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Comparison of Rolling Noise Detection Technique with GPS Detection System for Detection of Train

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ABSTRACT: Safety in railways is a crucial aspect of rail operation management all over the world. Malfunctioning of railway systems at level crossings results in accidents and usually get media coverage even when the railways is not at fault, therefore damages the image of railways among the uninformed public. Currently Global Positioning Satellite (GPS) communication system is the most advanced technique to locate the presence of different means of transport and is also very useful in detection of trains as well. The advantage of using GPS for train control functions is that it is more economical. However, the system does have some shortcomings, the most significant of which is that for certain applications it contributes error certainly excessive for locating trains in relation to level crossings. Considerably more accurate navigational information is desirable at minimal cost. For that purpose authors have proposed a train detection system based on the measurement of acoustic signal produced due to the interaction of train wheels with the rails of track. This paper is aimed to provide a comparison between both the techniques and a solution for railways to make level crossings more safe and reliable by detecting train well before in time.

Keywords: Global Positioning System (GPS), Rolling Noise Detection (RND), Selective Availability (SA)

I.INTRODUCTION

Railways are the biggest transport system all over the world and also for any country too. It the main backbone for transport system and hence railway safety is a crucial part of railway management system. One of the major safety aspects is the safe level crossings. Level crossing is a point at where a railway track and a road interact on the same level and these are characterized as manned (where man power is available) level crossings and unmanned(no man power in any form available) level crossings. Hence unmanned level crossings are more prone to level crossing accidents. These accidents can be minimized by employing certain man power on gates, which is a very costly maneuver or by employing certain technological based solutions on the crossings like GPS[4][12], Radio based intelligent railway grade crossing system[3] and/or Rolling noise detection (RND) based level crossing[13][14] proposed by authors.

Global Positioning System (GPS) based rail crossing system is discussed by many authors. Some author discusses the use of data obtained from GPS devices located on trains or at railroad crossings to provide train's approaching information [8]. Other installed GPS receiver on top of a train and used to obtain information concerning the train's speed and position [2] and a radio link based system describe in by [4] .But all the systems are not useful for deriving arrival time and train speed information for multiple trains at a time and they cannot derive information concerning the identity and status of individual trains (like entering or leaving the system).

This paper discusses the pros and cons of GPS based train detection system and Rolling Noise based train Detection system for level crossings.

II.GLOBAL POSITIONING SYSTEM

GPS is a space-based radio navigation system which is managed for the Government of the United States by the U.S. Air Force, the system operator. GPS was originally developed as a military force enhancement system and will continue to fill that role. However, GPS also has significant potential to benefit the civil community. In an effort to

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make GPS service available to the greatest number of users while ensuring that national security interests are protected, two GPS services are provided. The Precise Positioning Service (PPS) provides full system accuracy to U.S. and allied military users. The Standard Positioning Service (SPS) is designed to provide a less accurate positioning than PPS for civil and all other users throughout the world.

System accuracy for the SPS user is maintained at a lower level than the PPS user through the use of Selective Availability (SA). SA is the means by which the U.S. intentionally degrades full system accuracy to an unauthorized user (i.e., SPS user). SA was developed by the U.S. to ensure that an adversary does not use GPS as a military force enhancer against the U.S. and its allies.

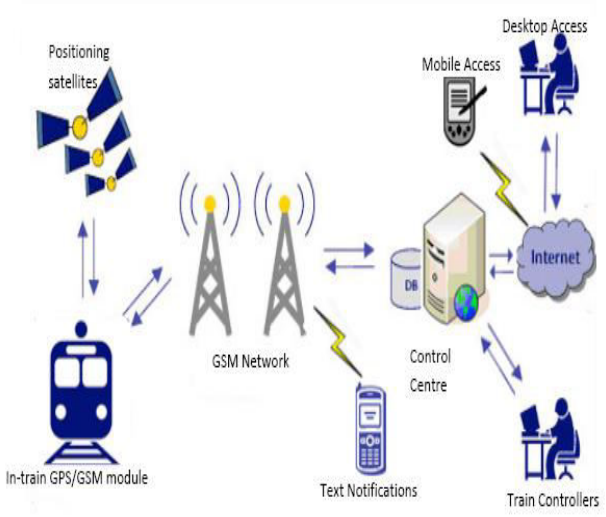

Fig. 1 GPS/GSM architecture

Figure 1 shows the GPS/GSM architecture [5].The fundamental process in this system is obtaining train location using GPS technology and transmitting the data via GSM network to the central control unit for data processing and information analysis. Real- time positioning information received by the server is made meaningful and extremely useful for the end user through integration of GIS technology where the end user can better organize and utilize information from a graphical view point.

The system consists of 3 main modules.

- The portable hardware unit (GPS/GSM train locator unit)
- Central server which handles receiving information from train locators and concurrent user requests
- Graphical User Interface (GUI) to provide services to Stakeholders.

III.ADVANTAGES OF GPS

Following are the main advantages of GPS [1]

- Ease of Navigation: - GPS-based navigation systems can provide turn-by-turn directions, a helpful feature in a strange town.
- Search Nearby Area: - Some GPS systems allow you to search the local area for nearby amenities, such as hotels, restaurants and gas stations.
- Water Navigation: - GPS devices are perfect for water navigation.

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IV.DISADVANTAGE OF GPS

Following are the disadvantages of GPS

- Possibility of Failures is big issue in GPS.
- GPS signals are not completely accurate. Accurately detecting the current position of the train by GPS in a mountainous area, tunnels or urban area is so difficult.[15]
- Depending on the signal reception conditions, the accuracy of positioning by GPS deteriorates markedly.[15]
- One of the key problem with GPS is the difficulty in resolving the track that the train has taken at a junction.[9]
- Theoretically, one can take a minimum of about 18 seconds of data from four satellite and be able to calculate the user position but practically 30 s are required to collect necessary data from satellite and calculation of user position.[7]
- GPS is totally dependent upon the technology owned by other administrator than user hence crashing or blocking of GPS data will result in collapse of all system.

V.RND – ROLLING NOISE DETECTION

Running train produces different type of noises. Figure 2 shows the noises associated with trains. Among all rolling noise is the main contributor of noises at 0 meter and 0.5 meter heights. Rolling noise detection [13], [14] is based on the measurement of wave propagation in solids and this is done with the help of piezoelectric sensor attached with the solid that is rail structure. The sensor of high sensitivity will be used to measure the vibration noise. The output signal of the sensor is then fed to the interfacing and amplifying circuit.

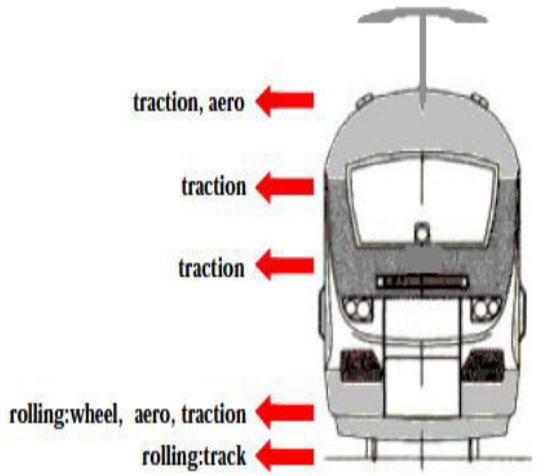

Fig. 2 Sources of noise

Firstly a model is constructed to demonstrate the railway tracks and a sensor is used to measure the sound intensity of rolling noise in the direction of propagation of rolling noise that is the direction of train.

Secondly Sensor is placed at 0 m level from rolling noise (rail height); it is the point on rail track as shown in figure 3. Piezoelectric Sensor is placed for the measurement of acoustic signal produced due to the impact of rolling noise inside the rails. Output of sensor is fed to electronic circuit and then finally recorded with the help of Goldwave sound analyzing software.

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Figure 3 shows the arrangement for the placement of sensor. This arrangement is used to measure the parameters related to wave propagation at a measurement point which is far advance to the train. Impact point is the location of interaction of wheel and rail and is the origin of wave propagation in both directions inside the rails as well as in air in all directions. Measurement point (MP) is the location of placement of sensor unit well in advance for the measurement of wave propagation inside the rails. Wheels of running train are producing rolling noise at impact point and this rolling noise then generates acoustic wave inside the rail track which is observed and recorded with the help of electronic circuit and analyzing software. Speed of train is measured by marking the train at certain distances and recording the time to cover that distance.

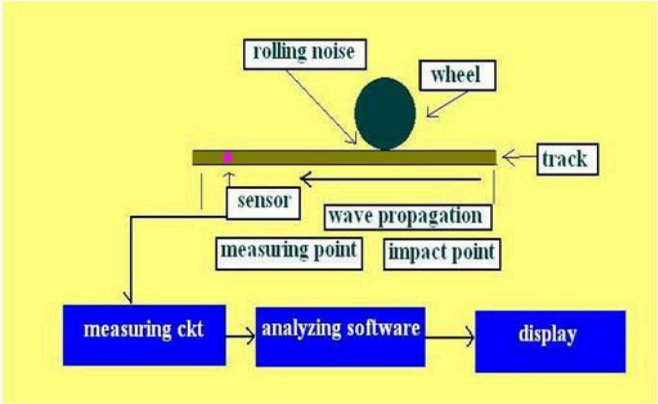

Fig.3 Measurement of rolling noise

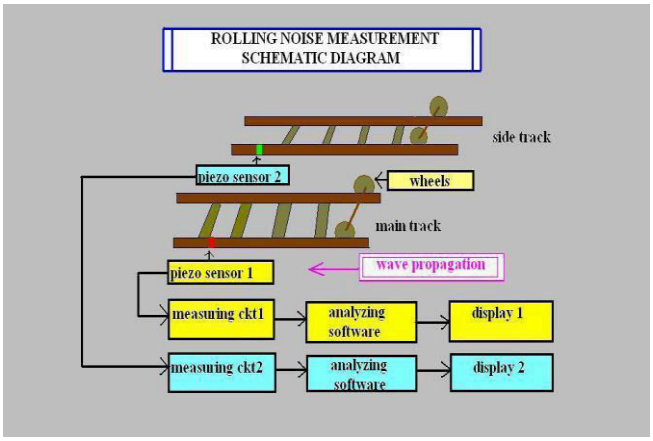

Fig. 4 Measurement of rolling noise on both tracks

The measurements are conducted on the main track and also on the side track so that the interfering signal, that is the signal propagating from main track to side track, can be measured. Similarly to measure the rolling noise on the side track, arrangement used, is shown in figure 4.

VI.ADVANTAGES OF RND TECHNIQUE

Followings are the advantages of RND technique.

- All the available techniques [14] measure the presence of train at the point of present position of train. In other words the train should be physically present at the measurement point but in rolling noise measurement, train can be measured well in advance to the measurement point

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- It uses very sensitive sensors like piezosensors and/or strain gauge hence sensitivity of measurement is high and depends upon the type of sensor used.
- The system provide extra time in measurement of train near to level crossing hence time taken to warn the road user will be more and barrier actuation can be done on right time.
- As it uses electronic components for measurement and actuation of barrier, the cost of implementation will be very low.
- This system can be integrated with any of existing system and technology.
- It is Low power consumption system.

VII.DISADVANTAGES OF RND TECHNIQUE

Followings are the disadvantages of RND technique.

- Intensity of vibration are maximum when train is on measurement point, therefore require extra protection of sensors.
- Seismic vibration can interfere the measurement carried out by sensors; hence shield will be required to guard the sensors and system from vibrations and any damage from humans and animals.

VIII.CONCLUSION

In this paper authors have discussed the advantages and disadvantages of GPS and RND Technique. It is worth to conclude here that, as discussed, both the techniques have their own pros and cons, but one main disadvantage of GPS is that, it is owned by other administrator than the railways who is responsible for safe and secure management of traffic at level crossings. That's why railways have to rely on the information provided by second party, whereas RND can be implemented by railways itself. Secondly possibility of signal failure is one of the major issues with GPS, which can lead to malfunctioning of barriers and warning devices. That will not be a big issue with RND. Third and most importantly, the crashing or blocking of GPS signal will result in crashing of whole system but RND system uses independent systems for each level crossing therefore failure of any one system will not result in failure of complete system.

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