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Crack Detection System for Railway Tracks by Using Acoustic Emission Sensor

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***Abstract*: In this paper detecting the faults in the railway infrastructure with the help of wireless sensor networks can be achieved. Nowadays Sensor technology can be used widely and the sensor devices have become cheaper. Wireless communication such as GSM-R, Satellite, GPRS is used for transmitting and receiving the signals. Railway infrastructure includes tracks, bogies, wheels can be monitored through condition monitoring. Defects can be identified using acoustic emission sensor and PIR sensor. Acoustic emission sensor is used for detecting the cracks on the tracks and PIR sensor is used for detecting the presence of human and animals on the track. Automated monitoring achieves accuracy of the fault and has a less cost, low power consumption and less analysis time. The exact location of the fault can be identified by the sensors without any human inspection so that people time can be saved.**

***Keywords:* Wireless Sensor Networks, Condition Monitoring, AE Sensor, PIR Sensor.**

I. INTRODUCTION

Characteristics of WSN:

Low consumption of power for battery nodes, Harvest energy, It has ability to deal with the failure nodes.

To monitor the physical and environmental conditions by wireless sensor networks such as sound, temperature, pressure, etc. and wireless sensor networks pass the data through network to main location. The military applications have been developed using wireless sensor networks.

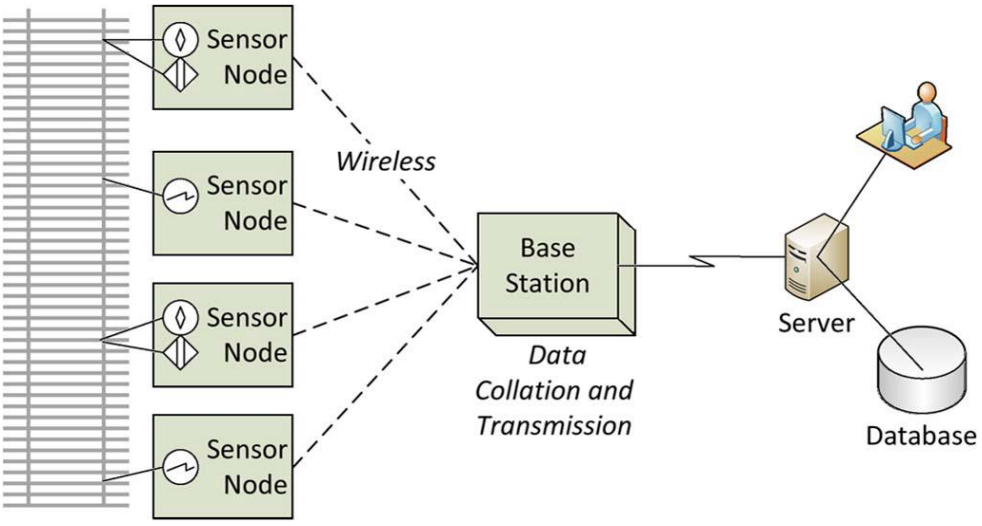

Fig.1. Figure shows the typical WSN setup for monitoring the railway conditions. Sensors are fixed on the object and communicate with the base station through Bluetooth or Wifi. Base station collates and transmits data to the control server using either satellite or GPRS.

Such applications are now developed for industries process monitoring, machine health monitoring and other real time applications. The wireless sensor networks consists of fewer to hundreds or even thousands of nodes. All these nodes in turn connected with many sensors in the network. Each node in the network consist of radio transceiver which has microcontroller, antenna connections, electronic circuit for connecting with sensors and other energy source. The railway infrastructure and geo physical processes can be monitored with the help of wireless sensor networks with help of data acquisition techniques or using the sensors. In this paper, railway monitoring process using wireless sensor networks is described.

WSN mainly used to pass the data to the main location through network. The challenge faced by WSN is producing large amounts of data at the same time. At this time data can be fused. The problem in railway industry is that lack of technology to detect the faults on the tracks. Now a days Sensor technology can be used widely and the sensor devices have become cheaper. By using the different sensor types the faults can be detected. Sensor is a device it takes input as light, heat, motion, etc. and produce the output corresponding to the inputs. Sensor data contains noise which can be pre-processed.

The sensors namely acoustic emission sensor and PIR sensor are used to detect the cracks and presence of human and animals in the track respectively. Acoustic emission sensor used to detect the different changes in the interior part of the object. PIR sensor used to measure the infrared light radiating from the object being moved. Hence the presence of human and animals can be detected.

II. BASIC METHODS

A.COMPOSITE DETECTION SYSTEM

In Composite Detection System laser beam from a laser source is collimated to a light plane through the optic lens. CCD cameras fixed to observe the track and it has digital processing system for a camera and monitoring system. It captures the image of the faulty objects. Operation of digital processing system includes filtering and extraction of real time image data. First issue is image contains nonlinearity and distortions. Second issue is processing of pixels has a variety of maximum light profile positions causes the inaccurate networks.

B. EMAT DETECTION SYSTEM

EMAT(Electro Magnetic Acoustic Transducer) used to measure the faults in both tracks and the wheels using Rayleigh wave propagation. The fault can be detected between the Rayleigh wave generator and the detector so that the depth of the fault can be identified. Disadvantage of this system is that there is no difference in acquiring the signals in a flat surface.

C. LDR-LED SYSTEM

In this approach LED is placed in one side of the rail and LDR is placed in the opposite to that rail. They are in direct contact with each other so that the light can be falls with the resistor. If there is a change between them then the fault is detected.

III. PROPOSED WORK

To detect the cracks on the railway tracks, and measure the presence of human and animals on the track, and also measuring the distance between the rail roads can be achieved. The issues in the existing system are exact location of the crack cannot be detected, presence of human and animals cannot be detected. To overcome these problems the following sensors can be used. Where acoustic emission sensors are used to identify the exact location of the crack. Distance between the rail roads are measured using ultrasound sensor. PIR sensors are used to measure the presence of human and animals on the track. If any cracks occurred on the track then the latitude and longitude of the location is sent to the nearest base station. If there is any change in measuring the distance of the rail roads then the message is sent to the base station using GPS for location identification and GSM-R for wireless communication. If presence of human and animals are detected they stop the process and they detect the track after crossing the rail road.

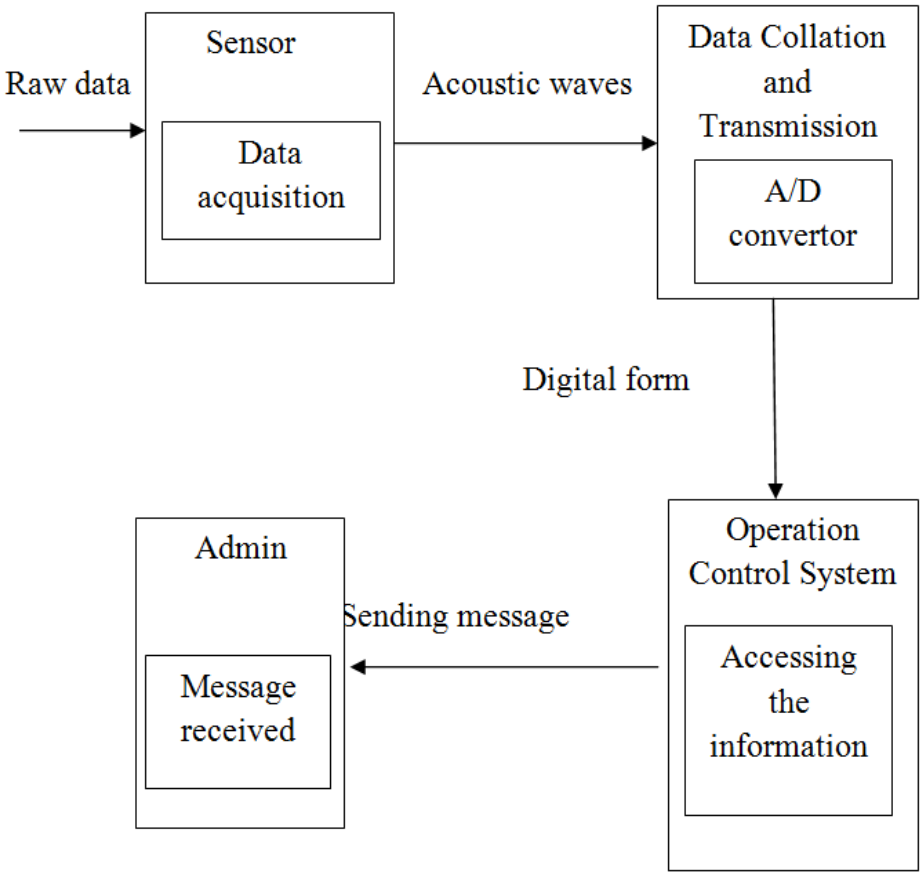

Fig.2.Figure shows the functional architecture of the crack detection system using acoustic emission sensor.

Data Acquisition:

Cracks on the track can be detected using acoustic emission sensor. Radiation of acoustic waves in solids that occurs when a material undergoes irreversible changes in its internal structure.

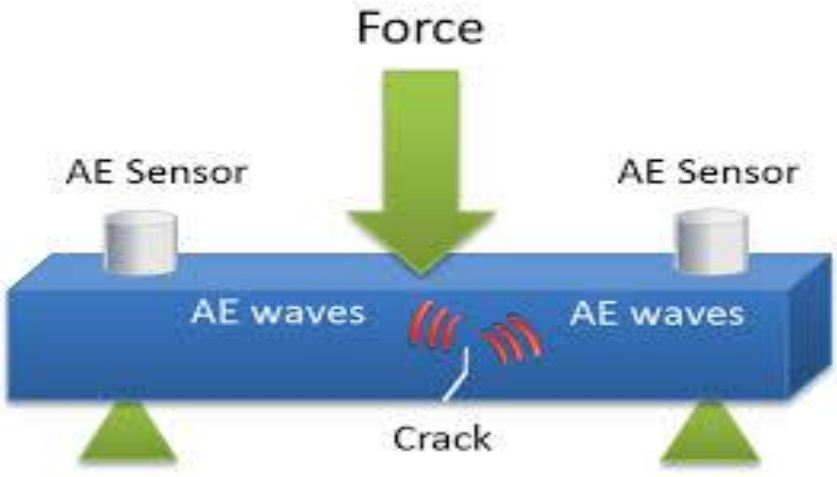

Fig.3. Figure shows the data acquisition using sensor.

Data Collation and Transmission

The base station collates data and transmits it to the control center server possibly through satellite or GPRS. It converts the acoustic waves in to the digital form.

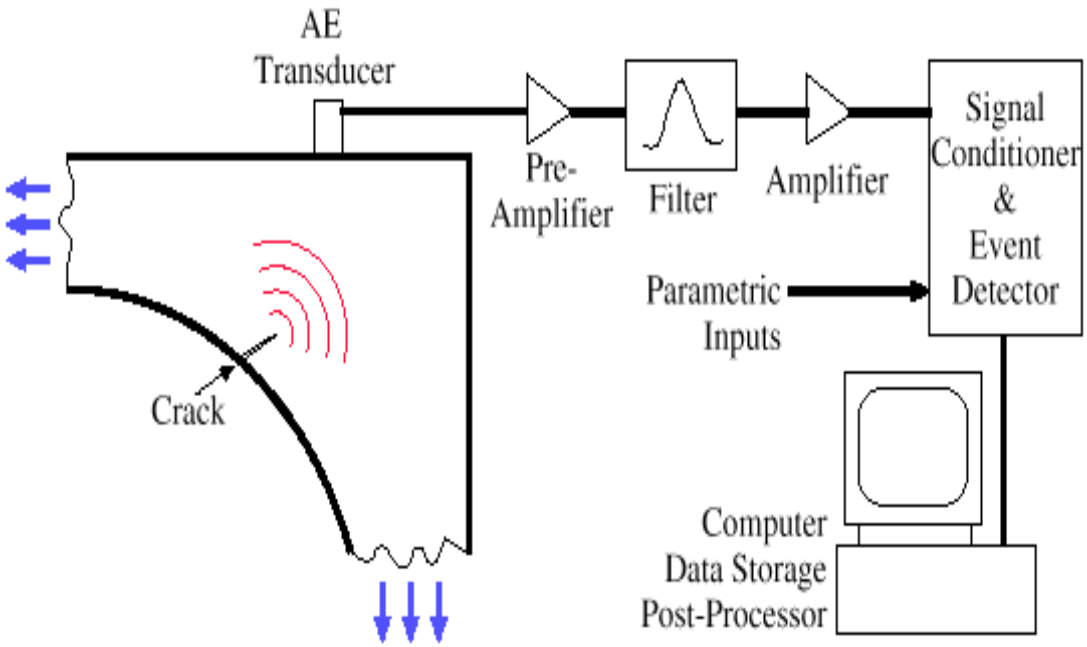

Fig.4. Figure shows the data collation and transmission.

IV. BASIC COMPONENTS

A. Microcontroller

A low power CMOS 8 bit ATmega162 microcontroller is used. Which allows 1MIPS per MHz to optimize the power consumption. A32/16 LPC2148 microcontroller used to combine the microcontroller and the embedded flash memory ranges between 32KB to 512KB. The controller receives the signal when the crack is detected and the signal is transmitted to the base station.

B. GPS

Global Positioning System is used to identify the position of the fault data where it occurs. There is an interface between the GPS and the communication link to transfer the data such as vehicle information, track etc. Here SR92 GPS receiver is used which includes high tracking capability and low power. GPS is actually used to send and receive the radio signals and provides these to the user with the location information.

C. GSM-R

Global System for Mobile communication is a wireless channel used to send the message to the mobile phones. For this messaging purpose SIM 300 GSM module can be used. Whenever the fault is detected GSM act as an instant messaging service to the users.

D. Acoustic Emission Sensor

AE sensor is used to identify the cracks in the object being monitored. Generally it radiates the acoustic waves in which the object has the irreversible changes in its internal structure.

Applications:

Application which detects the event location, Application for evaluating object performance, Application to monitor the safety of structures.

E. PIR Sensor

Passive Infra-Red sensor is used to identify the presence of human and animals in the field of view. Generally it is a device used to measure the infra-red light emitting from the object being monitored. When a motion is detected it emits the light and it is identified by the sensor.PIR motion detector used to sense the movement of the people in the field of view it is also called passive infrared detector.

Applications:

Triggering the alarm when the motion is detected, Setting a higher sensitivity threshold to ignore domestic pets.

V. RELATED WORK

Cracks on the railway track can be detected by the sensors. Sensor that takes input as a vibration, sound and heat and provides the output corresponding to the inputs. This output is generally a signal which is transformed to the base station through Bluetooth or GPRS. From the base station the signal is transformed to the control system by satellite. This information is sent to the respecting trains to indicate that the fault has been occurred and also stored in the database.

Victoria J. Hodge et al(2015) Railways uses several sensors to monitor the huge data available, vehicles, machinery and different structures by condition monitoring.

P.Navaraja (2014) Integration of Ultrasonic and total station for railway track geometry surveying System. The robots helps in detecting the crack on railway tracks. Few information like latitude, longitude and the nearest station will be sent as message.

Prashanth.addagatla et al(2014) Graphical inspections, Non-destructive testing technologies such as acoustic emissions or ultrasonic methods Shuddering-based global methods. The proposed broken rail detection system helps automatically detecting the railway track faults without any manual intervention.

V.Muralidharan et al(2015) Integration of Railway track surveying system. The Ultrasonic sensors helps in measuring the cracks in the track as well as the track distances. The result is highly efficient.

Ch.Muneendra Rao et al(2014) Powerful digital signal processors, image processing techniques. The proposed system attempts in providing a solution in making crack free tracks with IR photo diode, based on railway detection scheme.

Shailesh D. Kuthe et al(2015) IR LED-Photodiode based crack detector assembly. The objective of this system is for sensing the photo diode results from sensors available on board as and when the crack occurs on the railway tracks.

Kevin Chetty et al(2016) Passive radar technology. Train monitoring radar called GSM-R passive radar to find types of trains running, train directions and their speed.

VI. RESULT ANALYSIS

The performance analysis of the entire system is calculated based on the distance between sensor and the object being monitored.

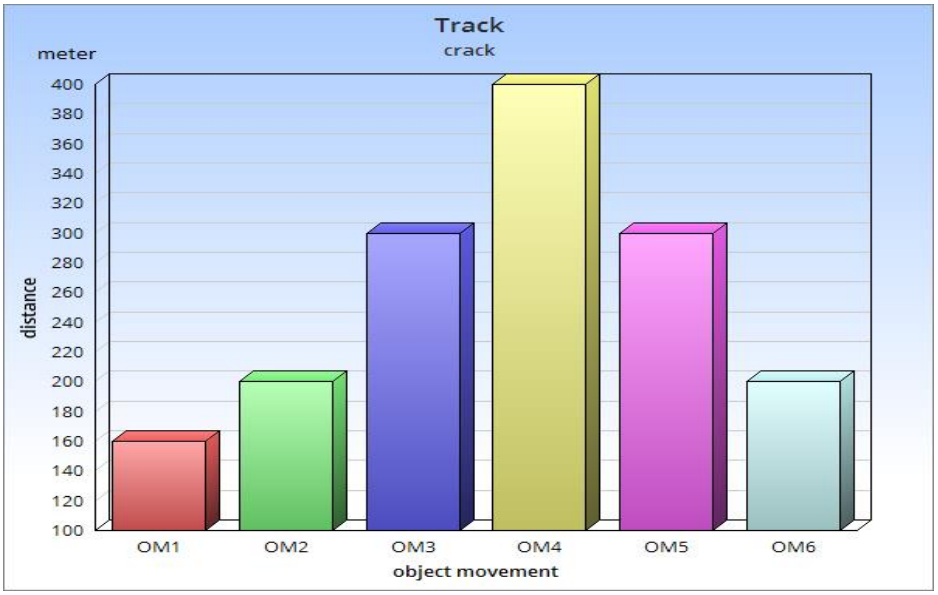

Fig.5. Figure shows that when the object movement is increased then the distance also increased and when the object movement is decreased then the distance also decreased. From this we come to know that changes in the object shows the crack detection on the track.

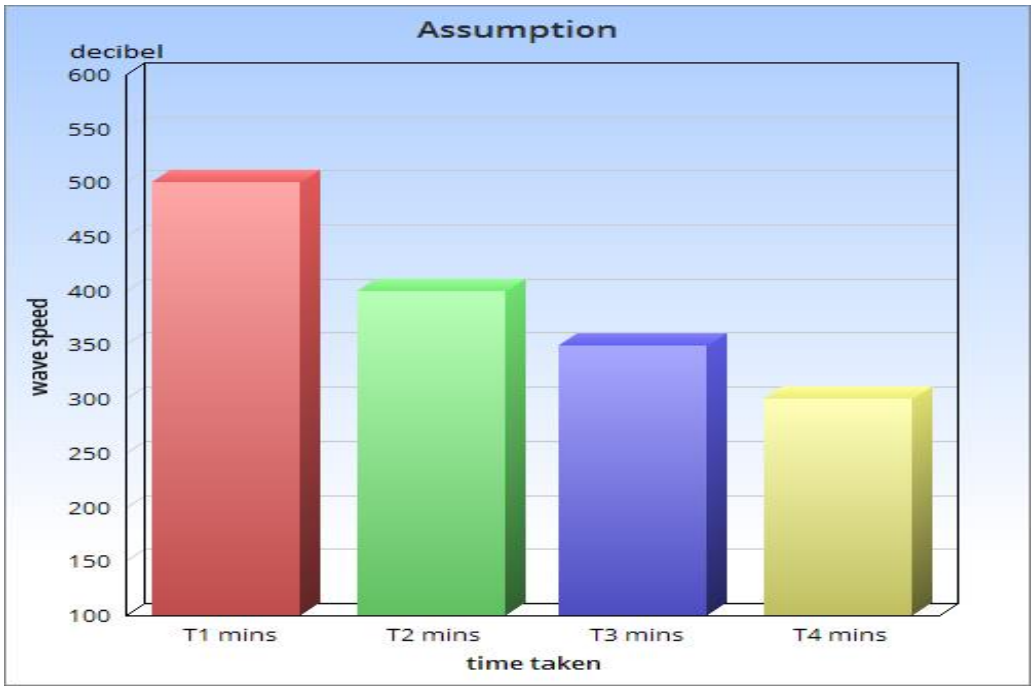

Fig.6. Figure shows that the assumption of wave speed with respect to the time taken. When the wave speed is high then the time taken is low likewise when the wave speed is low then the time taken is high. Using the wave speed and the time taken distance is calculated by the following formula.

Distance = (Speed*TimeTaken) / 2

S.NO	SPEED(db)	TIME(mins)	DISTANCE(m)
1	500	1	250
2	400	2	400
3	350	3	525
4	300	4	600

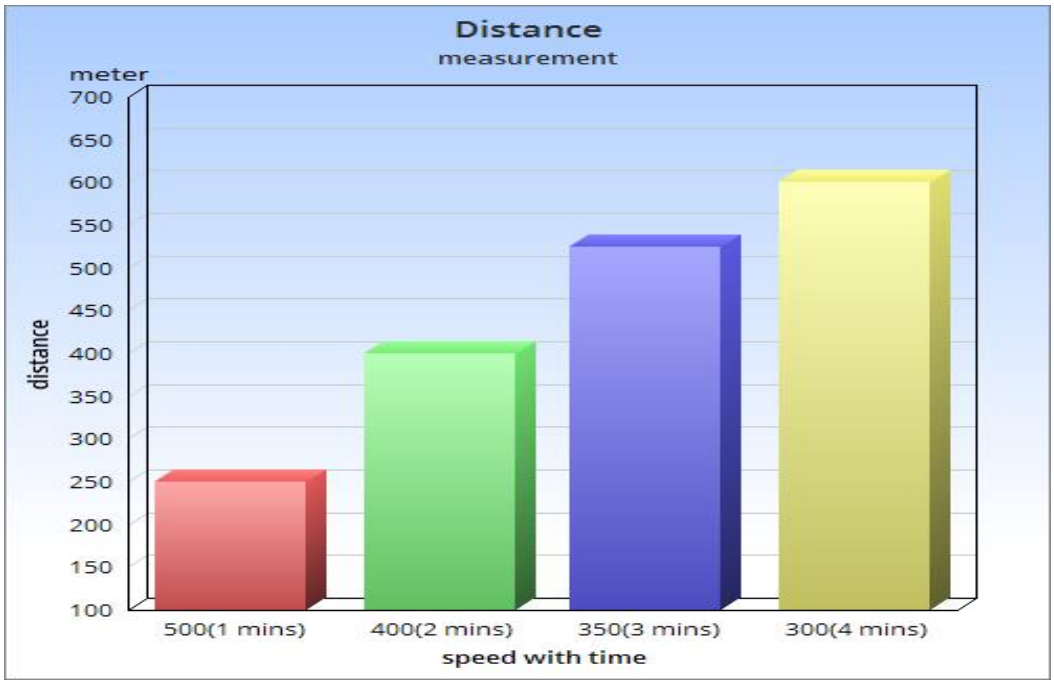

Fig.7. Figure shows that the distance measurement by using the speed and the time taken. Distance is minimum when the speed is high with respect to the time and the distance is maximum when the speed is low with respect to the time.

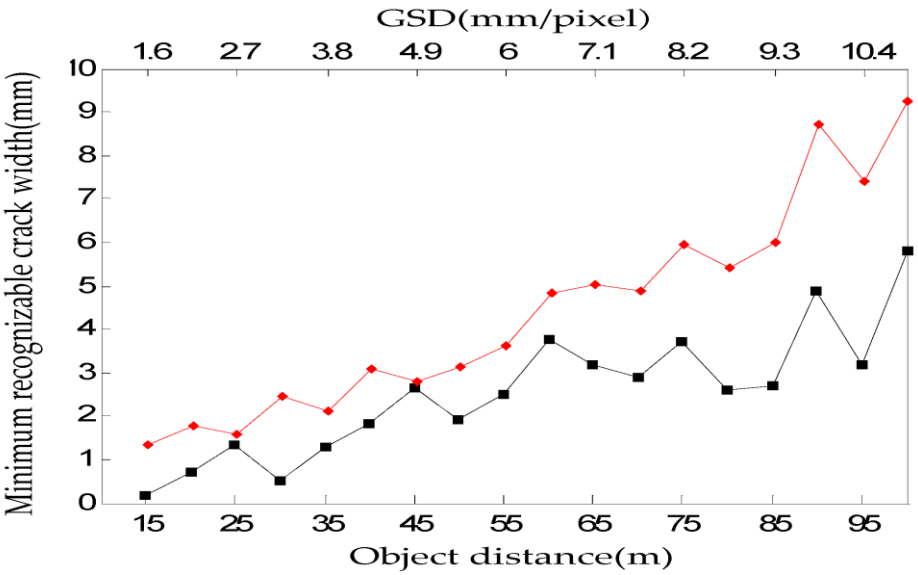

Fig.8. Figure shows that the actual object distance which is plotted as black marks and the crack distance which is plotted as red marks denotes the distance between the sensor and the cracked tracks.

VII. CONCLUSION

The proposed system presented the detection of cracks on the track automatically by the sensors without any human intervention. In existing system exact location of the fault cannot be calculated. In order to sort out this problem we have to move to the proposed method. There are several advantages, mainly which includes the people safety who travels by train.

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