

ESERT - THE COMPLETE SYSTEM DESIGN TO MAKE RAILWAY TRAFFIC EFFECTIVE, SAFER AND EASIER, USING WIRELESS COMMUNICATION AND WEB USER INTERFACE

ESERT STANDS FOR EFFECTIVE, SAFER AND EASIER FOR RAILWAY TRAFFIC

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Abstract

This proposal aims to develop complete system design for railways. It will focus to develop an Effective, Safer and Easier method to resolve Railway traffic issues. This simple method of continuous monitoring and assessment of the condition of the rail tracks can prevent major disasters and save valuable human spirits. Our system process is able to get attentive the train in case of any dislocations in the track, avert the collision of the train with train or other vehicle/mankind trying to moving across the level crossing. To accomplish this it uses wireless technology based Real time system with Web user interface.

Keywords: Vibration sensors, Zigbee, PIC microcontroller, Level Crossing, DC motor, Railway Gate.

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1. INTRODUCTION

Travel is fascinating, of them train travel is more exciting. With the increased comfort levels in train transport and traffic in trains we are in an extremely important situation to improve the safety concerns in the train travel. This paper explores the possible ways of increasing train track safety using monitoring system based on Web server and wireless technology.

History shows that many train accidents have occurred because of track failure or management failure. India with its increased technological inputs is in a critical situation to counter or opposing this problem. Emulating the previous human based erroneous and procedural system where track monitoring is done twice in a year, our dynamic technology will permit the trains to run safely. The previous system had only track monitoring and no onboard transformation of the data dynamically, but this paper proves its worth by providing solutions for the same. ESERT system is cost worth systems and on implementation can earn the excellent results.

The study of this design introduces the basic modules which contribute the track safety and management via Real time system implementation contains Web User Interface, firmware algorithms and embedded modules development. ESERT design process is able to get attentive the train in case of any dislocations in the track. Also it can avert the collision of the train with other or with the vehicle trying to moving across the unmanned level crossing. This system helps users to know the distance of the train in unguarded level crossings. Usually in unguarded railway crossings,

peoples cross the track without knowing whether train is coming or not. So many accidents happen. To avoid such a situation, this project will be very helpful. It consists of a vibration sensor in the railway track. In each and every unguarded level crossing, there is a display and a siren arrangement with gate mechanism. When the train is coming over the track, a vibration is produced in the track. The sensor connected near the unguarded level crossing senses the vibration. The vibration will be increased when the train comes very near to the sensor and decreased when the train is away from the sensor. The signal from the sensor is given to a microcontroller. The microcontroller converts the analogue signal to digital signal and according to the signal, it sends signal to the display, gate control machine and siren. Thus the user can easily know the distance of the train and will be alert. This system also consist railway gates for safety at the rail road crossing. The railway gates were closed automatically at the time of train arriving for road traffic user and gates are opened automatically at the time of departure of train for road user. This proposal of railway protection system consists of a micro controller and full duplex Zigbee based data communication system which performs round-the-clock to avert the train accidents at all the possible situations specified above. The entire arranged networks subsist of two network modules, and they are, the sensor organization system and the wireless organization system. Sensor organization system supervises the rail tracks and the information is collected in server at the regular interval. This information can be displayed via Web-UI and can used to send signal to perform required action like gate open or close, the alert signal, siren on/off, send

alert to train driver etc and hence prevent from any calamity or disaster. Hence, the project increases the safety in railway association and rescue many human life and tract or property. The complete arranged system has been designed simulated by using simulation software and implemented.

2. BLOCK DIAGRAM

In project the entire system can be classified into two Parts.

- Server module
- Remote-module.

2.1 Server Module

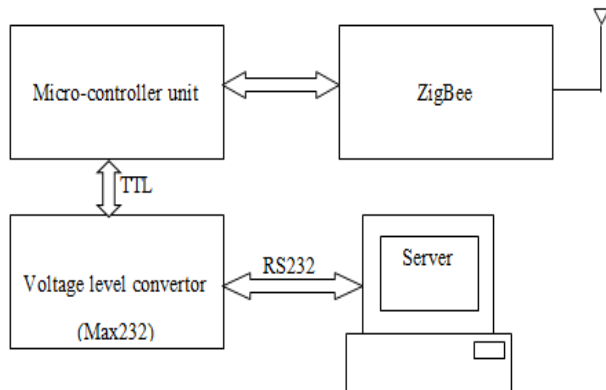


Fig1: Server module.

The Server module have database, where multiple management information's are saved. It consists of Zigbee transceiver, a microcontroller unit and the Server with software and database management. The usage of database management system is to process the data which is received from other subunit in the system and propagates it to the remainder of the subunit. The database gathers all the information in the course format of data frame. The motor driving module consists of Opto-coupler, and dual full bridge motor driver IC. The function of an opto-coupler is to block high voltage pulses affecting the system in receiving a signal from alternative unit. The role task of Driver unit in motor driving module is to close and open the gates at the time of arriving and departure of trains. Stepper motor operates the gates automatically when it is rotated clockwise or anticlockwise direction when the train arrives in specific authoritative direction. The arriving sensor senses the vibration and generates a signal. Simultaneously, the receiver point receives the signal and interrupt signal is generated. When the interrupt is generated the stepper motors rotate in clockwise direction and when interrupt ends the stepper motor rotates in anticlockwise direction.

2.2 Remote Module:-

There are multiple Remote modules and in each module contains vibration sensor, microcontroller and zigbee transceiver. The vibration sensor and zigbee transceiver interface with microcontroller to sense train arrival or departure and send the respected information to server module. There is multiple Remote modules place at the railway line crossing side, at signal post and at train side which can communicate and controlled by server module.

2.2. System at train side:-

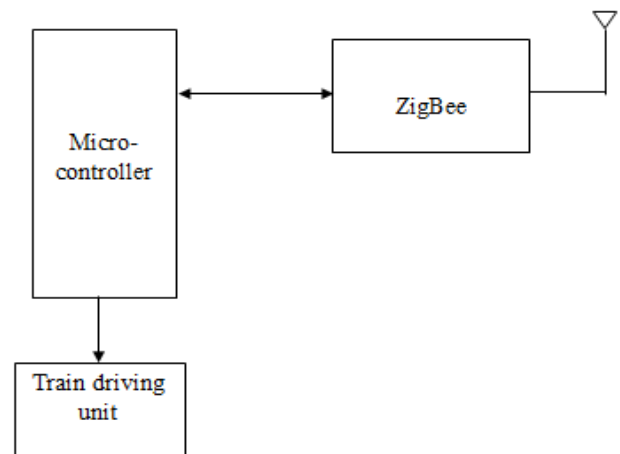


Fig2: Subunit at train

The sub module to be allocated in the train has a Zigbee module, microcontroller unit, train driving unit and necessary power supply. Fundamentally a train sub module is a receiving unit and the role task of this sub module in the train is to active the driver in case of any emergency. The train driving unit keeps commands on the brakes. In case of endangered collision, emergency brake system gets active and train will stopped. Zigbee module transmits and receives the data continuously at regular time interval. Train Sub module store the information in form of packets and these packets contain information such as track identification number TIN, moving direction of train, train identification number etc. The packets are received from railroad crossing remote module and these packets are monitored continuously in fixed time interval. This sub module communicates with the control room before the train starts from its starting point and feeds the track identification, TIN, starting or outset point and destination or terminal point etc. to the train sub module.

2.3 System At Rail Road Crossing Side:-

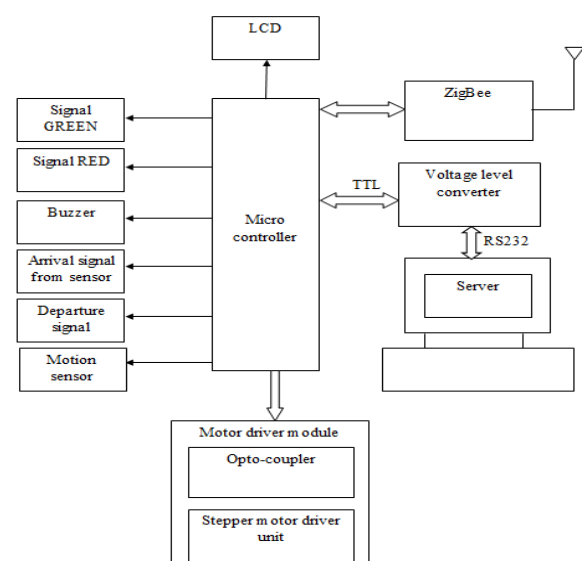


Fig3: System at level crossing side

The railroad crossing sub module has a Zigbee, micro-controller, LCD, buzzer, traffic light signal, vibration sensor, motion sensor, local server, motor driver module and necessary power supply. Railroad crossing remote module consists of 3 sections: - control centre module, signal post module and motor driver module. The rail road crossing sub module continuously checks the status of arriving trains. When the train about to reach before railroad crossing 5 km distance apart. The buzzer and display unit gets active by which road user receives signal of train arriving.

When a train is about to reach a station the train remote module and control station module communicates. The train transmits the authorized information to the control station simultaneously the LCD displays the information of the incoming train. Motion sensor is used to detect the movements on the railway track and send the signal to the microcontroller continuously in particular time interval. Microcontroller receives signal from motion sensor (PIR sensor) in fixed interval. Microcontroller activates the PIR sensor and receiving the signal of movement at the railway track in fixed interval.

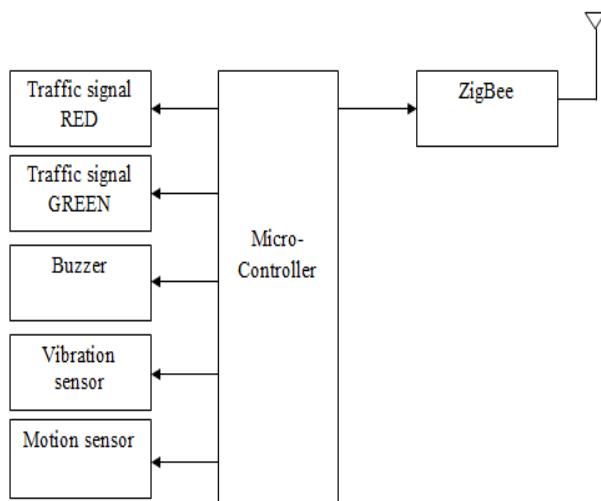


Fig4: subunit in signal post

The module in signal post consists of microcontroller, Zigbee module, traffic light signal, buzzer and necessary power supply unit. The purpose of the module along the signal post side is to send data based on color of present light at the signal station. If red light signal is ON then the module will send the data to stop the train and if green light signal is ON it sends the data to pass the train from crossing. The vibration sensor detects the abnormal vibration whenever any vibration comes it tries to communicate with the train otherwise, this module identify it as an abnormal vibration. This information passes to the nearby station using ad-hoc network approach. The module at station side passes this information with actual position to the main control room or server.

3. WORKING

The complete system is designed to make railway traffic effective, safer, easier using wireless communication and web user interface. Our design helps to save the human life

from accidents by using automatic system than manually. The fundamental objective of design is to set up an embedded system which is used to archive the location of the train by which the railway accidents get avoided and gather other management information's. It constructs an unit for monitoring constantly and assesses the situated location of train, train ID, and track ID.

Our proposed system was classified in two parts: first one is server module and another one is remote module. In server module consist of zigbee transceiver, a microcontroller unit and the server with software and database management. The database management stores all important information's and related to railway and process the data which is received from other subunit in the system. There are multiple remote modules placed at the railway line crossing side, at signal post, and at the train side which can communicate and controlled by server module.

3.1 Detection Mechanism:

In this section arrival of train and departure of train from level crossing, and if there is any crack or any obstacle is present on track side is detected. The detection mechanism was done through a sensor network. The sensor network placed at regular interval for sense the arrival and departure. The group of sensor consists of vibration sensor which is placed before and after the level crossing. The vibration sensor senses the vibration of the track and activates the sensor network. The sensor placed on either side of the tracks and collects the existing details of the track and output of which are fed to the microcontroller through a operational amplifier. The sensor places before level crossing detects the arriving signal of train and the sensor placed after the level crossing detects the departure signal of the train, as the microcontroller received the information from the sensor, this signal sense to the level crossing through a wireless network and GATE closes automatically and vice versa done at the of departure of train. If in case of any obstacle is present or any crack is detected on railway track, the sensor gets activate and sends a signal to the microcontroller.

3.2 Transmit Section:

In the transmit section, we use zigbee transceiver. The zigbee transceiver transmits and receives the signal in system by which wireless communication is done between remote module and sensor module. Here two zigbee transceiver are used. One zigbee transceiver placed before the level crossing and second is after the level crossing. The sensor network send arriving signal of train to crossing side through zigbee transmitter and departure signal of train to crossing for closing and opening the gate from before and after level crossing side. Zigbee transceiver work as a zigbee transmitter at transmit end and as a zigbee receiver at receiving end. One sensor placed before the level crossing, senses the vibration and sends the arriving signal of train to the level crossing side through a zigbee transmitter and arriving signal receives at the crossing side, and gate starts closing and buzzer get on for alerting the crossing person from railway track.

3.3 Receiver section:

The signal received by zigbee receiver is fed to the receiver section. Zigbee transceiver is used as a receiver. Zigbee transceiver communicates in wireless network. The zigbee receiver receives the departure signal of train and gate will open for the crossing person at crossing. The zigbee receiver receives a signal from the transmitting end of the transmitter section.

3.4 Gate closing mechanism:

The gate closing mechanism is divided in two sections: first section deals with the opto coupler circuit and second section deals with stepper motor driver circuit. The opto coupler unit coupling an optical signal and drives the circuit to operate the stepper motor in forward direction in orders to close the gate when a arriving signal is received from zigbee transceiver. When zigbee transceiver receives a reverse command to issue drive motor in reverse direction to open the gate. Thus the opto coupler circuit receives the input from the receiver and generates forward and reverse commands, which are to be issued to motor drive circuit. The drive circuit generates a particular phase sequence Needed to drive the motor and for this purpose, an oscillator is needed to be included in drive circuit. The direction of rotation of motor can be reversed by reversing the phase sequence. The control logic controls the phase sequence in order to change the direction of rotation of the motor. The stepper motor drive circuit is mechanically coupled to open and close the gate arms, depending on phase sequence received from drive card.

3.5 stepper motor drive circuit:

The stepper motor is used to open and close the gate automatically when it is rotated in clockwise direction or in anticlockwise direction. When the train arrives in a particular direction the transmitter section senses and generates appropriate signal, then at the same time the receiver section receives the signal and generate an interrupt. When the interrupt is generated stepper motor rotates in clockwise direction. When interrupt ends the stepper motor rotates in anticlockwise direction.

4. BASIC FLOW OF DESIGN

4.1 Receiving data at railway crossing:

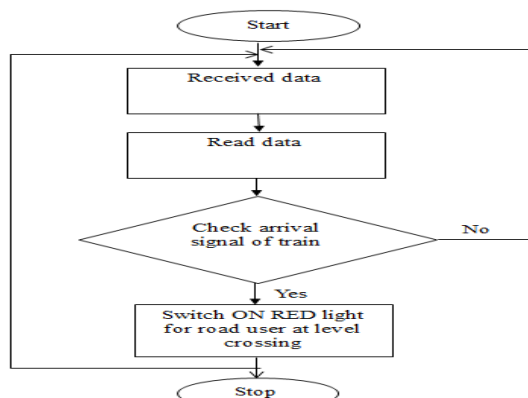


Fig 5: flow of receiving data at railway crossing

In receiving section at Railway Crossing the data are received which are transmitted by other subunits in RCPS Network. The data are received related to arriving, departure of train and related to other critical situation in case of any emergency is present. The received data was read by a microcontroller unit and check that data. If received data was of arriving train signal, then the warning system get active and red light get switch ON for the traffic road user. Simultaneously, gate start closing for road user and green get switch ON for train if there is no obstacle is present.

4.2 Sending Data from Level Crossing:

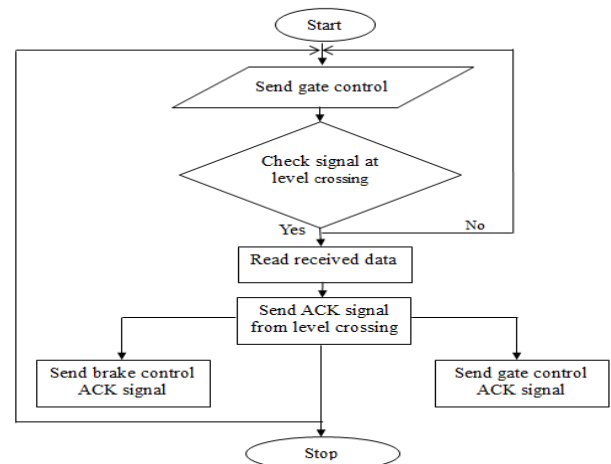


Fig 6: Flow of Sending data from level crossing

In sending section from railway crossing the control signal was transmit for controlling the speed of train due to presence of railway crossing after little distance. The signal received was checked and read by microcontroller unit. If data received from railway crossing was brake control signal then the red light get switch ON for train and if data received from railway crossing was gate closed signal then the red light get switch ON for the traffic road user and train get pass successfully from the railway crossing.

4.3 Primary Task

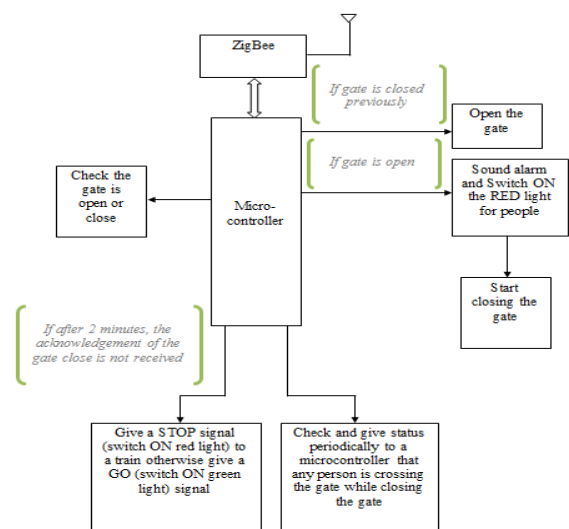


Fig 7: Block diagram of working of zigbee at railway crossing

This section describes flow of proposed design. Vibratin sensor senses the vibration in tracks and if those vibrations caused due to train arriving then this section transmits the arriving signal of train to the microcontroller unit; otherwise, sensor detects this as a abnormal vibration. A microcontroller unit reads this information and transmits it to the railway crossing subunit. Railway crossing subunit check the status of the railway and if gate is open then the warning system get active, sounds the buzzer and red light get ON for the traffic road user and simultaneously also start closing the gate. The status of railway gates was checked periodically as a loop for 2 minutes to check any road user are passing from railway gate or not. The status checked periodically for 2 min, if the railway gate closed signal is not received then the red light switch ON for train and emergency brake system get active for stop the train otherwise green light get switch ON for the train and train get pass over the railway crossing.

4.4 Flow Chart Design

Fig shows the basic flow design of system design.

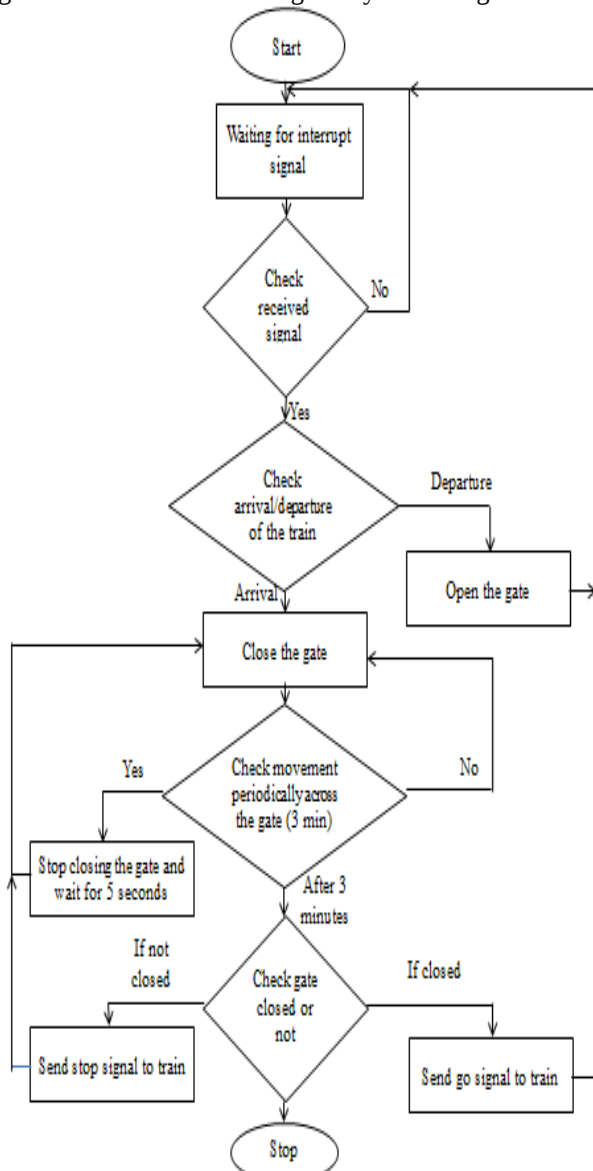


Fig 8: Flowchart of System Design

5. ARCHITECTURE

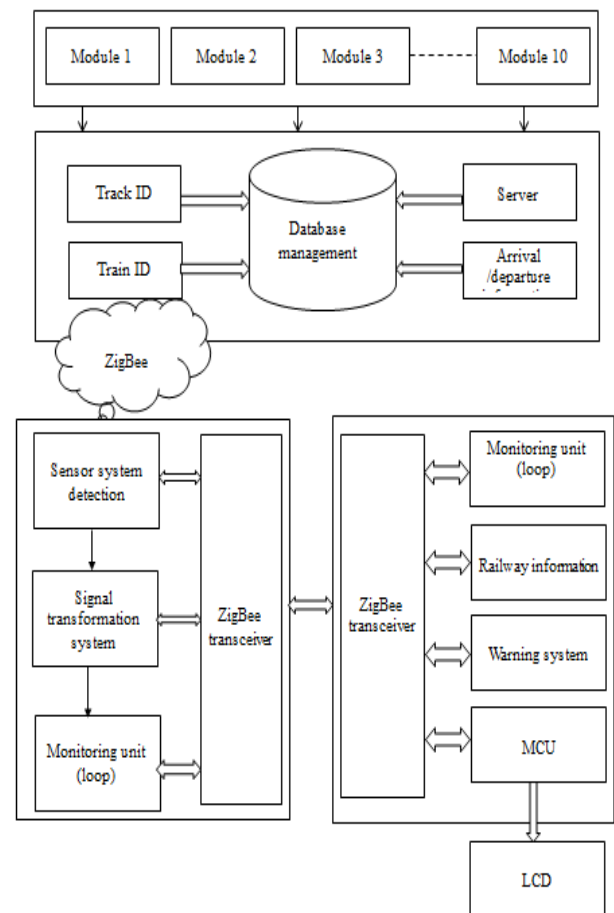


Fig 9: system architecture.

System Design

The architecture and flow diagram gives the overall system model. The main components of the system are Hardware, software, HTML Pages, and Transfer of Data.

6. CONCLUSION

The complete system is designed to make railway traffic effective, safer, easier using wireless communication and web user interface. The fundamental objective of design is to set up an embedded system which is used to archive the location of the train by which the railway accidents get avoided and gather other management information's. The advantage of this project is that human error is eliminated and controlling of the accidents at the unmanned railway crossing due to which we can able to avoid manual error and provide ultimate safety to the road users. So there is no need of any railway staff member for opening and closing of gate at the time of arrival and departure of train. The gates at railway crossing are operated automatically with the help of sensor technology by using stepper motor on gates. It uses the advanced features of PIC microcontroller with vibration sensor and zigbee communication techniques. Collision avoidance systems are especially useful in bad weather conditions. This design detects the railway line crossings for the safety of life and land. The accurate combo of latest information and communication technologies can provide a

successful and practical solution for the requirement of an authentic and accurate train tracking system to improve the efficiency and productivity of Indian Railways. Hence it is expected that, major train accident problem can be prevented and human life saved if this system is implemented.

6.1 Advantages

- Our system reduces the manual work or effort.
- Our system reduces the manufacturing lead time.
- High accurate.
- More efficient.
- Compact.
- Reliable.
- Accident avoidance.
- Human resources.
- Safety and quality of services.
- Avoid accidents at railway crossing.

6.2 Disadvantages

- Electronic system may be failure at any time.

- It is not applicable for ac motor.
- Maintenance cost is high.

7. FUTURE SCOPE

This project can be extended for the communication between the engine driver and officials when the train encounters a technical fault. Based on this we can also install, train protection system throughout the railway track, so the train accidents can be avoided.

RESULT

Our proposed model improves the railway security system due to which railway accidents can be controlled. Automatic train traffic controlling can be done by using vibration sensor, Zigbee module, PIC microcontroller and Web server. This proposed concept can be implemented for reducing human error, human efforts and save human lives. So this project provides safety to the railway passengers and road users. The communication can be done between train and crossing gate by using Zigbee module by which accidents can be reduced.

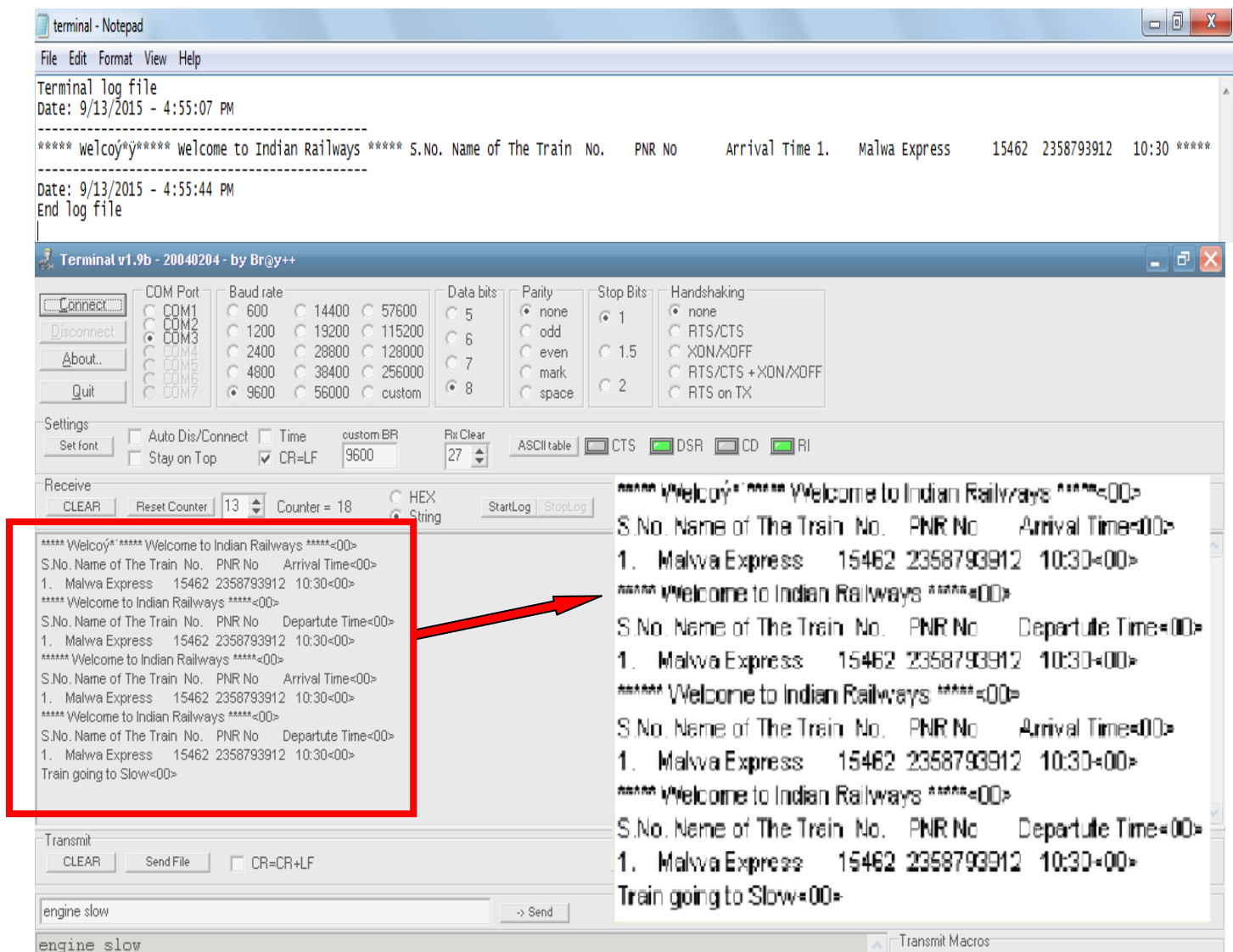


Fig 10: Result shown on Terminal

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The material available with the listed reference books has a significant impact on this paper. We gratefully thank to the authors and publication of these reference books

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BIOGRAPHIES



Mrs. Heena Jain is pursuing M.E in Embedded System & VLSI Design and B.E in Electronics & communication. Attended an International Conference on Emerging Trends in Instrumentation, Communication and Electronics and Electrical (ICE-ICEE) 2014 and workshop on MSP430 by Texas Instruments at SVITS, Indore, Madhya Pradesh, India. Her research interest includes Embedded Systems.



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