

UIT2739 – FULL STACK DEVELOPMENT

A PROJECT REPORT

on

Bus Management System

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NOVEMBER 2025

**SRI SIVASUBRAMANIYA NADAR COLLEGE OF
ENGINEERING**



Department of Information Technology

CERTIFICATE

Certified that this project titled "**Bus Management System**" is the bonafide work of "**Sachin M A(3122225002108), Srinivas S (3122225002135), Vansh Sharma(3122225002151)**", and is submitted for project review on **27 November 2025**.

Place : Kalavakkam

Date :

Internal Examiner

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Project Overview

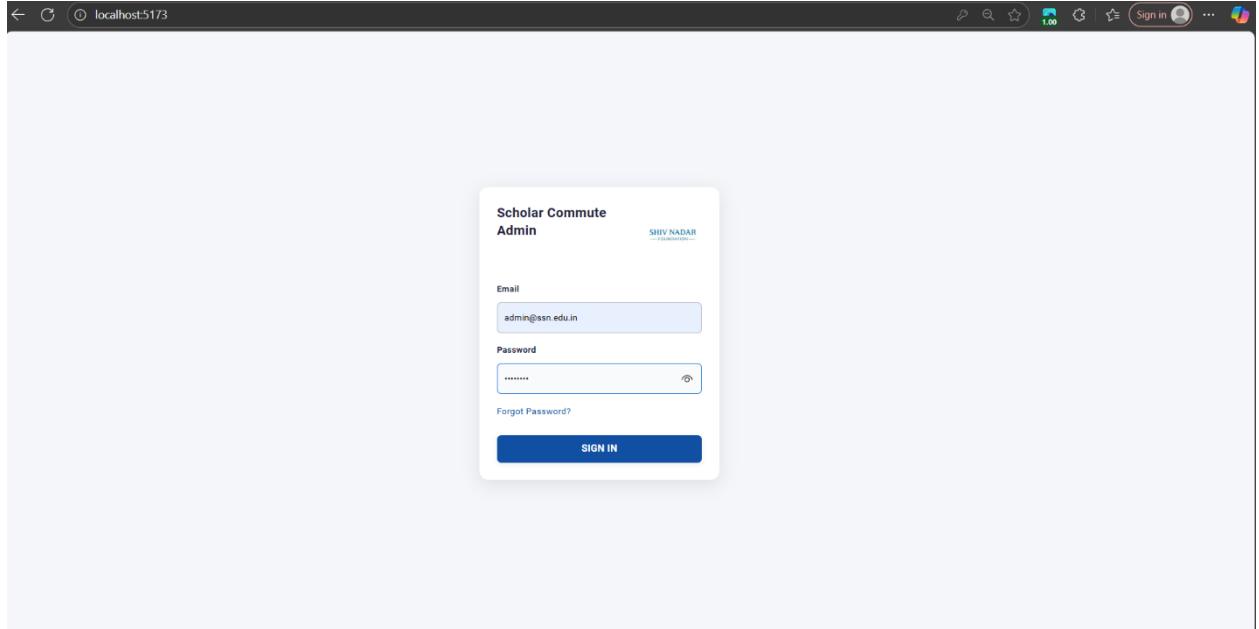
The Bus Management and Tracking System is designed to automate student transit monitoring and attendance across the college transportation network. The system integrates ML-based facial recognition using Raspberry Pi devices, GPS-based live bus tracking, route management, and role-specific web applications for both administrators and students. The solution eliminates manual attendance processes, improves real-time visibility, enhances operational efficiency, and provides students with accurate information on bus availability and movement.

Project Requirements

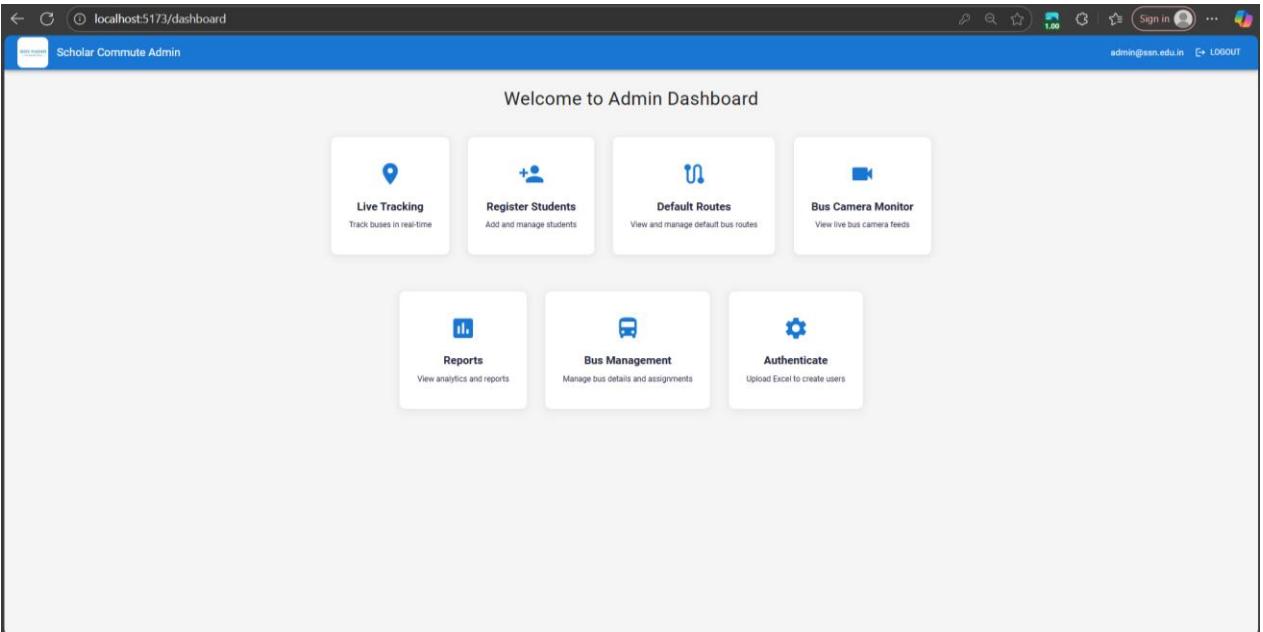
2.1 Wireframes / Screenshots

1) Admin Interface

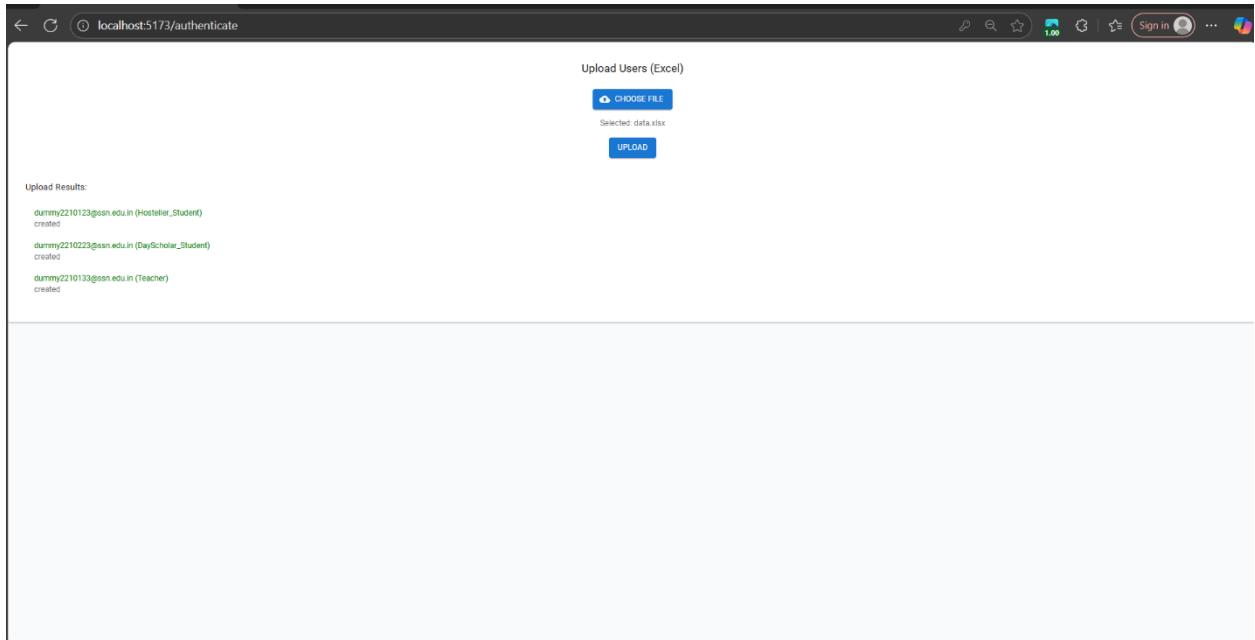
a. Login Page



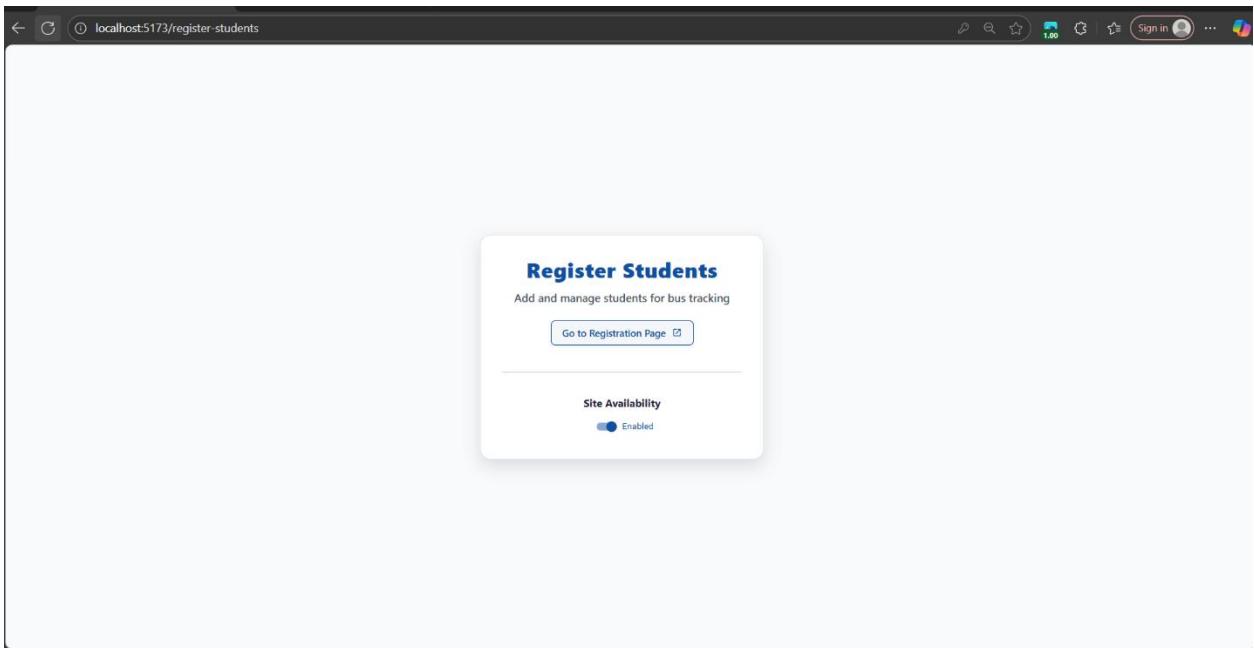
b. Dashboard



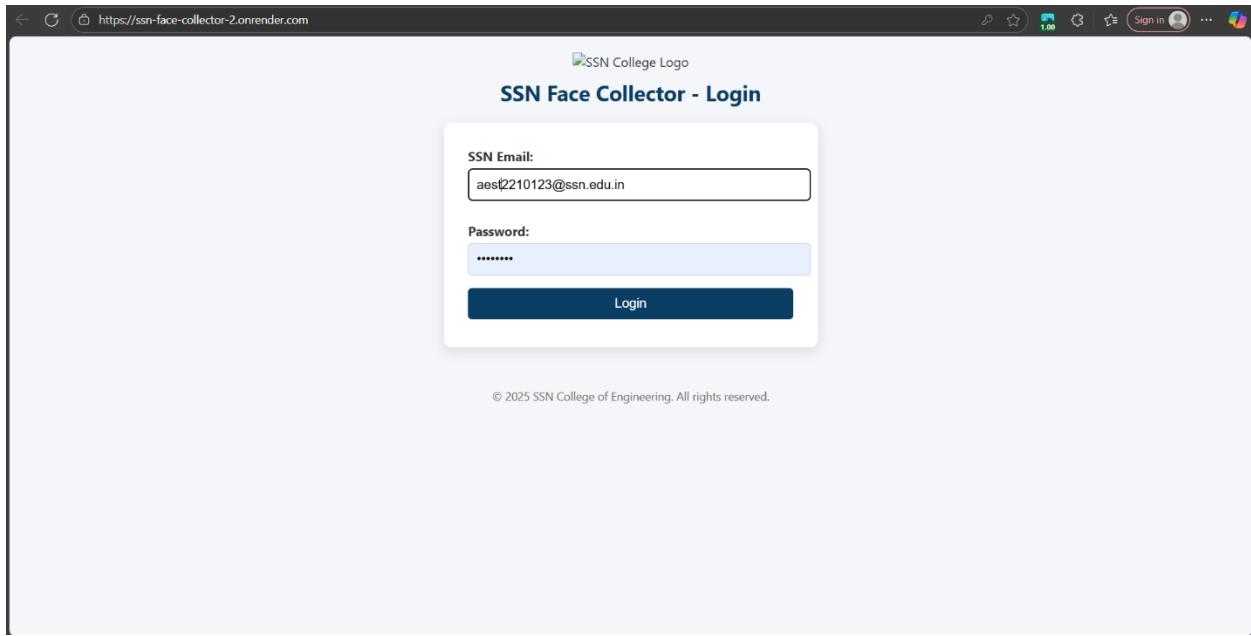
c. Authenticate Students



d. Registration Page



i. Login of Registration Page



ii. Student Detail collection Page



Register Your Face Data

Please fill in the form below to start face collection for bus attendance in future.

All data will be treated confidentially and securely.

Name

SSN Email

Date of Birth

Role

Bus Number

Bus Stop

Start Face Collection

SSN

Register Your Face Data

Please fill in the form below to start face collection for bus attendance in future.

All data will be treated confidentially and securely.

Name

SSN Email

Date of Birth

Role

Bus Number

Bus Stop

Start Face Collection

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← ⏪ https://ssn-face-collector-2.onrender.com/form

SSN

Register Your Face Data

Please fill in the form below to start face collection for bus attendance in future.

All data will be treated confidentially and securely.

Name: dummy

SSN Email: dummy2210123@ssn.edu.in

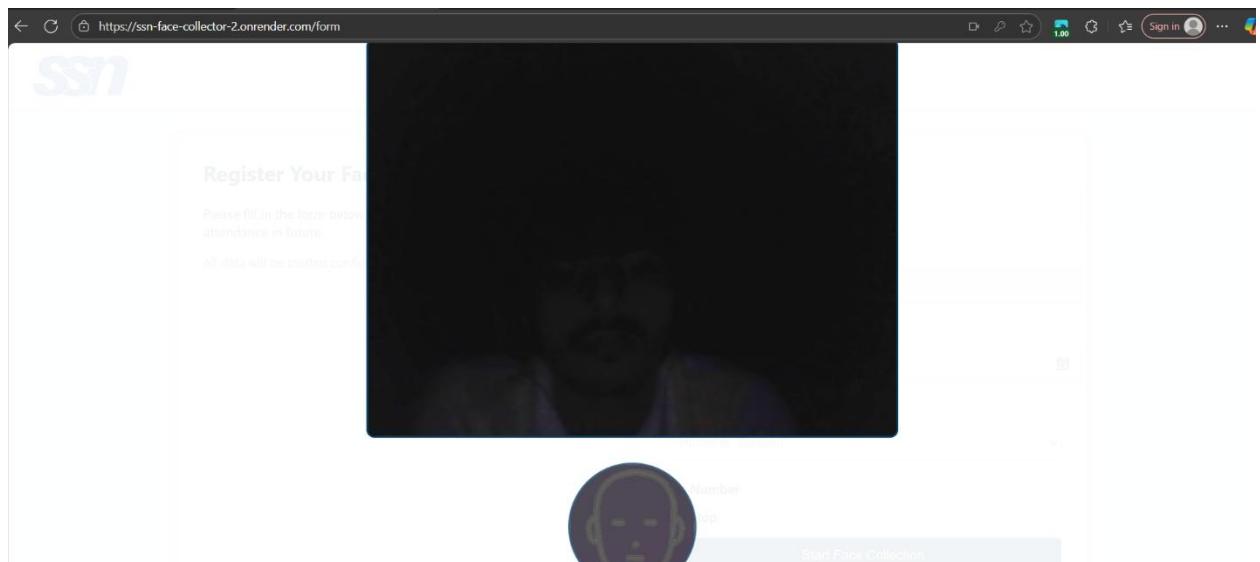
Date of Birth: 02-02-2004

Role: Hosteller_Student

Bus Number: Bus Stop

Start Face Collection

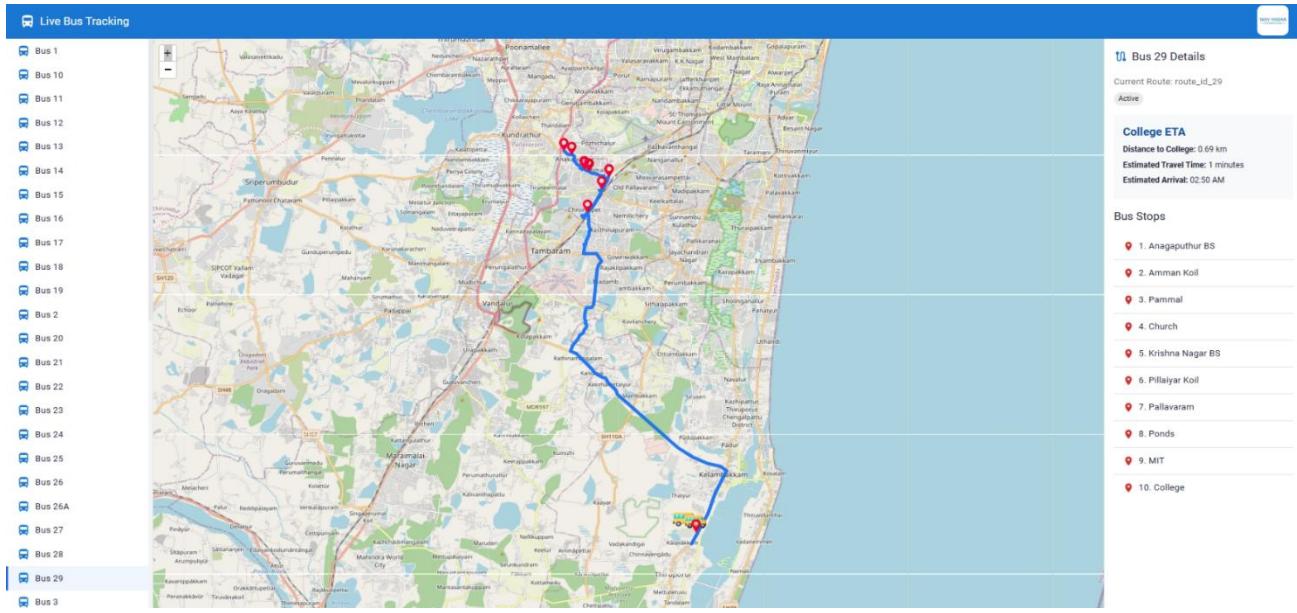
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Step 1: Look straight at the camera

Samples: 7

e. Live Tracking Page



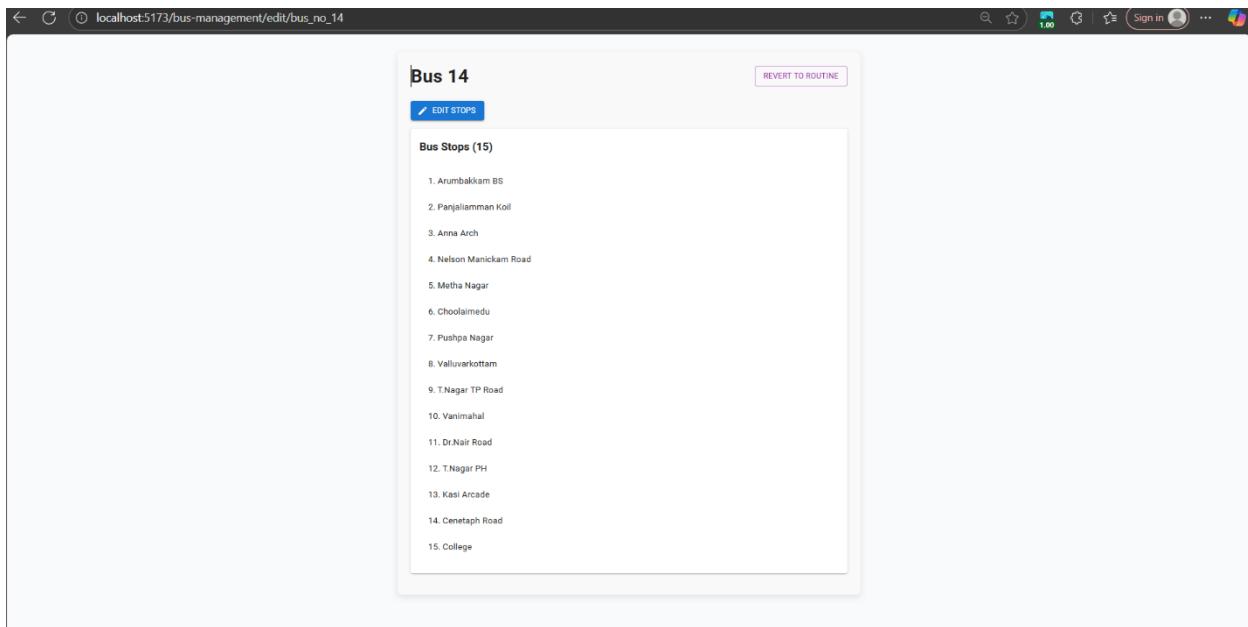
f. Bus Management Page

i. View Buses

The figure shows a bus management interface titled "Edit Bus Routes". At the top, there are buttons for "Search by Bus Number" and "REVERT TO ROUTINE". Below the title, a grid of 19 bus icons is displayed in a 4x5 layout. Each icon contains a small bus icon and the bus number. The buses are labeled as follows:

Bus 1	Bus 2	Bus 3	Bus 4	Bus 5
Bus 6	Bus 7	Bus 8	Bus 9	Bus 9A
Bus 10	Bus 11	Bus 12	Bus 13	Bus 14
Bus 15	Bus 16	Bus 17	Bus 18	Bus 19

ii. Edit Bus Routes



g. Bus Monitor Page

The screenshot shows a "Bus Camera Monitor" interface. On the left, a sidebar lists various bus routes: Bus 17, Bus 18, Bus 19, Bus 2, Bus 20, Bus 21, Bus 22, Bus 23, Bus 24, Bus 25, Bus 26, Bus 26A, Bus 27, Bus 28, Bus 29, and Bus 3. All routes are marked as "Active". In the center, a camera feed for "Bus 29 Camera Feed" (Route route_id_29) is displayed under the heading "Live Face Recognition Stream". The video frame shows a person's face with a red bounding box and the word "Unknown" overlaid. Below the date "2025-11-2" is also overlaid. At the bottom of the page, it says "Powered by SSN institution".

h. Default Routes

The screenshot shows a web application window titled "Default Bus Routes". The main heading is "Default Bus Routes" with the sub-instruction "View and manage all default bus routes and stops". Below this is a search bar with the placeholder "Search by bus number...".
Bus: 1
The route for Bus 1 consists of three stops: Ambattur Estate, Wavin, and College.
Bus: 2
The route for Bus 2 consists of several stops listed in two rows:
Row 1: Ratnakarai, Ratnakarai, Chengalpettu New BS, Chengalpettu old BS
Row 2: Mahindracity, Potheri BS, A2Z, Srinivasapuram(BATA)Showroom
Row 3: Srinivasapuram(BS), Guduvanchery, EB, Urapakkam Teskadal
Row 4: Singaperumal Koil Signal, Ford BS, Maraimalai Nagar BS, HP P8, Gurukulam

i. Reports Page

The screenshot shows a web application window titled "Bus Report - Bus No: 29". The title bar also includes "Entry Time: 03:25 PM" and "Sign in". On the right side of the title bar is a "DOWNLOAD PDF" button. The left sidebar has a "All Buses" section with a dropdown menu set to "Bus 29" and a "BACK TO OVERVIEW" button. The main content area is titled "Reports" and contains three download buttons:
• Daily Reports Download
• Weekly Reports Download
• Monthly Reports Download

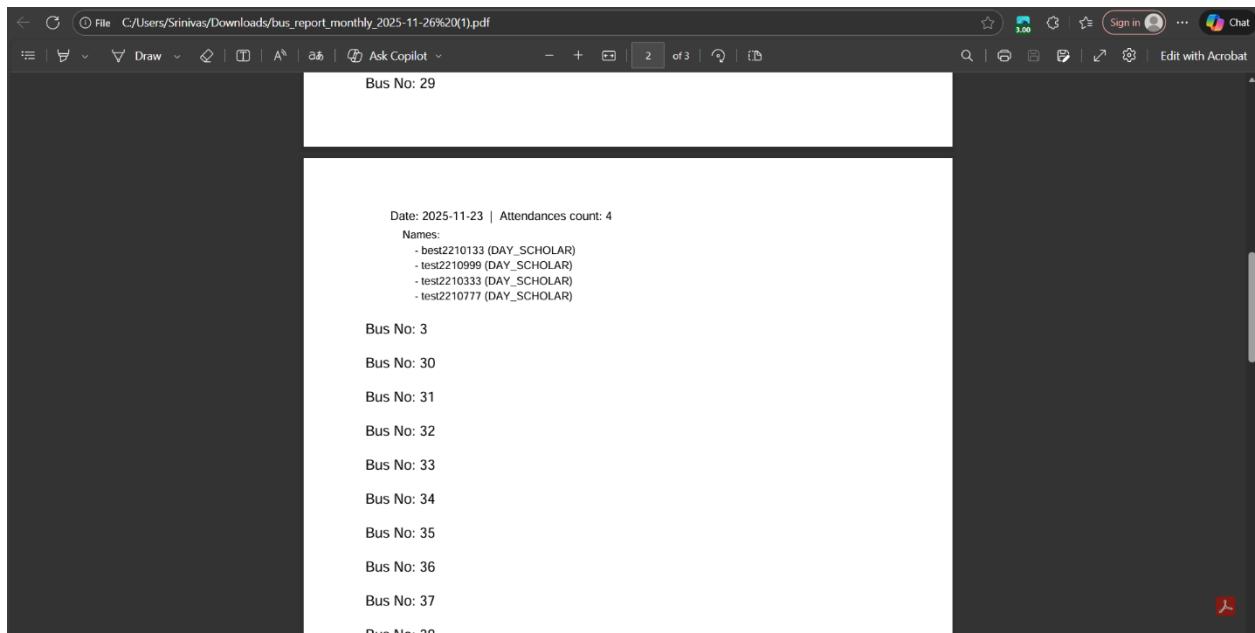
A screenshot of a web browser window displaying a bus report interface. The URL is `localhost:5173/reports`. The main title is "Bus Report - Bus No: 29" with the entry time "03:25 PM". On the left, there's a sidebar titled "All Buses" with a dropdown menu set to "Select Bus" and "Bus 29". A "BACK TO OVERVIEW" button is at the bottom of this sidebar. The main content area has a "Reports" tab selected. It contains three download buttons: "Daily Reports Download", "Weekly Reports Download", and "Monthly Reports Download". To the right, a "Downloads" sidebar shows five PDF files listed:

- bus_report_monthly_2025-11-26 (1).pdf
- bus_report_weekly_2025-11-26 (1).pdf
- bus_report_monthly_2025-11-26.pdf
- bus_report_weekly_2025-11-26.pdf
- bus_report_daily_2025-11-26.pdf

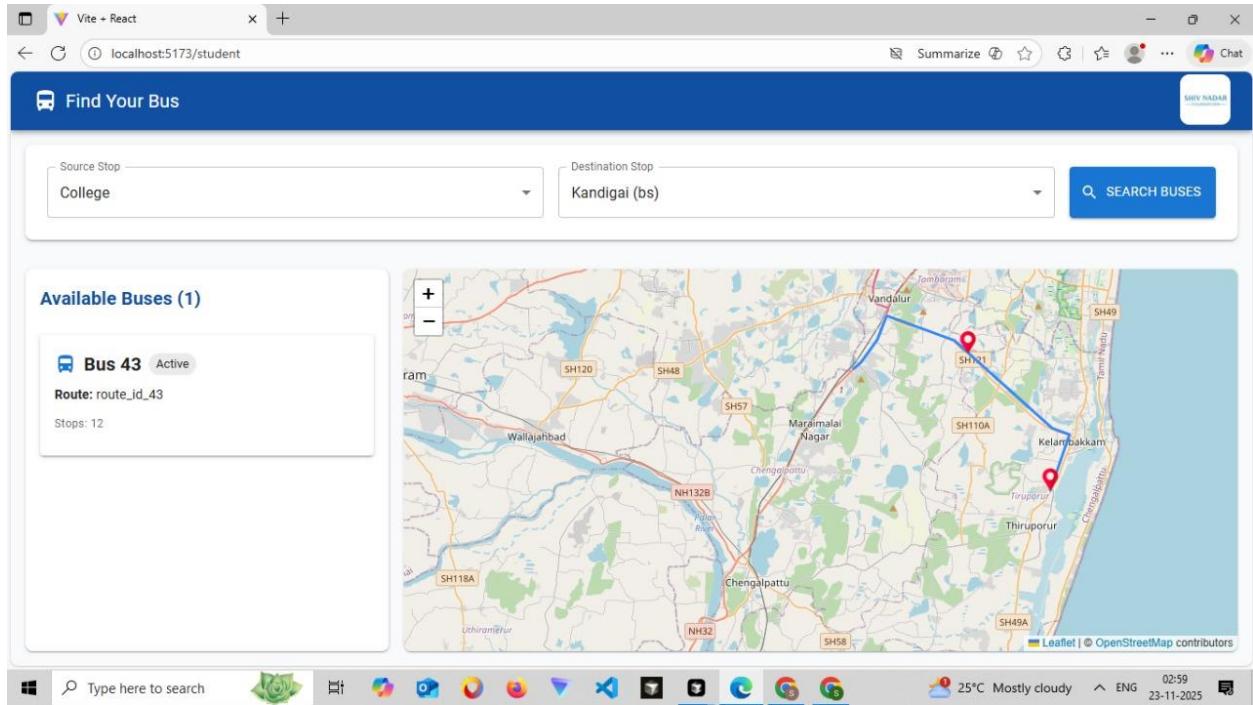
An "Open file" link is next to each PDF icon. A "See more" link is at the bottom of the sidebar.

A screenshot of a PDF viewer window displaying a monthly bus report. The file path is `C:/Users/Srinivas/Downloads/bus_report_monthly_2025-11-26(1).pdf`. The report title is "Bus Report - Monthly (last 31 days)". It was generated on "26/11/2025, 3:25:01 pm". The content lists bus numbers from 1 to 21, each preceded by a small red square icon:

- Bus No: 1
- Bus No: 10
- Bus No: 11
- Bus No: 12
- Bus No: 13
- Bus No: 14
- Bus No: 15
- Bus No: 16
- Bus No: 17
- Bus No: 18
- Bus No: 19
- Bus No: 2
- Bus No: 20
- Bus No: 21



2) Student Interface



2.2 Functional Requirements and Use Cases

Admin Use Cases

1. Student Account Setup & Authentication
 - o Admin verifies student details and sends system-generated login credentials to their registered email.
2. Student Registration with Facial Data
 - o Admin collects face data and student information using a dedicated registration microservice.
 - o The data is securely stored in Firebase for attendance processing.
3. Live Bus Tracking
 - o Admin can monitor the real-time location of each bus using GPS coordinates streamed from Raspberry Pi devices.
4. Route Management
 - o Admin can add, edit, delete, and review the default and updated routes of all buses, including stop-wise details.

5. Bus Monitoring (Raspberry Pi Integration)

- Each bus is equipped with a Raspberry Pi + camera module that streams attendance and camera feed via ngrok tunneling.
- Admin can view the live feed and attendance logs from the dashboard.

6. Attendance Reports

- Admin can download individual student attendance reports or consolidated bus-wise reports for audits and analysis.

Student Use Cases

1. Bus Discovery Based on Stops

- Students select their source and destination stops.
- The system displays all buses available for the chosen route with timings and route details.

2. Live Bus Tracking

- Students can track buses in real time on the map, ensuring accurate trip planning.

Technical Details

3.1 Tech Stack

Frontend

- React.js for the admin dashboard and student portal.

Backend

- Node.js + Express.js for core backend services (authentication, bus management, route management, tracking).
- Flask microservice for student registration and facial data capture.

Database & Authentication

- Firebase Firestore for structured data storage.
- Firebase Authentication for secure access control for admin and students.

IoT & ML Components

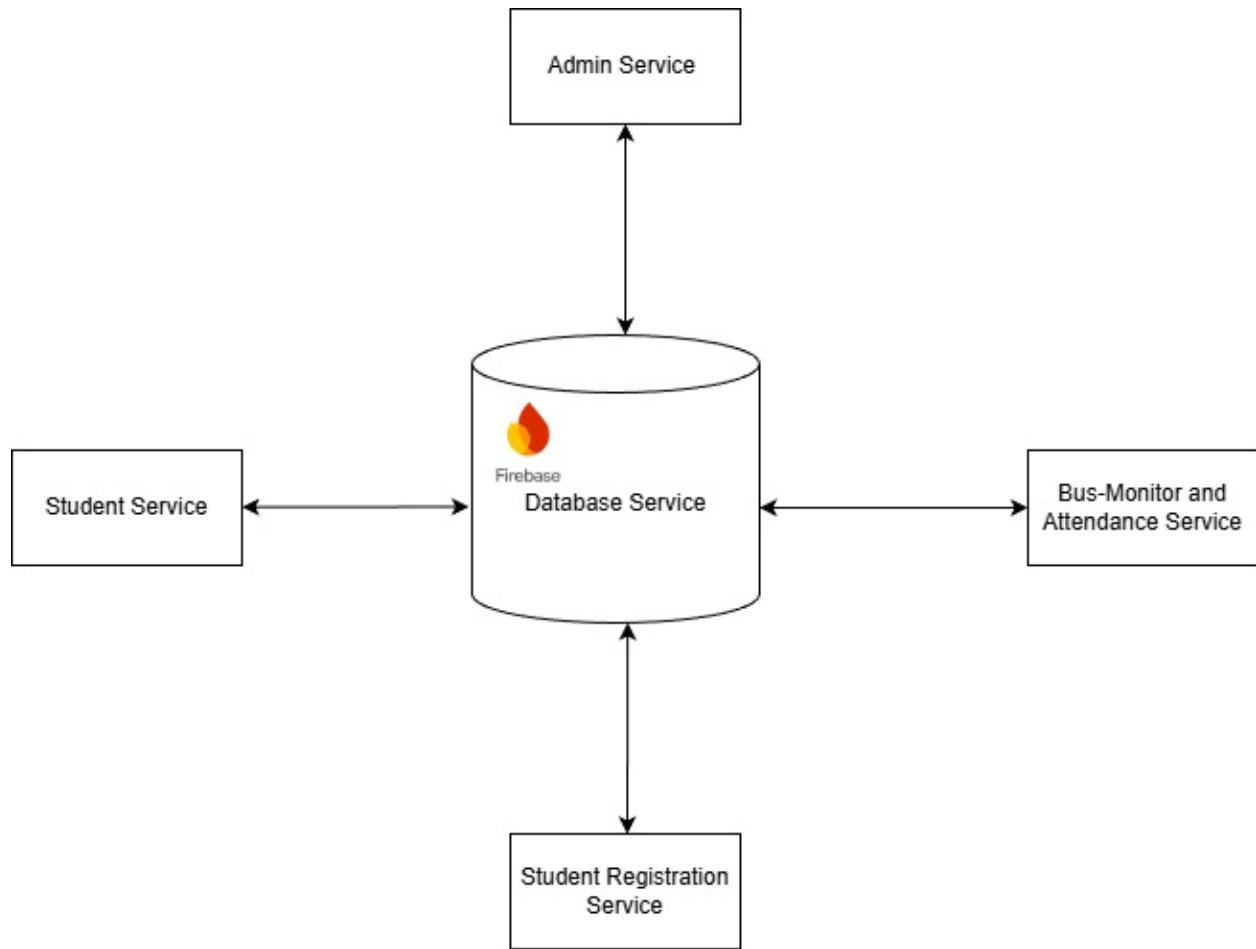
- Raspberry Pi + Camera Module for attendance capture using facial recognition.
- ngrok for secure tunneling and streaming camera outputs to the cloud.

Deployment & DevOps

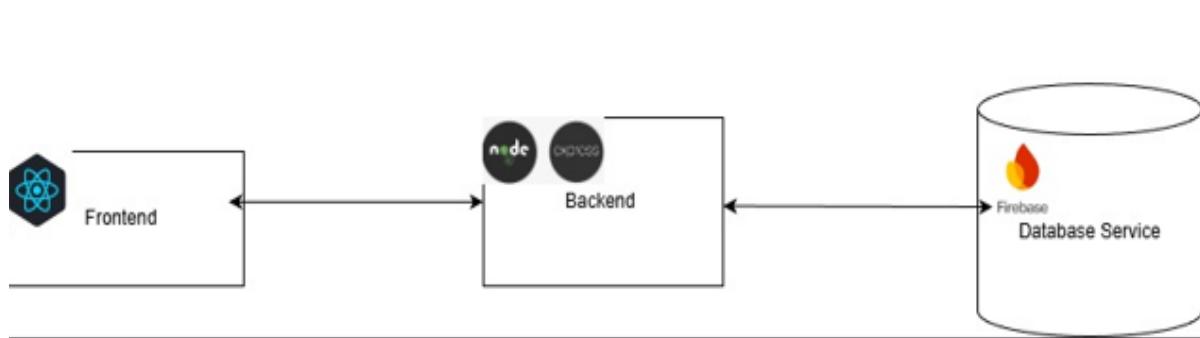
- Render for deploying the registration microservice.
- Git for version control and project collaboration.

3.2 Architecture Overview

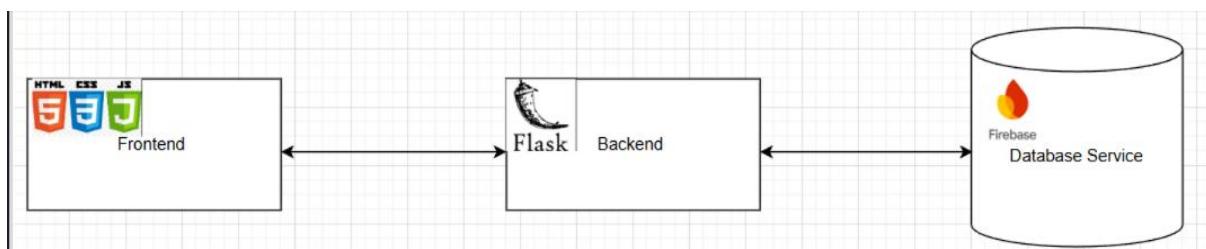
The system follows a modular, microservice-assisted architecture. The main backend (Node.js) handles authentication, bus route configuration, and real-time tracking. A separate Flask microservice manages face data registration. Raspberry Pi devices installed in buses capture facial images, recognize student entry, and push attendance + GPS details to Firebase via ngrok tunnels. The React frontends (admin and student portals) fetch data from Firebase and backend APIs to render dashboards, maps, and attendance information.



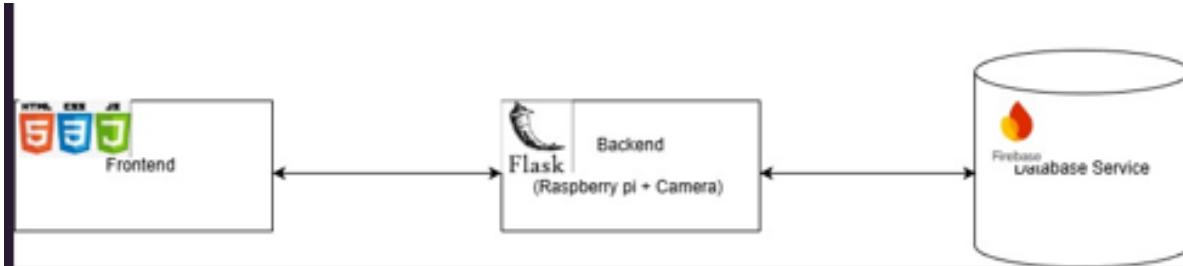
(i) Student and Admin Services



(ii) Student Registration Service



(iii) Bus-Monitor and Attendance Service



3.3 Design Patterns Used

1. Microservices Pattern

- The facial data registration and attendance capture module is built as an independent Flask microservice, allowing modular updates without affecting core backend logic.

2. MVC Pattern (Model–View–Controller)

- Applied in the Node.js backend for organizing routes, controllers, and data models cleanly.

3. Observer Pattern

- Real-time updates are pushed to Firebase, and all connected clients automatically receive updated values.

4. Client–Server Pattern

- Both student and admin interfaces operate as clients that interact with REST APIs and Firebase for dynamic data flow.