Wireless Cab Signalling For Railways

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Abstract — Railway's work on traditional fixed signalling system, as of now 2-aspect, 3-aspect and 4-aspect signalling systems are available. Fixed signalling are the existing system, which are robust and time tested. Many drawbacks are mainly due to the fixed signals, special focus to be given during the weather conditions. The train control system presented herein is a low cost solution which improves safety and introduces an interesting level of automation. It is based on data radio communication between central computer and trains, cab signalling in the trains and autonomous determination of train location using Wireless technology. Complete information of the path is stored on the computers database; Salient points along the route like Level crossings, railway station, Subways, big towns can the displayed on the screen beforehand.

Keywords –Wireless technology, Ultra-Sonic crack detection, sensors, buzzer system.

I. Introduction

Railway transportation system is one among the commonly used economical transportation system in India. Almost nearly 24 million passengers use the railway system on a daily basis. Railway authorities had made an analysis of the recent accidents and customer complaints to provide a safe and secured system which can be widely used throughout the railway connecting system. The major reason which is being analysed for the cause of the railway accidents is the Signalling System which is being done manually either by a telephonic intercom call or by a walkie talky, were the signal information is being sent from a station to the next upcoming station, and with this receiving information signal for the trains are said to be operated throughout the network. In Jammu & Kashmir, due to extreme cold weather conditions, the Loco-Pilots find it difficult to have an accurate view of the Signal. Hence, a complete networking system can be implemented, were an automatic signalling can be done. The trains can be controlled which would provide a better traffic control system as well as the monitoring can be done.

With the increased usage of railway system, the transportation system continue to upgrade at a remarkable note to maintain the efficiency, reliability, safety and security. Indian railways have planned for a trail check for the avoidance of the above discussed factors in the DEMU(Figure 1) train which is a recent technology train being introduced in the Sub-Urban & Rural places across India were the people density is less. DEMU(Diesel Electric Multiple Units) is a self-propelled train consisting of Driving Power Car and Trailer Cars which would run at a speed of 110 km/h.

Ensuring the safety in railway signalling system, a significant guarantee of the safety and efficient operation of the whole railway is considered. Importance of train detection to railway signalling and control systems, and highlights of today's train detection system is discussed in the paper[3]. Some of the important signalling aspects and their relationship to the rail infrastructure is discussed in[7]. An hierarchical methodology has developed for safety analysis based on the failure propagation model and state-transition model [5]. Evolution of rail signalling system from wayside signals to cab signals, to profile-based systems, to communication based train control systems are explained in [2]. The analytical model and simulation of the traction system are developed and its results are simulated using Visual Basics 6.0, Hi-Tech C.

Fig 1. A view of a DEMU Train in J&K

Almost all the advanced rail roads are having cab-signalling systems. There are various types of systems based on different concepts of design. All the types used as of now, use some kind or the other type of track mounted / side equipment's and on-board train equipment's. Track-side equipment's will be vulnerable to miscreant activities and vandalism. Hence, in this paper a concept is outlined to have a cab signalling system fully free from any track side equipment's with fail safe design and operation. This concept is based on Global Positioning System (GPS). This system can be explained with the help of three subsystems.

1. Locomotive subsystem: In the GPS based cab signalling, the locomotives are equipped with on board processor, GPS receiver with roof mounted antenna, residential data base for all the events like stations, signals, bridges, level crossings etc., suitable application oriented software, a full duplex VHF trans-receiver. The locomotive subsystem is shown in the figure 2.

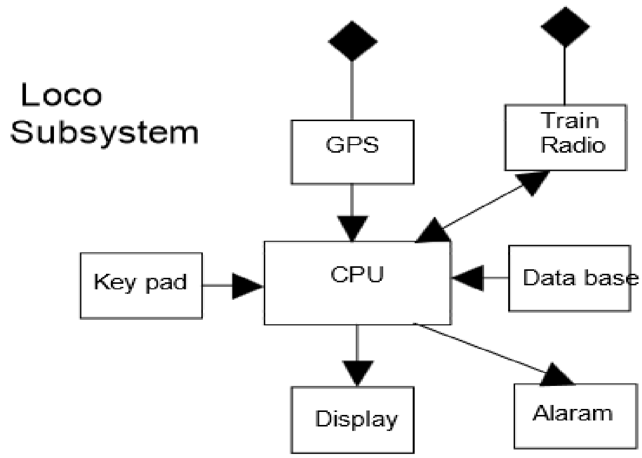

Fig 2. GPS based cab signalling for locomotive subsystem

2. Station Subsystem: All the stations to be equipped with their subsystems comprising power interlocking system(existing), station radio and station GPS.
3. Signal Subsystem: All the fixed signal posts to have their own subsystem comprising of colour light signal(existing), a full duplex VHF trans-receiver and GPS receiver. The station and signal subsystem of GPS based cab signalling is shown in figure 3.

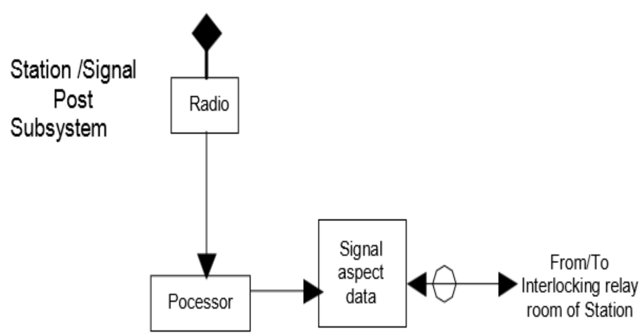

Fig 3. Station and Signal post subsystem of GPS based cab signalling

II. EXISTING AND PROPOSED SYSTEM

A. Existing System

The existing signalling system (Fixed signals) are very robust and time tested. It does not require any kind of on-board equipment to work on the railroad. Since all types of trains (freight and passenger) operate with a range of permissible maximum speed, this system serves its purpose quite well and fully safe. Comparatively fixed signals speaks more flaws such as the train driver must read the signal correctly in all weather conditions, if he fails to notice properly it may lead to accidents. The signals cannot convey the temporary speed restriction during critical situations.

B. Proposed System

Cab signaling system, communicates track status information to the driver's cabin, so that the engine driver can view the information and take action accordingly. The ordinary systems display the trackside signal aspect, while more tedious systems displays the signal aspects along with the allowable speed and dynamic information about the track in prior. In recent technology, a train protection system is laid over the top of the cab signalling system to caution the driver of dangerous conditions, and to apply brakes automatically and bring the train to halt if the driver ignores the signal alert. Cab signalling systems range from simple coded track circuits, to transponders that communicate with the cab and communication-based train control systems.

III. BASIC COMPONENTS AND PRINCIPLES OF THE SYSTEM

Basic principle of the system is to communicate between the driver's cabin and control room, about the information like weather condition, obstacle or any other emergency cases happening during the train travel. The medium of communication is done using GPS. The general block diagram is shown in figure 4.

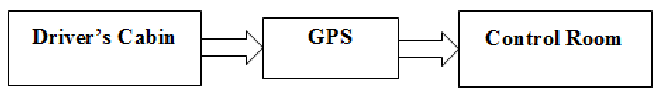

Fig 4. General block diagram of the project

A. Block Signaling

In this section, automatic signaling concept is defined. Signals are placed to indicate the approaching train's action and depending on the signaling system, the operational speed of the train will be changed.

Figure 5 shows the two-aspect signaling systems, train can move only when there is a green signal and halts when it is red and added the braking distance from line speed is distributed across the block sections. Blocks are said to be the railway lines that are divided into sections. By using the PIC16F877A controller the signals are automated and communication is done via GPS.

Fig 5. Two-aspect signaling system

B. Basic Design

Basic design includes five parts: master module, Zigbee module, dual power supply, motor and LCD. The block diagram of the project is shown in figure 6. PIC16F877A is selected as microcontroller for the master module. PIC(Peripheral Interface Controller) as 8Kx14 Flash program memory, high performance RISC based CPU, low power consumption and it has up to 14 sources of interrupts. Dual power supply is connected to the controller and a supply is used for motor drive. LCD is used for displaying the faults. Motor drive is used to control the speed of the motor.

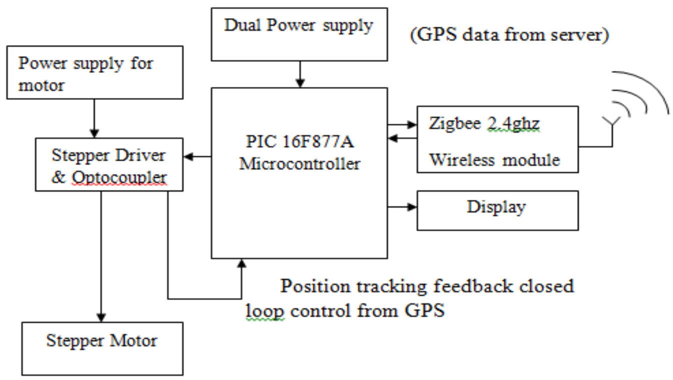

Fig 6. Block diagram of the project

C. Monitoring Unit

Monitoring unit consists of Zigbee wireless module, system interface and a dual power supply. The complete train information including position, speed, distance is transferred betweeen monitoring unit and driver's cabin through Zigbee module.

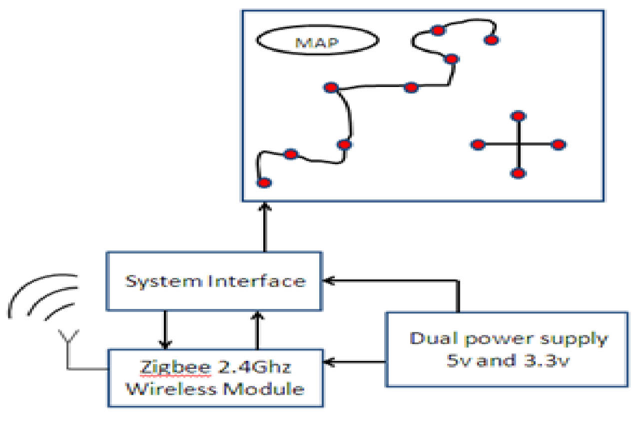

Fig 7. Block diagram of monitoring unit

D. System's Operating Principle

On-board equipment subsystem (figure 6) consists of control unit PIC16A877, LCD module, Zigbee module, dual power supply, motor drive, optocoupler, stepper motor. PIC microcontroller (PIC 16F87418877A) which integrates all the function. Such as given i/p to the stepper motor, speed control on recognition important zones, displaying signal information on LCD. The entire train information is transferred betweeen monitoring unit and driver's cabin through Zigbee module.

In monitoring section all the train activities which is entering and leaving the particular zone are monitored continuously. The root map is displayed on the monitor and an object indicating the train moves along the path, so that the position of the train can be tracked. These root maps will be stored in the server. Path validation can be done. The information is sent to the driver's cabin at a regular interval. And added an alarm is raised to draw the attention of the driver, whenever the signal is set. Henceforth, by using these methodology a continuous log of events in cabin can be monitored.

III. SIMULATION RESULTS

Simulation results includes the entire techniques like automatic traffic signal control, detecting train track fault and safety protection. PIC microcontroller plays a vital role in executing the simulation.

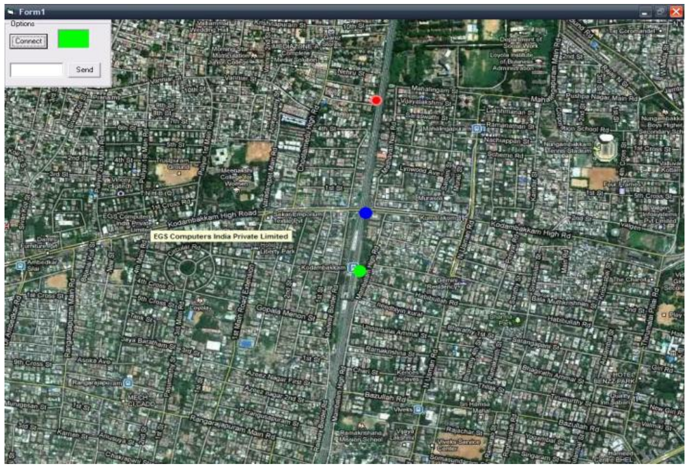

Fig 8. General simulation of the project

General simulation of the project(figure 8), shows the aerial view of the train route, the source and destination is indicated by red and green lights, simulation is done using Visual Basics and Hi-Tech C. These software programming language performs both front end and back end operations. **Visual Basic 6.0** is a tool that allows you to develop Windows (Graphic User Interface **- GUI**) applications. **HI-TECH** Software's range of C language embedded software development systems offer real benefits over traditional assembly language programming. **HI-TECH C** is not just a C compiler; it is a complete development system for C and assembler code. It integrates a powerful C compiler, producing code to rival hand-written assembler, a full-featured macro assembler for those occasions when you absolutely must program one instruction at a time, a remote debugger for running and debugging your code in your own hardware, without the expense of an in-circuit emulator, all tied together with a fast, flexible programming environment that lets you produce working code in less time than ever.

Fig 9. Establishment of connection

The route maps are monitored for the safety protection, figure 9 explains the connection establishment of the system and it is simulated using the visual basic. Before the connection establishment the status of the signal will be "red" and once after the connection establishment the status will change to "green" and signal information status will be connected to the monitoring unit.

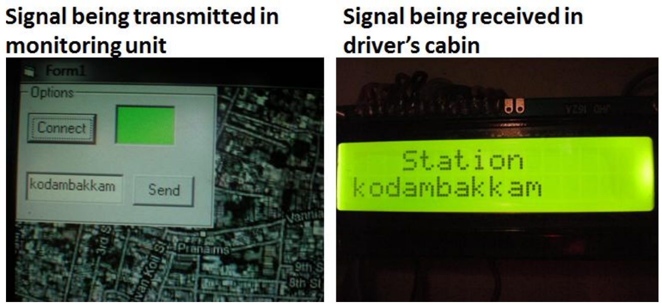

Fig 10. Display image in the driver's cabin

In the above figure 10, after the connection establishment the signal being transmitted in monitoring unit will be sent to the driver's cabin. LCD(16x2) used to display the information to driver's cabin and to the control room.

IV. Conclusion

In a demanding society, by using advanced techniques, railway network can be brought under a single cloud radar system which efficiently make passengers journey comfort. In this paper, considering the traffic conditions various parameters are introduced for the betterment of safety and added it shows improved adaptability to weather conditions, maintainability of centralized(cracks) and simplified equipment design. In real time, Ultra Sonic crack detection can be used to detect the cracks on tracks, this technique provides accurate and highly efficient results. GPRS can be used instead of RFID, it provides with no distance restrictions and high reliability. The signal information can be transmitted to the driver's cabin, position of the train can be tracked, speed control and route miss match is also identified. The authors hope that their idea can be implemented in large scale in the long run to facilitate better safety and secured travel.

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