An Innovative Design Initiative for Preventing And Or Interrupting Carnage during Surface Transportation.

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Abstract:- Adequate and coordinated consideration of safety integration issues, by both the Board and the Local Railroad Administration, are responsible for the enforcement of railroad safety and its implementation.Members of the Surface Transportation Technical Group recognize that the human operator is an integral component of a *system* comprised of the operator, the surface vehicle, and the environment. Therefore, the same effort that goes into designing and developing the vehicle and its infrastructure must be put into optimizing the behaviour and performance of the operator. As the performance capabilities of ground and rail, based vehicles become more advanced, accompanied by equal advances in the complexity of the operating environments, we must ensure that vehicle handlers are able to perform their tasks with minimal errors and maximum comfort. Adopting a systems approach to surface transportation security, including an understanding of the surface transportation sector as a complex, interconnected system of networks and functions is mandatory. It is critical to recognize the security measures currently in place to determine a strategic path forward for addressing the Nation's surface transportation security [2]. This paper presents a system to upgrade existing Security monitoring systems in the trains. The goal is to design and implement a cost effective and intelligent full-fledged microcontroller and wireless based system to save the lives of the passengers in a running train. This is very low cost solution as no change is necessary to be made to the infrastructure of the existing system. Key to success, however, still lies in the in the method to send distress signal to the person in charge with pin point accuracy and speed by using available robust and state of the art technology like ZigBee replacing age old conventional chain pulling systems[ACP]. This project uses ZigBee pro, communicating easily over 2 miles of outdoor and being interfaced with 8051 microcontroller kit and LCD display can process and communicate distress signals at great speed and accuracy, needed for safety of the passengers[at the flick of a button]. This is economically feasible in contrast to that using Wi-Fi system. Main purpose of this project is to install these modules in a train to save the lives of the passengers on moving train and to make safety and happy journey for the passengers.

I.INTRODUCTION

Improvements in security activities and coordination are needed to effectively reduce and manage risk and enhance security within surface transportation. Inability to apply an integrated systems management approach to assessing risk and improving security and resilience is short-sighted and does not fully account for a networked surface transportation system existing in our country. Using intelligence to identify potential threats by employing programs and procedures that allow for better identification and interdiction of threats prior to their arrival. Engaging system operators in intelligence sharing, security planning, and operations is required ensuring that key transportation workers are vetted. Increasing frontline worker and public security awareness; creating a more stringent, less opportunistic environment for terrorist attack [1] planning (e.g., non-intrusive inspection devices, canine teams, random bag checks, etc.) and counter-surveillance; changing operations to reduce vulnerabilities and potential consequences and to thwart attempts to circumvent security measures; hardening critical infrastructure (e.g., intrusion detection, facility hardening, smart Surveillance) and common operating picture development and improving general efficiency are some of the essential key measures to be put in place.

In the extreme cases of emergencies like fire, dacoity and the other forms of organised crimes, passengers travelling in high speed trains are really helpless on two grounds. One they are unable to locate /actuate the alarm during near stampede situations [during a fire hazard] as shown in the figure-1, or are rendered motionless due to mortal fear. Even if somebody gathers courage /chance to actuate the alarm, the motorman only stops the train to investigate the cause and its location by an elaborate search operation. By the time anybody checks in the compartment of distress, most of the damages are already done and the dacoits will

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get the opportunity to dismount and disappear easily from the scene of the crime. Irate passengers will wait for the train to reach the next station only to surround the Station Master as shown in the figure-2. By using ZigBee communication at 2.4GHz, situations could be handled in a better way even if the train speeds through a tunnel as shown in the figuure-3. Method will be clear as this paper sequences through.

Figure-1: Fire in an AC Coach. Coursey-Google.com

Figure-2: Tanusree Sil recounts at Howrah station how a robber held a pistol to her head. Picture by Gopal Senapati.Courtsey-Telegraph-Dec-20, 2013

Figure-3: Tunnel of Pir Panjal in J.K, Courtesy - Google.com

II.SYSTEM APPROACH

As shown in the figure -4, a train can be considered as a cluster of a number of microcontroller cards housing communication program and ZigBee-Pro unit fitted with each card, which can operate as a self contained trans-

receiver unit powered by the 135Volt AC power source of the compartment and an additional arrangement for standby operation with battery bank beneath the carriage. The arrangement looks like that shown in the figure -5 below.

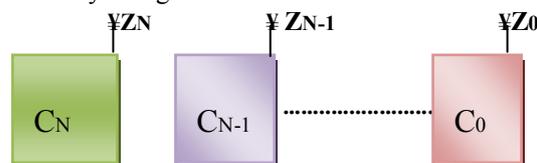Figure-4: A train moving over an embankment. Courtsey-Google.com

Figure-5: ZigBee configurations in different compartments.
ZigBee module with the microwave antenna is to be fitted on the top left on the rear side of each compartment for free space instant communication.

III.ZIGBEE TECHNOLOGY

ZigBee is the name of a specification for a suite of high level communication protocol using small, low power digital radios based on the IEEE 802.15.4 standard for wireless personal area networks (WPANs) [4]. The technology is intended to be simpler and less expensive than other WPANs, such as Bluetooth. ZigBee is used for radio-frequency (RF) applications that require a low data rate, long battery life, and secure networking. ZigBee is a wireless mesh networking standard. The low cost allows the technology to be widely deployed in wireless control and monitoring applications, where as the low power-usage allows longer life with smaller batteries, and the mesh networking provides high reliability and larger range of communication[4]. The ZigBee Alliance is a standard body defining ZigBee operational protocols. ZigBee operates in the industrial, scientific and medical (ISM) radio bands- 868 MHz in Europe, 915 MHz in countries such as USA and Australia, and 2.4 GHz ISM band in most other jurisdictions worldwide. Compared to existing wireless protocols like Bluetooth, and Wi-Fi ZigBee is more advantageous as we can get a communication range up to 1.6 km. ZigBee has excellent security features as encryption is used. Different topologies can be implemented with ZigBee protocol including mesh topology, peer to peer shown in figure-6. The ZigBee specification identifies three kinds of devices that incorporate ZigBee radios, with all three found in a typical ZigBee Network are given below.
1. **Coordinator**, which organizes the network and maintains routing, tables.
2. **Routers**, which can talk to the coordinator, to other routers, and to reduced function end devices

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3. **Reduced function end devices**, which can talk to routers and the coordinator, but not to each other [6].
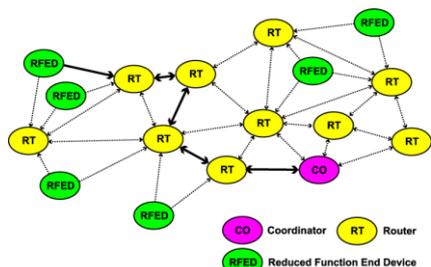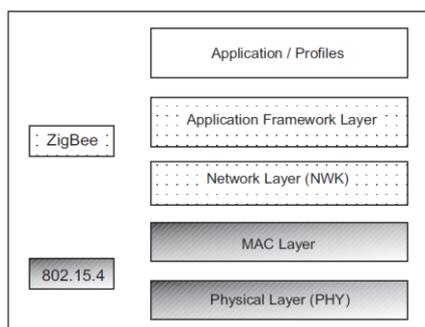

Figure-6: ZigBee Mesh Network [6]

Figure-7: ZigBee stack[5]

ZigBee is built on top of the IEEE 802.15.4 standard. ZigBee provides routing and multi-hop functions to the packet-based radio protocol. It is the foundation on which ZigBee is built. Figure-7 Shows a simplified ZigBee stack, which includes the two layers, specified by 802.15.4 the Physical (PHY) and MAC layers [5].

IV.MICROCONTROLLER

A microcontroller incorporates all the features that are found in microprocessor. The microcontroller has built in ROM, RAM, Input Output ports, Serial Port, timers, interrupts and clock circuit [7]. A microcontroller is an entire computer manufactured on a single chip. Microcontrollers are usually dedicated devices embedded within an application. It is very difficult to disable [by miscreants] an in-built digital communication by the microcontroller activated by a quick feather touch on an illuminated switch, since it is inaccessible .It works silently, instantaneously and decisively and in error free manner.P89C51RD2BN Philips made 8-bit microcontroller, because of its CMOS design and wide voltage operation, is useful for battery and AC power operations for a long time. It is best suited for the existing electrical setups of MEMUs/DEMUs. Its powerful instruction repertoire provides true flexibility in designing compact error free communication subroutines for this demanding environment. Its open architecture and bit processing capability greatly help bit-string manipulations [3]. This controller board is very versatile and operable from the lead acid batteries placed at the bottom of the carriage. Unique open ended architecture of the microcontroller P89C51RD2BN make this controller board very effective for networked operation for a long time without system chaos. Key board and LCD display allow inputting of user data and debugging of new programs and attachment interfacing [3].

V.DESIGN CONCEPTS

Proposed model consists of minimum two numbers of microcontroller boards interfaced with LCD, some low profile switches and a ZigBee module in each facilitating data communication, as shown in the figure-8 for enhancing the safety of the passengers by averting if not interrupting tragedies inside speeding carriages. These self sufficient microcontroller boards housing ZigBee act like individual trans-receiver modules and these modules can be installed in each and every compartment including the engine of the train. So that during emergency passengers can press one switch according to their needs and the corresponding message will be displayed in each and every compartment including the engine of a train. Then it becomes clear for all passengers- what happened and the necessary helps can be mobilized in no time.
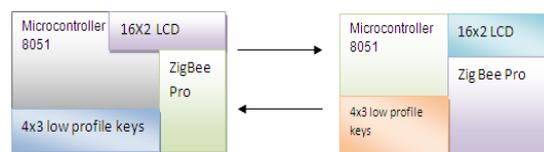

Figure-8: shows two almost identical modules capable alternate SEND RRECEIVE modes of operation by program and key board initiation through ZigBee communication
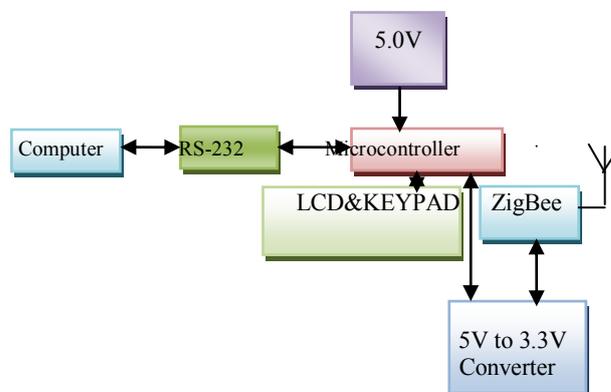
VI.HARDWARE

Figure-9: Block Diagram of the individual trans-receiver unit during development.

Figure-10 Shows the interface of ZigBee with microcontroller. The ZigBee modules works at the 2.4 GHz frequency which means smaller embedded board and antenna in size. ZigBee modules have the ability to transmit Digital, PWM, Analog or Serial RS232 signals wirelessly. For interfacing 8051 with a ZigBee we just need the TxD, RxD, GND and Vcc connections. Data communication is possible by using the ZigBee module digital data directly into the SBUF register of 8051 microcontroller as shown in figure-10. +5V and ground is connected to provide power to the module. While TX and RX pin is connected for communication.ZigBee is mainly working in the mesh topology.
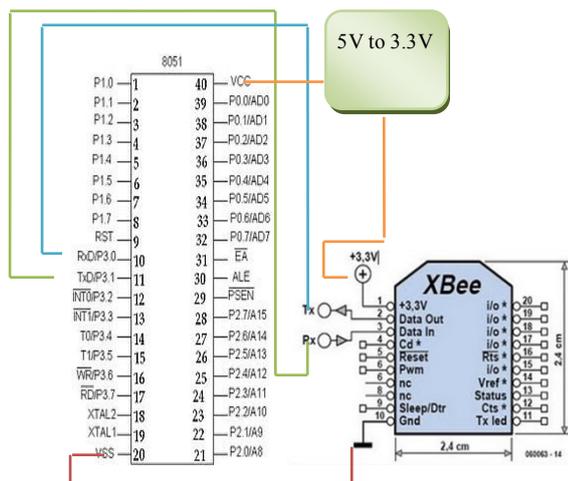
Figure-10: Circuit Diagram of the Proposed System

To establish a mesh topology in railway network using ZigBee Communication is also a very challenging and purposeful application. For constructing such kind of network, self-contained microcontroller board interfacing with ZigBee module, LCD, and some illuminated switches, is placed in each and every compartment including the Engine of the train in distributed manner near passenger berths as shown in the figure-11. Components of communication hardware are shown in the figure-12.

Figure-11: Emergency switches are located near the berths of the passengers.
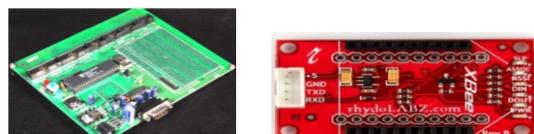
(a) Microcontroller board   (b) ZigBee Board [8]
Figure-12: Communication hardware.

VII.COMMUNICATION AND CONTROL

Otherwise peaceful and comfortable journey of the passengers of a high speed train can suddenly turn out to be a miserable one when the just joined passengers flash out a gun and start demanding money and jewellery or smokes bellows out from the adjacent joints of the carriage. In this case any passenger can push the right kind of feather touch switch to inform the motorman and passengers of all other compartments about the danger within split second and with deadly accuracy. Microcontroller senses the switch closure and relays the information through the ZigBee to all the compartments including Driver and the TTE. Motorman of the speeding train accesses the situation quickly and starts acting correctly in the present circumstances and sends armed personnel the scene of the crime through the common corridor in case of robbery.

Microcontroller board senses the keys all the time till a valid key closure is identified; it then sends a character string to all the other controllers in the vicinity through its own ZigBee and informs the exact danger and location by the sent information packet. Other microcontrollers receive these packets to decode the danger massage and location of it for its own in-house display. Controller in the driver's cabin will facilitate to inform the sender that the message is received and help is on its way through a keypad initiation to the great relief of the passengers in distress. Motor man will then start multiple activities like speeding/breaking the train, asking for further help and reinforcements from the nearest centres to ensure a tragedy interruption if not averted fully.
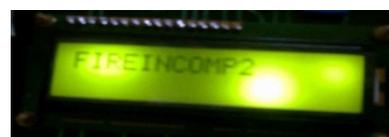
(a) Message received in the driver,s cabin
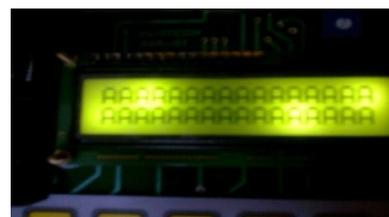
(b) Test message sent to the caller
Fuger-13:Typical interchange of test messages.

Figure -13 shows how messages are echoed back to the distressed caller from the motorman's cabin. Motor man of the speeding train can send armed force to the distressed compartment through the common corridors from both sides and also initiate rushing of fire extinguishers to the compartment in fire after slamming the break, as the situation warrants.

VIII.SOFTWARE DEVELOPMENT

1. Virtual Programmer. Development microcontroller board is connected to a PC using a serial cable. Program is developed using the development tools and is written into the memory of the microcontroller on the development board. The board has the facility of in-system programming [9]. We can download or erase the program on board without using any programmer device or even without removing the chip from its socket. This will avoid the damage to the chip as well as it will be very easy to proceed on program development. To download the programs to the board a virtual program utility (WINISP) package is pressed into the operation environment. This utility is from Philips and supports a number of on board microcontrollers of the same family. The screen shot in the figure-14 shows the features of the WINISP utility program.
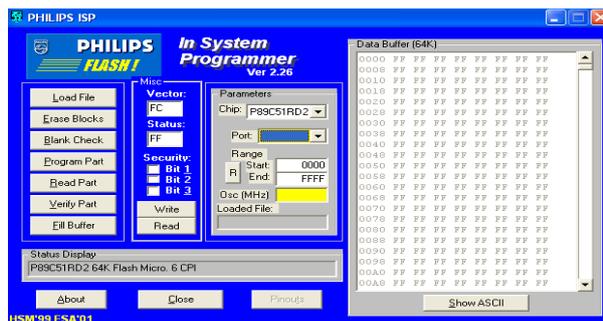
Figure-14: WINISP Screen shot

2. Virtual Programming Builder (VPB)

This is a software tool which provides facility to write a program in assembly language. Programming was decided to be written in the assembly language. This enabled us to write compact general purpose and multiple nestable programs for efficient utilization of memory space. Integrating various utility modules in future will become easy. This package converts assembly language program in hex codes which can be loaded into the development board using WINISP that creates four types of files on assembly programs these are .HEX files, .BIN files, .ASM files and .PRN files. The screen shot of the VPB software is shown in the figure.-15 below.
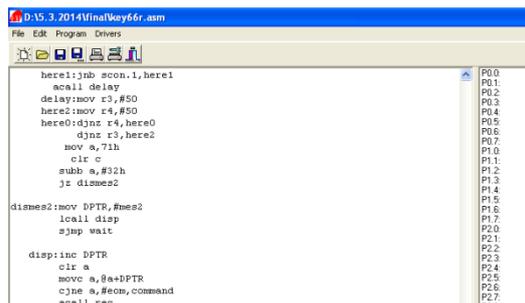

Figure-15: Program development screen in VPB

IX.TEST METHODOLOGY

1. Two wire communication.

Before interfacing ZigBee modules with two microcontroller development boards we have configured them as two trans-receiver units communicating through two wire connections. While the serial transmission program was being put in endless loop, a serial pulse train for transmission and reception of a specific ASCII character was visible on a CRO screen and also the ASCII character is display on the LCD whenever the respective switch will be pressed as shown in the figure-16 and Figure-17 below. Here CRO is used for testing purpose for ensuring that the boards are able to transmit and receive various ASCII characters accurately .For example after pressing the right switch of board-1, it is able to transmit and display an ASCII character A. After receiving A, the board-2 will transmit another ASCII character say U when the required key switch is pressed on the board in question.

2. ZigBee communication.

Two microcontroller boards tested [as above] with the programs loaded in the memory of 8051 were interfaced with the ZigBee modules with appropriate connections of TxD ,RxD, Vcc and Ground as shown in the Figure-10 and switched on to establish wireless communication between them. Wireless communication is the fastest and safest way of communication unlike wire connections which are susceptible to EMI present in the electrical wirings of MEMU and DEMUs. ZigBee option is low cost technology and can be consider as a mini WI-FI connectivity without massive infrastructural investments.

Figure-16: Two development boards in wired communication

(a)   (b)
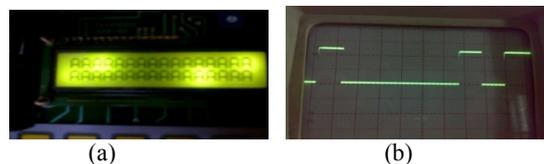
(a) Eco from reception after transmission (b) Pulse shape of transmitted character.
Figure-17: Message and pulse shape during continuous transmission and reception.

(a) Two test boards interfaced with ZigBee are communicating (Photocopy of Actual Design Circuit)

(b) Communicating ZigBees are placed side by side
Figure-18: Showing ZigBee setups during communication
Figure-18 shows how the boards were initialised into a closed loop communications in the laboratory.

X.TEST RESULTS

ZigBee communications were carried out in different laboratory set ups and with different personnel including corridors for ascertaining the effect of environment on secured ZigBee communications. Results are summarised on the table-I below.

Table-I Test Results

Serial No.	Distance(Indoor Range)	Laboratory	Observations
1.	7 meters	Solid state lab	Properly Receive and Transmit Data
2.	11meters	Solid state and Digital Lab	Send –Receive Ok through the glass panel.
3.	16 meters	Basic Lab	Working Properly
4.	35 meters	Corridor	Working Properly.

Prototypes are developed successfully and are awaiting field trials and testing in MEMUS/DEMUs.

Figure-19: Covering a Range up to 35 Meters in our College Campus Corridor-Block, 2nd floor-ECE Dept.

XI.CONCLUSION

For availing the comfort and benefit of Wi-Fi guided rail, we may have to wait for a decade or more considering the requirement of massive investment in this infrastructure. ZigBee, however, on the other hand, is a low cost option and bring us the benefit of safety by its secure, speedy and accurate communication capability being nearest to Wi-Fi. This project describes in short a sustainable method for uplifting passengers' safety without much Engineering modifications on the existing MEMUs/DEMUs's electrical setups.

The design outlined above will enable us to install these modules in a train to save the lives of the passengers on moving train and to make the travel a ZERO HARM proposition for the vast millions. The security of the women in a moving train can be increased to a point well above the present scenario. Incidence of pick-pocketing, theft or looting etc. will, we believe, drastically come down to a low level when all aspects of security as discussed earlier are put in place.

XII.FUTURE WORK

This project opens up immense possibilities like safety communications, processing of distress signals from vehicles, short robotics movement through ZigBee networks for attending places which are otherwise beyond human access- like chemical warfare zones, nuclear warfare etc This can be commanded and governed successfully in many areas including terrorist activities. This being a low cost solution is very helpful and can be adopted in numerous exploration and mining activities in our country.

XIII.ACKNOWLEDGEMENT

XIV.REFERENCE

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