Software Requirements Specification

Skill Development Project III – ICT 3206

Bachelor of Information and Communication Technology (Honors)

Department of Information and Communication Technology
Faculty of Technology
Rajarata University of Sri Lanka

Details of the Project

Project Title : Automated Train platform safety and Tracking System

Group Number : Group 14

Group Name : Team ECODUINO

Submission Date : 03/07/2025

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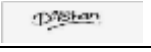
H.M.D.M Hearth	ITT/2021/039	1661	
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1. Introduction

1.1. Background of the project

For millions of people, railway travel is a key option for transportation, but it also has disadvantages in terms of efficiency and safety. Lack of real-time tracking, illegal entry, and train accidents all increase delays and safety risks. By combining automation, secure access management, and real-time monitoring, the Automated Train Platform Safety and Tracking System aims to overcome these problems.

By using real-time GPS monitoring and Estimated Time of Arrival (ETA) computation, the project aims to improve passenger experience, increase railway crossing safety, and reduce accidents on train platforms. The system ensures railway travel's safety, effectiveness, and convenience by using modern technology including ESP32, GSM modules, ultrasonic sensors, and QR code-based authentication.

1.2. Purpose and significance of the project

In the development of public transportation, railway transportation is important. However, passenger dissatisfaction delays, and accidents are frequently caused by operational inefficiencies and safety issues. By using automation and advanced technology, the Automated Train Platform Safety and Tracking System aims to increase railway efficiency and safety.

Our system's purposes are to prevent railway crossing accidents by putting automated gate control in location, reduce accidents on railway platforms by regulating passenger access with automated platform gates, give passengers reliable real-time train monitoring and ETA calculations so they can make effective travel plans. Improve boarding security by using QR code authentication to make sure that only authorized passengers enter 1st and 2nd class.

Passenger safety will be improved by our system. Trying to board a train before it completely stops is a common cause of train-related accidents. In order to prevent unnecessary deaths and injuries, the automated platform gate system makes sure that passengers can only enter the platform once the train has completely stopped. Railway crossings are also major accident areas because vehicles often cross the tracks as a train is approaching. Vehicle-train collisions are decreased by automated crossing gates, which respond quickly.

Time management and train tracking will be improved by our system. Uncertain train schedules and arrival times frequently cause problems for passengers. With an accurate Estimated Time of Arrival (ETA) provided by the real-time GPS monitoring system, passengers may better plan their trips and experience fewer problems from unexpected delays. Railway officials also gain from this since it enhances operational effectiveness and schedule management.

Our innovation will improve access control and security. Accessing reserved 1st class and 2nd class without authorization presents a security risk. Only first and second class passengers with confirmed bookings have to enter designated train compartments due to the QR code-based boarding system. This keeps assigned compartments from being overcrowded and improves security.

1.3. Scope of the project

To improve railway safety and efficiency, the Automated Train Platform Safety and Tracking System combines automation, real-time tracking, and access control. Both the features and restrictions of the system are specified in the project's scope.

A number of key components made up the Automated Train Platform Safety and Tracking System, which is intended to improve railroad efficiency and safety. In order to prevent errors caused on by rushing passengers, the automated platform gate system makes sure that platform gates stay closed until a train has completely entered and stopped at the station. In order to reduce car crashes, the system also has an automated railway crossing barrier system that closes up railway crossing gates when a train approaches. The technology uses real-time GPS monitoring and ETA calculation to enhance the passenger experience. Through a web-based application, passengers may receive precise train locations and predicted arrival times. Furthermore, only approved passengers are able to enter reserved cabins due to a QR code-based boarding system that limits access to first- and second-class compartments. The system uses ESP32 microcontrollers, GSM modules, and Firebase database technology to enable efficient data exchange and control. This allows for real-time updates and automation across all components.

The Automated Train Platform Safety and Tracking System has limitations even if it significantly increases railway efficiency and safety. Tracking updates may be delayed in distant locations with poor network coverage because the system depends on mobile networks (Dialog, Mobitel) to send GPS and control data. Due of financial limitations, the project makes use of inexpensive GSM and QR scanning modules, which could lead to worse accuracy and less performance when compared to more expensive options. Furthermore, because smaller rural stations could lack the infrastructure to handle them, automatic platform gates will only be installed in big railway stations. Only first and second-class passengers are subject to the QR code-based boarding system and public compartments will not be subject to limited access control. These limitations outline the project's limits and ensure its sustainability while resolving the main safety issues with railroad travel.

2. Use cases of the project

2.1. Actors

The main actors interacting with the system:

1. Passenger - Uses QR code-based access, views train location on Google Maps, checks ETA, and books tickets online.
2. Admin - Ensures passengers board with valid QR codes and control the manual systems.

2.2. Use cases

1. Use Case 01 – Automated Platform Gate Control
2. Use Case 02 – Automated Railway Gates Control
3. Use Case 03 – Real Time Tracking on Google Maps
4. Use Case 04 – QR Code Based Train Boarding
5. Use Case 05 – ETA Display for Passengers
6. Use Case 06 – Online Ticket Booking System
7. Use Case 07 – QR Code Generation and Email Notification

2.3. Use case diagram

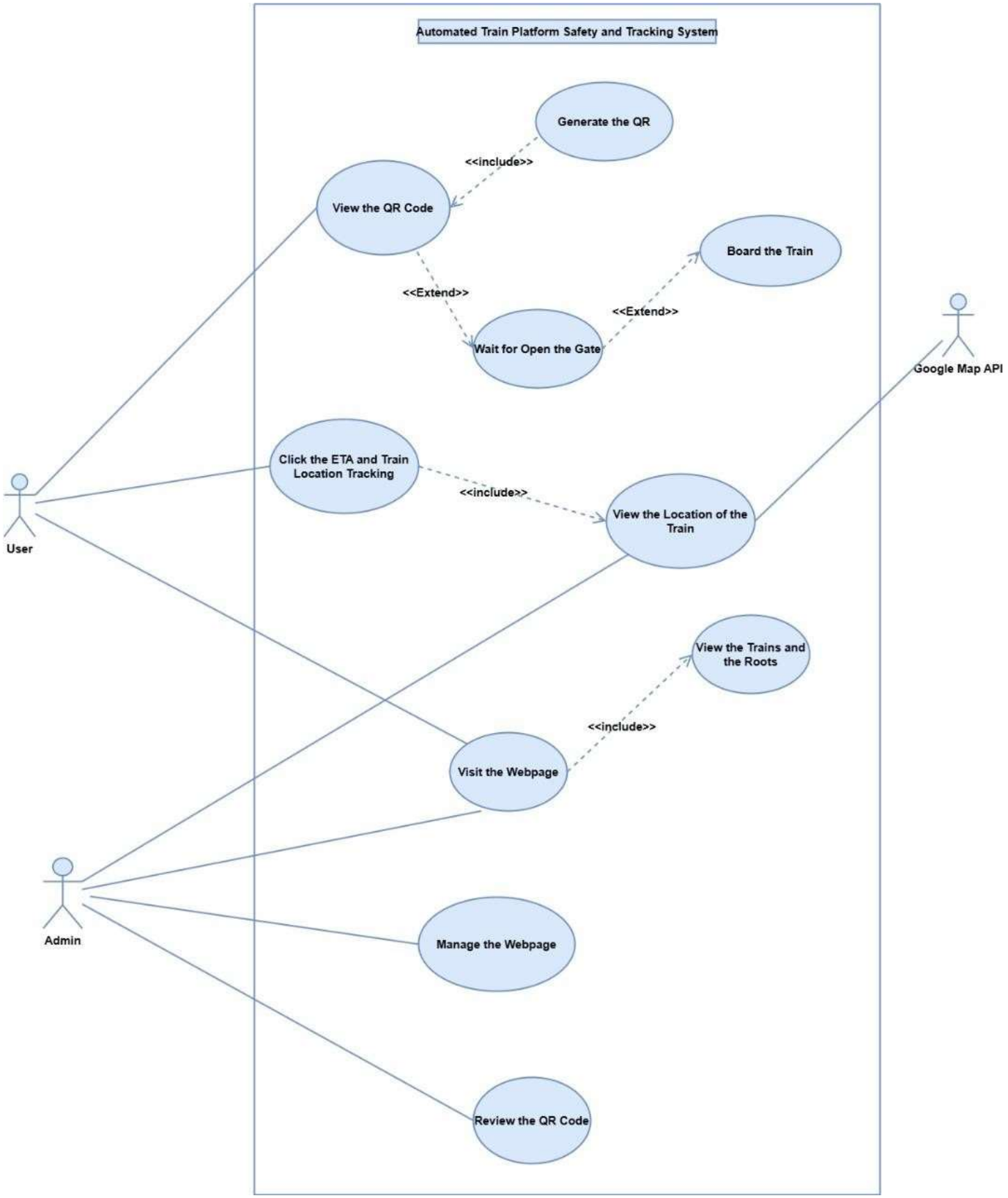


Figure 1 Use Case Diagram of the System.

2.4. Use case scenarios

Table 1 Platform Gate Control Use Case Scenario

Use case ID	01
Use case name	Platform Gate Control
Actor(s)	Passenger, Automated System
Pre-condition(s)	The train must be approaching or stopped at the platform.
Activity descriptions	1. Train arrives at the station. 2. Train detects by Ultra Sonic Sensor. 3. System detects the train's GPS location. 4. If the train has stopped or slowed significantly, platform gates open. 5. Passengers aboard the train.
Post-condition(s)	Platform gates close when the train departs.

Table 2 Railway Cross Road Gate Control Scenario

Use case ID	02
Use case name	Railway Cross Road Gate Control
Actor(s)	Vehicle Driver, Automated System
Pre-condition(s)	The train must be approaching.
Activity descriptions	1. Train is Driving toward the Railway Cross Gates 2. Train detects by Ultra Sonic Sensor. 3. Close the Railway Cross Gates 4. Vehicles Stop to train to pass.
Post-condition(s)	Railway Cross gates open when the train fully passes the Railway Cross Gates

Table 3 Real-time Train Tracking Scenario

Use case ID	03
Use case name	Real-time Train Tracking
Actor(s)	Passenger, Automated System
Pre-condition(s)	GPS module must be active, and the train must be moving.
Activity descriptions	1. The GPS module sends real-time location data to Firebase through ESP 32 controller that is connected to the internet through GSM 900A module. 2. The system updates train location on Google Maps Using Google API. 3. Passengers access the tracking page on the website.
Post-condition(s)	Train location updates in 3 second time gap in the web interface

Table 4 QR Code based Train Boarding Scenario

Use case ID	04
Use case name	QR Code based Train Boarding
Actor(s)	Passenger, Railway Security, Automated System
Pre-condition(s)	Passenger has a valid reservation and QR code.
Activity descriptions	1. Passenger scans the QR code at the train entrance. 2. The system verifies the QR code against Firebase. 3. If valid, the train door unlocks. 4. Security monitors access.
Post-condition(s)	Passenger successfully boards the train.

Table 5 Estimated Time of Arrival (ETA) Display Scenario

Use case ID	05
Use case name	Estimated Time of Arrival (ETA) Display
Actor(s)	Passenger, Automated System
Pre-condition(s)	Train must be moving
Activity descriptions	1. The system calculates ETA based on the train's real-time location in the Google API. 2. The ETA updates dynamically as the train moves. 3. Passengers view ETA on the website.
Post-condition(s)	Passengers receive real-time arrival information.

Table 6 Online Ticket Booking Scenario

Use case ID	06
Use case name	Online Ticket Booking
Actor(s)	Passenger, Automated System
Pre-condition(s)	Passenger must access the online booking system.
Activity descriptions	1. Passenger selects a train and seat class. 2. The system verifies seat availability. 3. Passenger enters payment details and confirms booking. 4. The system generates a QR code and saves it in Firebase. 5. Passenger receives a booking confirmation email.
Post-condition(s)	Passenger receives a QR code for boarding.

Table 7 QR Code Generation and Email Notification

Use case ID	07
Use case name	QR Code Generation & Email Notification
Actor(s)	Passenger, Automated System
Pre-condition(s)	Passenger must successfully book a ticket.
Activity descriptions	1. The system generates a QR code for the booked ticket. 2. QR code is stored in Firebase. 3. The system sends a confirmation email with the QR code to the passenger.
Post-condition(s)	Passenger receives the QR code and confirmation.

2.5. Alternative and exception scenarios

Table 8 Train Delay Alternative Scenario

Use case ID	05. I
Use case name	Train Delay
Actor(s)	Passenger, Train Station Masters
Pre-condition(s)	The train is delayed due to technical issues.
Activity descriptions	1. ETA Update becomes stable. 2. Notify the passengers by Train master.
Post-condition(s)	-

Table 9 QR Code Failure Alternative Scenario

Use case ID	04. I
Use case name	QR Code Failure
Actor(s)	Passenger, Railway Security
Pre-condition(s)	Passenger attempts to scan a QR code, but it does not work.
Activity descriptions	1. Passenger scans QR code. 2. System fails to recognize it. 3. Security manually verifies passenger details. 4. If valid, security allows access.
Post-condition(s)	Passenger is granted entry manually.

3. Activity diagrams of the project

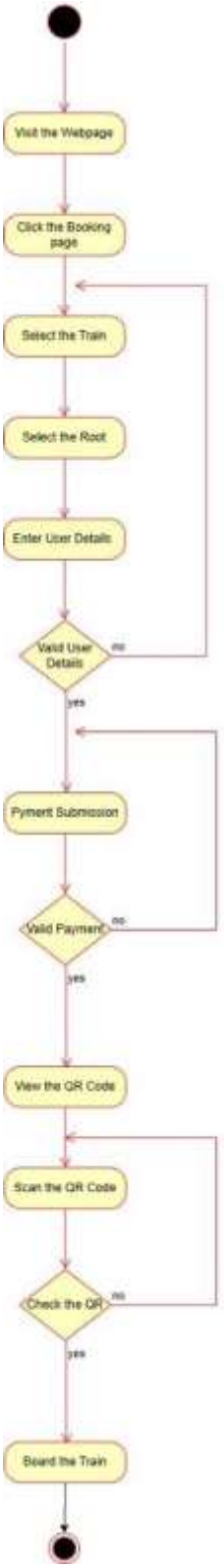


Figure 2 Activity Diagram of the User Interference

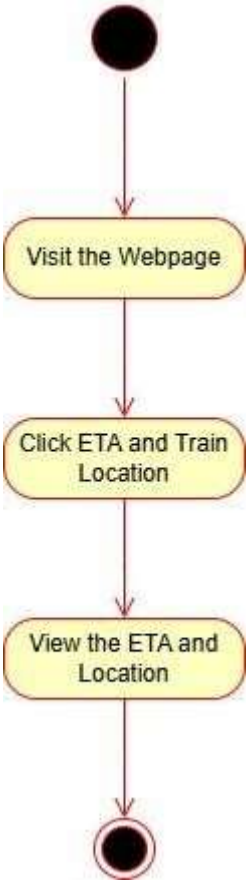


Figure 2 Activity Diagram of Visiting Webpage

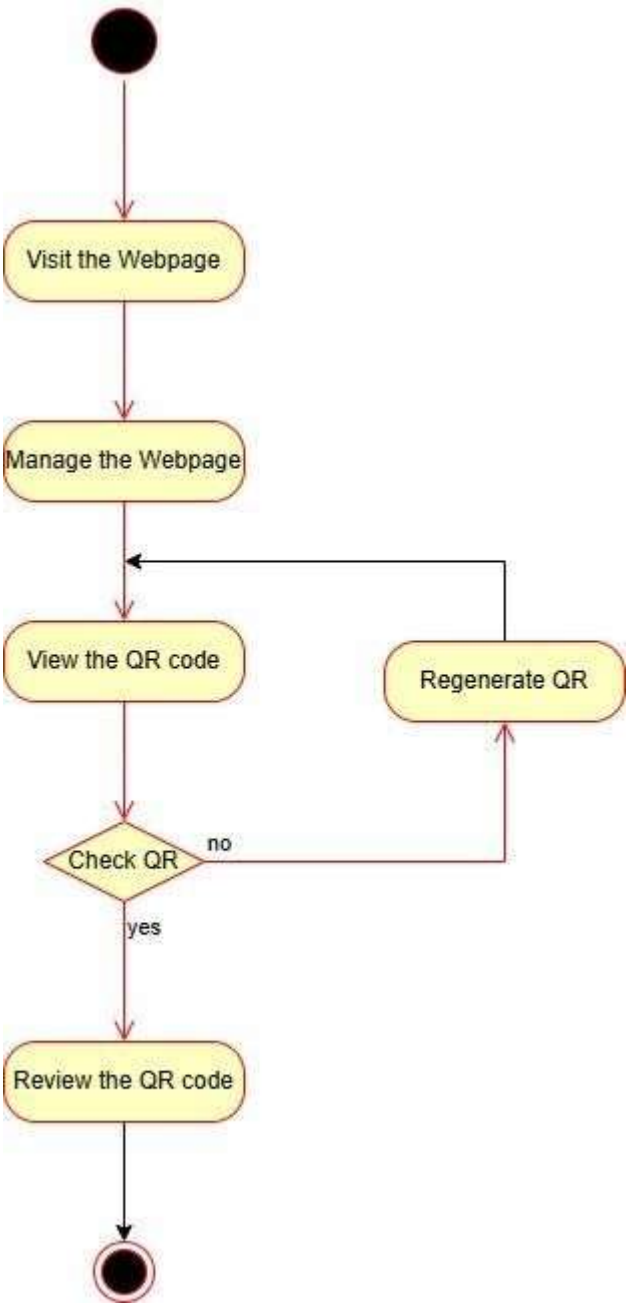


Figure 3 Activity Diagram of QR code function

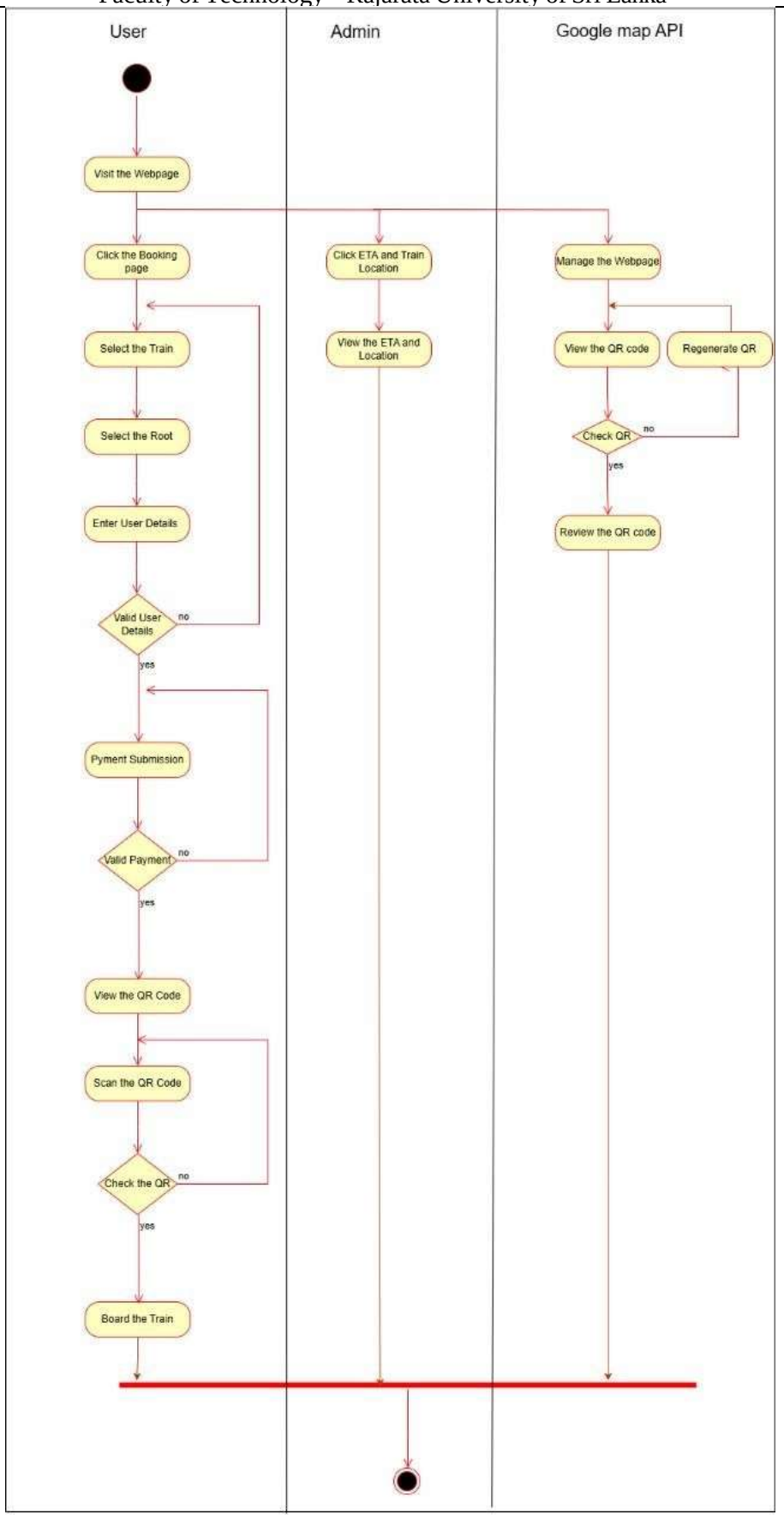


Figure 4 Activity Diagram of the System

4. Functional Requirements of the Project

Table 10 Function Name : Automated Platform Gate Control

Priority Number	01
Function Name	Automated Platform Gate Control
Description	The system should be able to close the platform gates until the train has stopped and slowed at the platform.
Input	GPS location status and the Ultra Sonic sensor Detection.
Process	Verify train's position and movement, trigger servo motor to open gates if conditions are met
Output	Gates open only when the train has stopped and slowed.
Assumptions/ Constraints	N/A

Table 11 Function Name : Automated Railway Crossing Gates

Priority Number	02
Function Name	Automated Railway Crossing Gates
Description	The system should be able automatically close railway crossing gates when a train is detected approaching.
Input	Ultra Sonic Sensor detection.
Process	Activate servo motors to close railway cross gate when train is detected.
Output	Railway cross gate close before the train reaches the crossing.
Assumptions/ Constraints	Sensors must be accurately calibrated to detect train distance.

Table 12 Function Name : Real-time GPS Tracking

Priority Number	03
Function Name	Real-time GPS Tracking
Description	The system should be able to provide real-time location tracking of trains and display ETA for passengers on a web interface.
Input	GPS location data from ESP32 and NEO-6M module.
Process	Use Google API for process GPS coordinates and ETA automatically.
Output	Train's real-time location and ETA displayed on a web application.
Assumptions/ Constraints	Requires stable mobile network connectivity.

Table 13 Function Name : QR Code-Based Boarding System

Priority Number	04
Function Name	QR Code-Based Boarding System
Description	The system should be allowing only authorized passengers with valid QR codes to access 1st and 2nd class compartments.
Input	QR code scanned by GM-805 module and servo motors open the door.
Process	Verify QR code with Firebase database and when the QR code verified the door will open.
Output	Doors unlock for valid QR codes and invalid QR codes are rejected.
Assumptions/ Constraints	Only implemented for reserved 1st class and 2nd class compartments.

Table 14 Function Name : Communication with Firebase

Priority Number	05
Function Name	Communication with Database
Description	The user should be able to view train status, passenger booking data, and QR codes in Firebase.
Input	Train location, QR codes, gate status, and timestamps.
Process	Data is updated and retrieved from Firebase in real time.
Output	Stored data is available for tracking, analytics, and access control.
Assumptions/ Constraints	Mobile network-based data transmission may cause delays.

Table 15 Function Name: Send an Email if booking is made for the user.

Priority Number	06
Function Name	Send an Email if booking is made for the user.
Description	The user should receive a QR Code and the booking confirmation letter through an Email.
Input	Filling the booking details and successfully book the train.
Process	QR code and Confirmation letter made by the system.
Output	QR code and Confirmation letter send to the user.
Assumptions/ Constraints	N/A

Table 16 Function Name : Viewing Train details

Priority Number	07
Function Name	Viewing Train Details
Description	The user should able to view the train roots and train status for booking the seats.
Input	Filling the date that the user intends to travel.
Process	Process the train routs and trains available at the user defining date.
Output	Train Routes and Train that are travel in that route and also the seat availability of that train
Assumptions/ Constraints	N/A

5. Non-functional Requirements

Product Requirements

1. Under normal conditions, the system has to manage train tracking, gate operations, and QR verification in less than 7 seconds because to take the accurate location where the train is and also in gate operations ultra sonic detection is always 5 seconds if an object detect for that amount of time signal will be send to gates to be close.

2. GPS tracking must provide train location updates with an accuracy of at least 10 meters apart**.**

3. The system should notify the Gate keepers, Train masters if there is a issue in the detecting systems and they must use manual switches to activate systems manually.

4. The web interface system should easily access by passengers in the train station through QR code access system. QR codes will be situated every where visible in the train station to scan by users.

Organizational Requirements

1. The automated platform gate control system should make sure that platform gates stay closed until the train has completely entered and stopped, in keeping with Railways Ordinance (Chapter 200), Section 3, which requires passenger safety regulations. This will prevent early track access and lower the risk of accidents.

2. Railway staff must receive training on system operation, manual operation when system error occur, and passenger guidance on how to use the system**.**

3. To ensure long-term reliability, regular maintenance plans and technical assistance must be offered.

External Requirements

1. The system relies on mobile networks for real-time data transmission and tracking and the system should use Dialog network due to providing stable 3G communication through the train tacks but as we done the preliminary investigation from Gampola to Hatton we have to use LORA system due to lack of network connectivity.

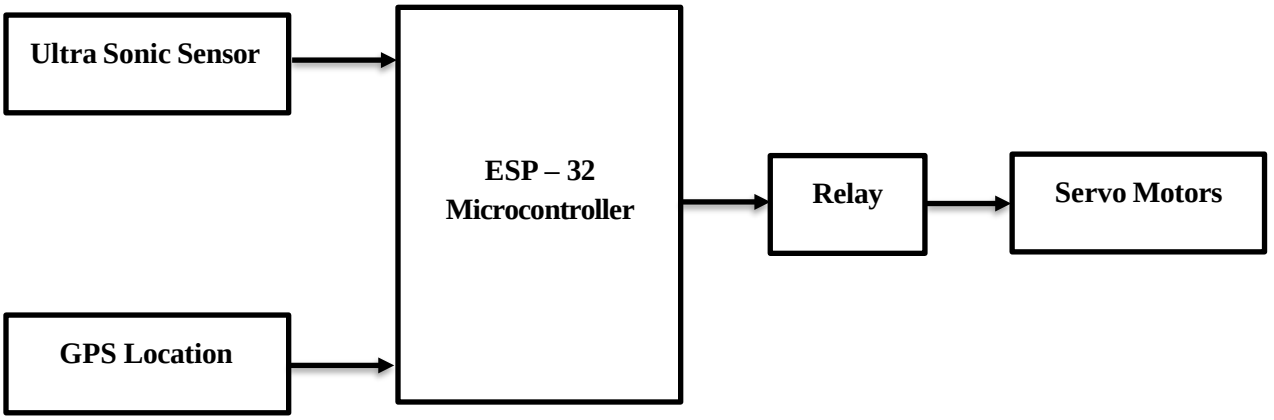
2. The system must comply with Sri Lanka's Personal Data Protection Act, No. 9 of 2022 to ensure secure collection, storage, and processing of passenger information.

3. Hardware components must be weather-resistant and durable to withstand outdoor conditions at railway stations and crossings.

4. Awareness programs should be conducted to educate passengers on using the QR-based boarding and tracking system**.**

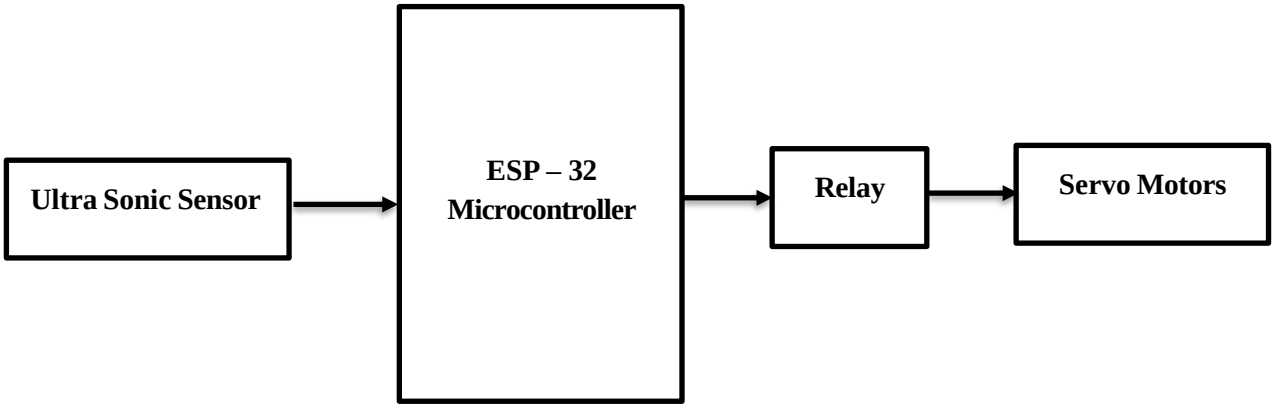
6. Hardware Design *(if exists)*

Automated Platform Gate Opening System



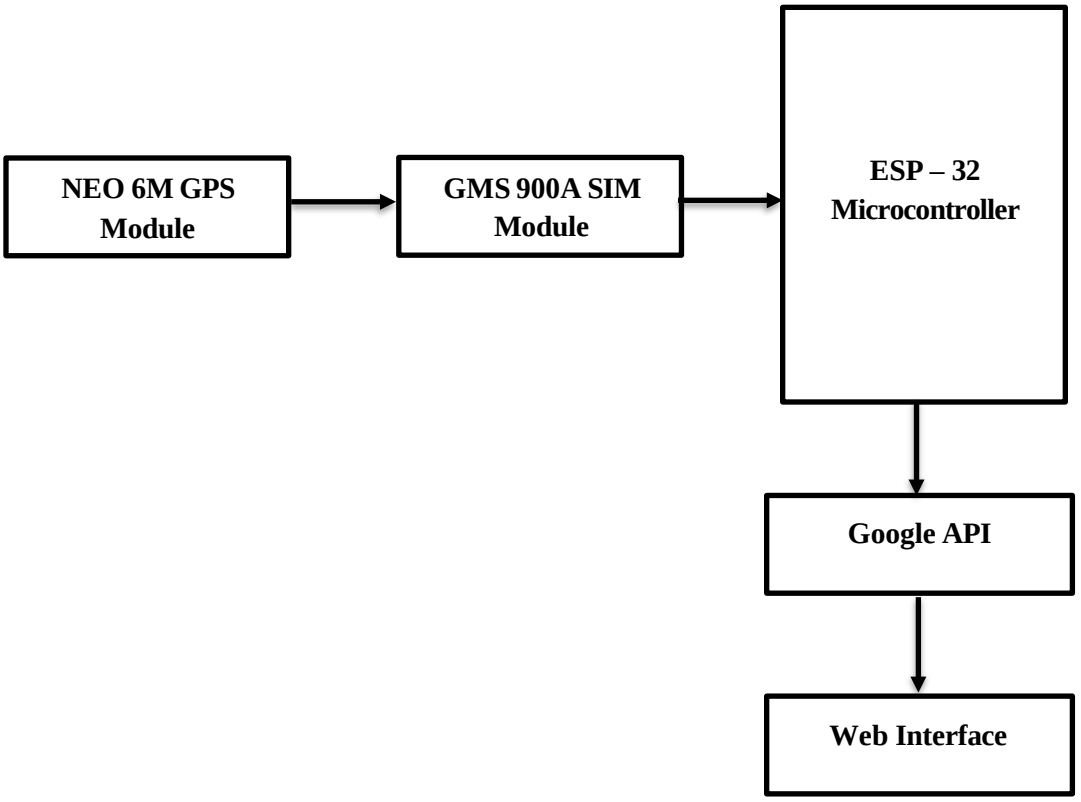
Platform gates are opened and closed by the system using servo motors. Until the train has fully entered the station, stopped completely, or is traveling at a very slow speed, these gates stay locked. Ultrasonic sensors identify the train, while GPS information from the train helps in confirming its condition. The servo motors turn on and open the gates to allow people to board safely.

Automated Railway Cross Gate System



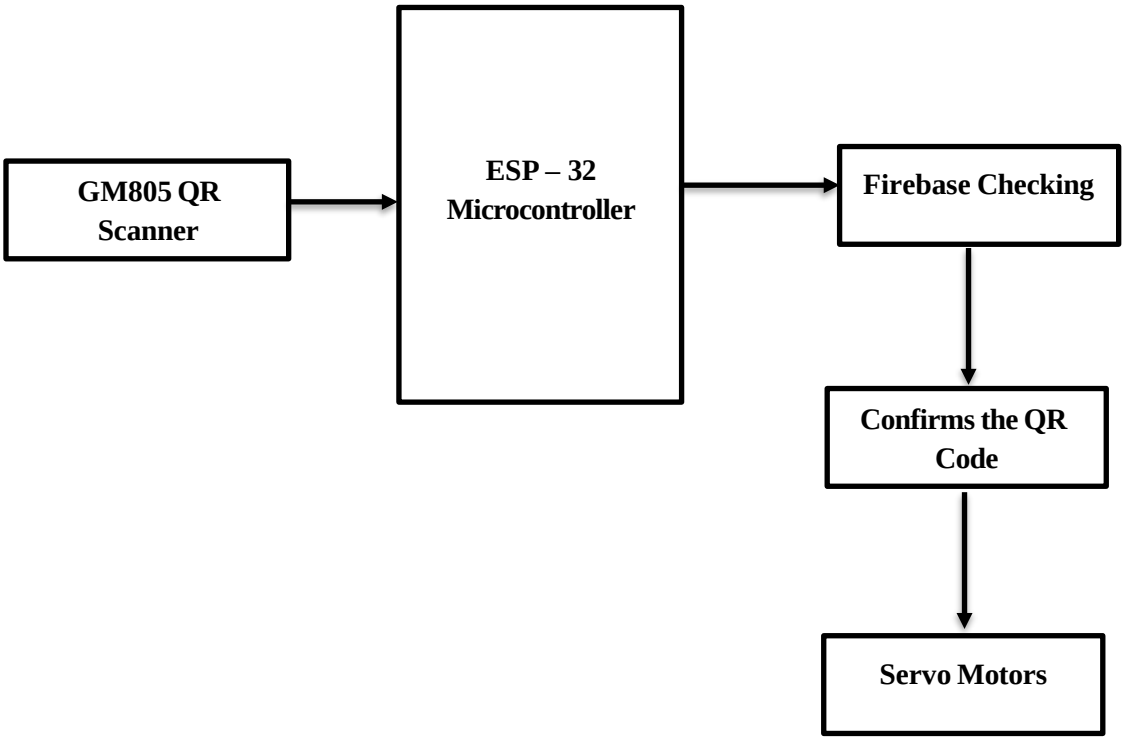
The system automates railway crossing gates using servo motors controlled by train detection sensors. Ultrasonic sensors placed near the crossing detect an approaching train if the sensor detect an object for 7 seconds system will trigger the gates to close automatically.

Real Time GPS and ETA Tracking System



The SIM 900A GSM Module is used to send the location data that the NEO-6M GPS Module continuously gathers from the moving train to a central database. Passengers are given accurate details about the train's location and expected arrival time when this data is processed and presented on a web interface.

QR Code Based Boarding System



The GM 805 QR Scanner Module reads the QR code and verifies its validity by sending the code to check the presence in the firebase. If the QR code is valid, the system sends a signal to servo motors to unlock the internal 1st class or 2nd class train doors, granting access to the booked seating areas.

7. Recommendation of supervisor(s) on the document

(This section should be filled by the supervisor(s)).

Comments (if any):

I/We certify that, the student engaged continuously with me in developing the proposal and, I am confident that they are adequately competent to defend this viva.

Signature(s) of Supervisor(s):

Date: 08/03/2025

8. Viva presentation assessment team

(This section should be filled by the department)

Date of viva presentation: .....

Panel members	Name	Department / Institute
Chair		
Member		
Member		
Member		
Member		

9. Comments of the assessment team on viva presentation

(This should be filled by the chair of the assessment panel. In case of revision or fail, needed revision or reasons to fail the viva presentation should be mentioned here)

Result of the viva presentation	Excellent / Good / Pass with revisions / Fail
Score	
Signature of the panel chair	
Date	