Zero-Visibility Navigation For The Indian Railways

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ABSTRACT
Every year the Indian Railways incurs heavy losses due to fogs. In last 3 years the Indian Railways has lost in access of 1 lakh crores due cancellation of trains, heavy delay in running trains and accidents occurring due to foggy conditions. Moreover many people have lost their lives in these mishaps, which has tagged the Indian Railways as 'unsafe' and 'unreliable'. The Indian railways is an amazing example of successful government run enterprise not only in India but also for the whole world. Government has taken back foot policy of cancelling and delaying trains which has worsened the crisis. This project is aimed towards the normal operation of Indian Railways even in dense fog as well as in zero-visibility condition[1] This project puts forth an innovative and dynamic concept aimed to provide a practical tool in the hands of railways to fight with fogs and continue normal operations even in zero-visibility condition.

The concept of this project "Zero-Visibility Navigation" is based on using different aspects such as laser signaling systems, RF signaling systems, embedded systems, digital communication systems as well as visual graphics and animation systems. A well designed system based on optimum utilization of all the above mentioned technologies is the zero-visibility navigation system.

The first requirement is the speedy survey of a particular rail route and to compile a full and detailed database[2] which will store the relative positions of all the important landmarks useful in train movements All the intermediate signals, all the intermediate stations, warning signs, important signs, symbol boards, speed limit boards, information about forthcoming bridges, tunnel, trench, elevation, angle-turning, level-crossing etc

All these important information of landmark will be fed into a database along with their respective distances. The system will take the instantaneous speed of the train from the speedometer at a particular sampling interval (preferably lesser sampling interval for better accuracy) and show all the landmarks accordingly on a display system which will be installed inside the locomotive. Also all the signals will be using Laser lights which can pierce fog easily. Hence the driver does not need to look outside in foggy condition and the system will drive him through the route effectively. For example if the Loco-driver starts from Jaipur station the software driven program will auto start and guide the driver up to the destination New-Delhi station.

As the system is program driven the data from various other modern devices such as Anti-Collision Device[3] (ACD), Vigilance Control Device[4] (VCD) etc can also be included to make the system accurate and flawless. As the concept is fresh and innovative it might be thought to be a costly affair, but when program-run software games like road-rash and Y-city can be developed with thousands of crores of investment where unnecessary violence is shown, it is better to invest just a fraction of sum to save lives of people.

On the basis of interviews and conversation it has been found out that this technology is very innovative and never ever thought of. This technology can change the face of Indian Railways and is also very efficient, feasible and cost-effective.

Keywords
[1]Zero-visibility, [2]database. [3]Anti-collision device, [4]vigilance control device.

1. INTRODUCTION
It is the month of extreme winters in India and winter comes along with many other calamities such as fog. This fog causes several restrictions on the transport system. This project concerns itself over the damages and losses incurred by Indian railways every year due to fogs.

Fog causes the following problems:-

1. Due to extremely low visibility many serious rail accidents occur causing severe loss to life and property.

2. The trains get late by hours together causing difficulties to passengers and losses to the railways.

This year the Indian railways followed a back-foot policy of cancelling certain trains and reducing the speed of many others by considerable margins causing complete chaos. The basic problem still lies to be the fact of poor visibility and the railways does not want to take any risks against life of passengers.

The train accidents reportedly took place due to heavy fog , low visibility and human error. The accidents have raised serious concerns on railway safety. During fog conditions trains must stick to the speed limit of 30 km per hour and in the dense fog *International* eight km per hour.Railway officials say most accidents are due to the failure of their own staff. But of the 177 accidents that occurred in 2008 to 2010, less than half were due to human error.The truth is the railways are still using outdated techniques like detonators to warn the train drivers during fog.When the train passes over them the driver gets a warning to slow down. Another technique is for train drivers blow the horn ahead of crossings to warn road users. This project is a modern solution to this problem.

The railways recently have approved to use LED signaling system. But even LED is incapable of piercing the fog. Instead use of LASER signals will enable efficient signaling

even in zero-visibility conditions. The beam created by the LASER is highly focused a comparison between a light bulb and has a range of about 25 km. Light bulbs illuminate the whole space but a laser concentrates power in one spot. The power in beam can be concentrated, too, and sent in the right direction .Hundreds of milli watts of Omni-directional power is not as effective as focused power of a few milli watts.We are in a computer programming age. The power of language based programs is so immense that we can perform almost all activities we aspire of. While performing the track sectioning of the railway tracks by the multi-purpose advanced machines , if we video- record the important landmarks such as the position and state of signal ,bends or speed limit marks, distance of station and platform , important signals like blow horn, level crossing, loop extension etc. are present. All this data will be data recorded and fed in the database along with their relative distances. The software will be enabled to record the speed of the moving train and simultaneously display the important marks like signaling and speed control which shall be entertained by the loco-pilot.

Hence the driver will be looking at the virtual animation video of the happenings outside and he does not need to look outside while running the locomotive and hence the problem of visibility is solved. In short, the driver merely follows an animated video like one plays a computer game. The following flow-diagram represents some of the various aspects that we will take into consideration for the database. In the games like Road rash, the speed taken into account is the instantaneous speed, but calculating the instantaneous speed of the model toy train is not possible, so we assume the speed of the remote controlled train as constant. Hence, the position of the landmarks can be fixed as per the time required to reach them.

2. BASIC PRINCIPLE INVOLVED

2.1 Concept of navigation

It is to be noted that the train will not be converted into an automated vehicle. It will still have a loco-pilot who just has to follow the instructions appearing on his screen. And all those landmarks will be fed into the database by us for which a track-analysis (feeding the relative distances of landmarks like signals, sign-boards, speed-limit boards etc) needs to be done. We already fed the complete database of the route (say an example from Agra to New Delhi). Now on this route from Agra to New Delhi the relative positions of all the expected and important landmarks will have to be noted down. Such landmarks will be numerous such landmarks present on this railway route. But our database system will be efficient to hold all this data. The data will comprise of all necessary landmarks to be considered along with their relative distances of occurring e.g.

All the intermediate signals

- All the intermediate stations
- Warning Signs.
- Important signs, symbol boards
- Speed limit boards

Information about forthcoming bridges, tunnel, trench, elevation, angle-turning, level-crossing etc.

2.2 The basic structure of program to be written:

Expected Time of appearance

Landmark 1(Signal) --------- (To be filled by

Landmark 2(Blow Horn symbol) --------- user as per the

Landmark 3(Signal) --------- requirement)

Landmark 4(Speed limit board) ---------

2.3 Calculation

There will be a system to constantly keep checking the instantaneous speed of the loco from its odometer directly at a particular sampling interval. The sampling interval can be 1 second, 0.5 seconds or even smaller. Smaller the sampling time interval better the resolution and performance of the zero-visibility Navigation system. Now suppose we move from Agra, and the immediately next landmark is a signal which is say 20 meters away, and the sampling rate of speed in our system is say 500 ms(very good resolution). Then our system will keep tracking the instantaneous speed of the loco for every passage of 200ms. We set the reaction time for the driver then for different speeds the display will be shown with different distances of the landmark. Here, if the speed of train is very less say (25 kmph i.e 6.94 m/s), and the reaction time is set as 4 seconds, then distance left for the landmark when the display will be shown= 6.94*4= 27.76m. Since in the sample no. 5 the distance left is less than 27.76, the program written will automatically start displaying the information about the approaching landmark along with the expected time of occurrence as per the current speed

Table 1. Calculation of relative distance

Sample no.	Instantaneous Speed	Distance Covered	Remaining landmark distance
1	18 kmph= 5m/s	5*0.5s=2.5m	40-2.5=37.5m
2	20kmph= 5.55m/s	5.55*0.5s=2.77m	37.5-2.77=34.23m
3	20kmph= 5.55m/s	5.55*0.5s=2.77m	34.23-2.77=31.46m
4	25kmph= 6.94m/s	6.94*0.5s=3.47m	31.46-3.47=27.99m
5	25kmph= 6.94m/s	6.94*0.5s=3.47m	27.99-3.47=24.52m

3. FIGURES:

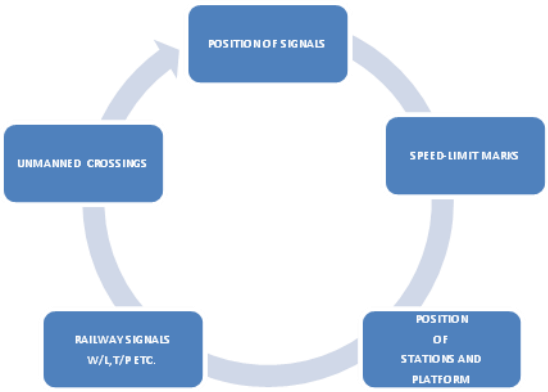
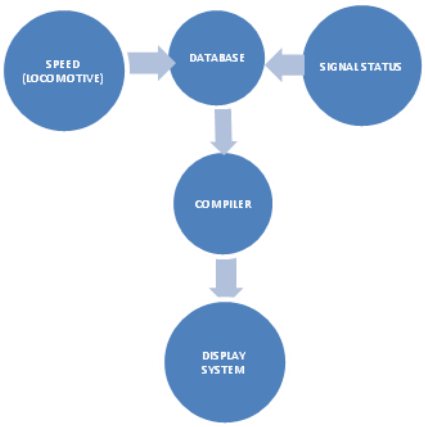


Fig 1: Basic database



1

Fig 2: Basic structure of the system

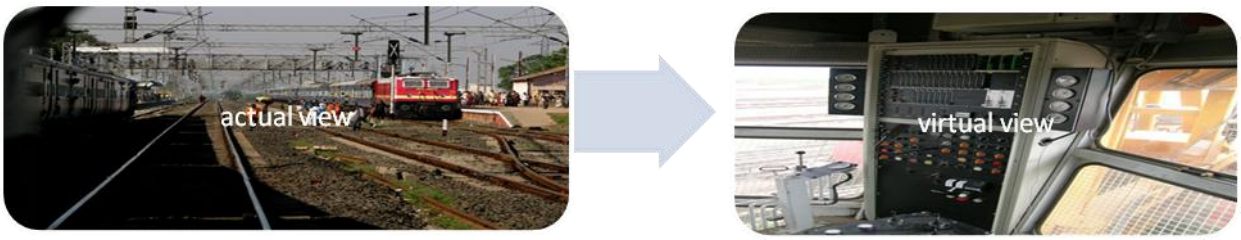


Fig 3: Conversion of actual view to virtual view

3. CONCLUSION

Constant interaction with Railway employees and seniors studying in Engineering institutes like IIT Powai helped in drawing the conclusion that this technology is very innovative and never ever thought of. This technology can change the face of Indian Railways and is also very efficient, feasible and cost-effective. There are certain important conclusions which can be drawn after practical implementation of this project:

As the system is program driven the data from various other modern devices such as Anti-Collision Device (ACD), Vigilance Control Device(VCD) etc can also be included to make the system accurate and flawless.

The project is very innovative as well as extremely cost efficient.

If we have access to the graphics control systems we can directly use a computer monitor or laptop screen instead of 2x16 LCD display, this make the project even more presentable

While implementing, the areas worst affected by fogs should be first targeted as in a vast railway network like that of India, it will take considerable time to prepare database of all rail-routes.

In the practical implementation we can use also use the technology of graphic image processing, hence instead of merely displaying the name of the landmark we would rather be able to display a digital/graphics based images of the landmarks

The logic and programming associated with this project is much simpler than those required in software database-based games like Road-rash or Need for Speed (NFS).

This project will be a boon for the loco-pilots while driving the trains

This project will not only help the Indian Railways during foggy conditions but also during other Zero-visibility situations like Heavy rains, storms, smog etc

This project will ensure complete passenger safety and convenience. Moreover it will help in rebuilding the trust of Indian passengers on the services of Indian Railways.

4.1Previous response to the paper: Because of the innovative idea involved in the project, the paper has been awarded the best paper twice in paperfest organized under TECHNOVISION (National level Technical Symposium) of Ramdeobaba College of Engineering and Management, Nagpur. The same paper got placed in top 3 papers at MINDSPARX (National-level technical event) organized by College of Engineering, Pune in association with IEEE

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