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Design of Auto Level Crossing and Signal Indicating System

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Abstract*: The main objective of this paper is to overcome the major issues in Indian Railways. In essence to do the project we need to scrutinize the Research papers, newspapers and internet. In that we notice many dreadful rail-road accidents arose in unmanned level crossings which greatly affect the human life and railway infrastructure. This has to be a certain consequence of heedlessness in crossing of railway line, paying less concentration in performing manual operations and availability of less no of workers. Another major issue we come across is in winter season most of the long haul express trains are running late nearly by 6-7 hours due to the obscurity in the visibility of caution signals caused by the dew. In the project period we design an embedded system named "Auto Level Crossing and Signal Indicating System" based on GPS, ZigBee and RF Communication Technologies to counteract the adverse effects of above issues. It is composite structure of two subsystems namely train subsystem and signalling post subsystem. To get the best improvement in solving of above issues is by extreme working capability of GPS module, long distance transmission capability of ZigBee and RF transmitter modules and computer control technology are used in this system, results in providing incredible safety to public by implementing this system in Indian Railways.

Keywords— LPC2148 microcontroller, GPS, ZigBee, Horn, RF communication technology, Train subsystem and Signalling post subsystem.

I. INTRODUCTION

Indian Railways is one of the world's largest railway networks and it is a widest used transport entrance for carrying of goods and passengers at a decent cost to both long and short distances. Although the organisation incorporates with so many advantages, its administration fails to maintain punctuality in running of trains and preferable prevention methods to avoid accidents at rail-road mixings. Level crossings are cardinal death traps of worldwide. By examine the documentation "Rail accidents due to human errors" From Amitabh [1] we find 16% of total railway accidents in India is crossing accidents of which majority occurs at unmanned level crossings. To conquer this problem many sensors based embedded systems are designed and discussed in [2], [3] but their real time implementation rate is vey less. The main explanations are maintenance, sensors activity and their life time, varying nature in working of system due to overheat generation components and less lifetime components.

In general the conspicuous vision of a Loco Pilot is in the range of 500-700 meters, but dew cover on the ground, the perceptibility range is reduced to just 200-300 meters. At that time succeeding the caution order becomes difficult to loco pilot so that he moves the train with a speed of 30-60 kilo meters per hour instead of 90-110 kilo meters per hour. In general based on the relation among constant distance, speed and time trains are late in reaching the destination if they runs with less speed. So the Centre for railway information systems [4] maintains a server in order to know the train location from home by browsing internet

To surpass all the above techniques we design a new system named "Auto level crossing and Signal indicating system" in which location values of level crossings are updated in real time through two-way ZigBee [5]. GPS [6] locator fastened to the top of the train traps the location values of train. The master unit of our system "Microcontroller" replaces the requirement of man source. When the train comes in the range of signal pole the RF transmitter [8] setup on the signal pole communicates with RF receiver [8] in train and gives caution order directly in train with the aid of processing element.

II. OVERALL FRAMEWORK

Fig. 1 shows the Overall Framework of proposed system. The subsystem in train comprises of LPC2148 microcontroller. It embedded several interfaces for connection with serial communication devices like GPS and a two way ZigBee and parallel communication devices like Liquid crystal display, Buzzer and Light emitting diodes. Parallel communication devices present in our project acts as output devices and GPS acts as input device. RF receiver acts as an input device to microcontroller through a serial to parallel decoder. Signalling pole subsystem made up of a voltage regulator, a 12 bit parallel to serial encoder and

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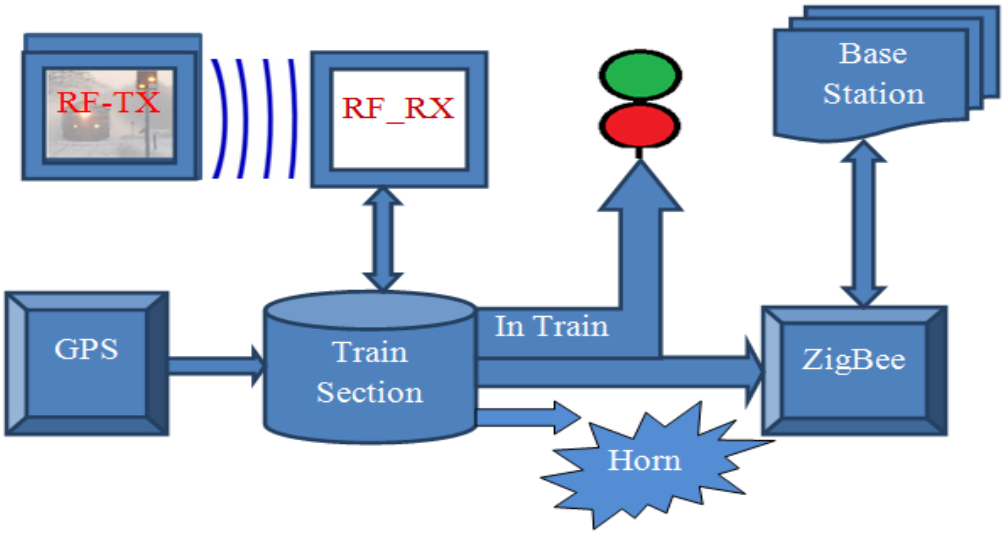

Radio Frequency (RF) transmitter to transmit information at signal poles.

Fig. 1 Overall Framework

A. Subsystem in Train

The train at base station sends the signal to control room requesting for level crossing coordinates with the help of microcontroller through ZigBee communication technology. Later on while train is moving the GPS locator fastened to the top of the train traps the location values of train and sends them to the microcontroller. Then, microcontroller examine the differences between location values of train and the predefine level crossing coordinates using control logic put down in it. If any location coordinates looks almost same then microcontroller sends the signal to blow the train horn. This blowing of train horn continues until the train reaches the end of level crossing there again GPS coordinates looks same with the already defined coordinates so that, the microcontroller again sends the signal to stop the blowing of train horn. According to Federal Rail road Administration the location required to start the blowing of train horn is placed one quarter mile in advance to the level crossing. The microcontroller sends the feedback messages like “Enter into level 1”, “Exited from level 1” to end stations through ZigBee. So it helps in updating the information in internet and also helpful for giving train alerts to people at end stations. This process continues until the train reaches another base station where again the locomotive requests for new level crossings coordinates and the procedure starts again. In this way we maintain a volatile memory for storage of level crossing coordinates from station to station and requests for level crossing coordinates at each base station. The data flow of train subsystem at level crossings is shown in Fig. 3.

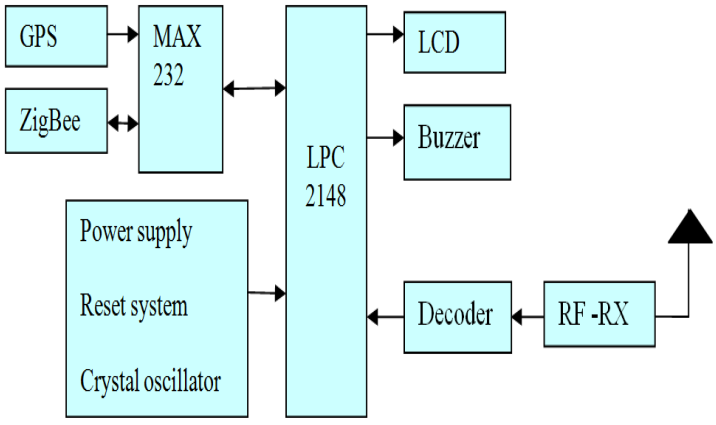

Fig. 2 Block diagram representation of Train subsystem

Volume 3 Issue IV, April 2015
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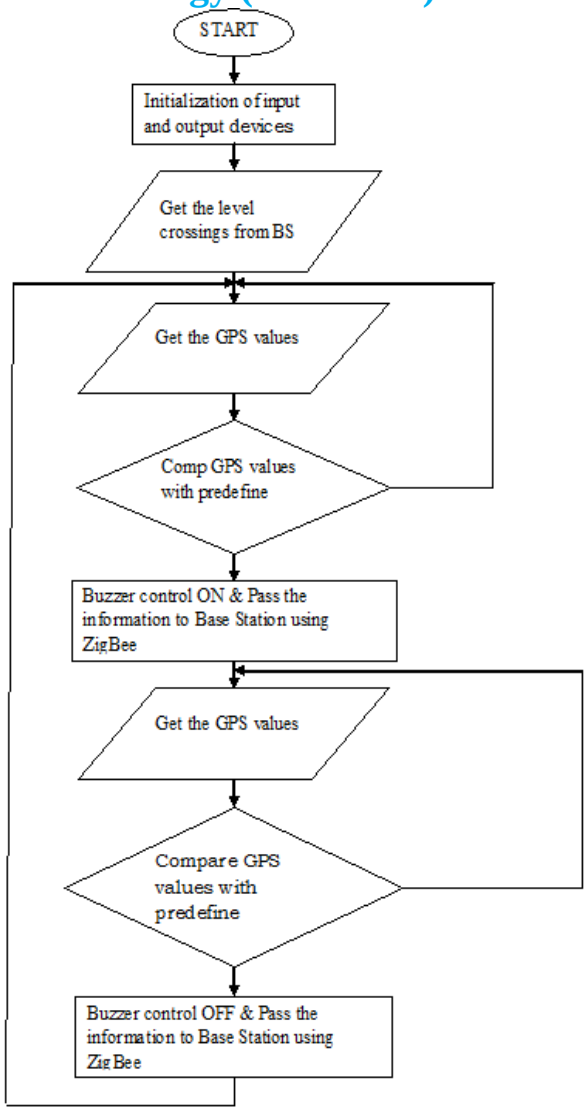

Fig. 3 Flow chart for data flow of train subsystem at level crossings

The RF-RX section in Fig. 2 activates when the train is nearest to signal pole. It receives the signals send by the RF-TX in the distance range of maximum 1km. The RF-RX demodulates the received Amplitude Shift Keying (ASK) signals and sent them to the decoder. The parallel response from decoder is given as input to the microcontroller. The processing element examines differences between decoded data and predefines data using control logic put down in it. If decoded data looks similar with predefined red colour signal coded data, then microcontroller cast a red light into the locomotive or if decoded data looks similar with predefined green colour signal coded data then microcontroller cast a green light into the locomotive. The data flow of train subsystem at signal poles is shown in Fig. 4.

B. Signalling pole subsystem

In the signal poles the power supply required is 12V dc, obtained from 440V ac main supply available at Railway stations. It is converted to 12V dc using step down transformer, rectifiers with filters to pass out the ripple content. This 12V dc is given as supply to the signal pole lights through switches by station masters. From signal poles we further stabilize12V dc to 5V dc using 7805 IC regulator and given as input to encoder. The coded data is modulated using ASK modulator of having carrier frequency 434MHZ and transmitted to free air through antenna. Block diagram representation of signalling pole subsystem is shown in Fig. 5.

Volume 3 Issue IV, April 2015
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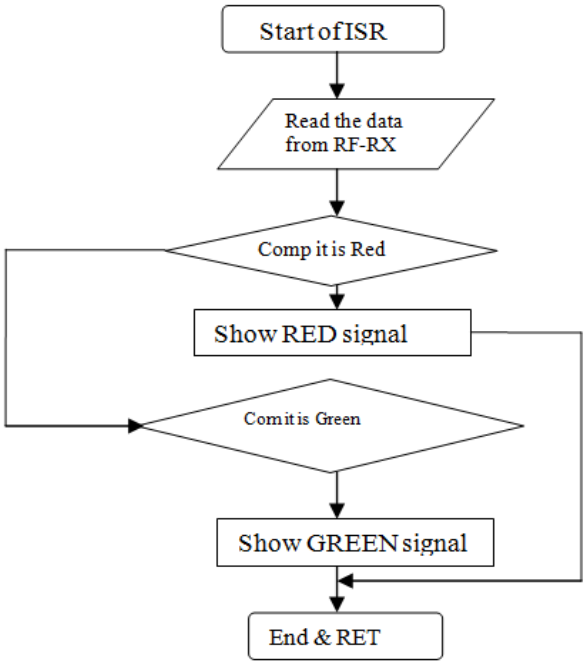

Fig. 4 Flow chart for data flow of train subsystem at signal poles

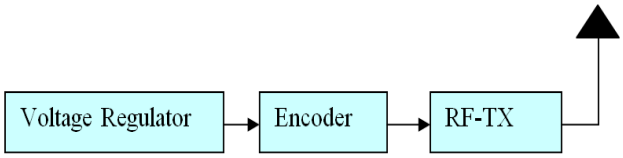

Fig. 5 Block diagram representation of signalling pole subsystem

III. ANALYSIS OF SYSTEM STRUCTURE

A. *Features of LPC2148 Microcontroller*

1) Its native area from 32 bit/16 bit extreme performance ARM7TDMI-S architecture.
2) It is a tiny LQFP64 package.
3) Having memory size of 512KB on-chip Flash ROM with In-System Programming (ISP) and In-Application Programming (IAP) and 40KB of on chip static RAM in that 8KB is accessible to USB by DMA.
4) Vectored Interrupt Controller with adaptability in priorities and vector addresses.
5) Two 10bit ADCs with 14 analog inputs and single DAC with variable analog output.
6) USB 2.0 Full Speed Device Controller with 2KB of end point RAMS.
7) It holds several serial communication interfaces from USB, two UARTs to SPI, SSP and two fast I2C bus.
8) Two 32-bit timers or external event counters.
9) In the total of 64 pins 45 pins are used as fast general purpose input or output pins in that 9 pins are used as edge or level sensitive external pins. By using pin select registers we select only one particular function among the multiplexed functions of the pin.
10) 60 MHZ maximum CPU clock available.

B. *GPS Module*

GPS system is a worldwide radio navigation system formed from a group of 24 satellites uniformly in six orbital planes and base stations spread over the earth for their maintenance. To have information about 3-dimensional position and clock deviation from true time of anything on the earth the thing must accompany with GPS receiver and an unobstructed line of sight with four GPS satellites. According to own clock of the GPS receiver it computes the arriving time of four satellite signals. By performing

difference operation on arriving time and time at which the signal starts transmission at satellite is incorporated in the message signal of satellite stretched at receiver, acquires the journey time of four satellite signals with four unknown variables each which are each approximately equal to distance between receiver and satellite.

C. ZigBee Module

ZigBee is a specification for a set of high level communication protocols used to create personal area networks. It is quite good for appliances which are must satisfy the requirement of long battery life and safe networking. It is implemented and manufactured based on an IEEE 802.15.4 standard. Its signal power covers the area of up to 10-100 meters. The coverage area may be enhanced by passing data through intermediate devices. It has a defined data rate of 250kbits/sec and it is best suited for low data rate applications.

D. HT-12E Encoder

HT-12E is an encoder integrated circuit of 2^12 series of encoders. It has paired with 2^12 series of decoders for use in remote control system applications. It facilitates with 12 number of parallel input lines among them 4 lines are used to give input which we want to transmit to other side through RF or IF transmission medium and the remaining 8 lines are used for the purpose of addressing which limits the receiving of data to only particular receivers of having tuned to this address. After its data packet accommodates with 8-bits of address and 4-bits of information with enabled signal at /TE pin, the encoder starts sending 4 data words serially available at DOUT pin. If disabled signal is available at /TE pin the encoder stops transmission only when complete 4 data words are transmitted serially otherwise it continuously transmits. Connecting of HT-12E encoder with 434 MHZ RF transmitter is shown in Fig. 6.

E. HT-12D Decoder

HT-12D is a decoder integrated circuit that belongs to 2^12 series of decoders. They are coupled with 2^12 series of encoders. The chosen pair should have same address and data pattern. It converts the serial data received from RF or IF receiver, into parallel data and sends them to output data pins. It compares the received data with local addresses three times continuously and decodes the input data when similarity is found. A valid transmission is indicated by a high at VT pin in the decoder pin diagram. Connecting of HT12D with 434 MHZ RF receiver is shown in Fig. 7.

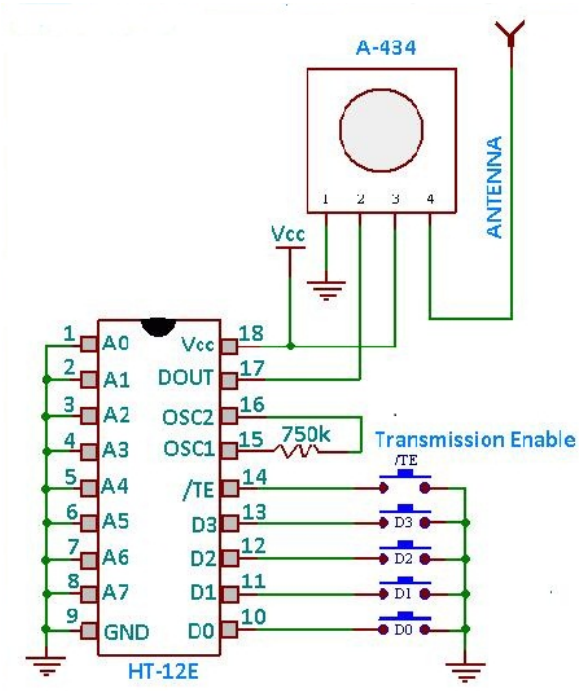

Fig. 6 Interfacing of HT-12E Encoder with 434 MHZ RF transmitter

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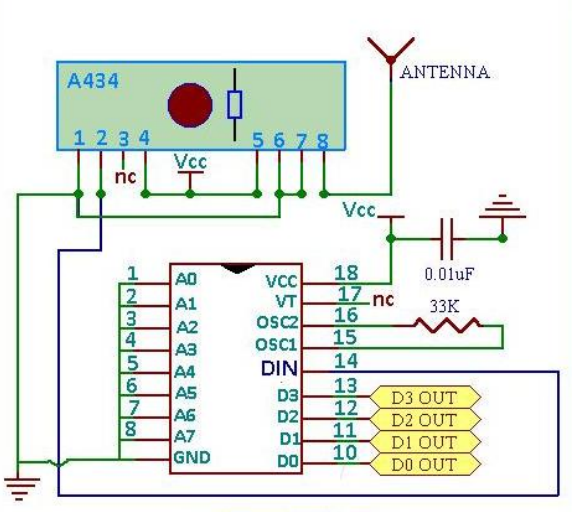

Fig. 7 Interfacing of HT12D-Decoder with 434 MHZ RF receiver

F. MAX232

The MAX232 is an IC, first created by Maxim Integrated Products that converts signals from an RS-232 to signals suitable for use in TTL compatible digital circuits. The MAX232 is used for dual driver/receiver purpose. The drivers provide RS-232 voltage level outputs approx. ± 7.5 V from a single + 5 V source. The receivers reduce RS-232 inputs which may be as high as ± 25 V to standard 5 V TTL levels.

IV. BUILDING OF PROTOTYPE

In train subsystem ZigBee and GPS modules are connected to the microcontroller using the serial communication ports UART1and UART0. Using LCD and ZigBee technologies the information about train location is continuously showing in train and continuously transmitted to end stations respectively. The switching of the buzzer takes place consecutively as the train enters into the GPS locations similar to the values given by the station master. The caution LEDs are connected to any port pin of the microcontroller by selecting that port pins as General Purpose Input Output port using Pin Select registers. The Hardware integration with microcontroller is shown in Fig-8.

The signalling pole subsystem acts as a RF transmitter. In experimentation section we don't have the necessity to use of rectifier section; simply we require the voltage regulator, RF transmitter and 12 bit parallel to serial HT-12E encoder.

V. RESULTS

About the successful travelling of train at level crossings the subsystem in train sends the feedback messages to the control room at end stations through ZigBee technology. At end stations control room PC is connected to the ZigBee modem with the help of adapter. The information to and from of the ZigBee modem in control room is entered using PC and observed in PC respectively using Modem application software. The information sent by the ZigBee modem present in the locomotive is observed in control room PC is given in Fig. 9.

The glowing of caution LED in train when train comes nearer to the signal pole and displaying of train locations are both shown in Fig. 10.

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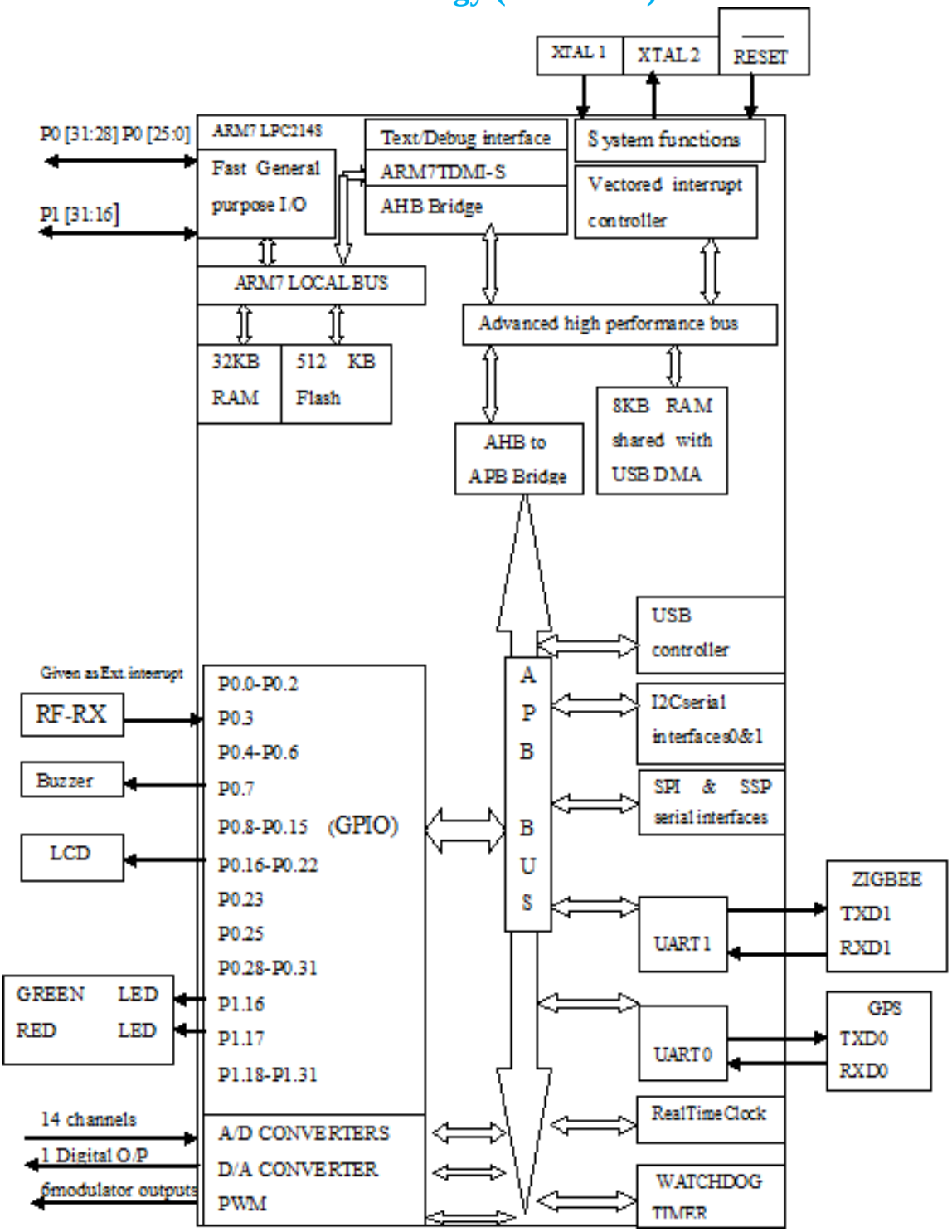

Fig. 8 Hardware integration with Microcontroller

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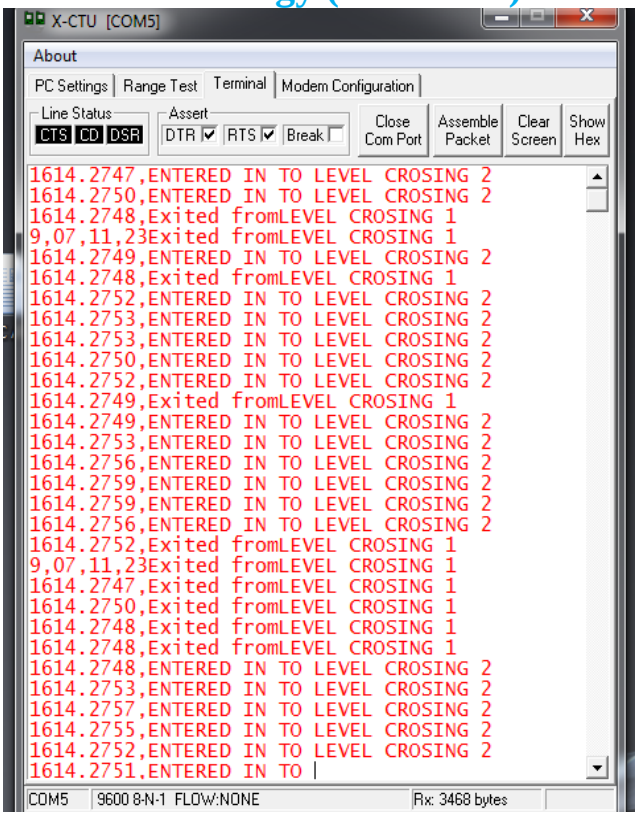

Fig. 9 Output from ZigBee modem connected to the PC in control room

Fig. 10 Proposed system of showing caution signal directly in train when it reaches in the range of signalling pole subsystem and the LCD display of showing train location

VI. CONCLUSIONS

Here by we conclude that this project is very easy to implement on existing signalling system in Indian Railways. The embedded system we designed works for a long time and requires less maintenance since its operation depends on independent well established GPS system, ensures maximum safety to passengers and public, the loco pilot gets all information in advance about the level crossings and caution signalling directly in train without diversion him from driving, the loco pilot gets all

information even in bad weather conditions, the system controls the traffic at level crossings by automatically blowing of train horn from a specified location placed at one quarter mile in advance to the level crossing so that the persons, animals alert to the presence of train and can clear the track before the train reaches the level crossing, the system incorporates the facility of sending feedback messages about train "Entering into" or "Exited from" level crossing x to end stations so that it helps in updating the information about train location in internet and also helps in giving train alerts at end stations, achieving fast response with the help of microcontroller. In our project the 434 MHZ ISM frequency band is used for checking the desired operation of designed prototype. In the application implementation case in real time, the frequency band that is allocated by the Government of India to the Indian Railways is used. In our project we are using two-way ZigBee as transmission medium technology, but in real time for transmitting larger distance repeaters are used. The project "Auto Level Crossing and Signal Indicating system" can be further extended by adding another application to the same system such as automatic speed control of train when the train gets any hazard signal from outdoor caution indicating systems respective to particular train.

VII. ACKNOWLEDGMENT

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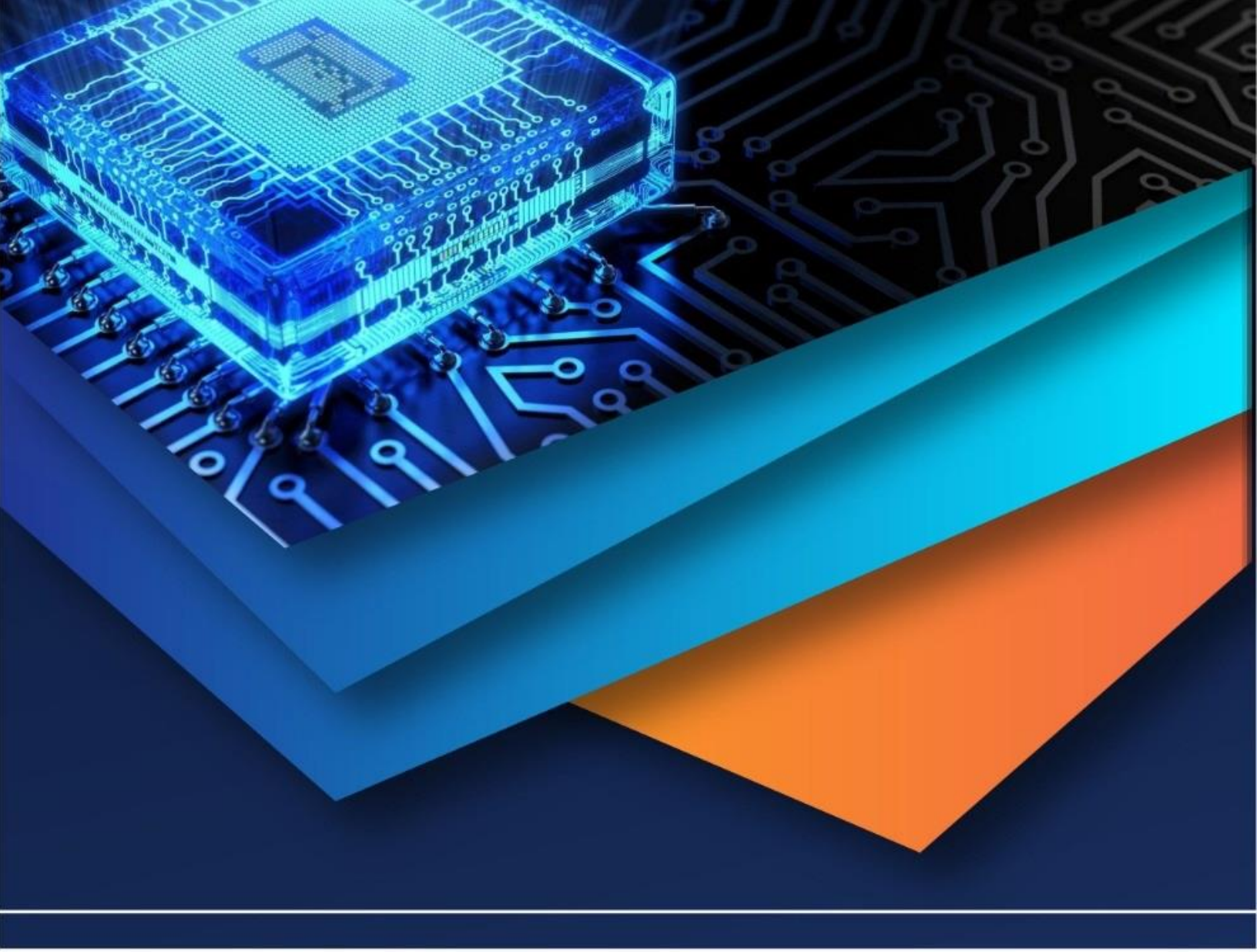

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