

Wireless Sensor Networks for Monitoring Indian Railways Trains

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Abstract: Indian Railways has the largest rail network in the world and is also responsible for transferring millions and millions of passengers on a daily basis. But it has obtained the reputation of being accident prone. Consequently the safety record of Indian Railways is very low. Many factors affect the safety of the trains in Indian Railways. Major environmental conditions, geographical conditions and the conditions of the driver's driving the trains are all factors which contribute towards accidents. Along with these conditions the track conditions and the asset conditions also contribute towards accidents. This paper presents a simple technique to reduce accidents in Indian Railways as well as monitor the train on a real time basis with very low cost application

Keywords: Wireless networks Remote monitoring Train safety Real time data monitoring Optical Fiber communication Application of Optical Fiber communication Wireless sensor networks

I. INTRODUCTION

Indian Railways is a government organization which is operated by the Ministry of Railways of Government of India. Which the route length of 673638 kilometer, Indian Railways is one of the largest transportation in the world standing at the 4th position in terms of railway tracking. More than 20000 passenger train run on a daily basis which includes both the local roads and the long distance road .As of now Indian Railways has a total track length of 12140 7 kilometers which is increasing on a daily basis with the development of Railways in the country.

Trains being run by the Indian Railways run at an average speed of around 50 km per hour while some of the passenger trains like the Rajdhani and Shatabdi have a peak speed of roughly around hundred and thirty kilometers per hour. The Government of India has invited the concept of bullet trains and has already started a pilot project on the same the bullet trains will be running at a speed of 180 kilometers per hour or more. Along with the passenger trains there are a number of trains which are being run by the Indian Railways for transportation of goods and other essentials. Transportation trains are extremely slow trains running around at the speed of an average of 24 km. They use the same tracks as that of the passenger trains.

One of the most vital links in the development of the economy and running of the economy, Indian Railways is prone to accidents. Accidents on the Indian Railways cause a lot of destruction as well as a lot of inconvenience to the passengers on the tracks.

The reason for Indian Railways being accident prone is due to a number of incidents and a number of reasons. Running on one of the oldest tracks in the world Indian Railways safety record is something that is to be taken care of very seriously.

With the number of trains increasing drastically there is a lack of increase in the safety features for the trains. Signaling systems are being continuously updated and upgraded but there is still a lot of work to be done. The ministry of Railways is presently thinking of introducing artificial intelligence to prevent accidents on Indian Railways.

Quantum jump in technology for transportation Indian Railways needs to implement technology in its management and services for the safety of the passengers travelling on Indian Railways. This paper attempts to provide a feasible, low-cost, reliable solution to reducing accidents occurring in Indian Railways through a real time monitoring system.

Present system of train monitoring in Indian Railways [2]

In the present monitoring system of Railways in India which trains are monitored manually. The present train monitoring system works in this way';

Each station on the tracks is connected to the communication network of Indian Railways. The moment I train passes through the station ahead of the present station and the station just before the present station are informed about the same through the communication networks manually by the station Manager or somebody who is deported to handle the communication systems .Online tracking system of the Indian Railways the nearest station that has an internet connectivity to the online train monitoring system is informed about the train that has just passed the present station and the same data is uploaded manually to the train monitoring system of Indian Railways

This method of monitoring the Indian Railways manually has a lot of drawbacks and has resulted in a number of accidents taking place by having the trains which collide with each other being on the same track. The present method doesn't involve the drivers of the locomotives to know the present condition of the tracks on which they are travelling the number of trains are ahead of them the distance of the trains from the present position of their train and the speed at which the train in front of them is travelling. As a result the locomotive driver is unable to control the speed of the train which method result in accidents if and if the train in front of them is travelling on the same track and at a lower speed.

While the signaling system of Indian Railways has become automated to a certain extent on most of the sectors this signaling system is unable to take into account the faulty train if it lies beyond the range of its coverage.

When the train has crossed a signaling system but has not reached the other signaling system then in the present scenario the signal that has been crossed turns is system which has been crossed by the train goes to Green and allows the train coming behind it to cross that signaling system easily.

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If the train ahead has not cleared the next signaling system then because the signal in the previous case which has crossed is given to Green Signal, there is a chance that the train coming from behind may collide with the train resulting in an accident.

In other cases like adverse climatic conditions the same situation arises. In these conditions where visibility becomes very poor, the drivers are unable to view the track ahead of them, resulting in the trains travelling at extremely low speeds for preventing a collision. As a result there is always a delay during winter conditions and during extreme rainfall.

The above is the primary reason because of which Indian Railways faces accidents every year during adverse climatic conditions like the winters when it is foggy like the situation when it's extremely heavy rainfall taking place and when there is no Line of Sight visibility.

The basic reason of accidents due to collision in Indian Railways is of the fact that its tracks are never cleared off trains for safe passage. A clear track prevents collisions which is what is the main problem plaguing the Indian Railways

II. PROBLEM STATEMENT

Drawbacks of the present monitoring system of trains in Indian Railways is addressed and mitigated by the use of Technology which this paper presents. There are many methods which can be used to address the drawbacks of the present system of monitoring Indian railway trains. This paper presents every simple and effective method of monitoring Indian Railways Trains on a real time basis as well as mitigating the effects of environmental conditions that are playing havoc in the present system

Indian Railways has a lot of advanced assets in the communication sector which can be easily used to prevent collision between trains. The most important asset that the Indian Railways has at the present moment and the one which is continuously increasing also is the optical fiber cable network.

Optical Fiber system of Indian Railways.

Indian Railways has laid down an extensive network of optical fibers all along its tracks.

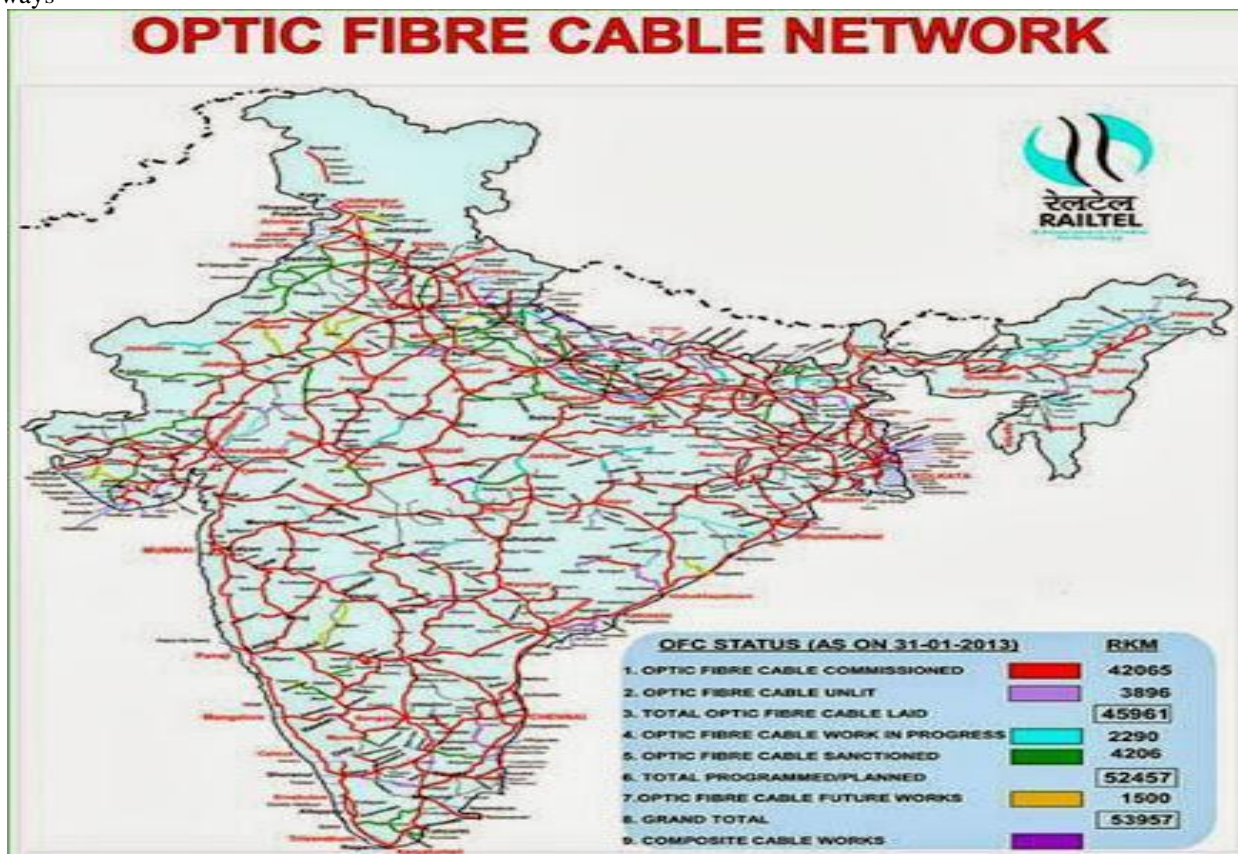


Figure 1

Figure-1 shows the extensive network of optical fibers[1] laid by the railway all along its tracks. This details of Optical Fiber network laid by the Railways has increased since the days of this publication of this figure. Indian Railways has also covered all of its stations including the small and big ones with optical fiber communication system. Indian Railways through its Optical Fiber cable network provides National long distance calling to all the Telecom subscribers of various telecom service providers. With such a provision already available, character data of huge quantity on a daily basis of the trains, the optical fiber communication system of Indian railways can easily be used with the various wireless sensor technology to monitor the movement of trains of Indian Railways on a real time basis.

Proposed solution;

The present paper attempts to provide a solution using the optical fiber network asset of the Indian Railways to monitor the train movement on a real time basis. The proposed solution reduces the manual intervention and provides a direct communication of the present status of the train position to the trains in front of the present train and to the train coming behind the present train it will try to provide the exact location the speed and the present status with respect to the trains to all the trains travelling on the same track.

This solution is expected to reduce the incidents of accidents due to collision but will not take into account the accidents that may occur due to situations other than the speed control and movement of the trains.

Setup



Figure 2

The heart of the setup of the new system proposed is the wireless sensor (Figure 2) connected to the optical fibers laid along the railway tracks. The sensor is configured to detect the speed of the train passing across it and it is also enabled to capture raw data from the train like the train number and the time and date.

The sensors are connected to an embedded device which runs off solar power and is a very low power device. This device accepts the data from the sensors and over the optical fiber network passes on to the previous Optical Fiber embedded device and to the next Optical Fiber device.

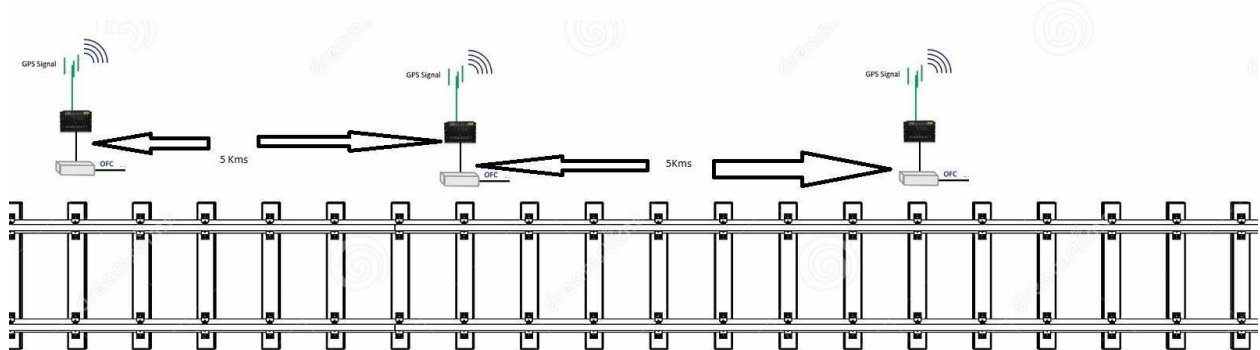


Figure 3

This setup is repeated at an interval of every 5 kilometers (Figure 3). All the wireless sensors are connected to each other forming a wireless sensor network. This entire network of wireless sensors can easily be connected to the computer network of the Railways or can easily be monitored at a centrally located place.

The wireless sensors and the embedded system are generally low power devices and can be powered off solar panels with a small battery pack for backup and operation during night hours. The wireless sensors can also act as a wireless transmitter which can transmit the information stored in the embedded device over a range which may go up to 1 kilometers in radius.

This setup is repeated on both the up Line and the down line of the railway system.

The engine of each train is also connected with a wireless transmitter receiver network which captures the speed of the train on a real time basis and also has the facility to manually enter the train details like the train number and the date of journey. This unit continuously transmits the speed of the train and its identification number i.e. the train number.

III. WORKING

When a train crosses a wireless sensor the sensor is able to catch the data sent by the wireless transmitter and receiver in the engine of the train. Once the data is received by a wireless sensor which has been crossed by the train the same

data is transmitted through the embedded device and the optical fiber network to the sensor before the same sensor and after the same sensor.

The same sensor also transmits to the engine which is just crossing the particular sensor location the details of the trains that has crossed that particular sensor earlier including the speed and number. The information regarding whether the next five kilometers track is clear of any trains or not is also past to the present train crossing the sensor. Consequently the present train is able to get the information regarding the clearance of the track for the next 5 kilometers.

It results in the present train getting information whether the next 5 kilometers of track is clear of any trains or not. As a result the driver of the present train can continue at the same speed or reduce the speed to prevent any accidents occurring due to any blockage that may have taken place because of the earlier train.

The wireless sensors along with the embedded device active smart element and are responsible for providing information on a real time basis to the trains passing across them. The trains get the exact location of the train ahead of them and are consequently able to calculate the distance that separates both the trains.

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This knowledge helps the drivers of the trains to control their speed effectively which will help them reduce the possibility of a head on collision to the barest minimum.

IV. RESULTS

The range of the trans receiver is 1 km in radius. Effectively it can cover 500 mts of track on either side. As a

EBD of coaching stock hauled by single locomotives:-[5]

Table 1

No. of Coaches	EBD in meter at varying speed KMPH						
	50	60	70	80	90	100	110
16 Air Brake coaches	180	260	358	487	642	815	1019
18 Air Brake coaches	183	263	362	489	645	819	1024
20 Air Brake coaches	189	271	363	497	655	829	1043
16 Vacuum Brake coaches	240	332	452	590	761	971	1196
18 Vacuum Brake coaches	243	344	457	604	784	980	1216
20 Vacuum Brake Coaches	252	357	471	619	801	1004	1227

As can be seen from the above table, a head on collision will occur if the train ahead stops within 500 mtrs of passing the wireless sensor. Even in such a case the sensor will send the position data to the previous sensor about the train not crossing the point. The train driver in such a case can apply the emergency brakes to prevent a head on collision.

V. ADVANTAGES OF THE SYSTEM

This system is a completely automated system which reduces human errors and increases the efficiency of monitoring of the Railways trains.

This system interacts with the trains and its drivers wirelessly which is independent of the weather conditions and has no manual intervention. The transfer of vital parameters of the train like the speed and number identification of the train is on real time basis and is automated. System is automated hence the effect of weather is minimized and this system can also act inclement weather when the visibility of the railway tracks is practically zero like that which takes place during heavy rains or dense fog.

This system will also help in increasing the average speed of the trains while maintaining a gap between trains which will be more than sufficient to prevent head on collision between the trains.

This system can also be used to automate the signaling system of the Railways. This network can be connected to the signaling system of Railways and help in real time monitoring of the trains.

VI. DISADVANTAGES OF THE SYSTEM

The system although providing a lot of advantages to the monitoring and safety of Indian Railways has its own disadvantages also. The network of Indian Railways passes through a lot of hostile environments. Consequently the

result the train driver gets the required information 500 mtrs before reaching the sensor point. If it applies emergency brakes, the train will stop at the maximum distance as specified by the following table1

sensors and the embedded system please Salem the tracks are also prone to the hostile environment. They are subject to extreme climatic conditions and to the surroundings in which they are placed. Damage to the infrastructure can take place from climatic conditions as well as from nature like wild animals damaging the infrastructure.

When there is a damage to the infrastructure as the possibility of the failure of the network becomes very high. This may result in possible accidents occurring between trains as the data cannot be available as well as the trains make get delayed as the continuous wait for information from the networks which has already been damaged and is unable to send any information.

The power supply availability to the network and the sensors is an essential component of the success of the network. During heavy rain conditions or during heavy fog conditions, the solar panels may not provide sufficient amount of charge for the operation of the sensor network. In such a case the network will depend on the battery backup available for its operation. If battery backup runs out of charge the possibility of the network sensors not providing any data over the network becomes great. This will result in the failure of the network.

VII. CONCLUSION

Even with the drawbacks that the network my face in practical conditions the benefits that the network provides to the safety and monitoring of the Indian railway trains is huge. This network in future can be upgraded at any instant of time at a very low cost using the very latest technology available at that period and can continuously monitor the railway network trains for the future.

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