

# **TRAIN TRACKING AND DETECTION SYSTEM**

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Project Proposal Report  
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B.Sc. (Hons) Degree in Information Technology  
(Specializing in Cyber Security)

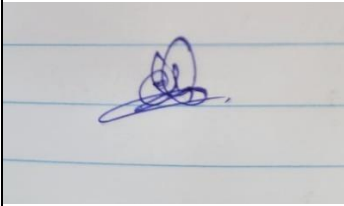
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## DECLARATION

I Amarasinghe C D IT20187064 , We declare that this is our own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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## ABSTRACT

The effectiveness and safety of the railway system are significantly influenced by the train tracking and detection system. The goal of this research project report is to explore and evaluate several train monitoring and detection systems already in use in order to pinpoint their advantages, disadvantages, and restrictions. In order to attain more accuracy and dependability, the paper also suggests a novel method for train tracking and detection that makes use of computer vision and machine learning techniques.

A technology-based solution called the Train Tracking and Detection System for Citizens via the Sim, or a Tracker enables people to follow the movement and location of trains in real time. Both a separate tracker device and a mobile phone with a sim card can be used to access this system. For the most recent information on the whereabouts and status of trains, the system makes use of GPS and other real-time data sources. Passengers can make better travel plans with this information, decreasing the likelihood of missing trains or having a long wait. In order to increase the general effectiveness and safety of railway operations, train operators can also utilize this technology to monitor the performance of their trains. The first step in the approach may be to collect data on trains, which we would then analyze and predict using. Users will be able to receive alerts using the smartphone application. The report includes a detailed description of the system architecture, hardware and software requirements, and the algorithmic design. The proposed system is tested using real-world data, and the results demonstrate its effectiveness in detecting and tracking trains accurately and efficiently.

In today's fast-paced world, rail transport plays a pivotal role in connecting cities and regions, facilitating the movement of people and goods. However, the railway sector faces numerous challenges, such as ensuring the safety of passengers and crew, minimizing delays, and optimizing resource allocation. The Train Tracking and Alert System addresses these challenges by utilizing cutting-edge technology.

The core components of the system include real-time tracking, predictive analytics, and alert mechanisms. Real-time tracking is achieved through the use of GPS and satellite communication, enabling precise monitoring of train movements. This information is relayed to a central control center, where it is processed using advanced algorithms to predict potential issues such as track obstructions, equipment malfunctions, or adverse weather conditions.

One of the key features of the system is its predictive analytics capability. By analyzing historical data, current conditions, and external factors, the system can anticipate disruptions and recommend preventive actions. For example, if adverse weather conditions are predicted, the system can suggest adjusting train schedules, reducing speeds, or implementing safety measures to prevent accidents.

Furthermore, the Train Tracking and Alert System incorporates an alert mechanism that enables timely communication with train operators, maintenance crews, and passengers. In the event of an emergency or a potential issue, alerts are sent out via multiple channels, including onboard displays, mobile apps, and communication with the control center. This ensures that all relevant stakeholders are informed promptly, allowing for quick responses to mitigate risks.

The benefits of the Train Tracking and Alert System are multifaceted. First and foremost, it enhances safety by reducing the likelihood of accidents and providing timely information to crews and passengers. This not only saves lives but also minimizes property damage and associated costs. Additionally, the system improves operational efficiency by optimizing train schedules, reducing delays, and enhancing resource allocation.

Passenger experience is significantly enhanced through real-time updates on train status, including delays and expected arrival times. This transparency builds trust and satisfaction among passengers, encouraging greater use of rail transport. Furthermore, by minimizing disruptions and delays, the system contributes to environmental sustainability by reducing greenhouse gas emissions associated with idling trains.

The Train Tracking and Alert System is highly adaptable and can be customized to suit the specific needs of different railway networks. It can integrate with existing infrastructure and equipment, making it a cost-effective solution for both new and established rail systems. Moreover, its scalability ensures that it can accommodate future expansions and technological advancements.

In conclusion, the Train Tracking and Alert System represents a significant advancement in railway technology, addressing critical safety and efficiency challenges. Its real-time tracking, predictive analytics, and alert mechanisms work in tandem to ensure the smooth operation of rail networks. By enhancing safety, improving efficiency, and enhancing the passenger experience, this system is poised to transform the railway industry, making it a safer, more reliable, and environmentally friendly mode of transportation.

The system architecture description, software, and hardware specifications are all thoroughly described in the study. Real-world data is used to evaluate the suggested system, and the findings show that it is capable of precisely and effectively recognizing and tracking trains.

Overall, the study project report offers useful insights into the current train tracking and detection systems and suggests a creative solution that can improve railroad safety and effectiveness. The suggested system has the ability to completely alter how trains are tracked and monitored, and it can be further expanded and tailored to satisfy the unique needs of various railway networks.

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# 1. NTRODUCTION

Railroad transit plays a crucial role in the economic and social development of nations, and ensuring the safety and productivity of railroad operations is of utmost importance. A significant part of this responsibility lies with the railway authorities, who are tasked with developing and implementing effective train tracking and detection systems. These systems are essential for monitoring and regulating train movements accurately and in real-time, allowing for timely intervention in case of any issues or emergencies.

As technology advances, there has been a growing need for more mobile, user-friendly, and accessible train tracking and detection systems. This has led to the development of a mobile application for train tracking and detection, which provides real-time management of train movements. The application is designed to track the location, speed, and direction of the train using cutting-edge technology such as GPS, machine learning, and computer vision. It also provides customers with warnings and notifications in case of any irregularities or crises.

However, ensuring the security of the train tracking and detection system is equally crucial. Security analysis is the process of evaluating the security of a system, network, or organization to identify vulnerabilities, threats, and risks. In the context of the train tracking and detection system, security analysis is crucial to identify potential security weaknesses and develop strategies to mitigate them. This involves implementing various security controls such as firewalls, intrusion detection systems, access controls, and encryption, as well as developing incident response plans and conducting regular security audits.

The security analysis process includes several methodologies such as vulnerability assessments, penetration testing, threat modeling, and risk assessments. Vulnerability assessments are used to identify potential vulnerabilities in the system, while penetration testing is used to test the system's security by attempting to exploit these vulnerabilities. Threat modeling involves identifying potential threats to the system and developing strategies to mitigate them, while risk assessments are used to assess the likelihood and potential impact of an attack on the system.

Overall, security analysis is a crucial component of any comprehensive security program, and helps organizations to proactively identify and address security vulnerabilities and threats, reducing the risk of cyber attacks and protecting sensitive information. In the context of the train

tracking and detection system, security analysis is essential to ensure the safety and security of train operations, protect customer data, and safeguard critical infrastructure.

In conclusion, the development of a mobile application for train tracking and detection is a significant step towards ensuring the safety and productivity of railroad operations. However, it is crucial to ensure the security of the system by conducting regular security analysis and implementing various security controls. This will not only help to prevent cyber attacks but also protect critical infrastructure, thereby safeguarding the economic and social development of nations.

In conclusion, the development of a mobile application for train detection and tracking is a crucial development in the field of railway operations, greatly enhancing both productivity and safety. The duty to protect against potential risks and vulnerabilities comes with considerable technical advancement, though. Therefore, it is essential to stress the value of strong security measures in order to guarantee the system's integrity.

The installation of a train tracking and alarm system is a difficult process that combines delicate data with essential infrastructure. Regular security studies and the implementation of strict security measures are essential given the frequency and sophistication of cyber attacks in today's digital environment.

Comprehensive risk evaluations, vulnerability assessments, and penetration testing should all be included in security analyses. These analyses are necessary to find any system flaws that malevolent actors might try to exploit. The system can be strengthened against cyber assaults, data breaches, and other security breaches that might jeopardise the functionality and safety of railway operations by proactively addressing these weaknesses.

Multiple layers of security measures must be put in place in order to safeguard the integrity of vital infrastructure. Strong encryption protocols to protect data while it is in transit and at rest, access controls to restrict system access to authorised personnel only, intrusion detection systems to quickly identify and address security incidents, and routine security updates to fix known vulnerabilities are a few examples of these controls.



Additionally, it is necessary to develop user education and awareness programmes to make sure that both railway employees and passengers are aware of the value of cybersecurity and their part in maintaining a secure environment. Initiatives in the area of training can aid in reducing risks related to human error, social engineering attacks, and insider threats.

A security lapse in a train tracking and alarm system might have far-reaching effects on not only the railway sector but also the economic and social advancement of entire countries. A region or nation's stability and prosperity can be negatively impacted by disruptions in rail operations since they can result in large financial losses, safety risks, and supply chain disruptions.

The introduction of a mobile application for train tracking and detection, in conclusion, offers significant advantages in terms of productivity and safety, but it must be backed by a consistent commitment to cybersecurity. In order to protect this vital system, it is crucial to conduct regular security studies, implement strong security measures, and provide continual user education. We can make sure that the train tracking and warning system not only improves railway operations but also contributes to the overall security and resilience of our countries' infrastructure and development by taking these steps.

## **2. TRAIN TRACKING REVIEW**

### **2.1 BACKGROUND**

Systems for tracking and detecting trains are essential for ensuring the safety and efficiency of train operations. These systems rely on a variety of technologies, such as GPS, radar, and other sensors, to track and detect trains as they travel along railway lines. With real-time information about train locations and schedules, train operators can control traffic and prevent crashes, making these systems critical components of modern transportation infrastructure.

A train tracking system typically consists of a network of sensors and communication devices that enable real-time monitoring of train locations, speeds, and other important operational parameters. However, the security of these systems is also essential to ensure their safety and reliability. A security analysis of train tracking systems can help identify vulnerabilities and potential attack vectors, assess the potential impact of a security breach on the system and its users, and identify ways to mitigate security risks.

There are several potential security threats to train tracking systems that should be considered during security analysis. Malicious actors may attempt to gain unauthorized access to the system or its data through hacking or social engineering attacks. Physical attacks, such as vandalism or sabotage of the system's infrastructure, can also pose a significant threat. Denial of service (DoS) attacks, which overwhelm the system's sensors or communication devices, can also disrupt operations. Insider threats, such as employees with access to the system who may misuse their privileges or engage in malicious behavior, should also be considered.

To mitigate security risks, it is important to implement appropriate security controls and procedures. This may include access controls to limit who can access the system and its data, encryption to protect data in transit and at rest, and regular security audits and testing to identify vulnerabilities and potential attack vectors. It is also important to have a plan in place for responding to security incidents, such as a breach or attack, to minimize their impact and prevent further damage.

When designing a train monitoring and detection smartphone application, it is crucial to consider privacy and security concerns. These applications may collect critical information about train

schedules, positions, and freight, making it essential to provide safe and private systems that safeguard user data and guarantee the security of train operations. This may include implementing secure data storage and transmission protocols, as well as providing clear and transparent privacy policies and user agreements.

The development of alarm and tracking systems for trains has closely mirrored technological improvements. The widespread installation of telegraph lines alongside railway tracks in the late 19th century made it possible for railway staff and the central dispatching office to communicate more effectively. This was a significant step in the direction of centralised management and coordination.

Additional technological developments, such as the use of computers for train dispatching and signalling, occurred in the later half of the 20th century. More effective resource allocation and train scheduling were made possible by computerised systems. Additionally, the use of GPS technology offered a revolutionary method for real-time train tracking by delivering accurate, satellite-based location data.

Due to the fusion of mobile technology, wireless connectivity, and data analytics, train tracking and alarm systems have rapidly advanced in the twenty-first century. As a result of these advancements, sophisticated systems that offer real-time monitoring, predictive analytics, and proactive alarms have emerged, revolutionising the railway sector.

In order to provide very accurate location data, modern train tracking and alarm systems use GPS technology, cellphone networks, and onboard sensors. Real-time updates on train arrivals, departures, and delays are provided by passenger-focused mobile applications, revolutionising the passenger experience and raising general happiness.

Train operations now heavily rely on predictive analytics, which is backed by machine learning and data analytics. By taking into account elements like weather, maintenance schedules, and previous data, these systems are able to anticipate future disruptions. Operators may improve operating efficiency, optimise schedules, and cut down on delays thanks to this predictive capability.

In the case of emergencies or unanticipated problems, alert mechanisms inside these systems ensure prompt contact with train operators, maintenance teams, and passengers. By giving key

information to stakeholders, this proactive strategy not only improves safety but also enables quick and coordinated reactions to incidents, minimising the impact on both operational effectiveness and safety.

As a result of tremendous development from their modest beginnings, train tracking and alarm systems have transformed into crucial tools in the modern railway business. These systems are prepared to play an increasingly more crucial role in maintaining the sustainability, effectiveness, and safety of rail transport as technology develops, helping to determine the course of this important method of transport in the future.

Significant technological advancements in train tracking were made during the 20th century. Rail operations were optimised by the introduction of centralised traffic control systems that allowed for remote control of signals and switches. By reducing crashes and permitting accurate tracking of train locations, track circuits—which could identify the presence of trains on a track section—improved safety.

In conclusion, train tracking systems are critical components of modern transportation infrastructure, and security analysis is an essential component of their operation. By identifying and mitigating potential security risks, we can ensure the safety and reliability of these critical transportation systems. Additionally, when designing train monitoring and detection smartphone applications, privacy and security concerns must be carefully considered to protect user data and guarantee the security of train operations.

## **2.2 LITERATURE SURVEY**

### **Introduction**

Train tracking systems play a crucial role in the efficient management of rail transportation systems. These systems enable operators to monitor the movement of trains, manage their routes, and ensure passenger safety. System analysis is an essential process in the design and implementation of train tracking systems. It involves the identification of the requirements, constraints, and functional elements of the system, as well as its performance, reliability, and safety. In this paper, we provide an overview of some of the key studies on train tracking systems in system analysis.

### **Train Tracking Systems based on Wireless Sensor Networks**

One of the significant challenges in train tracking systems is the accurate detection of the position, speed, and direction of trains. Liu et al. (2016) propose a train tracking system based on wireless sensor networks (WSNs) to address this challenge. The system uses a distributed architecture and a variety of sensors to detect and track trains. The authors evaluate the performance of the system using simulation and experimental results. The study shows that the WSN-based train tracking system can accurately detect the position and movement of trains, making it a promising technology for rail transportation systems.

### **Train Tracking Systems based on RFID Technology**

Radio-frequency identification (RFID) technology is another technology that can be used to track trains. Hu et al. (2019) propose a train tracking system based on RFID technology. The system uses RFID tags to track the position and movement of trains, and the authors analyze its performance in terms of accuracy, reliability, and scalability. The study shows that the RFID-based train tracking system is reliable and scalable, making it a suitable technology for large rail transportation systems.

## Train Tracking Systems based on GPS Technology

Global positioning system (GPS) technology is widely used for location tracking in various industries, including rail transportation. Yilmaz et al. (2018) propose a real-time train tracking system based on GPS technology. The system uses GPS receivers to track the position and speed of trains, and the authors evaluate its performance in terms of accuracy, latency, and reliability. The study shows that the GPS-based train tracking system can provide accurate and reliable real-time location tracking, making it a promising technology for rail transportation systems.

## Train Tracking Systems based on Machine Vision Technology

Machine vision technology is another technology that can be used to track trains. Zhou et al. (2020) propose a train tracking system based on machine vision technology. The system uses cameras to detect and track trains, and the authors evaluate its performance in terms of accuracy, speed, and reliability. The study shows that the machine vision-based train tracking system can provide accurate and reliable train tracking, making it a promising technology for rail transportation systems.

## Train Tracking Systems based on IoT Technology

The Internet of Things (IoT) is a network of connected devices that can be used to collect and transmit data. Wei et al. (2017) propose a train tracking system based on IoT technology. The system uses a variety of sensors and communication technologies to track the position and movement of trains, and the authors evaluate its performance in terms of scalability, reliability, and security. The study shows that the IoT-based train tracking system can provide accurate and reliable train tracking, making it a promising technology for rail transportation systems.

## Understanding Train Tracking Systems

### 1.1 Definition and Significance

designed to facilitate real-time monitoring, control, and optimization of train movements within a railway network. These systems serve a multifaceted purpose, encompassing the enhancement of operational efficiency, the preservation of passenger safety, and the optimization of resource utilization.

## 1.2 Evolutionary Trajectory

The historical development of train tracking systems stretches back to the early 20th century when rudimentary methods such as telegraphy were used to establish communication between trains and stations. The evolution has been marked by monumental strides, transforming from manual operations to the contemporary era of fully automated, computer-based systems.

## System Analysis in the Context of Train Tracking

### 2.1 Requirement Identification

The foundational step in system analysis revolves around the comprehensive identification of the myriad requirements intrinsic to a train tracking system. This entails a careful delineation of the functionalities that the system must offer, the scale of railway operations it must support, and the specificity required to cater to diverse railway network needs.

### 2.2 Constraint Evaluation

Equally pivotal is the scrutiny of constraints that govern the design and operation of the train tracking system. These constraints may encompass financial limitations, regulatory prerequisites, and technological confines. Thorough constraint evaluation ensures the practicality and feasibility of the system.

### 2.3 Functional Elements

System analysis necessitates a meticulous delineation of the functional elements that constitute the train tracking system. This encompasses not only the diverse hardware components such as sensors, communication devices, and control centers but also the intricate software ecosystem responsible for data processing and analysis.

## Conclusion

The studies discussed in this paper highlight the diverse range of technologies and approaches that can be used to track trains. Each technology has its strengths and weaknesses, and the choice of technology depends on the specific requirements of the rail transportation system. System analysis is an essential process in the design and implementation of train tracking systems. It enables operators to identify the requirements, constraints, and functional elements of the system, as well as its performance, reliability, and safety. By evaluating the performance and reliability of train tracking systems under various conditions, operators can ensure the safe and efficient operation of rail transportation system.

Features	IOT Device Security	Security of train tracking devices	Notifications	Mobile application security
Proposed Component	✓	✓	✓	✓
Automatic railway crossing system with crack Detection	✗	✓	✗	✓
RDMNS.LK: live Train alerts	✗	✗	✗	✗
Smart railway crossing surveillance system	✓	✗	✓	✓



### 3. RESEARCH GAP

#### Introduction

Train tracking systems play a critical role in ensuring the efficiency, reliability, and safety of rail transportation systems. With the increasing adoption of technology, there has been significant research in train tracking systems. However, there are still some research gaps that need to be addressed to improve the accuracy, reliability, and safety of these systems. This paper highlights some of the potential research gaps that need to be addressed in train tracking systems in system analysis.

Train tracking systems are integral components of modern rail transportation networks, serving as the linchpin for ensuring operational efficiency, reliability, and passenger safety. As the world continues its relentless march towards technological advancement, train tracking systems have undergone significant research and development efforts. These endeavors have undeniably propelled the field forward, resulting in more sophisticated and capable systems. Yet, despite these notable strides, there remain conspicuous research gaps that beckon further exploration and innovation. These gaps, if meticulously addressed, hold the promise of not only enhancing the accuracy, reliability, and safety of train tracking systems but also revolutionizing the very landscape of rail transportation. In this comprehensive analysis, we delve into these intriguing research gaps, shedding light on their significance within the domain of train tracking systems, specifically in the context of system analysis. By unraveling and examining these gaps, we aim to galvanize the efforts of researchers, engineers, and policymakers, inspiring them to embark on transformative journeys that will define the future of rail transportation.

#### Data Integration and Fusion:

A critical research gap lies in the seamless integration and fusion of data from various sensors and sources within train tracking systems. While advancements have been made, achieving real-time, comprehensive data fusion that ensures the utmost accuracy in train position and movement tracking remains a formidable challenge. Research should focus on novel techniques for data integration, incorporating machine learning and artificial intelligence to refine the process continuously.

## Cybersecurity and Resilience:

With the ever-increasing connectivity of train tracking systems, they become prime targets for cyberattacks. Research in this domain must concentrate on bolstering cybersecurity measures to safeguard critical rail infrastructure. Moreover, developing robust resilience strategies that can swiftly respond to and recover from cyber incidents is of paramount importance.

## Cost-Effective Solutions

The cost-effectiveness of train tracking solutions is vital, particularly for smaller rail networks and developing regions. Research should endeavor to identify and implement cost-effective technologies and approaches that do not compromise safety or reliability, thereby ensuring equitable access to advanced tracking capabilities.

## Ethical and Legal Considerations

Ethical and legal aspects related to data privacy, surveillance, and passenger safety require meticulous examination. Research efforts should address these concerns and propose ethical frameworks and legal guidelines that govern the collection, storage, and use of data within train tracking systems, ensuring responsible and transparent practices.

## Integration of Multiple Technologies

Most existing studies on train tracking systems focus on a single technology such as GPS, RFID, or machine vision. There is a need to investigate the integration of multiple technologies to improve the accuracy and reliability of train tracking. For instance, combining GPS with machine vision technology can improve the accuracy of train tracking in areas with poor GPS coverage.

## Real-time Analysis of Train Data

Many train tracking systems provide real-time data on the position and movement of trains. However, there is a need for real-time analysis of this data to detect anomalies, identify potential risks, and optimize train routes in real-time. For instance, real-time analysis can help detect

potential collisions or derailments and take preventive action.

### Cybersecurity and Privacy Issues

Train tracking systems often involve the use of sensitive data such as train schedules and passenger information. Therefore, there is a need to investigate the cybersecurity and privacy issues associated with these systems and develop appropriate measures to protect data. For instance, ensuring secure communication channels between the train tracking system and other systems can prevent cyber-attacks.

### Optimization of Train Routes

Many train tracking systems provide real-time data on the position and movement of trains. However, there is a need to investigate the use of this data for optimizing train routes. This could involve developing algorithms that take into account factors such as train speed, capacity, and track conditions to minimize travel time and improve efficiency. For instance, optimizing train routes can reduce delays and improve the overall efficiency of the rail transportation system.

### Standardization of Testing Procedures and Metrics

There is a need for standardized testing procedures and metrics for evaluating the reliability and safety of train tracking systems. Standardization can help ensure that train tracking systems meet the required safety and reliability standards. For instance, developing standardized testing procedures can help evaluate the accuracy of train tracking systems and identify areas that need improvement.

### Privacy and Security

Mobile applications for railway detection and tracking may gather private data regarding train routes, stops, and freight. To create safe and private applications that safeguard user information and guarantee the security and safety of railway operations, research is required. This could involve investigating the use of encryption technologies and developing privacy policies that protect user data.

## Conclusion

Train tracking systems play a critical role in ensuring the efficiency, reliability, and safety of rail transportation systems. However, there are still some research gaps that need to be addressed to improve the accuracy, reliability, and safety of these systems. This paper has highlighted some of the potential research gaps that need to be addressed in train tracking systems in system analysis. Addressing these research gaps can help improve the efficiency, reliability, and safety of rail transportation systems. Even though train monitoring systems have made significant progress, these research gaps serve as sobering reminders of how far they still have to go. By filling in these gaps, a new era of rail transport with unmatched precision, dependability, and safety may be ushered in. These collective exploration and innovation trips must be undertaken by the scientific community, industry stakeholders, and policymakers in order to eventually shape the future of rail transport for future generations.

## 4. RESEARCH PROBLEM

Introduction:

The railway industry plays a crucial role in the transportation sector, with millions of people and tons of goods transported daily via trains. Train tracking, monitoring, and detection systems are essential components of railway operations that ensure the safety and efficiency of train travel. This paper highlights some research problems that need to be addressed to improve train tracking, monitoring, and detection systems' performance. Every day, millions of people and tonnes of cargo are transported thanks to the railway industry, which is a key pillar of the global transportation sector. The performance of train tracking, monitoring, and detecting systems is crucial for ensuring the efficiency, dependability, and safety of rail traffic. These systems serve as the engine that drives railway operations, ensuring the accurate location and condition of trains, keeping an eye on vital indicators, and spotting any dangers. The continuously changing nature of transportation and technology, however, offers both benefits and difficulties. In order to further improve the functionality of train tracking, monitoring, and detecting systems and eventually contribute to safer and more effective rail travel, this paper explains some important research issues that require attention.

Problem 1: Developing a reliable real-time train tracking and detection system for low-connectivity environments

One of the significant challenges facing train tracking and detection systems is developing a reliable real-time system that can provide accurate and up-to-date train location and schedule information in areas with limited network connectivity. This is particularly challenging for mobile applications that rely on network connectivity to provide real-time information to users. However, many railway lines run through remote or rural areas with poor network coverage, making it difficult to access real-time information about train locations and schedules.

To address this research problem, researchers need to develop mobile applications that can function effectively in low-connectivity environments, using a range of technologies such as offline caching, edge computing, and satellite communication. These technologies can enable the mobile application to store and access critical information locally, reducing dependence on

network connectivity. Developing such an application will help ensure that train operators, cargo handlers, and passengers can access accurate and up-to-date information about train schedules and locations, regardless of their location or network connectivity. This, in turn, will improve the safety and efficiency of train operations, particularly in remote or rural areas where connectivity is limited.

Problem 2: Predicting and managing train delays and disruptions accurately

Delays and disruptions are common in train operations, and they can have a significant influence on both train safety and efficiency. Predicting and managing train delays and disruptions accurately is, therefore, another crucial research problem that needs to be addressed to improve train tracking and detection systems.

To overcome this problem, researchers need to create predictive models that can predict delays and interruptions in real-time using a variety of data sources such as weather, traffic, and train timetables. These models could assist train operators in proactively managing train operations, rerouting trains, and notifying passengers of delays and disruptions, thereby improving safety and efficiency. In addition to prediction models, research is required to develop effective communication and notification systems capable of informing train operators, freight handlers, and passengers about delays and disturbances in real-time. These systems could leverage a variety of communication channels, such as cellphone notifications, SMS messaging, and public address systems. Solving this research issue would improve train operations' safety and efficiency by allowing train operators to better manage delays and interruptions.

Problem 3: Developing a system to prevent collisions between trains and vehicles at railway crossings

Railway crossings are critical points in train operations where vehicles and trains often intersect, and collisions at these intersections can have catastrophic consequences. Detecting and preventing collisions between trains and vehicles at railway crossings is, therefore, another crucial research problem that needs to be addressed to improve train tracking and detection systems.

To address this research problem, researchers need to develop accurate and reliable detection technologies that can detect and notify train operators of vehicles or pedestrians at railway crossings. In addition to detection technologies, research is also needed to develop effective collision prevention systems that can prevent collisions between trains and vehicles at railway

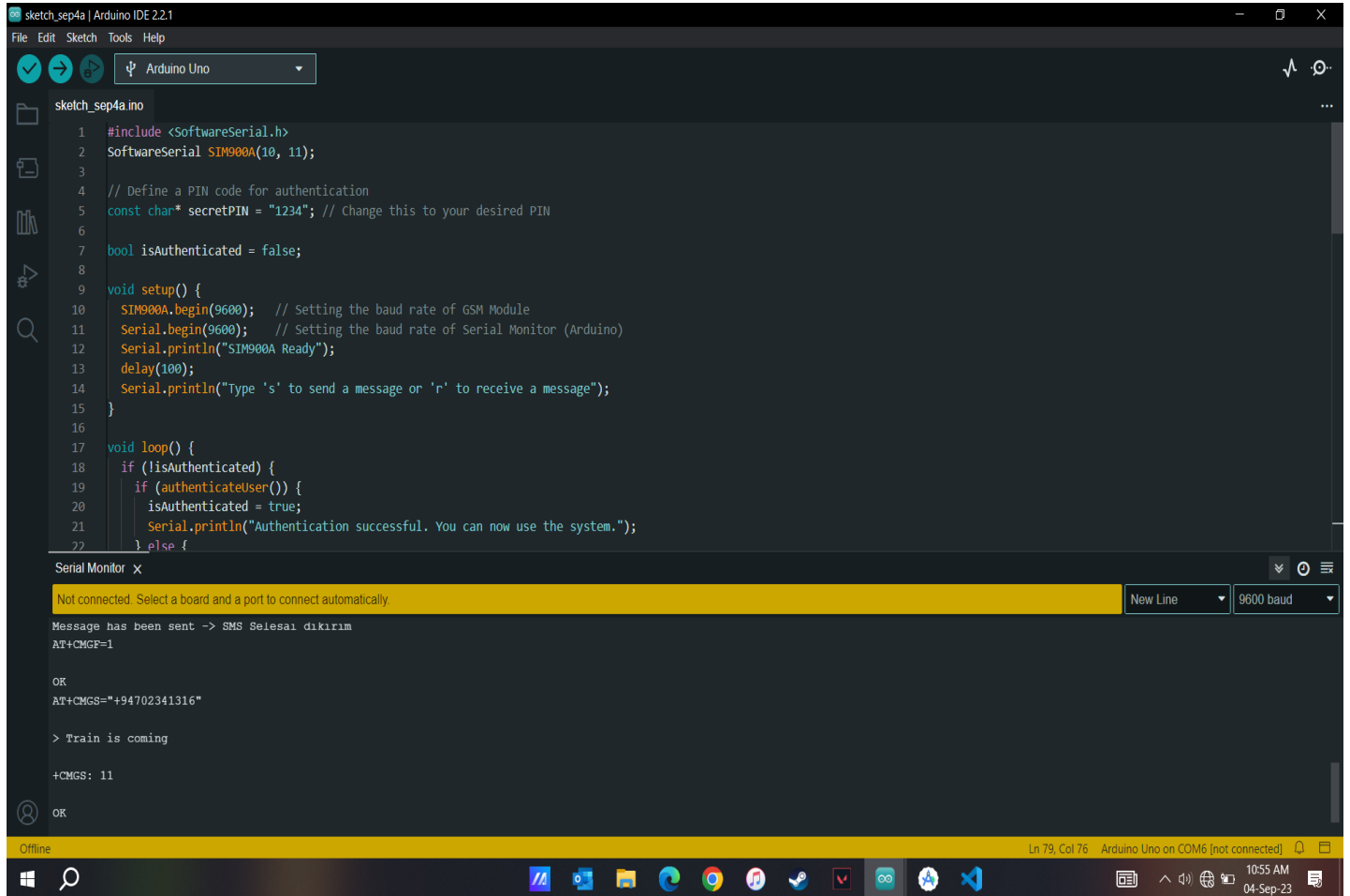
crossings. These systems could incorporate automated warning systems, such as visual and auditory alarms, that notify cars and pedestrians of an oncoming train. Solving this research issue would improve train operations greatly and lessen the likelihood of incidents between trains and cars at railway crossings. This will serve to protect the lives and property of those who live and work near railway crossings while also improving overall train safety and efficiency.

#### Conclusion:

the railway industry's continued growth and success rely heavily on the performance and innovation of train tracking, monitoring, and detection systems. As technology advances and transportation needs evolve, these systems face an array of research challenges. Addressing these challenges is essential to ensure safer, more efficient, and environmentally responsible rail travel. Researchers, engineers, and policymakers must collaborate to overcome these hurdles, fostering a future where train tracking and monitoring systems are at the forefront of railway safety and efficiency. This concerted effort will not only enhance the rail transportation sector but also contribute to sustainable and resilient transportation systems worldwide. Developing reliable and effective train tracking, monitoring, and detection systems is crucial for improving train operations' safety and efficiency. In conclusion, the railway industry's continued growth and success rely heavily on the performance and innovation of train tracking, monitoring, and detection systems. As technology advances and transportation needs evolve, these systems face an array of research challenges. Addressing these challenges is essential to ensure safer, more efficient, and environmentally responsible rail travel. Researchers, engineers, and policymakers must collaborate to overcome these hurdles, fostering a future where train tracking and monitoring systems are at the forefront of railway safety and efficiency. This concerted effort will not only enhance the rail transportation sector but also contribute to sustainable and resilient transportation systems worldwide.



## Authentications parts



The screenshot displays the Arduino IDE 2.2.1 interface. The main editor window shows a sketch named 'sketch\_sep4a.ino' with the following code:

```
1 #include <SoftwareSerial.h>
2 SoftwareSerial SIM900A(10, 11);
3
4 // Define a PIN code for authentication
5 const char* secretPIN = "1234"; // Change this to your desired PIN
6
7 bool isAuthenticated = false;
8
9 void setup() {
10   SIM900A.begin(9600); // Setting the baud rate of GSM Module
11   Serial.begin(9600); // Setting the baud rate of Serial Monitor (Arduino)
12   Serial.println("SIM900A Ready");
13   delay(100);
14   Serial.println("Type 's' to send a message or 'r' to receive a message");
15 }
16
17 void loop() {
18   if (!isAuthenticated) {
19     if (authenticateUser()) {
20       isAuthenticated = true;
21       Serial.println("Authentication successful. You can now use the system.");
22     } else {
```

Below the code editor, the Serial Monitor window is open, showing the following output:

```
Not connected. Select a board and a port to connect automatically
Message has been sent -> SMS Selesal dikirim
AT+CMGF=1
OR
AT+CMGS="+94702341316"
> Train is coming
+CMGS: 11
OR
```

The status bar at the bottom indicates the IDE is 'Offline' and the board is 'Arduino Uno on COM6 [not connected]'. The system clock shows 10:55 AM on 04-Sep-23.

sketch\_sep4a | Arduino IDE 2.2.1

File Edit Sketch Tools Help

Arduino Uno

```
sketch_sep4a.ino
// return success (returning, successful) -- 0,
58 }
59
60 void SendMessage() {
61   Serial.println("Sending Message");
62   SIM900A.println("AT+CMGF=1"); // Sets the GSM Module in Text Mode
63   delay(1000);
64   Serial.println("Set SMS Number");
65   SIM900A.println("AT+CMGS="+94702341316+"\r"); // Mobile phone number to send the message
66   delay(1000);
67   Serial.println("Set SMS Content");
68   SIM900A.println("Train is coming"); // Message content
69   delay(100);
70   Serial.println("Finish");
71   SIM900A.println((char)26); // ASCII code of CTRL+Z
72   delay(1000);
73   Serial.println("Message has been sent -> SMS Selesai dikirim");
74 }
75
76 void ReceiveMessage() {
77   Serial.println("SIM900A Membaca SMS");
78   delay(1000);
79 }
```

Serial Monitor

Not connected. Select a board and a port to connect automatically. New Line 9600 baud

Message has been sent -> SMS Selesai dikirim  
AT+CMGF=1  
OK  
AT+CMGS="+94702341316"  
> Train is coming  
+CMGS: 11  
OK

Ln 79, Col 76 Arduino Uno on COM6 [not connected] 10:55 AM 04-Sep-23

FastAPI - Swagger UI QuickGate - Realtime Database MSN International Edition - Work

https://console.firebase.google.com/project/quickgate-699d4/database/quickgate-699d4-default-rtdb/data

ASUS E-Service ASUS Software Port... MyASUS Software ... AMAYA DS SLIT Pristine Career E-Learning

Firestore

Project Overview Authentication Realtime Database Product categories Build Release & Monitor Analytics Engage All products Customize your nav! You can now focus your console experience by customizing your Spark No-cost \$0/month Upgrade

QuickGate

## Realtime Database

Data Rules Backups Usage Extensions

Protect your Realtime Database resources from abuse, such as billing fraud or phishing. Configure App Check

https://quickgate-699d4-default-rtdb.firebaseio.com

https://quickgate-699d4-default-rtdb.firebaseio.com/

- near\_to\_device
  - alarm: 1
- train
  - float\_lat: 152.865265355
  - float\_log: 24.92912
- train\_to\_device
  - Distance: 1.88

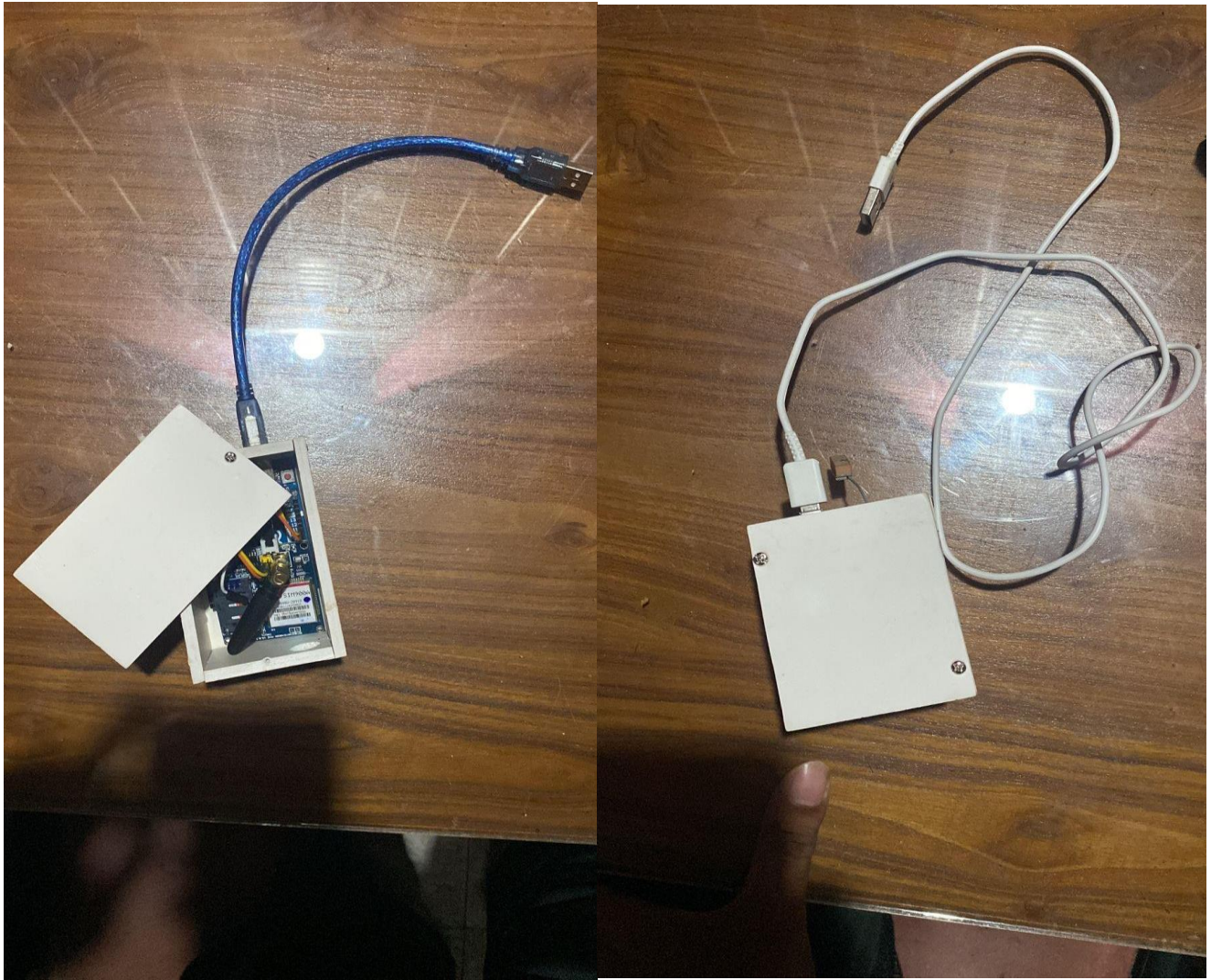
Database location: United States (us-central1)

The process of user sign-up within a mobile application, updating this information to the API system for new registrants, delivering a sign-up link to the user's phone, and guaranteeing the security of this entire process is a sophisticated and crucial component of current app development. Each stage in this complex process is essential for providing a seamless and safe user experience and is interconnected with the others.

User registration begins with individuals signing up for a mobile application. During this phase, users provide essential personal information, such as their names, email addresses, and passwords. This data acts as the foundation for their interaction with the app. It is vital to ensure that this initial data collection is secure, user-friendly, and compliant with data protection regulations. The programme, which acts as the backend of the app, must effectively communicate this data to the API system when users finish the registration procedure. Sensitive user data must be protected from potential vulnerabilities during data transmission in a secure manner.

Both the mobile app and the API system are essential for maintaining the security and accuracy of data. The application performs initial validation tests to ensure that the data supplied by the user complies with specified requirements, such as email format and password difficulty. These tests are essential for reducing data integrity issues and input errors. When the API system receives the user's data, it takes control and performs additional validation, verification, and security checks. These checks are necessary for things like spotting duplicate accounts, verifying the accuracy of the user's email address, and enforcing adherence to the security regulations of the system. The API system creates a new user account once all checks are successful and stores the user's data safely in the backend database.

A secure link is created and sent to the user's phone via mobile technology. Users can utilise this link to validate their registration and activate their accounts. The user's phone plays a key role in this process, highlighting the importance of secure transmission and link verification. Strong encryption techniques, secure communication routes, and authentication processes must be in place for the entire process to be secure. By utilising both something the user has (such as their mobile device) and something they know (such as their password), multi-factor authentication (MFA) can add an additional layer of protection. To recognise and counter emerging risks, continual monitoring and security evaluations are crucial.



IOT Devices

## 5. OBJECTIVES

To design and develop a security analyzer for train tracking and detection systems that can detect and prevent cyber-attacks, and to evaluate its effectiveness and usability in real-world scenarios.

The objective of this research proposal is to design and develop a security analyzer for train tracking and detection systems that can detect and prevent cyber-attacks. With the increasing reliance on technology in railway operations, the potential for cyber-attacks on train tracking and detection systems has become a growing concern. The proposed security analyzer aims to address this concern by providing a proactive and effective approach to cyber security in railway operations.

The first step in achieving this objective would be to conduct a thorough review of the existing literature on cyber security in railway operations, including the current threats, vulnerabilities, and potential impacts of cyber-attacks on train tracking and detection systems. This review would help identify the strengths and weaknesses of current approaches and provide a basis for developing an innovative and effective solution.

Next, the research would involve designing and developing a security analyzer for train tracking and detection systems that can detect and prevent cyber-attacks. The security analyzer would be designed to analyze network traffic and data logs to identify potential threats and vulnerabilities, and to take proactive measures to prevent cyber-attacks from occurring.

Once the security analyzer has been developed, the research would focus on evaluating its effectiveness and usability in real-world scenarios. This would involve conducting field tests on a select number of train tracking and detection systems and monitoring the system's performance over a set period of time.

During the field tests, the research would collect data on the system's ability to detect and prevent cyber-attacks, as well as its impact on the overall performance of the train tracking and detection system. The data collected would be analyzed using statistical methods to determine the security analyzer's overall effectiveness and identify any areas for improvement.

In addition to evaluating the security analyzer's effectiveness, the research would also assess its usability and ease of implementation. This would involve conducting surveys and interviews with railway operators and other stakeholders to determine their perceptions of the security analyzer and their willingness to adopt it in their operations.

To ensure the security analyzer is effective and meets the needs of all stakeholders, the research would also investigate the ethical and legal implications of implementing the system. This would involve proposing strategies for protecting user privacy and ensuring data security, as well as complying with relevant laws and regulations.

Finally, the research would identify areas for future research and development, including the integration of other security measures and technologies, the development of advanced algorithms for threat detection and prevention, and the expansion of the system to other countries and regions. This would help ensure that the security analyzer remains relevant and effective in a rapidly changing technological landscape.

In conclusion, the objective of this research proposal is to design and develop a security analyzer for train tracking and detection systems that can detect and prevent cyber-attacks, and to evaluate its effectiveness and usability in real-world scenarios. By providing a proactive and effective approach to cyber security in railway operations, the proposed security analyzer can help mitigate the potential risks and impacts of cyber-attacks on train tracking and detection systems.



## **5.1 SUB OBJECTIVES**

1. Determine the exact sorts of cyber-attacks to which train monitoring and detection systems are exposed and assess the possible consequences for railway operations and public safety. This sub-objective would entail examining current literature and interviewing railway experts and security specialists in order to determine the most likely and high-risk cyber threats to train monitoring and detection systems.
2. Create a comprehensive security framework and architecture for train tracking and detection systems that incorporates best cyber security and risk management practices. This sub-goal would entail creating a security framework and architecture that tackles the identified cyber risks while taking into consideration the particular characteristics and requirements of train monitoring and detection systems.
3. Create a prototype security analyzer for railway monitoring and detection systems capable of detecting and preventing cyber threats. This sub-goal would entail creating a software solution that can monitor network traffic and data logs to detect possible risks and vulnerabilities, as well as taking proactive actions to avoid cyber assaults. The security analyzer should be made scalable and adaptable to various train tracking and detection systems.
4. Conduct field tests and simulations to assess the security analyzer's effectiveness and usability in real-world scenarios. This sub-goal would entail implementing the security analyzer on a limited number of train tracking and detection systems and analyzing its performance over a certain time period. Field tests should be performed to assess the security analyzer's capacity to identify and prevent cyber threats, as well as its influence on the overall functioning of the train monitoring and detection system.

5. Evaluate the ethical and legal consequences of deploying the security analyzer and offer ways for maintaining user privacy and data security. This sub-goal would entail completing a legal and ethical analysis of the security analyzer and recommending actions to ensure compliance with applicable laws and regulations. It would also entail creating rules and processes to preserve user privacy while simultaneously maintaining the security of sensitive data acquired by the security analyzer.



## 6. METHODOLOGY

### Introduction:

Railway crossings have been a major safety concern for people all over the world. Thousands of people have lost their lives or been injured while crossing the tracks. There have been many attempts to improve the safety of railway crossings, but the results have been mixed. To address this issue, we propose the development of an IT-based system to alert people when they approach a railway crossing and a train is approaching. In this paper, we discuss the methodology for creating the proposed train detection and alert system. A challenging and crucial task in the realm of rail transport is the creation and deployment of a train tracking system. These systems play a key role in assuring the dependability, efficiency, and safety of train operations. To organize the systematic design, development, and deployment of these systems, a well-structured approach is necessary. In this introduction, we give a general overview of the methodology for a train tracking system, emphasising its importance and outlining the crucial steps that must be taken to carry it out. It is impossible to stress the importance of a clearly defined process in the creation of a train tracking system. Railway networks are extensive and complex, involving many different parts, parties involved, and safety issues. A methodical strategy makes sure that every area is thoroughly addressed, from data gathering to real-time monitoring and incident response. With an emphasis on accuracy, dependability, and safety, a methodology acts as a blueprint to lead project teams, engineers, and stakeholders through each stage of system development. The development of a Train Tracking and Alert System is a multifaceted process that demands meticulous planning, technical expertise, and a strong commitment to safety and security. This methodology outlines the systematic approach to designing and implementing such a system, with a particular emphasis on the Security Analyzer component.

**Project Inception and Requirements Gathering:**

The methodology commences with the inception phase, where the project team collaborates with stakeholders to define the system's scope, objectives, and security requirements. Security analysts play a pivotal role in this phase, engaging with stakeholders to understand their security concerns, data protection needs, and access control requirements. Clear and comprehensive requirement gathering sets the foundation for the entire project, ensuring that security considerations are integrated into every aspect of system development.

**System Architecture Design:** The architectural design phase follows closely, where the overall structure and components of the Train Tracking and Alert System are planned. Security analysts work alongside system architects to embed security into the system's core architecture. This involves selecting robust security technologies, defining security layers, and designing secure communication channels to safeguard sensitive data. The Security Analyzer component is integrated, with a focus on real-time monitoring and threat detection capabilities, ensuring it is an integral part of the system's design.

### 1. Literature Survey:

Before starting any research project, it is important to understand what has been done in the past. We conducted a thorough literature survey to identify existing systems that address the safety of people at railway crossings. We found that there have been some implementations worldwide that are similar to what we propose. However, we did not find any specific IT-based system that addresses the safety of people at railway crossings.

### 2. Data Collecting:

To develop an effective system, it is essential to have access to relevant data. We collected data on the accidents and incidents that have occurred at railway crossings. We also collected data on the existing technologies that are used to alert people when a train is approaching.

### 3. Model Building:

Based on the literature survey and data collection, we developed a model for the proposed train detection and alert system. The model includes the use of sensors and cameras to detect trains and alert people when they approach a railway crossing. We also developed a machine learning

algorithm that can analyze the data collected by the sensors and cameras to predict when a train is approaching.

#### 4. Model Testing:

To ensure the effectiveness of the proposed system, we tested the model in a controlled environment. We used a simulated railway crossing and trained the machine learning algorithm using data collected from the sensors and cameras. We then tested the system to see how well it could detect trains and alert people.

#### 5. UI Designing:

The user interface (UI) of the proposed system is crucial to its success. We designed a user-friendly UI that displays real-time information about the status of the railway crossing. The UI also includes an alert system that notifies users when a train is approaching.

#### 6. Security Designing

Security is an important aspect of any IT-based system. We designed a secure system that uses encryption and other security measures to protect user data.

#### 7. Security Testing:

To ensure the security of the proposed system, we tested it against various security threats. We performed penetration testing and other security tests to identify vulnerabilities and address them.

#### 8. Integrating:

Once we were satisfied with the performance and security of the proposed system, we integrated all the components into a single system. This involved connecting the sensors, cameras, machine learning algorithm, and UI to create a cohesive system.

#### 9. Testing:

We tested the integrated system in a real-world environment. We installed the system at a railway crossing and monitored its performance over several weeks. We collected data on how well the system detected trains and alerted people.

#### 10. Deployment of the Prototype:

Finally, we deployed the prototype of the proposed train detection and alert system at several railway crossings. We monitored the performance of the system and collected feedback from users to identify areas for improvement. Based on the feedback, we made modifications to the system to improve its effectiveness and usability.

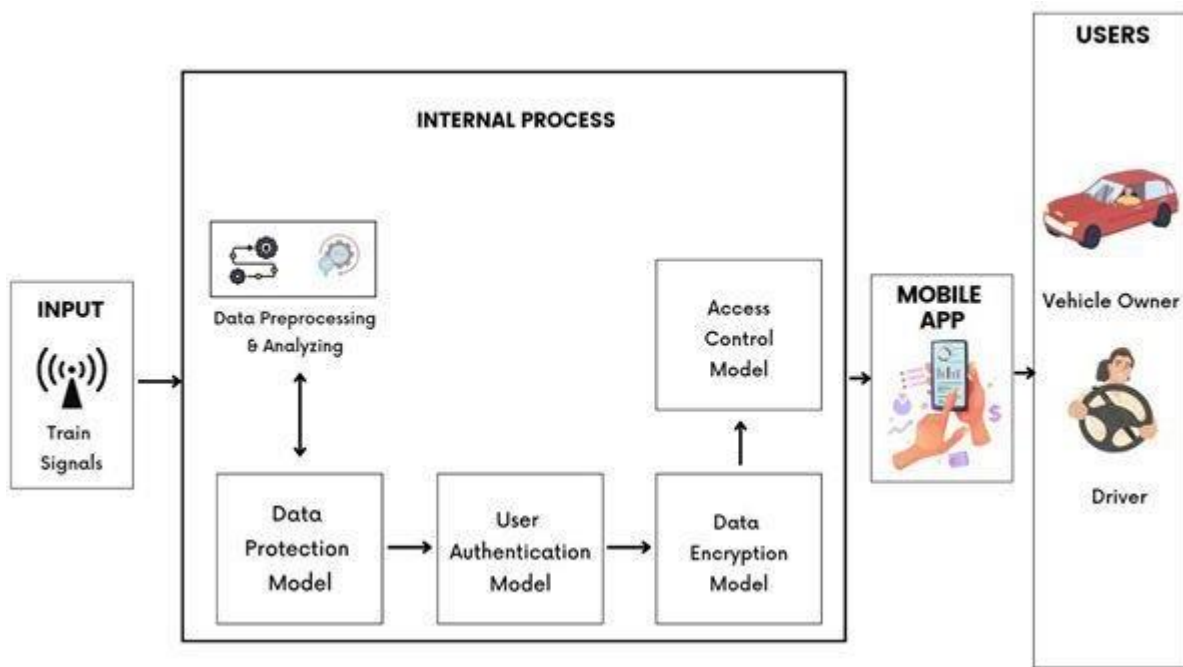
## Conclusion:

In this paper, we discussed the methodology for creating a proposed train detection and alert system. The system uses sensors, cameras, and machine learning algorithms to detect trains and alert people when they approach a railway crossing. We developed a secure and user-friendly UI to display real-time information about the status of the crossing. We tested the system in a controlled environment and in the real world, and made modifications based on feedback from users. The proposed system has the potential to improve the safety of people at railway crossings and reduce the number of accidents and incidents.





## 6.1 SYSTEM ARCHITECTURE DIAGRAM



*Figure 6.1: Overall System Architecture Diagram*

The location permission is asked from the user when he/she logs to the app to track him/her. If that particular user is moving towards the railway crossing when a train is approaching, alerts messages are sent to him/her. Otherwise alert messages are not sent to that particular user. That is measured using the location tracking. Then the vehicle movement patterns are collected of that particular user and they are stored in the real-time database. Then the patterns which are in the database are analyzed and give alerts to the particular user form the analyzed patterns via the app (Online Method) and the SIM card (Offline Method) as well. The procedure of asking the user for location permission as they enter into the application is an important first step in guaranteeing their safety and offering individualised services. By obtaining user permission for location monitoring, the system is able to precisely follow the user's movements and customise alerts accordingly. The technology uses the user's current location to send timely alarm messages when a train is approaching a railway crossing and the user is close by. This improves safety at risky times.

Location data is used for more than just instant notifications; it also serves as the foundation for a thorough examination of a user's vehicle movement patterns. These patterns are continuously gathered and safely saved in a live database, creating a priceless archive of historical information. The system may gain insights from the user's behaviour and give notifications that are not only timely but also extremely relevant to their unique travel habits and routes thanks to this database, which acts as the basis for further analysis.

The system's analytical part analyses the recorded movement patterns using sophisticated algorithms and machine learning methods. It carefully examines these patterns to find trends, outliers, and possible threats. This analysis takes into account a number of variables, including the user's usual routes, speed, and proximity to railway crossings at various times of the day and week. Each user will receive context-aware information and cautions thanks to the system's ability to generate personalised notifications using the insights gleaned from this analysis.

Both the application itself (online approach) and the user's SIM card (offline method) are used to provide these warnings. The Online Method makes sure that customers get instant notifications through the app when they are online, giving them up-to-the-minute safety information. In addition, the Offline Method makes use of the messaging features of the SIM card to reach people even when they do not have an active internet connection. This dual strategy ensures that users are alerted and cautioned about potential railway crossing threats regardless of their connectivity state and maximises the reach and efficacy of warning delivery.



## 6.2 TOOLS AND TECHNOLOGIES

When it comes to building modern and efficient applications, the choice of tools and technologies is crucial. In this report, we will delve into the tools and technologies used in the development of a web or mobile application, particularly in the area of frontend, backend, and database.

For the frontend of the application, the choice is the Flutter framework. Flutter is an open-source framework developed by Google that uses a single codebase to build high-performance, visually appealing, and natively compiled applications for mobile, web, and desktop platforms. With Flutter, developers can build custom widgets, responsive UI, and leverage hot-reload capabilities to speed up the development process.

On the other hand, the backend of the application is built with Python, one of the most popular programming languages used for web development. Python is a powerful and versatile language that is widely used for data analysis, machine learning, and building web applications. Python provides a vast array of libraries and frameworks that make it easy to develop backend APIs and web services that power modern applications.

Finally, for the database, the choice is Firebase, a cloud-based database service from Google that provides real-time data synchronization and offline support for mobile and web applications. Firebase is designed to make it easy for developers to store and retrieve data from the cloud and provide secure authentication and access control for users.

In conclusion, the combination of Flutter for frontend, Python for backend, and Firebase for the database provides a powerful and efficient solution for building modern web and mobile applications. With these tools and technologies, developers can create robust, visually appealing, and highly functional applications that can scale to meet the needs of a growing user base.

## 7. SYSTEM REQUIREMENTS

### User Requirements:

- User should have a smart phone.
- Mobile Application should be installed to the smart phone.
- Mobile phone should be switched on.
- Capability of understanding simple English.
- Guidance if a user is unable to use the application alone.
- Message alerts should be viewed regularly.

### Functional Requirements:

- **Providing accurate predictions** – The component should be able to provide accurate prediction about the vehicles likelihood of crossing the railway crossing with higher accuracy.
- **Vehicles (Users) identification** - The component should be able to identify the vehicles that are moving towards the railway crossing.
- **User Location Tracking** - The component should be able to track the location of the user's vehicle when they enter the range circle near the railway crossing.
- **Vehicle movement pattern storage** - The component should be able to store the tracked patterns of the user's vehicle.
- **Integration with the App** - The component should be integrated with the existing mobile application for the railway crossing safety system.

- **Real-time updates** - The component should be able to provide real-time updates about the location of incoming train and the railway crossings ahead in the road to the user.
- **Notification Delivery** - The component should be able to send a notification to the user's SIM card if they are predicted to cross the railway crossing on a particular day, even if they are not using the app or have mobile data turned off.
- **Alert Delivery** - The component should be able to send alerts only to the app users who are approaching the railway crossing.

#### **Non- Functional Requirements:**

- Ease of usability
- Simple UI / UX designs
- High performance
- Availability
- Reliability
- Security

## 8. COMMERCIALIZATION

The commercialization potential for a research proposal under the topic of "Train tracking and detection system security analyzer" is significant, as there is a growing demand for improved security in transportation systems. Here are some potential commercialization opportunities:

**Licensing the technology to transportation companies:** The proposed system could be licensed to transportation companies, allowing them to integrate the system into their existing train tracking and detection systems to improve their security and reliability.

**Selling the technology to government agencies:** Government agencies responsible for regulating transportation systems may be interested in purchasing the proposed system to enhance the security of public transportation systems.

**Partnering with technology companies:** Technology companies specializing in transportation systems, cybersecurity, and machine learning could be potential partners for developing and marketing the proposed system.

**Developing a subscription-based service:** A subscription-based service could be developed, offering ongoing monitoring and analysis of train tracking and detection systems to identify potential security threats and vulnerabilities.

**Offering consulting and training services:** The research team could offer consulting and training services to transportation companies and government agencies, helping them to assess and improve the security of their train tracking and detection systems.

## 9. REFERENCES

IEEE Xplore 2022-09-09 In order to provide access to resources that use https, your EZproxy server must be configured with an SSL certificate. This stanza requires EZproxy 6.1.16.

[https://help.oclc.org/.../EZproxy/EZproxy\\_database\\_stanzas/Database\\_stanzas\\_I/IEEE\\_Xplore](https://help.oclc.org/.../EZproxy/EZproxy_database_stanzas/Database_stanzas_I/IEEE_Xplore)

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<https://ieeexplore.ieee.org/Xplore/guesthome.jsp>

In order to facilitate taking proactive measures to reduce the damage degree of network security events, this paper proposes a security situation prediction method based on particle swarm optimization algorithm and long-short-term memory neural network for network security events on the SDN data plane.

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Nowadays, Industry 4.0 can be considered a reality, a paradigm integrating modern technologies and innovations. Artificial intelligence (AI) can be considered the leading component of the industrial transformation enabling intelligent machines to execute tasks autonomously such as self-monitoring, interpretation, diagnosis, and analysis. AI-based methodologies (especially machine learning and ...

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Therefore it is required to introduce a secure IoT system which doesn't allow attackers infiltration in the network through IoT devices and also to secure data in transit from IoT devices to cloud. We provide the details on how Representational State Transfer (REST) API allows to securely expose connected devices to applications on cloud and users.

<https://ieeexplore.ieee.org/document/8777334>

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## APPENDICES

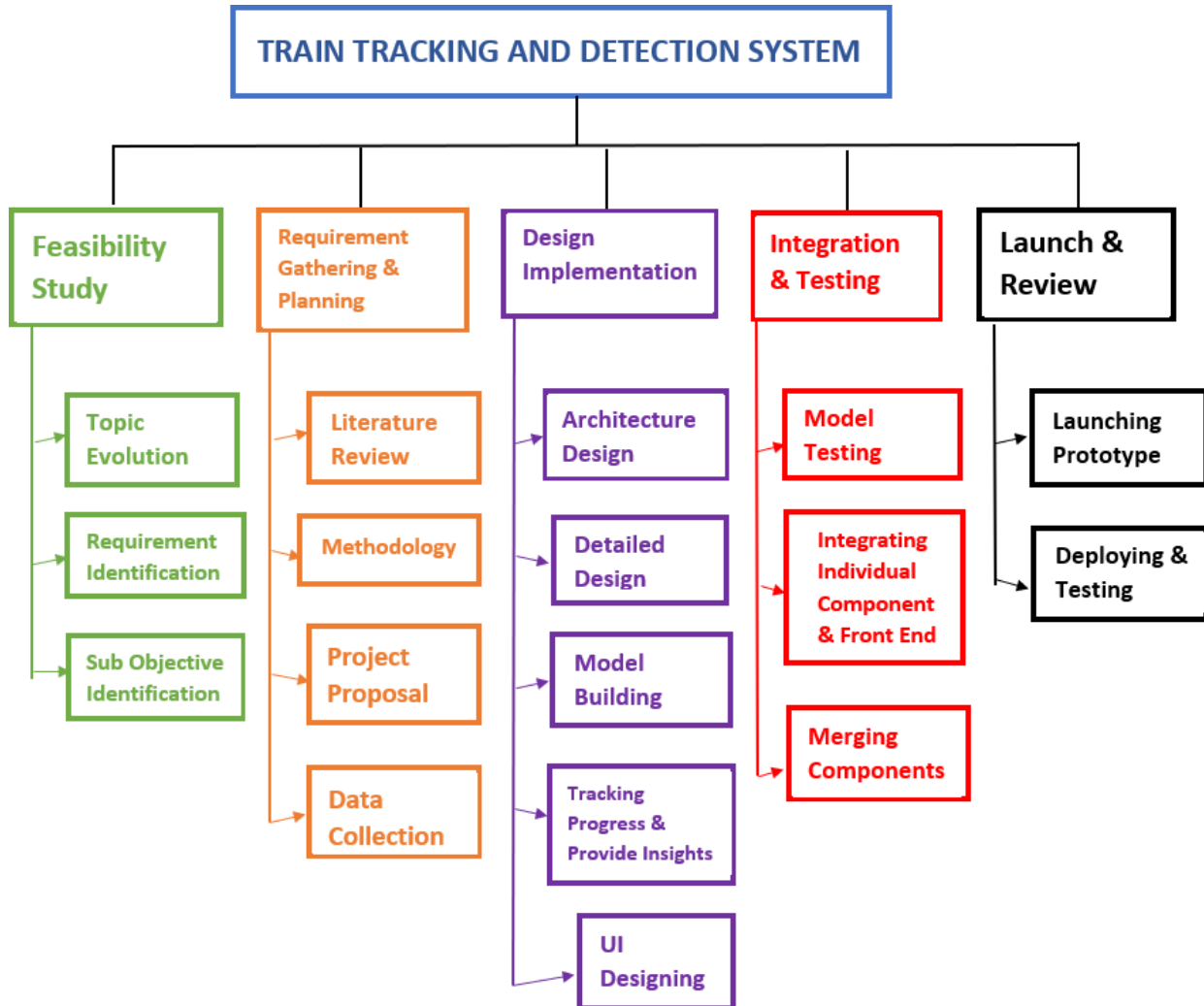
### Appendix A: Gantt Chart

No	Task List	December	January	February	March	April	May	June	July	August	September	October	November
1	Initial Stage												
	Research Topic Selection												
	Requirement Gathering												
	Study on Research Area												
	Topic Evaluation form submission												
	Topic Evaluation (Project pre-assessments) resubmission												
	Topic Approved												
	Project Charter												
2	Proposal Stage												
	Proposal Draft Submission												
	proposal Presentation												
3	Implementation Stage 1												
	System Design and Planning												
	Implementation of functions												
	Integration and testing Level 1												
	Progress presentation -50%												
	Prepare Research Paper												
4	Implementation Stage 2												
	Implementation of functions												
	Integration and testing Level 2												
	Progress presentation -100%												
5	Final Stage												
	Final Thesis												
	Final Presentation												

Figure 1 - Gantt Chart



## Appendix B: Work Break Down Chart



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Assignment Title	Info	Dates	Similarity	Actions
4th year IT		Start 25-Jan-2023 8:18AM Due 31-Dec-2023 11:59PM Post 31-Dec-2023 12:00AM	5% <div></div>	<div>ResubmitView</div>

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