Emergency Management of Urban Rail Transportation Using CBTC System

S.Aparna¹, A.Sujatha Priyadharshini²

¹(PG Scholar, Communication System, PRIST University, Thanjavur, INDIA)
²(Assistant Professor, Electronics & Communication Engineering, PRIST University, Thanjavur, INDIA)

ABSTRACT: Urban rail transit systems are rapidly developing around the world. Due to a great deal of urban traffic pressure, improving the efficiency and capacity of urban rail transit systems is an increasing demand. Because it is a key subsystem of urban rail transit systems, communication-based train control (CBTC) is an automated train control system that makes use of train–ground wireless communications to ensure the safe operation of rail vehicles. It can enhance the level of safety and service offered to customers and improve the utilization of railway network infrastructure. CBTC is a modern successor to the traditional railway signaling system using interlocking, track circuits, and signals. Building a train–ground wireless communication system for CBTC is a challenging task. As urban rail transit systems are mostly deployed in underground tunnels, there are large amounts of reflections, scattering, and barriers that severely affect the propagation performance of wireless communications. However, most of the current WLAN standards were not originally designed for the high-speed environment in tunnels. Furthermore, the fast movement of trains will cause frequent handoffs between WLAN access points which can severely affect CBTC performance. The sensors such as speed sensor, gas sensor, fire sensor, mems sensor are used to send the speed and fire position direction and location of the train then the Zone controller send the brake curve to the corresponding train. Here we are using the WIFI or Zigbee WPAN (Wireless Personnel Area Network) is operating on the frequency 2.4 GHz which has more coverage comparing RF Transceiver. The Microcontroller constantly reads the data of sensors and sends the information as serial

I. INTRODUCTION

Urban rail transit systems are rapidly developing around the world. Due to a great deal of urban traffic pressure, improving the efficiency and capacity of urban rail transit systems is an increasing demand. Because it is a key subsystem of urban rail transit systems, communication-based train control (CBTC) is an automated train control system that makes use of train–ground wireless communications to ensure the safe operation of rail vehicles. It can enhance the level of safety and service offered to customers and improves the utilization of railway network infrastructure. CBTC is a modern successor to the traditional railway signaling system using interlocking, track circuits, and signals. As urban rail transit systems are mostly deployed in underground tunnels, there are large amounts of reflections, scattering, and barriers that severely affect the propagation performance of wireless communications. Furthermore, the fast movement of trains will cause frequent handoffs between WLAN access points which can severely affect CBTC performance of urban rail transit systems, communication-based train control (CBTC) is an automated train control system that makes use of train–ground wireless communications to ensure the safe operation of rail vehicles. It can enhance the level of safety and service offered to customers and improves the utilization of railway network infrastructure. CBTC is a modern successor to the traditional railway signaling system using interlockings, track circuits, and signals. The railway line is usually divided into areas or regions. Each area is under the control of a zone controller (ZC) and has its own radio transmission system. Building a train–ground wireless communication system for CBTC is a challenging task. As urban rail transit systems are mostly deployed in underground tunnels, there are large amounts of reflections, scattering, and barriers that severely affect
communication using UART (Universal Asynchronous Receiving and Transmitting).

**Keywords-** CBTC (Communication Based Train Control System), Emergency response, Master-Slave, Sensors, WIFI.

- The Lloyd–Max technique [17] is used to determine the signal-to-noise ratio (SNR) level loss model of tunnel channels is given in [5], which describes the characteristics of large-scale fading. Although some excellent works have been done on modeling channels, most do not consider the unique characteristics in CBTC systems, such as high mobility speed, deterministic moving direction, and accurate train-location information. In this paper, we develop a finite-state Markov channel (FSMC) model for tunnel channels in CBTC systems. FSMC models have been widely accepted in the literature as an effective approach to characterizing the correlation structure of the fading process, including 1.8-GHz narrow-band channels [7], high-speed railway channels [8], satellite channels [9], indoor channels, Rayleigh fading channels.

**II. OVERVIEW OF CBTC**

In train, the Engine is Master unit which monitors the other Cars / Compartments as a Slave units which has gas sensor, fire sensor, MEMS sensor, RF transmitter etc., By using WIFI, the zone controller gathers the train’s condition & information. Then control room gives the information about the brake curve receiving speed and identity the train’s condition and location. PIC16f877a controller is the main unit for sensing and transferring the information to the zone controller. Here, CBTC technology is used. CBTC -Communication-based train control system is an automated train control system. CBTC system for railways that ensure the safe operation of rail vehicle using RF data communication between train engine & other compartments. It can enhance the level of safety and service offered to customers. CBTC is a Modern Successor to the traditional railway signaling systems.

Communication-based train control (CBTC) is being rapidly adopted in urban rail transit systems, as it can significantly enhance railway network efficiency, safety, and capacity. Since CBTC systems are mostly deployed in underground tunnels and trains move at high speeds, building a train–ground wireless communication system for CBTC is a challenging task. Modeling the tunnel channels is very important in designing the wireless networks and evaluating the performance of CBTC systems. Most existing works on channel modeling do not consider the unique characteristics of CBTC systems, such as high mobility speed, deterministic moving direction, and accurate train-location information. In this paper, we develop a finite-state Markov channel (FSMC) model for tunnel channels in CBTC systems. Fig. 1 describes a CBTC system. In this system, continuous bidirectional wireless communications between each mobile station (MS) on the train and the wayside APs are adopted instead of the traditional fixed-block track circuit. The railway line is usually divided into areas or regions. Each area is under
systems have not been studied in previous works. Therefore, there is a strong motivation to develop an FSMC model for tunnel channels in CBTC systems. Some distinct features of the proposed channel model are as follows

- The proposed FSMC model is based on real field CBTC channel measurements obtained from the business operating Beijing Subway Changping Line.
- Unlike most existing channel models, which do not use train-location information, the proposed FSMC channel model takes train locations into account to create a more accurate channel model.
- The distance between the transmitter and the each train the location of the train in front of it and gives it a braking curve to enable it to stop before it reaches that train. Theoretically, as long as each train is traveling at the same speed and they all have the same braking capability, they can travel together as closely as a few meters between them. When a train moves away from the coverage of an AP and enters the coverage of another AP along the railway, the handoff procedure may result in communication interruption and long latency. In CBTC systems, it is important to maintain communication link availability in order to guarantee train operation safety and efficiency. Wireless channels in CBTC systems are different from those in other wireless systems, since most CBTC systems are deployed in underground tunnels, where there are large amounts of reflections, scattering, and barriers that severely affect the propagation performance of wireless communications. In order to design the wireless networks and evaluate the performance of CBTC systems, modeling the tunnel channels in CBTC systems should be carefully studied.

III. TRAINGUARD MT- AUTOMATIC TRAIN CONTROL SYSTEM

The modular train control system Trainguard MT provides the signaling basis for attractive, reliable, and efficient mass-transit systems. The radio-based system allows a choice between fixed or moving block operation and achieves headways of 90 seconds. Trainguard MT includes functions for monitoring, implementation, and control of the entire operating sequence. It can be implemented the control of a zone controller (ZC) and has its own radio transmission system. Each train transmits its identity, location, direction, and speed to the ZC. The radio link between each train and the ZC should be continuous so that the ZC knows the locations of all the trains in its area all the systems normally have less wayside equipment and their time. The ZC transmits to diagnostic and monitoring tools have been improved, which makes them easier to implement and, more importantly, easier to maintain.

CBTC technology is evolving, making use of the latest techniques and components to offer more compact systems and simpler architectures. For instance, with the advent of modern electronics it has been possible to build in redundancy so that single failures do not adversely impact operational availability.

Moreover, these systems offer complete flexibility in terms of operational schedules or timetables, enabling urban rail operators to respond to the specific traffic demand more swiftly and efficiently and to solve traffic congestion problems. In fact, automatic operation systems have the potential to significantly reduce the headway and improve the traffic capacity compared to manual driving systems.[10][11] Finally, it is important to mention that the CBTC systems have proven to be more energy efficient than traditional manually driven systems. The use of new functionalities, such as automatic driving strategies or a better adaptation of the transport offer to the actual demand, allows significant energy savings reducing the power consumption.

The typical architecture of a modern CBTC system comprises the following main subsystems:

3.1.1 Wayside equipment, which includes the interlocking and the subsystems controlling every zone in the line or network (typically containing the wayside ATP and ATO functionalities). Depending on the suppliers, the architectures may be centralized or distributed. The control of the system is performed from a central command ATS, though local control subsystems may be also included as a fallback.

3.1.2 CBTC onboard equipment, including ATP and ATO subsystems in the vehicles.

3.1.3 Train to wayside communication subsystem,
in different degrees of automation, e.g., semiautomatic operation, operation under driver control, and driverless operation. Trainguard MT is compatible with various different operation control systems, interlocking designs, and track-vacancy detection systems.

3.1 Main benefits of CBTC

The evolution of the technology and the experience gained in operation over the last 30 years means that modern CBTC systems are more reliable and less prone to failure than older train control systems. CBTC

- other serial communications interfaces like PC, Serial Peripheral Interface and Controller Area Network for system interconnect
- peripherals such as timers, event counters, PWM generators, and watchdog
- clock generator - often an oscillator for a quartz timing crystal, resonator or RC circuit
- many include analog-to-digital converters, some include digital-to-analog converters
- in-circuit programming and debugging support

3.2 Proposed framework

Integrating artificial systems, computational experiments, and parallel execution (ACP) is an effective approach to modeling, simulating, and intervening real complex systems. Emergency response is an important issue in the operation of urban rail transport systems for ensuring the safety of people and property.

- serial input/output such as serial ports (UARTs)

is also defined as any device that converts a signal from one form to another. Sensors are mostly electrical or electronic.

Some of the sensors used in slave units in train section are Strain sensor, Fire sensor, MEMS sensor, Hydrostatic sensor.

STRAIN SENSOR: A strain gauge takes advantage of the physical property of electrical conductance and its dependence on the conductor's geometry. When an electrical conductor is stretched within the limits of its elasticity such that it does not break or permanently deform, it will become narrower and longer, changes that increase its electrical resistance end-to-end. A typical strain gauge arranges a long, thin conductive strip in a zig-zag pattern of parallel lines such that a small amount of stress in the direct ion of the orientation of the parallel lines results in a multiplicatively larger strain measurement over the effective length of the conductor surfaces in the array of conductive lines—and hence a multiplicatively larger change in resistance—than would be observed with a single straight-line conductive wire.

FIRE SENSOR: Fire accidents in trains are among the most serious disaster to human lives and to the property if government. Because the only precautionary warnings about the fire in each compartment are the notices showing “Do not Smoke”, “Do not carry inflammable material”. Flame detection is the technology for detecting flames, using a flame detector. Flame detectors are optical equipment for the detection of flame phenomena of a fire.
4.2 ADC (analog to digital converter)

An analog-to-digital converter (ADC, A/D, or A to D) is a device that converts a continuous physical quantity (usually voltage) to a digital number that represents the quantity's amplitude.

The conversion involves quantization of the input, so it necessarily introduces a small amount of error. Instead of doing a single conversion, an ADC often performs the conversions ("samples" the input) periodically. The result is a sequence of digital values that have been converted from a continuous-time and continuous-amplitude analog signal to a discrete-time and discrete-amplitude digital signal. An ADC may also provide an isolated measurement such as an electronic device that converts an input analog voltage or current to a digital number proportional to the magnitude of the voltage or current. However, some non-electronic or only partially electronic devices, such as rotary encoders, can also be considered ADCs. The digital output may use different coding schemes. Typically the digital output will be a two's complement binary number that is proportional to the input, but there are other possibilities. An encoder, for example, might output a Gray code.

4.3 Sensors in slave unit

A sensor is a technological device that detects / senses a signal, physical condition and chemical compounds. It

There are two categories of flame detection:-Flame detector for the detection of a fire in a fire alarm system-Flame scanner for monitoring the condition of a flame in a burner. The thermocouple temperature sensor is to monitor for conditions within rail coach represent in fig 3. And also it provides external and internal alarms, together with automatic operation of the train braking system. WIFI which transmits signal to the engine driver LCD panel enabling the warning light and alarm to function and also send the message to zone controller by using wifi communication.

an output voltage of around 7 V as soon as the signal frequency drops below 1 Hz. Another method used is to detect a 50 MHz output signal from the sensor when the power supply is periodically modulated at 50 MHz. It is also common for two-channel sensors to have electrically isolated channels. Occasionally it is necessary to take off the wheel slide protection signal at the traction motor, and the output frequency is then often too high for the wheel slide protection electronics. For this application a speed sensor with an integrated frequency divider or encoder can be utilized.

5.3 MEMS Sensor

Microelectromechanical systems (MEMS) (also written as micro-electromechanical, MicroElecroMechanical or microelectronic and microelectromechanical systems and the related micromechatronics) is the technology of very small devices; it merges at the nano-scale into nanoelectromechanical systems (NEMS) and nanotechnology.

V. MASTER UNIT TOOLS DESCRIPTION

5.1 PIC16F877A

PIC- Peripheral Interface Controller. It is an 8 bit
microcontroller and it is a 40 pin IC. It is a bit addressable microcontroller i.e., each bit can be controlled separately. It is a fully RISC (Reduced instruction Set Computing), the instructions will be executed only by a particular hardware. Six modules - ADC, timer, RS232, CCP, SPI. PIC is families of Harvard architecture microcontroller. There are three memory units present in PIC. They are RAM, ROM and data EEPROM. PIC IC having three packages and five ports such as PORT A, PORT B, PORT C, PORT D and PORT E. PIC is a family of modified Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC originally developed by General Instrument's Microelectronics Division. The name PIC initially referred to "Peripheral Interface Controller" now it is "PIC" only. PICs are popular with both industrial developers and hobbyists alike due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (and re-programming with flash memory) capability.

5.2 Speed Sensor

Bearingless speed sensors may be found in almost every wheel set of a rail vehicle. They are principally used for wheel slide protection and usually supplied by the manufacturer of the wheel slide protection system. These sensors require a sufficiently small air gap and need to be particularly reliable safety. One special feature of rotary speed sensors that are used for wheel slide protection is their integrated monitoring functions. Two-wire sensors with a current output of 7 mA/14 mA are used to detect broken cables. Other designs provide for

5.4 GPS

The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites. The system provides critical capabilities to military, civil and commercial users

It combines computer with tiny mechanical devices such as semiconductor chips. To design and analyze MEMS transducers such as pressure sensors, accelerometers, angular rate gyros, microphones, and resonators. MEMS are separate and distinct from the theoretical vision of molecular nanotechnology or molecular electronics. MEMS are made up of components between 1 to 100 micrometres in size (i.e. 0.001 to 0.1 mm), and MEMS devices generally range in size from 20 micrometers (20 millionths of a metre) to a millimetre (i.e. 0.02 to 1.0 mm). They usually consist of a central unit that processes data (the microprocessor) and several components that interact with the surroundings such as microsensors.

VI. CONCLUSION

Wireless sensor network are increasingly applied in the field of urban rail safety and monitoring with the help of our proposal, we pointed our unique advantage of safety in signal transmission, flexibility in network setup and low cost. We propose this system as first attempt and complement to Indian railways safety monitoring system. In this paper, we have proposed an FSMC model for tunnel channels in CBTC systems. Since the train location is known in CBTC systems, the proposed FSMC channel model takes train locations into account to have a more accurate channel model. The distance between the transmitter and the receiver is divided into intervals, and an FSMC model is designed in each interval. The accuracy of the proposed model has been illustrated by the simulation results generated from the proposed model and the real field measurements.
around the world.

5.5 WIFI

Rail systems are expected to be one of the fastest and most efficient means of transportation. WiFi Rail has designed and patented an end-to-end solution comprised of proprietary architecture, wayside and on-train equipment, and an application suite tailored for mass transit metros.

The network and applications deployed include above and below ground wayside wireless and fiber-optic infrastructure, our jointly developed on-board Train Communications and Recording Unit (TCRU), and a myriad of applications. These applications include live and recorded CCTV, centralized train telemetry (data logging), converged communications (VoIP), radio interoperability, location based services, digital media and passenger information, energy efficiency, and public WiFi for passengers. Replication and incremental deployment of the WiFi Rail technology platform require significant support from our partner ecosystem.

Wireless telecommunications, is the transfer of information between two or more points that are physically not connected. Distances can be short, as a few meters as in television remote control; or CBTC is partially implemented only on the Metro rails. We planned to implement in PTC (POSITIVE TRAIN CONTROL) on all urban rail Transportation. PTC is a system of functional requirements for monitoring and controlling train movements and sends SMS (SHORT MESSAGE SERVICE) to all passengers about the train’s condition by using wifi to provide augmented safety. This may tackle on board train then enforce this, its preventing unsafe movement. PTC systems may work in either dark territory or signaled territory, and may use GPS navigation to track train movements. Embedded system debugging involves more conceptual layers of a target system than debugging for time-sharing systems. Consider the case of debugging a C program within a time-sharing system. User-debugger interaction occurs almost entirely at a C language level of abstraction. Descent into assembly language and machine code representations of a target program is rare. Suspicions about a compiler bug may require inspection of generated assembly code. The overall performance of a rail rapid transit system depends largely on the performance of the automatic train control (ATC) system employed. A communication-based train control (CBTC) system is devised by adding modern communication technologies to the ATC concept.

CBTC signaling is currently standardized in accordance with IEEE 1474.1 and has become the reference technology for metro operators worldwide. IEEE defines CBTC as a continuous automatic train control system utilizing High-resolution train location determination, which is mainly used for the PTC systems, may work in either dark territory or signaled territory.

REFERENCES

long ranging from thousands to millions of kilometers for deep-space radio communications. Integrating artificial systems, computational experiments, and parallel execution (ACP) is an effective approach to modeling, simulating, and intervening real complex systems. Moreover, due to the available commercial off-the-shelf equipment, wireless local area networks (WLANs) are often adopted as the main method of train-ground communications for CBTC systems. However, most of the current IEEE 802.11 WLAN standards were not originally designed for the high-speed environment in tunnels [4].

**FUTURE WORK**

The main concept in PTC (as defined for North American Class I freight railroads) is that the train receives information about its location and where it is allowed to safely travel, also known as movement authorities. Equipment on board the train then enforces this, preventing unsafe movement. PTC systems may work in either dark territory or signaled territory, and may use GPS navigation to track train movements. Various other benefits are sometimes associated with PTC such as increased fuel efficiency or locomotive diagnostics; these are benefits that can be achieved by having a wireless data system to transmit the information, whether it is for PTC or other applications.


