Real Time Wireless based Train Tracking, Track Identification and Collision avoidance System for Railway Sectors

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Abstract — Now a days a hectic problem around the world is about traffic densities. This is also common to railway sectors too. Recent years we often hearing the word train collision and it bags huge precious human life and time. With great passion regarding this issue, this paper deals the solution for this great problem. In this paper we propose the system which deals with automation of trains. We are using the concept of Global Position system (GPS) for tracking each trains and a proposed system by which each trains are individually monitored and passing necessary messages to the individual trains during the emergency situation of chance of collision occurrence.

Index Terms — Train Mounted Module, Sensor Post, Collision avoidance, GPS, Password Protection.

I. INTRODUCTION

Vehicle tracking is one of the very important issues in this world in recent years. And even train tracking and monitoring is also an important crisis now a days. Because a train collision takes huge amount of human life and creating a massive loss to the railway sector in terms of money and time. So the system what we are proposing here is a real time wireless based, which will track trains through wired and wireless communication, make the communication between each trains through wireless, share their location details and track details between themselves. Our system is used for each train to identify they are travelling in which track number. Based on this, each train can calculate their distance from other trains and exchange emergency messages between other trains when they are near about few kilometers and travelling in a same track. So just by this collision occurrence between the trains can be avoided. We are introducing here a concept called Sensor Post. This is one of important part of our system seated in the each rail tracks at specific distance between each other having unique identification number (ID), which is the one can identify train is moving in certain direction and by frequent exchange of information between them and passing trains, each passing trains can update their track id and also its transferring the passing train details (Number, Direction, Speed) to the Server or nearby control room for train position updating in server side through wired or wireless communication. Based on the information received from the server side the train signaling can be operated and updated. So stopping the trains is possible by manually (by drivers) through signaling or automatically by our system. So during emergency situations like driver is not available or driver is not in the position to control the trains, our system will intelligently monitor the trains operation and take necessary steps to guide the train and even stops thee train in a must stop situation. Our proposed system consists of GPS for finding the trains position and APC 220 a RF Transceiver in both train side and Sensor post side for wireless communication for more than 1000 meter distance and Load cell bonded in a rail track which is connected with a each sensor post for a trains to find its track identification and ground station to find trains direction and train details. Arduino a open source Microcontroller used as a Heart of this system for all decision making process and for all communication initiatives.

Track Information:-

We know that real rail track is very tricky in few places nearby stations and very simple at some places. For our work we have consider the track also in same fashion and we are giving each track with their own Identity Number (ID). This is very important issue in updating track details for trains and for our collision avoidance system. Each train will update their track no after crossing each sensor posts. The basic structure of track and sensor post we are using for our system will be as follows.

Fig: 1.1 Details of Track Structure & Sensor post Fixation
II. HARDWARE DETAILS

The system what we are proposing is the real time based system and hence we have developed a real model. The proposed system consists of two environments. They are

1. Sensor post Module
2. Train mounted Module

SENSOR POST MODULE:

One module will be fixed in the rail at specific distance on each track and another module will be fixed on the train. Module fixed on the rail/track will be having two load cell or IR Sensors. For our system we are using IR sensors. For real time implementation load cell can be preferred. Two IR sensor/Load cell will be fixed at distinct distance, so when train passed by, each sensor will give max output at a period of crossing the sensor. By this, sensor post can come to know the passing train is going in which direction based on this it will communicate with the passing train and update their track information and transfer the train details information to the nearby server or control room with wired or wireless communication.

RF Transceiver:-

The RF Transceiver used for our system is APC 220. Its an semi duplex low power transceiver module. It can be used for data transfer upto 1000 meter with 9600 bps at line of sight. It has the power consumption of low as 5uA. In sleeping mode upto 42mA. It has the communication range between 418MHZ to 455 MHZ. Its communication is viable with UART/TTL based concepts.

Load Cell / IR Sensor:

Actually for our system we are using IR sensor for the purpose of identification of Trains. We are using two IR sensors which is keep apart. IR sensor having contact range upto 5 cm. So train is moving from one sensor to another sensor the microcontroller can identify the train is moving in what direction. This is very important part of our system. We are suggesting Load cell can be bonded under the rail for this application if this system applied for real train applications.

Microcontroller:-

Arduino UNO is nothing but a microcontroller board based on ATmega328. Its a heart of our system. It has 14 digital input output pins & 16 Analog pins. It can be communicate to computer via USB cable. All our sensors, communicating devices connected through this microcontroller only.
TRAIN ENVIRONMENT MODULE:

It’s an important module in our system. This module will be present in the driver’s cabin. This module consists of Keypad interface, RF transceiver, Microcontroller, LCD and a GPS. A train engine is interfaced with this module. Only after driver given the details about the train No, Direction and Track No the engine will start. For this information to be feed into the system keypad interface is used. The complete hardware description as follows.

The main purpose of this module is to provide a authentication for a train to get started and also updating the train details (train No, track no) before its started. Our system is password protected; this module will protect the train from any unknown person access. The train driver has to give the password for engine to get started. If the entered password is wrong it will reboot the system until getting the correct password. If the entered password is correct it will give Authentication to the driver to enter the train details.

For entering the data, keypad is provided. After entering the details the information will be displayed in the LCD display. When all the details are provided the engine will start and GPS will initiated for finding its coordinates (Latitude, Longitude). And also RF transceiver data transfer will be initiated.

Sequence of this module’s Screen shot as follows
1. Enter Password is Highlighted – Have to enter Password.

2. If Password is wrong, Wrong Password Highlighted and system reinitialize.

3. If Password is correct, Authenticated is Highlighted

4. If Authenticated, message as “WELCOME BOARD”

5. Train No is Highlighted – Enter Train Number

7. Direction is highlighted – Enter train Direction

8. Track No is Highlighted – Enter Track No.

9. After all information will be given, Updated Messages will be displayed and train engine will get started.

10. After getting message from sensor post, Track updated message will be displayed.

11. Complete Information about Train No, Track No, Distance, Speed, GPS Co-ordinates etc

These are the responsibilities and sequence happen in Train mounted module during the initialization and running of train operation. This will act as an interface for train’s driver through which he can access the train.
GLOBAL POSITIONING SYSTEM (GPS):-
The Global Positioning System (GPS) is a satellite-based navigation system uses a 33 satellites for this operation and which is put into orbit by the U.S. Department of Defense. GPS was originally implemented for military applications, but in the 1980s, the government made the system open for civilian use. GPS works in any environment and weather conditions, all over the world, 24 hours a day. There are charges to use GPS. GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth. GPS receivers in the earth take this information and use triangulation concepts to calculate the user's exact location. Essentially, the GPS receiver compares the time delay a signal was transmitted by a satellite with the time it was received. This time difference is the key tells the GPS receiver how far away the satellite is. Now, same calculations from a few more satellites, the receiver can determine the user's current position and display it on the handheld unit's or mobile's map. For this retrieving of position information at least we need signal from three satellites to calculate a 2D position (latitude and longitude) and track movement. Even with four or more satellites in view, the receiver can determine the user's 3D position (latitude, longitude and altitude). Once the user's position has been determined, the GPS unit can further calculate other information, like speed, bearing, trip distance, track, distance to destination, sunrise and sunset time and so on.

GPS satellites are getting powered by solar energy. They will run in case of solar eclipse and it can run for long time because it having backup batteries onboard, when no solar power is available, Small rocket boosters on each satellite keep them flying in the correct path.

III. OPERATION & SEQUENCE OF PROPOSED SYSTEM
Our proposed systems completely rely on wireless communication. It uses serial communication for its operation. When each train is get authenticated with train mounted module its ready to connect with GPS to find its own position. So every 30 sec, train mounted module has to send the position details, train details, track details simply through the RF transceiver. RF transceiver which we are using for system can able to transmit the data for 1Km. If suppose this sytem is implemented for real application RF transceiver has to replace with data transmission capacity of at least 5 Km. So with in this distance if any train is coming in a same Track No can read this data and can calculate the distance the two trains. So based on the distance the two trains the various alarm level is provided and when distance is much reduced less than 750 meters, our system (Train mounted Module) will stop the engine and will avoid the collision occurrence. This is the way our system will quickly respond and avoid the collision. The complete sequence of exchange of information between train, sensor post and between trains is as follows.

1. Every 30 sec each train will transmit the following code through RF Transceiver (APC 220)

#, Direction, Track Number, Latitude, Longitude, Speed, Length

2. Each Track having its sensor Post at the various point which will give direction of train which is going and will provide the Track Number & also give the information to the server or computer that recently or currently which train with train Number is crossed through wired communication with Time.

3. Each sensor post have 2 or more Load cell or FSR based on sensed value the microcontroller will detect the train is passing and in what direction. Once the sensor post detects the train crossing it will transmit the following code immediately and wait for acknowledgement from the train.

@, Security Code, Train Number, Speed

4. Once the train receives the code it will update its track Number based on the data received from the sensor post and it will give the acknowledgement back to the sensor post by giving details of Train Number, Speed its travelling and a security code which receives recently from the sensor post.

&, Sensor Post ID, Direction of Train, Time, train Number, Speed

5. Sensor codes receive this code from train & update this information to the nearby Computer or server by wired communication by the following code.

$, Remote Train Number, Own Train Number, Security Level, Distance, Direction, Track Number, Speed

6. Once each train crossing the sensor post it can update its Track number details. After updating of track details same code of 1 point is repeated from the train every 30 seconds.

7. So all the near by trains receive this code and processing the code and check whether its travel in a same track with irrespective of directions, if yes calculate the distance between the other train and if distance below the threshold levels based on distance different emergency codes are transmitted from the train.

## Security Level Details:

<table>
<thead>
<tr>
<th>Distance</th>
<th>Security Level</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1 Km</td>
<td>1</td>
<td>Low</td>
<td>LED Indication</td>
</tr>
<tr>
<td>&lt; 2 Km</td>
<td>2</td>
<td>Medium</td>
<td>Buzzer Indication</td>
</tr>
<tr>
<td>&lt; 3 Km</td>
<td>3</td>
<td>High</td>
<td>Strong &amp; Rivalive Light</td>
</tr>
<tr>
<td>&lt; 1 Km</td>
<td>4</td>
<td>Highest</td>
<td>Train Control Movement to Automatic Mode</td>
</tr>
</tbody>
</table>

Fig 3.1 Tabulation of various levels of annunciations
These are the sequence, our proposed system is following and during emergency situation like when both trains travels in a same track the above sequence will proceed and stops both the train and avoid the chance of collision occurrence. And also its clear from the point 6 that, after each trains crossing the sensor post, its transfer the complete information about the crossing train to the nearby station (server) wirelessly, so remote monitoring is also possible by our proposed system.

IV. RESULTS & CONCLUSION

Our proposed system is clearly taking care of avoiding trains from collision occurrence and any unknown person access. Also any communication loss of data during data transmission it can able to get back the information from the source based on request. So our system is clearly revealing that it can be really implemented for railway sector for train tracking and collision avoidance.

Few Screen Shots of System Results:-

The above figures are the final result of our proposed system. When two trains share the same track and when distance between the two trains is lesser than the minimum level, automatically both the trains on the same track will immediately stopped and avoid the collision. This is our strengthness of our system.

REFERENCES