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Train Accidents Prevention System with FPGA Control System

Nagarathna H S Asst. professor,
Kushal C K, Chandan A C, N M Siddharth, Sriram Vishnu Prasad.
Dr Ambedkar Institute Of Technology, Bengaluru-560056, India

Abstract:- Train accidents have serious consequences such as loss of life, damage to property, and disruption of transportation. To reduce these risks and improve rail safety, the development of high-speed trains is becoming a priority. This summary provides an overview of state-of-the-art train crash avoidance systems designed to prevent train crashes and improve rail safety.

These measures were taken in many ways, causing numbers to drop further and in serious situations. This article presents technologies that can be used in preventive measures to reduce train suicides, crime and level crossing customer accidents.

It describes their ability to reduce accidents, their cost effectiveness, and their integration into all train transport.

Keywords:- *Train Collision Avoidance System, Train Collision Avoidance, Train Collision, Automatic Train Protection (ATP), Automatic Train Control (ATC), Positive Train Control (PTC), Traffic Communication Based Traffic Management (CBTC), Train -to - Train communication, train detection, train location, train anti-collision signal system, train speed control, train separation, train approach detection, train accident assessment, train emergency braking, train control system, train security system, railway safety, Railway signal.*

I. INTRODUCTION

Rail transport plays an important role in international mobility and economic development. However, ensuring railway safety remains a major challenge due to the complexity of railways and therisks associated with traffic accidents. The Train Accidents Prevention System has become an important technology for reducing the risk of collisions and improving railway safety.

TCAS refers to the maximum safety system designed to prevent train collisions. These systems use technology, sensors, and communication and control systems to detect collision risks and take appropriate action to prevent accidents.

By constantly monitoring the train's position, position and speed, TCAS can issue timely alerts, coordinate train movements, and implement security measures to ensure departure.

The purpose of this journal is to conduct research on train crashes and their effects on rail safety. Thisstudy aims to determine the effectiveness, problems and future expectations of TCAS in preventing train accidents. It will review the existing literature, industry practices and technological developments regarding TCAS.

This study will focus on evaluating TCAS performance and capabilities in a variety of operational situations, including high speed train, intersections and intersections.

It will explore the integration of TCAS with existing signals and trains, as well as the integrationof new technologies such as advanced sensors, dataanalysis and communication processes.

In addition, this study will examine the humanfactors of TCAS use, including operator training, decision making, and usability of the TCAS interface. Understanding the interaction between train operators and TCAS will also help improve the quality of education.

II. TRAIN ACCIDENTS PREVENTION SYSTEM

Enhanced HMI for seamless integration and optimized use of TCAS systems.

In addition, this study will solve problems and decisions during the use of TCAS such as cost,coordination, control and system reliability. It will review current standards and regulations governing TCAS deployment, emphasizing the importance of international cooperation and harmonization to ensure consistent safety standards across different train races.

With a comprehensive TCAS analysis, this newsletter aims to provide insight and recommendations for the development, optimization and future development of collision avoidance systems. The findings of this research will helpimprove rail safety, reduce the risk of trainaccidents, and improve the overall efficiency and reliability of operations on the train.

III. RELATED WORK

Train Collision Avoidance Systems (TCAS) are safety critical systems designed to prevent train collisions. In recent years, there has been an interest in the development of TCAS technology to improve safety in the railway industry. Below is a brief history of train accidents:

- Li Si-huia, b, Cai Baigena, b, N, Liu Jianga, b, accident risk analysis based on early train crashes by Wang Jian - With the development of transportation in China, many passenger and high-speed trains were built and put into use. Currently, China Train Control System (CTCS) Level 3 has been approved in the management and delivery of passengers and high-speed trains, and has become a common unified technology for safety and reliability decisions.

- Designing a train collision detection system using a wireless sensor network", M.Anas Imtiaz and M. Yasin Raja. This article presents a TCAS that uses a wireless sensor network to detect and avoid collisions between trains. The system plans to use acceleration and position sensors to control the train's position and speed and warn the driver in case of a possible collision.
- "Avoiding a train crash using computer vision and deep learning", by A.B. Kulkarni and M. P. Sharma. This article presents a TCAS that uses computer vision and deep learning techniques to detect and avoid train collisions.
- The proposed system uses cameras mounted on trains to capture real-time images of the tracks and uses deep learning algorithms to analyze images to detect collisions.
- B.K Pradhan and S.K. Dash. This article introduces TCAS to detect and avoid train collisions using artificial intelligence. The proposed system uses machine learning algorithms to analyze train speed and location data and alert drivers if a collision is detected.
- "Avoiding a train accident using RFID technology", S. V. Shinde and SR Sawant. This document introduces TCAS to detect and avoid train collisions using RFID technology. The system plans to use RFID tags placed on trains and tracks to determine the train's position and speed and alert drivers when an accident is detected.
- "Train Collision Avoidance System (TCAS) Based on Wireless Sensor Networks" by D. D. Datta and M. N. Mohanty.
- This article presents a TCAS that uses a wireless sensor network to detect and avoid train collisions. The proposed system uses accelerometers to measure the train speed and warning the driver when a collision is detected.
- "RF Based Train Collision Avoidance System"**-** Human errors has become the number one reason of train crashes. The purpose of this article is to eliminate train collsions using analysis. Each locomotive is equipped with an automatic control system. Railway lines are divided into sections and different numbers are given, which are read by following the locomotives. This tracking number will be shared with neighboring trains using radio communication for tracking.
- The system then compares its operator with neighbouring trains. After finding the same part number, the monitoring system will stop the train and warn the driver to avoid collision.. This article presents a special method for piecewise train movement numbers. The communication protocol is also prepared to enable the system RF transceivers to transmit data in half duplex mode.
- "Avoiding Train Collisions Using GPS and GSM Modules", Aamir Ahamed Md. Sayed Hossen and Naeemul Islam **-** This article presents a methodology to analyze the problems of railways. The system combines a PIC16F877A microcontroller, an ultrasonic sensor, and GPS and GSM. An ultrasonic sensor interfaced with a microcontroller is used to detect the problem. GPS is used to locate the train by identifying obstacles behind the train stop.
- The job is sent to the control room using GSM. The system works fine except in bad weather conditions. Since it is an ultrasonic sensor project, this project will not work well when the air pressure is too high.

IV. METHODS

- Data Collection and Analysis: Collect and analyze data on train operations, track configuration, machinery configuration, and accident history. This information can provide insight into patterns, risk factors and potential areas for accident development.
- Sensor Technologies: explores and evaluates different sensor devices that can be used to identify trains and monitor their location and movement. This may include technologies such as radar, lidar, infrared sensors, or roadside sensors such as axle counters or track circuits.
- Communication Engineering: Research and development of communication systems and systems that enable real-time data exchange between trains, facility control and household appliances. This will include measuring the reliability, latency and scalability of various communication methods such as radio, Wi-Fi or mobile.
- Algorithm Development: Design and implement intelligent algorithms that process sensor data and make decisions to prevent train accidents. These algorithms can include collision risk assessment, crash prediction, and collision avoidance based on predefined rules or machine learning techniques.
- Simulation and Modeling: Use computer simulations or mathematical models to design and analyze train movements and accidents. This allows the different TCAS codes, configuration settings and functions to be reviewed without actual use.
- Field testing and verification: Conduct field tests or field trials to evaluate the effectiveness and feasibility of train collisions in real-world operations. This will include the development and testing of a standard TCAS solution on selected train lines or test tracks.
- Human Factors Assessment: Consider the human factors involved in the process of working with and dealing with train crashes. This may include evaluating the usability of the user interface, assessing the impact of the machinist's work, and conducting user surveys or research to gather feedback and improve the design.
- Compliance: Review and comply with the regulatory procedures and standards that govern the use and operation of 0+.
- Train Collision Avoidance Systems.
- Ensure TCAS solutions meet required security standards and are connected to business processes.
- Cost-Benefit Analysis: Perform a cost-benefit analysis to evaluate the economy and benefits of using a train crash prevention system. This will include analyzing delivery, maintenance and operational costs and comparing them to reductions in damage, injury and operational disruption.

V. TRAIN COLLISION PREVENTION SYSTEM

Continuous Improvement: Use feedback and techniques to continuously improve train wrecks to prevent accidents. This includes monitoring system performance, reviewing incident reports, and drawing lessons learned toimprove the effectiveness and reliability of theTCAS system.

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VI. WORKING

The road subsystem consists of RFID tags mounted on the road at stations and on roads, providing information about the road to on- board Loco TCAS units. Parts of the road, including vehicles, lights and barriers, are assigned identification numbers called Track Identification Numbers (TINs). TINs are used with RFID tags to determine the direction of a train.

The system also includes fixed TCAS units andradios installed at the station for communication with locomotives in the stationarea. Fixed TCAS is associated with the station connection and receives dynamic information about various navigation information in real time.

Routing information for all signals monitored by a fixed TCAS station is set according to the TCAS control table (except for shunt signals and overlapping signals). Fixed TCAS units receive real-time information via UHF radio communications, such as the location and speed of various trains in their area.

TCAS stand-alone units are provided in the centre of the cross section and in the intermediate blocking signal (IBS) position if they are not within range of the radio stations. Interconnect Units (RIUs) are used where a signal can be routed to a nearby TCAS location, such as LC ports / IBs / distribution interface on the radio at the end or the server station car tower.

The TCAS train is installed on the train todetermine the location of the train by reading the data from the RFID tag with the help of an RFID reader. The Loco TCAS unit sets the location uncertainty (the approximate distance of the train from the location) and the TIN to undefined (zero) before making a decision. When a train/train passes two RFID tags in sequential operations, the train's direction of travel must be determined.

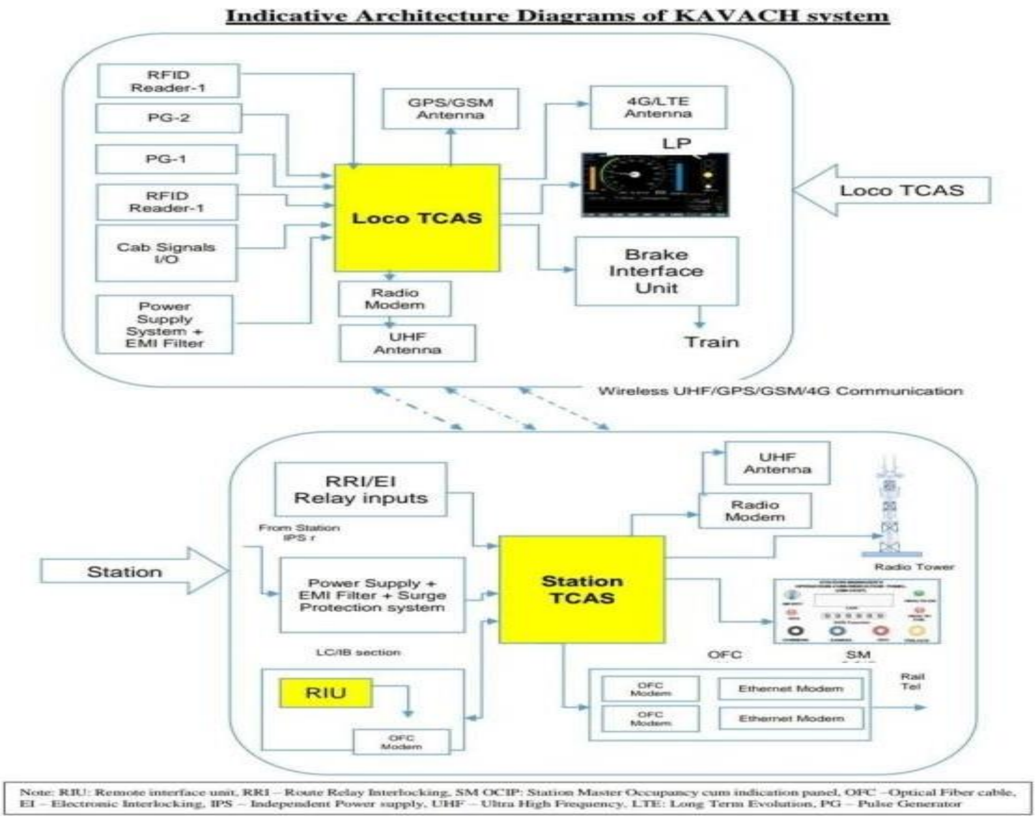

Fig 1. Block Diagram of TCAS

The Loco TCAS unit sets the location uncertainty(the approximate distance of the train from the location) and the TIN to undefined (zero) before making a decision. When a train/train passes two RFID tags in sequential operations, the train's direction of travel must be determined. The Loco TCAS unit dynamically calculates the position of the train between two RFID tags based on thedistance traveled by the last RFID tag from the speedometer provided on the locomotive. After theRFID card has passed, the Loco TCAS unit sends the train's position and direction to the TCAS unit via a UHF radio antenna.

Fixed TCAS units must use the train/train travel direction to detect train/train signals. Fixed TCAS unit, moving in the direction of the signal or/and following the state in the circuit or/and entering theoff state, point

VII. TRAIN COLLISION AVOIDANCE SYSTEM

Position and condition of the docking circuit circuit. Then the fixed TCAS unit must transfer theauthority to act at the decision area station to the TCAS area. The length of the actual travel dependson the signal direction of the line of sight of the stop signal. The locomotive unit should accelerate/decelerate in various situations based onmovement

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rules, speed limits, and other information from the Trackside subsystem. TCAS trains must display train speed, allowable speed, target distance and target speed to the Train Interface (DMI).

If the road signal is red (danger), the fixed TCAS unit should send this information to the local TCASand reset the mobile license to zero.. If the locomotive driver does not stop the train, the brakeis applied, preventing the signal crossing hazard (SPAD). If there is a conflict between signals, direction points, segments of the race, signal combinations and TINs, the fixed TCAS unit should send the most limited number of signals andreduce the right to act for this reason. This will prevent trains from colliding at the station.. In the case of sections, if the fixed TCAS detects that twotrains are moving towards each other on the same TIN, the fixed TCAS will generate SoS commandsfor both trains.

When the Loco specific SoS is received from the TCAS station station, the train will be stopped by applying the brake. The regulations also provide for the forwarding of SoS messages from the localTCAS to the other local TCAS in an emergency.

The communication technology used for data transfer between stations is multi-channel full duplex UHF radio communication using TDMA/FDMA. For communication between the TCAS station and the Loco it controls, the station is assigned a unique frequency pair. A Loco TCASunit can also communicate with other Loco TCAS units in community, parking and emergency situations (SoS, frontal collision, traffic collision) and use the program (f0) in its program.

A Network Monitoring System (NMS) with a central office in the OFC network will be provided for central monitoring of TCAS-equipped trains and stations in the network. Transmission of fault/critical messages from TCAS station and local TCAS to NMS is done via existing GSM interface.

Trouble shooting, offline simulation, real-time monitoring of TCAS locomotives, etc., developed by NMS. In the TCAS system, radio communication between Loco TCAS and TCAS fixed units must use encryption.

For fixed TCAS and secure communication, Loco TCAS receives authentication keys using GSM/GPRS communication over Key Management System (KMS). The Real Time Clock(RTC) of each TCAS is synchronized with GPS/GNSS.

VIII. COMPONENTS

Fig. 2: Key components

IX. TRAIN COLLISION PREVENTION SYSTEM

General train accident includes the followingitems:

A. Monitoring equipment includes fixed TCAS and

B. Onboard equipment

- *The Trackside Subsystem*
- *Consists of the Trackside Subsystem*

- RFID tag
- TCAS unit
- Tower and Antenna Air Subsystems Air subsystems must have

C. Loco TCAS Vital Computer (ii).RFID reader

D. Loco TCAS radio unit

E. Driver Machine Interface (DMI) (v). Brake Interface Unit (BIU)

- RFID Tag

The RFID tag provides station static information tothe locomotive. In addition to working as a reference, they broadcast radio channels and transmit signals to the locomotive unit, etc. They provide instant information such as RFID tags should be placed on the road in the parking lot, point area, next to the signal, and on the roadsection to provide tracking information to the localTCAS. As per Indian Railways guidelines RFID tags must be placed on the sleepers in the tabs.

- Stationary TCAS Unit

Fixed TCAS Units fixed TCAS units will be implemented on all Indian Railways providing signal colors. By default it should work to interactwith panel locks and electric/solid state locks.

Stations should always have fixed TCAS units to cover all traffic signals. Areas with insufficientTCAS radio signal tower should be provided in themiddle of the field (IBS) and in the center of the intersection. This should be related to the interaction tool to get important information about the installation, such as various signals, in a timelymanner.

It contains information about the location and content of RFID tags and static signals such as speed limits.UHF radio communication receives real-time information such as the location and speed of various trains in the area. Based on this information, he saw an emergency and could orderLoco to stop the process.

- Tower and antenna Antenna

The antenna of the Station / IBS / Locked Door Unit must be a combination of vertically polarized omnidirectional and/or fixed communication antenna. Antenna cables and antennas must be suitable to provide a minimum communication distance of approximately 1 .The initial signal of afixed TCAS unit is close to 5 km (usually 4.5 km in case of Indian Railways two zones).

➢ *On-Board Subsystem (Locomotive TCAS Unit)*

The locomotive's TCAS host is a system that monitors the train's movement based on data exchange with fixed TCAS units and other TCAS trains. A minimum of 2 out of 2 is required for theComputer Architecture section.

Fig. 3: Loco TCAS unit

- Loco TCAS host

X. TRAIN COLLISION PREVENTION SYSTEM

Loco Pilot will have mechanisms and Loco TCAS master must be synchronized in time with the GNSS clock and synchronized with other TCAS systems in hot standby mode.Loco TCAS host must have the following functions:

A. Train interface and brake.

- Bidirectional inductive speed sensor interface for measuring distance and speed.
- Interface with RFID reader for reading RFID tags installed on the road.
- Interacts with the BTM reader to read the rail-mounted transponders of the TPWS section.
- Interfaces with Driver Interface (DMI) with display and activation button/switch.
- Two GSM interfaces to connect the main network monitoring system
- (NMS) and the main system (KMS). It will also work with LTE-capable LTE.
- USB interface for downloading logs and other files for diagnostic purpose

B. Loco TCAS host

Loco TCAS radio unit (if using UHF) Regional TCAS radio must be the same as TCAS radio. In order for the Loco TCAS radio to communicate with the TCAS unit, it must have twoUHF full-duplex radio modems with separate cables and antennas in hot standby mode. Locomotive antennas must be omnidirectional, have vertical polarization and gain better than 3 dB.

C. RFID Readers

Each Loco TCAS unit must be equipped with two RFID readers to receive information from RFID tags attached to the side of emergency equipment.

D. Loco Pilot Machine Interface (DMI)

Much of the information presented is presented in the form of a circuit (spring) simulation and is based on ergonomics management and driver comfort.

Release additional debt. Reminders and remindersare also effective. The operating and instrumentation panel (LP-OCIP/DMI) of the buttons/switches to display/operate the following functions:

- Communication with Loco TCAS.
- Locomotive drive selects train type.
- SOS action for drivers.
- Signal representation.
- train length screen
- train mode screen
- screen of all locomotive operating modes
- current speed
- overspeed
- allowable speed
- target speed (Enter Circular Line for)
- Action Authority (MA) (xiii)

Contextual Message display function on DMI toget Loco Pilot's attention.

E. Brake Interface Unit (BIU)

The BIU should use the locomotive's normal braking, service braking and emergency braking, respectively, depending on the type of braking command it receives from the locomotive TCAS unit. In addition to these brakes, if Loco TCAS generates a Loco Brake command, it must use LocoBrakes.

➢ *BIU consists of two modules: Electronic Module:*

It has a control card with built-in air brake control logic. The board interfaces with theanalog input module, digital input module and digital output module to monitor and control the stop/release application.

➢ *Pneumatic Panel:*

Contains various valves, pressure switch and manual valves and electronic equipment forbrake control related to the IRAB system. BIU the location of the TCAS confirms the needfor collision.

XI. ADVANTAGES

➢ *Train Collision Prevention System*

- Road safety: The main benefit of collision avoidance is to ensure the safety of passengers and crew. The system provides early warning to prevent accidents by identifying potential collisions or derailments.2. Avoid human error: Train accidents are often caused by human error, be it the driver, conductor or other train personnel.
- Accident prevention can help reduce human error by providing automated alerts and alerts.
- Improved efficiency: The system helps improve train times and schedules by allowing trains to run faster and stick to tighter schedules. This will help reduce lags and improve overall performance.
- Low costs: Train crashes can be costly, both in terms of damage to the train and infrastructure and potential legal issues. Avoidance techniques can help reduce these costs by preventing accidents before they happen.
- Improved maintenance: Supervisors can use accident prevention data to identify and correct errors and processes that could cause problems.
- Reduce environmental impact: Train crashes cause serious damage to the environment, causing oil spills and other pollution. Collision avoidance by preventing such incidents can help reduce the environmental impact of transportation.

XII. CONCLUSION

The number of events that occurred in the previous year. We have implemented new products with RFID to prevent train accidents. This product has been tested and works well. The main purpose of this study is to prevent the train from stopping if the mechanic does not use the brakes, and the brake brake unit (BIU) will also be used.

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