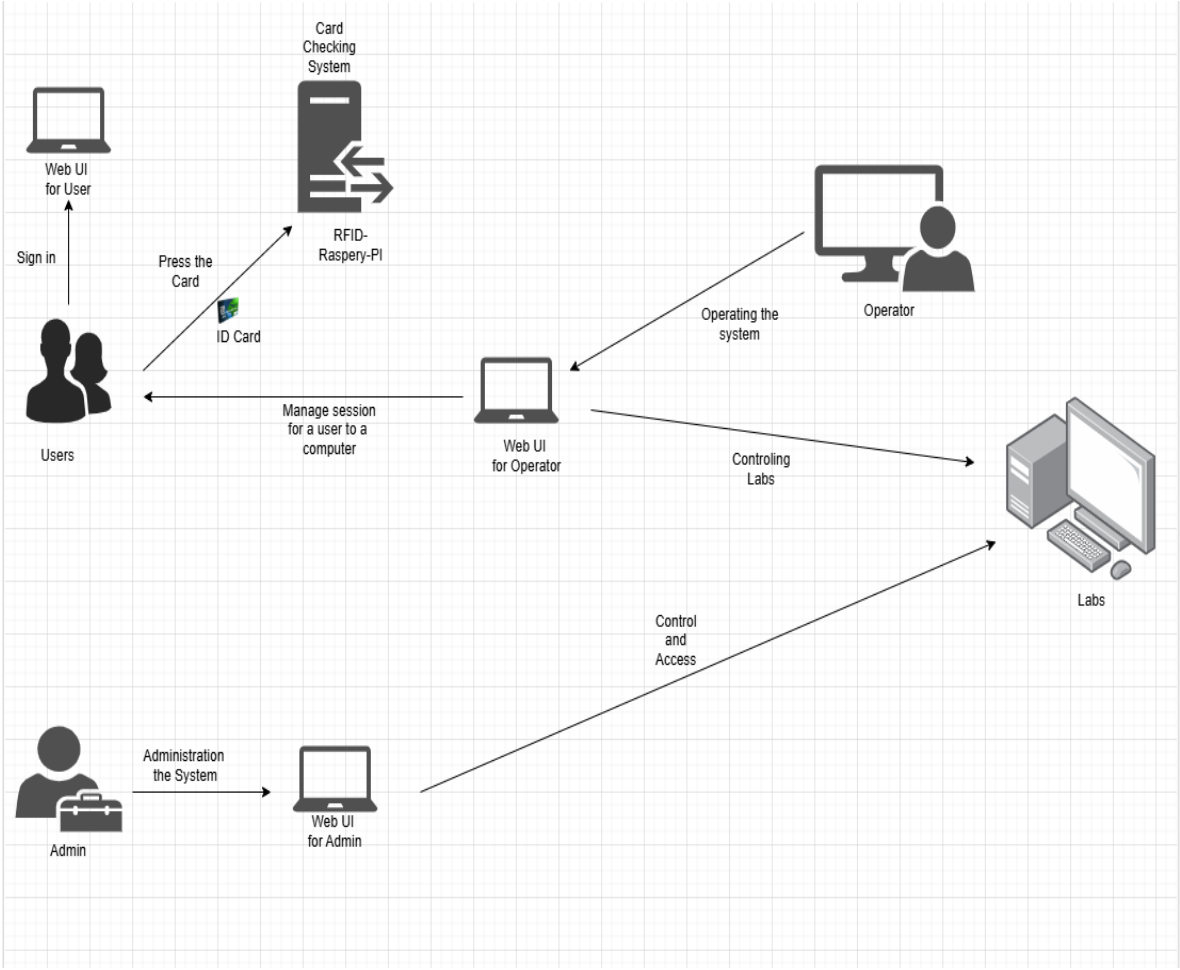

Figure 2: System Architecture

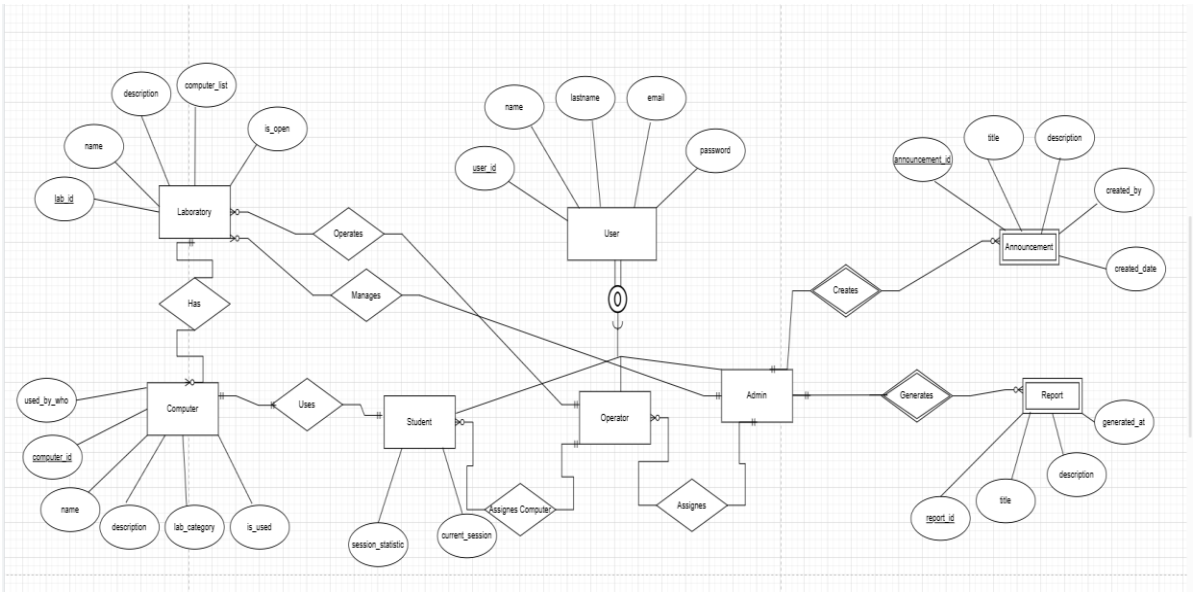

Figure 3: ER Diagram

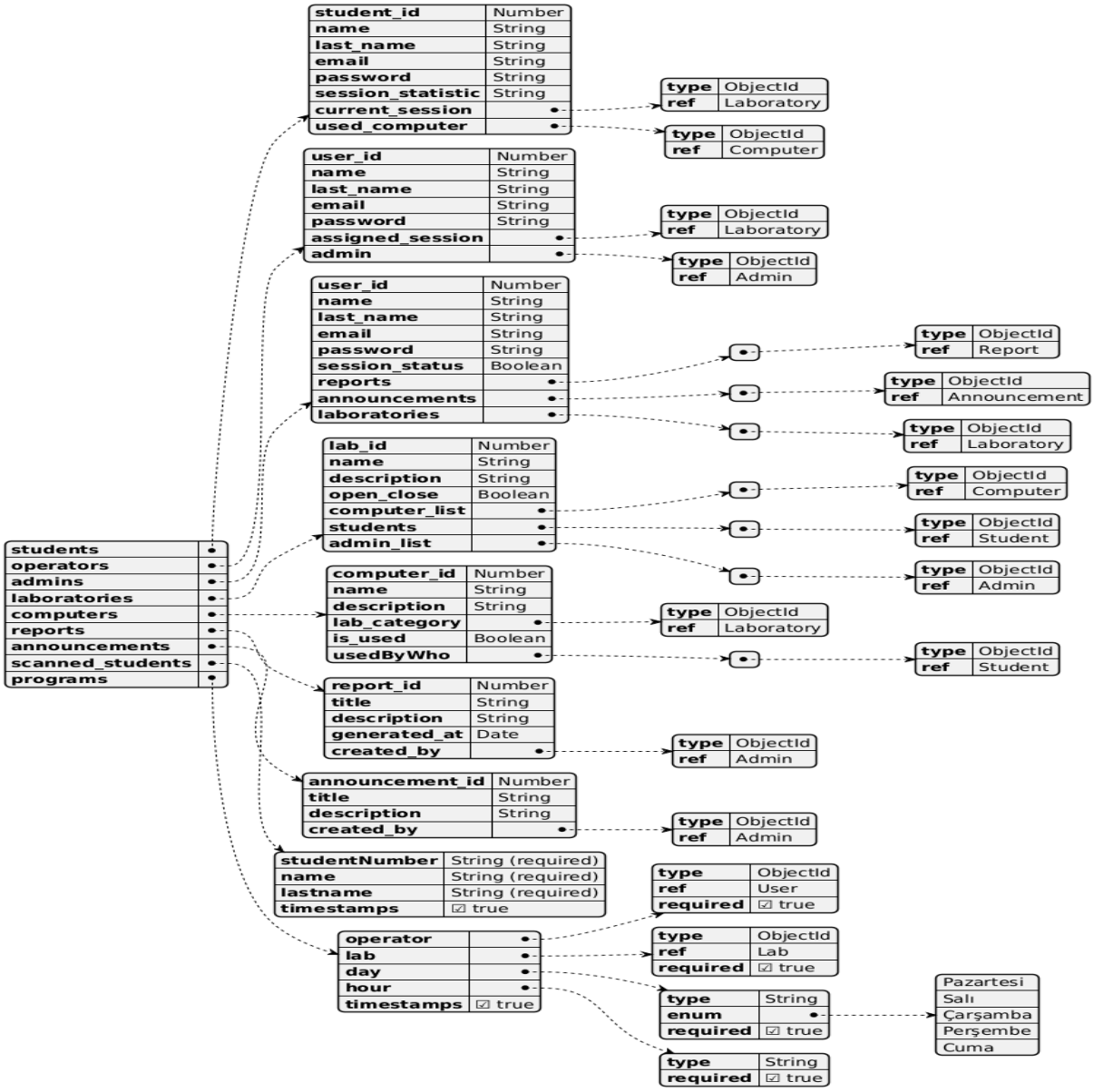

Figure 4: Data Model

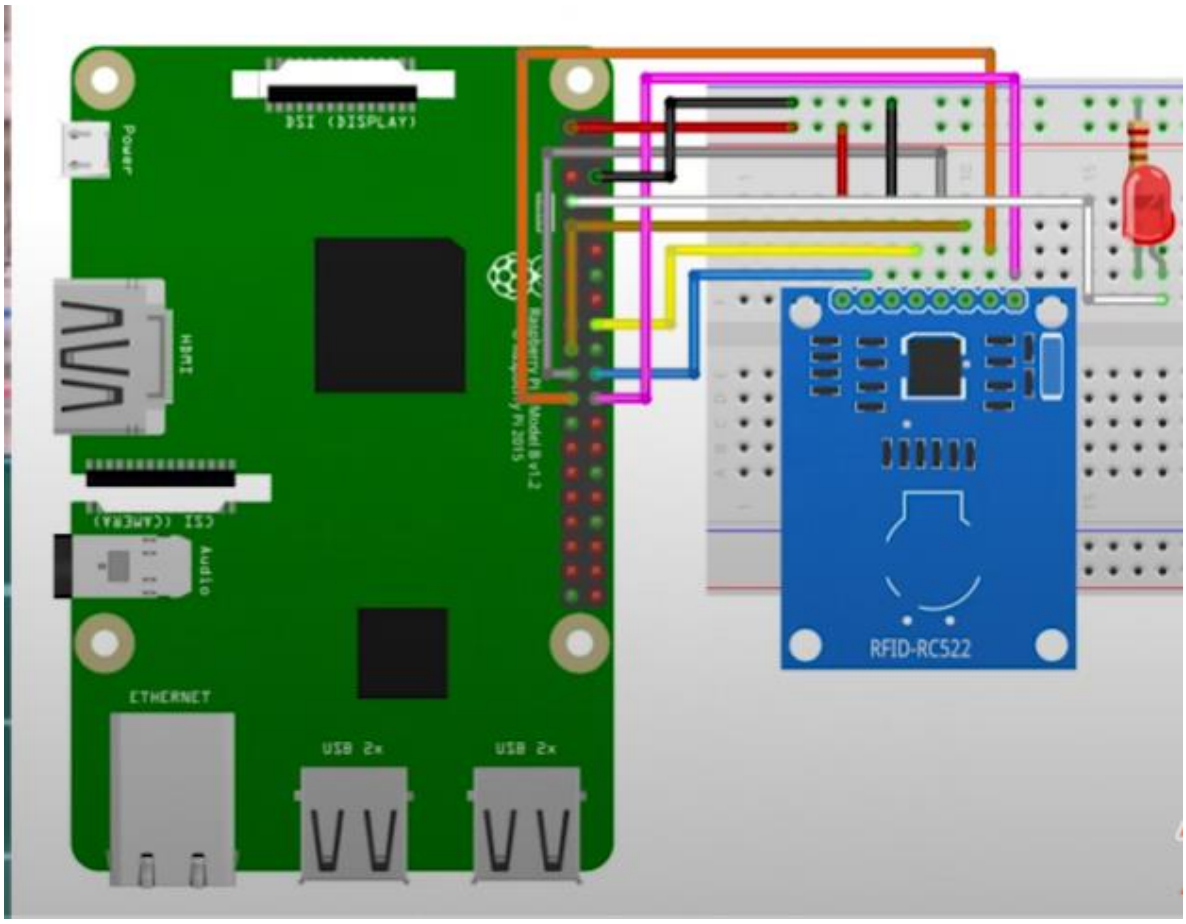

Figure 5: Raspberry Pi – RFID

9. SYSTEM COMPONENTS STRUCTURE

The **Computer Laboratory Information System (CLIS)** project consists of **four core components** and several supporting modules. The key modules work together to manage student authentication, operator interactions, lab usage tracking, and computer assignment via RFID technology and a web-based management interface.

The four primary components are:

- scannedStudent.js
- app.js
- dashboard.ejs
- MongoDB (Database)

The project also includes configuration files (such as .env, config.json) and predefined role-based routes to manage system-level access.

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scanAndSend.py

This Python script runs on the **Raspberry Pi** and is responsible for reading **RFID cards** using the **RC522 RFID module**. It reads the UID from the scanned card via **SPI communication**, and then sends this data to the backend API.

- **Hardware Integration**: The script uses **GPIO and SPI** pins on Raspberry Pi to communicate with the RFID reader.
- **Main Functionality**: After reading a student's RFID card, it sends the UID and timestamp to the server using an **HTTP request**.

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app.js

This is the **Node.js backend** of the system, handling API endpoints, authentication logic, database communication, and RFID-based student check-in.

Key responsibilities:

- Receives card UID data from Raspberry Pi via REST API.
- Matches the UID with a registered student in MongoDB.
- Logs entry time, updates lab activity, and responds to frontend requests.

- Controls role-based routing and API access for **students**, **operators**, and **administrators**.

Example Logic:

If a valid UID is received, the system checks if the student is already logged in. If not, a new session is created. If already logged in, no duplicate entry is created.

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dashboard.js

This JavaScript file handles the **frontend logic** for the web-based operator and admin panel. It dynamically fetches and displays:

- Lab availability status
- Logged-in students
- Assigned computers
- Computer statuses (Active / Maintenance / Broken)
- Operator scheduling panels

The interface allows:

- Operators to assign computers
- Mark a computer as broken or under maintenance
- Admins to manage lab schedules, view reports, and track system performance

📌 *The dashboard reacts to live data using asynchronous API calls and reflects real-time state changes (e.g., a student entering the lab or a PC marked as broken).*

MongoDB Database

The MongoDB database stores all core application data including:

- **Users** (students, operators, admins)
- **RFID card mappings**
- **Lab entry logs**
- **Computer assignments**
- **Computer status values**:
    - "active": usable

    - "maintenance": temporarily offline
    - "broken": unusable until repaired
- **Operator Schedules**: Each operator's weekly lab shifts, including start/end times

Database access is protected via role-based logic on the backend, and only authorized users can read or write specific collections.

System Modes and State Transitions

Though the CLIS project does not use facial recognition "modes" like Active, Marked, or AlreadyMarked, it uses **status codes** and **logical states** to handle student and system flow:

- **EntryStatus: "checked-in"** → Student is successfully logged as entered.
- **EntryStatus: "already-checked-in"** → Repeated scan attempt within an active session is ignored.
- **ComputerStatus: "active" / "maintenance" / "broken"** → Displayed in the operator dashboard with appropriate filters.

📌 *This status-based architecture allows the system to simulate "modes" using database flags and frontend visual feedback.*

Configuration Files and Tools

- .env – Stores environment variables (DB credentials, API URLs)
- config.json – Contains static settings such as RFID reader options, default roles, lab capacity
- mongoose models/ – Define the data schemas for users, sessions, computers, and schedules

10. Discussion

The **Computer Laboratory Information System (CLIS)** project was initiated in response to the inefficiencies and limitations of traditional, paper-based methods of managing university computer labs. As educational institutions increasingly prioritize automation, security, and data-driven decision-making, CLIS presents a comprehensive solution that integrates modern web technologies with embedded systems to create a seamless, automated, and intelligent environment.

At its core, CLIS combines **RFID-based identification** with **Raspberry Pi** microcomputers and a **Node.js/MongoDB web platform** to enable real-time tracking of student entries, computer assignments, and lab status. By doing so, the system streamlines operator responsibilities, enables administrators to make data-informed decisions, and provides students with transparent access to lab availability. Unlike many prior systems that rely solely on biometric identification or mobile apps, CLIS emphasizes **practicality, modularity, and privacy-friendly design** by avoiding facial recognition and focusing on card-based authentication.

Throughout the development process, multiple core features were introduced and iteratively improved:

- **RFID-based student entry tracking**
- **Manual student exit logging by operators**
- **Computer status management** (Active, Maintenance, Broken)
- **Operator-based lab scheduling and shift assignment**
- **Role-based access control** for students, operators, and administrators
- **Dynamic lab dashboards and real-time database synchronization**

These features reflect not only technological integration but also a deep understanding of real-life operational workflows within educational institutions.

In terms of system architecture, the use of **Raspberry Pi with SPI communication** for RFID scanning ensures a cost-effective yet scalable hardware implementation. On the software side, the web platform follows the **Model-View-Controller (MVC)** pattern, promoting clean separation of concerns, maintainability, and extensibility. The **MongoDB schema** was

designed to accommodate multiple user roles, flexible lab management, and future integration with additional components like notification systems or analytics dashboards.

However, like any complex system, CLIS is not without its limitations. The reliance on operators for logging student exits could introduce human error. The system also assumes consistent internet connectivity for real-time synchronization, which may be a challenge in less stable environments. Moreover, while the interface is functional, future versions could benefit from more advanced user experience (UX) features, such as drag-and-drop scheduling or real-time alerts.

Feedback gathered during testing revealed high satisfaction among all user types. Students found the system transparent and easy to use. Operators appreciated the reduction in manual tasks and the clarity of the dashboard. Administrators reported that access to live and historical data significantly improved their ability to oversee lab activity and plan resource allocation.

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11. Conclusion

The **Computer Laboratory Information System (CLIS)** successfully demonstrates how modern technologies can be combined to solve long-standing problems in the management of university computer labs. By integrating **RFID, Raspberry Pi, Node.js**, and **MongoDB** within a **modular, role-based web system**, CLIS offers a powerful, scalable, and user-friendly platform for educational environments.

The system automates previously manual processes such as entry tracking, computer assignment, and reporting. It also empowers different user types (students, operators, and admins) with tailored tools, enabling a smoother and more controlled lab experience. Importantly, the design respects privacy regulations by avoiding biometric data, instead relying on physical ID cards.

From an architectural perspective, the project demonstrates best practices in both hardware-software integration and full-stack web development. The use of open-source technologies ensures cost-efficiency, while the layered, scalable design makes it adaptable for future enhancements.

In the broader context of digital transformation in education, CLIS contributes to the vision of **smart campuses** by introducing automation, transparency, and efficiency into one of the most resource-intensive academic environments.

Future Work Suggestions:

- Implement **dual-point RFID scanning** for automatic exit detection.
- Add **mobile application support** for real-time notifications and self-check access.
- Integrate **analytics and visualization dashboards** for long-term usage reporting.
- Enhance UX/UI for better operator usability.
- Extend system capabilities to cover **printer use, locker access**, or other lab peripherals.

In summary, CLIS stands as a robust, extensible, and practical example of how digital systems can modernize traditional educational processes. It not only increases operational efficiency but also improves the overall learning environment for students and staff alike.

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