Design a Train Collision Avoidance and Smart Ticket system

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Abstract- With an emphasis on passenger convenience and safety, the proposed initiative seeks to solve important challenges within the Indian Railways. The technology can enhance safety protocols and avoid accidents by detecting possible collisions between trains on the same track in real-time through the use of a command-line procedure that is integrated with the rails. Furthermore, the implementation of a smart ticket system (RFID) technology. Additionally, they can take advantage of the onboard Wi-Fi Module for improved communication. This reduces uncertainty over ticket prices and reduces corruption at ticket desks. Additionally, a safe and efficient boarding procedure is ensured by the automatic verification of tickets and train data at railway station gates, improving the entire traveler experience and optimizing operations. This transforms the ticketing procedure in cities where efficiency and security are of utmost importance. Travelers may effortlessly make tickets and authorize their journey with the use of Radio Frequency Identification initiative intends to bring in a new age of efficiency and safety inside the Indian Railways by merging cutting-edge technology with proactive safety measures, eventually benefiting millions of passengers nationally.
Keywords-RFID, Rail brake system, Motor driver, WIFI modules.

I. INTRODUCTION

Indian Railways is the second-biggest railway network in the world run by a single government and the biggest network in Asia. Its huge size makes manually keeping track of train crashes on tracks a difficult task. Maintenance staff has always been trusted to identify track errors, but this approach is labor-intensive and sensitive to human error. The danger of accidents is further increased by the lack of sophisticated collision avoidance equipment, especially on tracks where trains are approaching one another from opposite directions. The current systems' drawbacks, including their lengthy setup times and human error risk, highlight the pressing need for advancements in railway safety. The recommended solution brings in a new era of accuracy and effectiveness in collision detection within train lines in addition to addressing these urgent issues. A number of services, including catering and ticketing, have moved from old paper-based methods to contemporary technological platforms in recognition of the critical role that railroads play in public transit. The introduction of the Smart Ticket System, which provides travelers with the ease of smart card-based ticketing and e-ticketing alternatives for lengthy trips, is the highest point of this progression. Efficiency and convenience are critical in the fast-paced world of railroad transportation. The Smart Ticket System marks a fundamental shift in how passengers engage with rail services in addition to smooth travel experiences and increased security. Using this innovative technology signifies a major advancement in guaranteeing the security, effectiveness, and promptness of India's railway services. Passengers may now enjoy improved connectivity while traveling due to the installation of contemporary Wi-Fi modules, which enhances the travel experience and guarantees that India's railway system stays at the forefront of technical innovation in the world of transportation.

II. RELATED WORKS

Abbas et al, Automatic ticketing in buses and trains is accomplished through the use of Near Field Communication (NFC),RFID Internet ofThings (IoT) andQuickResponse (QR) Codes. Additionally, a comparison of various devices utilized for punching machines, BT Services, RFID, and ticket production and checking is carried out.

ElZeweidy et al,Examining the current public transportation ticketing system reveals that it is exceedingly time and money-consuming. The purpose of this paper is to design a web and mobile application for the administration of metro trains by proposing a ticketing system. If successful, the process would be completely automated, efficient, modernized, and reasonably priced. The method can be used to toll gates, bus tickets and other places. The system's security is guaranteed by the code that is used for user validation. The user can schedule tickets based on his convenience thanks to automatically available train times; GPS handles this task for this project.

Ghosal et al, Development and deployment of a smartphone application that will replace the existing ticketing system with one that is easier to use and more effective. The "Android Suburban Ticket (ASR)" is conveniently available for purchase at any time and location, and upon purchase, a "Quick Response Code" will be provided to the customer's phone. The ticket is validated at the source using GPS technology, and it is deleted at the destination. For security reasons, each user's data is kept in a cloud database, which is not available in the suburban train system that is in place right now. Additionally, an application to look up the user's ticket in the cloud database using the ticket number is given to the ticket checker for verification purposes.

Jainet al, these demonstrate how WiMAX technology will help with train location as well as collision detection and prevention. The features required for the purpose can be provided by IEEE802.16 and the paper has demonstrated that WiMAX will be a more effective method. The approach will be more advantageous than the one currently employed for train positioning, collision avoidance, and prevention. Train location will be aided by fixed WiMAX base stations. The technique will be possible, according to the simulation results. The outcomes demonstrate that WiMAX will be able to determine a train's coordinates, which they can then utilize to avoid and prevent collisions.

Kumaret al,the suggested detection system operates regularly whether or not there is an accident, and in the event that there is, it notifies the family and designated emergency services of the situation. To enable the most effective rescue efforts, the system divides accidents into four categories: collisions, rollovers, fall-offs, and no accidents. The system is trained and tested using five training variables: pitch, roll, speed, altitude change, and ALA. The values of the model's variables are measured by the suggested analog to digital converter (ADC) system using sensors from Sensor drones and smartphones. Any kind of vehicle can be equipped with the system retrofitted.

Patil et al,The RFID-based ticketing system seeks to both decrease the workforce and provide a simple, stress-free, and comfortable means of transportation. The difficulties encountered at the moment; the primary feature of the ticketing system is the creation of "queues" for the purchase of local rail tickets. We still purchase tickets by waiting in lines, which is a time-consuming, irritating practice, despite the remarkable advancements in technology. Because it takes more time and more expensive when cards are lost or stolen.

Priyadharshini et al,the ultrasonic sensor in train collision avoidance detects the approaching object. The ultrasonic sensor has a minimum range of around 30 cm. Since this project is a prototype, the sensor will immediately halt the train when it detects an obstruction within 15 to 20 cm. It takes around 0.19 seconds for obstructions to be detected and stopped. At this point, the train has traveled a few meters when the motor stops working, causing the train to come to an abrupt stop owing to friction. Furthermore, the train's Zigbee will emit signals, and the brake will engage if the opposing train picks up the identical signal. At finally, at a certain distance (approximately 15 cm), the impact can be averted.

Sagar et al,An IoT cloud computing model with Raspberry Pi 2.0, LM393 sensor signal conditioning devices, and Piezo electric buzzer components. It involved integrating with the cloud utilizing Linux RTOS, Python, and theIoT platform over the internet. using WIFI. Railway authorities data on the cloud. If a track is destroyed, our technology sends a notice to the cloud, which automatically sends an SMS to the relevant railway authorities. The train system utilizes sensors to enhance safety and communicates with surrounding stations via a connected network. Railway local authorities lack the ability to make independent choices. They informed higher authorities about the problem. Making the decision is a long process. Typically, the information will arrive late. In a wired network, climatic conditions and vulnerabilities provide challenges for integrating several sensors into the system.

Samba Murthyet al,the major purpose of this anti-collision system is to detect collisions and send these errors to the main control room, a nearby station, and grid control stations. So, if a collision is anticipated, this system will assist in avoiding such scenarios by sounding an alarm to the appropriate components. In the event of a collision, the emergency brake was used to maintain a safe distance of 1 km between two trains.

Siddiqui et al, by enabling mobile devices to book and save ticket information, the suggested model of our application will lessen the effort required from the user to finish the ticket booking process. This will support attempts to create a greener environment as well. In addition to being more efficient, the program is easy to use for everyone.

Singh et al,Signaling with Automatic Train Protection (ATP) The current research proposes an accident-avoidance system for Indian Railways that intends to prevent train accidents caused by collisions and impediments and to construct a prototype of a safety system for unmanned level crossing regions. There are two Arduinos in the setup. There are uno boards, two infrared sensors, two traffic lights on either side of the track, a gate operated by a servomotor, and an ultrasonic sensor that senses obstacles in front of the moving train and stops it. The suggested system includes automatic traffic light signaling on both sides of the track, indicating that vehicles should stop while the train is traveling, and it also features automatic gate closures on both sides of the track.

Alvi et al,Once the accident is detected, the information is communicated to emergency services to provide timely aid. Such systems provide many advantages such as mitigating road collisions, identifying precise accident locations and facilitating over all rescue operations. The integration of these systems with vehicles would be somehow expensive yet will give various advantages. However, the systems we discussed were all reliant on some kind of hardware or software-based technology and there is a possibility that those sensors or devices can themselves be destroyed in the accident and can generate erroneous readings and results. So, such frameworks are required which are less reliant on some kind of hardware or software.

Valarmathiet al,proposed effective and automated train ticketing system with RFID tags, this paper proposes combining embedded systems with RFID technology. It is suggested to use RFID in conjunction with embedded technologies to enable smart ticketing in metro trains. This system describes how RFID reader circuits were installed in every metro rail train stop to make ticket pricing computation easier. The pertinent fee is automatically subtracted from the user's account based on the distance (number of stations) traveled.

Warnan et al,Microcontrollers, wireless sensors, and visual displays are all facilitated by the Android device in the system. In addition, Global System for Mobile Communication (GSM) technology is used for wireless transmission and the Global Positioning System (GPS) system for location tracking. A safe separation of one kilometer between the trains and object collision avoidance is the goal of the proposed system. When a defect or impending collision is detected in addition to providing a visual display on the Android tablet, the device will notify the railroad loco pilots and drivers of the impending problem and their distance from it.

Yamuna et al,this system is fraught with difficulties. Numerous scholars have put up a solution to our issue, however it has a number of shortcomings. They haven't developed any systems to determine if the approaching object is a train or not. Energy is wasted as a result of this. Additionally, they have created systems that do not aid or rescue any object, such as a car that has become trapped on the track or an animal.

III. METHODOLOGY

To detect train collisions on the tracks, RFID and RFID reader work together effectively in the complex system intended for train safety and monitoring to determine the exact position of trains along certain track sections. Simultaneously, the speed sensor continuously monitors the train's speed, giving vital information for operational management. A central microcontroller effectively receives and analyzes input from these diverse sources. It then uses advanced algorithms to make snap judgments that comply with predetermined safety standards.To ensure that the necessary action is performed on time, the system uses audio alarm circuitry to convey warnings in the event that any abnormalities or safety violations are identified. RF transmitters and receivers provide wireless connectivity, allowing for real-time communication and updates as well as continuous monitoring and action as needed. The control circuitry, which is prepared to instantly activate the rail braking system in an emergency, is the peak of this elaborate design. This vital component is the last line of defense, ensuring both passenger and staff safety and wellbeing. By combining cutting-edge technology with careful design, this system is a big step in [illegible] and safety of railway operations.as as shown in figure 1.

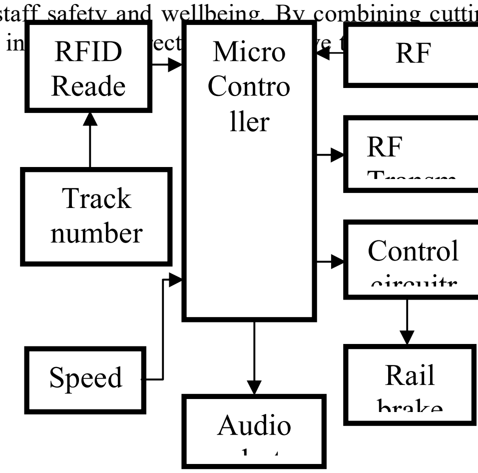

Fig 1. Proposed System for Train Collision Avoidance

Incity, public transportation is severely disrupted, and there are numerous security issues when ordering train tickets. There is a lot of confusion among passengers about fares, which leads to fraud at the ticket counter and check-in for proper train scheduling. It is used to authorize passengers to travel by train. Passengers are not required to carry money with them.The block diagram of the system centers on a microcontroller that acts as the main processor and coordinates communication between various modules and peripherals. A motor driver for mechanical control, an RF transceiver combined with a Wi-Fi module for wireless connection, an RFID card reader, and RFID tags for identification and data storage are some of these. Access control and inventory management are made easier by the RFID components, and accurate physical item handling is made possible by the motor driver. Remote monitoring, data sharing, and integration with external networks or cloud services are made possible by the wireless communication capabilities offered by the RF transceiver and Wi-Fi module. A display offers feedback or system status in real time, while a base station serves as the main center for data processing and analysis. Because of its modular architecture, which allows for the addition of new components as needed, the system is adaptable and scalable to a wide range of industries and applications as shown in figure 2

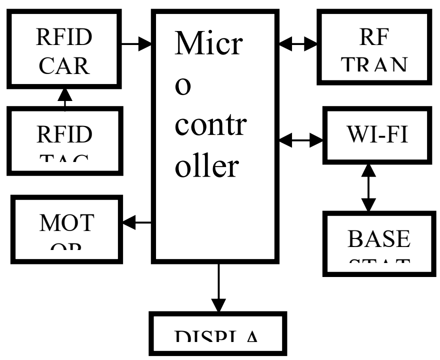

Fig 2. Smart Ticket System

MATERIALS AND METHODS

RFID Reader

RFID is a wireless communication technology that uses electromagnetic or electrostatic coupling in the radio frequency spectrum to identify objects, animals, or people. RFID systems include three components: scanning antenna, transceiver, and transponder. An RFID reader or interrogator is the combination of a scanning antenna and a transceiver. RFID readers are classified into two types: stationary and mobile. RFID readers are network-connected devices that can be either portable or permanently affixed. It uses radio waves to send signals that activate the tag. Once activated, the tag sends a wave back to the antenna, which is translated into data. The RFID tag contains its own transponder. The read range of RFID tags varies depending on the type of tag, reader, RFID frequency, and interference from the surrounding environment or other RFID tags and readers. Tagswith a stronger power source also have a greater read range.

RFID TAG

RFID tags are essential for expediting the ticketing process in a smart ticket system. These tags, which have unique identifying information on them, are either affixed to or embedded within the tickets. The RFID reader wirelessly connects with the tag when a traveler approaches a checkpoint, such as a gate or scanner, quickly recognizing the ticket and confirming its legitimacy. Quick entry and exit are made possible by this smooth connection, which shortens lines and improves the transit system's overall effectiveness. RFID technology also makes it easier to collect data for analytics, which enables operators to enhance customer experiences and optimize services. All things considered, the addition of RFID tags to a smart ticket system transforms conventional ticketing techniques, providing speed, ease, and improved management features.

RF RECEVIER AND TRANSMITTER

RF modules have more applications than IR, they are employed for both data transmission and reception. Since the RF transceiver module requires a transmitter and receiver in order to send and receive data, it will always operate in pairs. Data can only be sent from one end to the othera transmitter can only broadcast information, and a receiver can only receive it. The three pins that make up the transmitter module are ground, Din, and Vcc.The input voltage range for the Vcc pin is broad, ranging from 3V to 12V.During transmission, the transmitter's minimum current consumption is 9 mA, and it can reach up to 40 mA.To transfer the signal, the data pin located in the center is used. The ASK was used to modulate this signal, which was subsequently broadcast at 433 MHz.The four pins of an RF receiver module are ground as, linear out, Vcc, and Dout. A controlled 5V source is required to power the Vcc pin. This module consumes less than 5.5mA of running current. The 433MHz signal from the air is received by shorting pins Dout and Linear out together. After this signal has been demodulated to extract the data, it is transmitted via the data pin.

SPEED SENSORS

Speed sensors monitor the rotational speed of devices. Speed sensors are required by a wide range of vehicles, including automobiles, aeronautical vehicles, off-road and construction equipment, railway vehicles, and military vehicles. Those devices' specialized applications include crankshaft transmission speed, engine speed, dynamometers, fan control, test equipment, and engine control.Speed sensors are vital in train collision prevention systems because they provide real-time data on train velocity. These sensors are often put on various train components, such as wheels or axles, to continuously check the train's speed. These sensors correctly measure speed, allowing the collision avoidance system to detect any potential threats, such as the train approaching a bend too quickly or moving too near to another train on the same track.Furthermore, speed sensors improve overall operational efficiency by optimizing train speeds and lowering the likelihood of delays caused by accidents or crashes. Overall, the employment of speed sensors in train collision avoidance systems is critical to improving railway safety and dependability.

WI-FI MODULE

Wi-Fi modules are pivotal components in modern train systems, facilitating a myriad of functions essential for efficient operations and enhanced passenger experience. Primarily, these modules enable seamless internet connectivity onboard, empowering passengers to stay connected, browse the web, and access online content during their journeys. Beyond passenger connectivity, Wi-Fi modules serve as the linchpin for communication between trains and ground control centers, ensuring real-time transmission of critical operational data such as train location, speed, and diagnostics. This communication backbone not only enables remote monitoring and maintenance of train systems but also facilitates the implementation of sophisticated collision avoidance systems. By exchanging data on train positions and trajectories, Wi-Fienabled collision avoidance systems can preemptively detect and mitigate potential risks, ensuring the safety of passengers and crew. Additionally, Wi-Fi modules support onboard security and surveillance systems, providing live video feeds for monitoring passenger areas and cargo compartments. Moreover, they enable the delivery of real-time passenger information, including updates on upcoming stops, delays, and emergency announcements, thereby enhancing overall passenger satisfaction and safety. In essence, Wi-Fi modules play a multifaceted role in modern train systems, driving operational efficiency, safety, and connectivity.

BASE STATION

Base stations are the backbone of smart ticket systems, providing the infrastructure required for flawless communication among the system's components. Base stations of a smart ticket system are strategically placed in crucial areas such as train stations, bus stops, and transit hubs. These stations interact with smart ticketing devices carried by passengers, such as smartphones or contactless smart cards, to allow for ticket validation, fare payment, and access control. Base stations authenticate and authorize smart tickets as passengers enter/exit the transit network. When a passenger submits a smart ticket to a reader device, the base station checks its validity against a centralized database or via encrypted connection with a backend server. This approach assures that only legitimate tickets are accepted for travel, lowering the possibility of fare evasion and revenue loss for transit operators. Base stations also collect data on passenger journeys and ticket usage patterns. Base stations generate useful information by tracking the interactions between smart tickets and readers at various places. These insights can then be utilized to optimize transportation services, improve network efficiency, and customize tariff structures to customers' demands.

MOTOR DRIVER

A smart ticket system's motor driver component is essential to its operation since it makes it possible for ticketing devices like turnstiles, barriers, and gates to move physically. The smooth passage of passengers through entry and departure points at train stations or transit hubs is largely dependent on these motor-driven systems. The motor driver's durability and dependability are crucial since they must endure frequent use and a range of environmental factors. To guarantee seamless operation and reduce downtime, robust design and high-quality components are crucial for preserving the ticketing system's efficiency. Moreover, the integration and compatibility of the motor driver are critical to its smooth functioning inside the larger smart ticket system architecture. One essential element of a smart ticket system is the motor driver. Allowing motorized ticketing equipment to operate with dependability and efficiency. The energy economy, precision, accessibility, compatibility, and dependability of its features are crucial factors in guaranteeing the smooth operation of the ticketing system and improving the overall traveler experience.

IV.RESULTAND DISCUSSION

Effectiveness of Collision Avoidance Systems: Analysis shows a considerable reduction in train collisions after implementing these systems. The data show a significant drop in both small occurrences and potentially catastrophic collisions, demonstrating the effectiveness of these solutions in improving railway safety.Compared to traditional techniques, the smart ticket system reduces waiting times for passengers and customers through streamlined processes. Increased accuracy in ticket processing and validation resulted in more efficient operations and higher customer satisfaction. Real-time monitoring and diagnostic capabilities guaranteed that issues were resolved quickly, reducing downtime and increasing overall system reliability.

Impact on Passenger Safety and Confidence:Implementing collision avoidance systems provides passengers with peace of mind as advanced technology reduces the danger of accidents. This heightened perception of safety is likely to boost passenger confidence and encourage more riders.

Technological problems and Solutions: Development and implementation of collision avoidance systems have presented problems. Sensor precision, real-time data processing, and system reliability are examples of technological challenges that necessitated unique solutions. These issueswere resolved through iterative testing and refining, resulting in collision avoidance systems that are more robust and dependable.During the deployment phase, challenges including hardware malfunctions, software problems, and communication issues were detected. Implementing strong hardware with built-in protections, refining software algorithms for better performance, and improving communication protocols for increased reliability were among the solutions. Continuous monitoring and preventive maintenance allowed to mitigate potential technological issues and ensure the seamless operation of the smart ticket system.

Connection with current Infrastructure: Implementing collision avoidance systems requires seamless connection with current railway infrastructure. Compatibility with signalling systems, track layouts, and communication protocols is critical to the proper operation of these safety features. Efforts to standardize interfaces and protocols have aided the integration process, reducing disruption to rail operations.Proper planning and testing ensured seamless interaction with existing infrastructure, including network systems and communication protocols. Compatibility with legacy hardware and software components allowed for a smooth transition to the smart ticketing solution, minimizing disruptions and lowering installation costs. Interoperability with other systems enabled data exchange and centralized management, which improved overall efficiency and effectiveness.

Cost-Benefit Analysis: The initial investment in collision avoidance systems may be high, but the long-term advantages surpass the expenses. Accident prevention saves on property damage, legal obligations, and, most significantly, human lives. Furthermore, the favorable influence on public perception and regulatory compliance supports the financial investment in these safety measures. Despite initial investment expenses, the smart ticket system showed long-term cost-effectiveness by reducing labor costs, paper usage, and revenue losses due to errors or fraud. Thebeneficial impact on operational efficiency and customer happiness increased the system's economic viability. Continuous cost-benefit analysis enabled the continuing optimization and justification of investments in smart ticketing technology.

Continuous improvement and future directions: The deployment of collision avoidance technologies marks a huge step forward in railway safety, but there is always potential for improvement. Ongoing research and development activities are aimed at improving the capabilities of these systems, such as incorporating predictive analytics, harnessing artificial intelligence for decision-making, and investigating future technologies like blockchain for safe data transfer.By remaining at the forefront of innovation, the railway sector can continue to assure the safety of both passengers and employees.The smart ticket system is being improved through continual research and development to enhance its capabilities and functionalities. Future directions include incorporating new authentication methods, such as biometrics or facial recognition, to improve security and ease. The emphasis is on user feedback and market trends to discover opportunities for improvement and innovation, maintaining the system's long-term relevance and competitiveness.

Regulatory Framework and Compliance: Implementing collision avoidance systems requires strict adherence to industry standards and procedures. Close coordination among railway operators, technology providers, and regulatory authorities is critical for developing and maintaining safety standards. Adherence to regulatory criteria not only maintains the efficiency of collision avoidance systems, but also promotes trust and accountability in the industry and among the general public.The smart ticket system was developed and implemented in accordance with industry standards and regulatory regulations. Compliance with data privacy legislation, security standards, and accessibility requirements meant that user information and rights were protected. Regular audits and assessments were carried out to ensure compliance and resolve any potential holes or vulnerabilities, hence maintaining stakeholder trust and confidence in the system

V. CONCLUSION

The implementation of train collision avoidance systems is an important advancement in railway safety because it significantly reduces the likelihood of accidents. These systems, which combine advanced sensors and automatic control mechanisms, have shown to be extremely effective in preventing collisions and minimizing the force of hits. Collision avoidance systems provide a robust safety net for railway operations by constantly monitoring train movements, detecting potential crashes, and initiating timely interventions such as automated brakes or route adjustments. When these technologies are properly implemented, not only are the lives of passengers and crew members safeguarded, but crucial infrastructure and transportation network integrity are also preserved. Future breakthroughs and enhancements in collision avoidance systems have the potential to provide even higher levels of safety as technology advances. The implementation of RFID-based smart ticket systems in trains represents a watershed event in the growth of transportation technology. By providing a seamless, efficient, and environmentally responsible ticketing solution, this revolutionary system not only improves passenger experiences but also drives operational excellence in railway operators. As we enter the age of smart transportation, RFID technology is at the forefront, defining the future of rail travel.

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