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Analysis of Mechanical Vibration and Fault Detection of Railway Track Using Lab View System

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Abstract: The main aim of this paper is to develop a Lab view based system for analysis of mechanical vibration and fault detection of railway track. The Indian railway is the biggest means of transportation. But now a days accident due to railway are increase so it is need to have safety element in order to avoid accident. To avoid this problem we are using fault detector robot, which detects the fault in track and also detect obstacle. Vibration sensor is used for crack detection and ultrasonic sensor is used for obstacle detection. GPS provide location track as well as obstacle. SMS will display on LCD. Internet of Things (IOT) is implemented to give an update of crack and obstacle detection with location. The advantages of proposed system are that, it is cheap and suitable to the Indian scenario. The system can be helpful to operate at tunnels as well.

Keywords: AtMega328 IC, Vibration sensor, Ultrasonic sensor, GPS, HC12, ESP8066, Motor driver, Lab View software.

I. INTRODUCTION

Fault detection of railway track i.e. Detection of cracks in railway track is a big problem, and much research is done in the development of reliable, repeatable crack detection methods for use on in-service rails. Rails examination strategies embrace harmful techniques and Non-destructive techniques, like hammer encompassing, however these strategies simply cowl restricted area and have restricted effectiveness in distinguishing the faults. Non-harmful analysis techniques for rail track examination had developed. These technologies embody unbearable and eddy current ways, neither technique is particularly effective for detection of cracks in the rail foot. The existing systems are more complicated and time-consuming. Hence, this paper proposes an additional reliable and fewer long mode of crack detection within the railway tracks. This is a true time application which may be performed simply. The main aim of the project is to detect the faults in the railway tracks using vibration sensor, GPS & microcontroller and the obstacle detection using ultrasonic sensor. We can find out the crack & obstacle in the railway track. And intimate to the nearby station or train.

Vibration Analysis

Vibration produces noise. The analysis of the vibration is very effective. In fact, each track defect produces vibrations with distinctive characteristics that can be measured and compared with reference for fault detection. Analysis/monitoring of signal are required for the fault detection of railway track. Information about a fault features of the track are built in vibration signal. Hence measurement & Analysis of Vibration are necessary.
Vibration analysis is widely used to predict the health condition of the tracks. In this approach the data recorded by the accelerometer sensors are analyzed to extract out information about the source of vibration.

Need

Most of the accidents are caused due to cracks in the railway tracks, which cannot be easily identified. The manual scrutiny of railway track took longer. Another problem is obstacle detection. The train accidents cause severe damage of life & property. So it is more necessary to have safety elements in order to avoid accidents.

II. LITERATURE SURVEY

Different methods of Crack detection

- Crack detection using LED-LDR

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Mr. Prashanth addagatla and Mr. G. Koteshwar Rao proposed a system in which Rail track detection system architecture consists of ARM7 controller, GPS, GSM, LED-LDR Assembly, and GPRS, DC Motor. The principle involved in their crack detection method is concept of LDR. In the paper, they explain that the LED will be attached to one side of the rails and the LDR to the opposite side. When there is no crack, the LDR resistance is high because the LED light does not fall on the LDR and when the LED light falls on the LDR, the resistance of the LDR is high.The amount of reduction is roughly proportional to the intensity of the incident light-weight. When LED light deviates from its path due to the detection/presence of a crack or a break, there is a sudden decrease in the resistance value of the LDR.This change in resistance indicates the presence of a crack or another similar structural defect within the rails.GPS is used to detect the current location of the device in case of detection of a crack [1].

- Crack detection using GSM, GPS,IR

Nithin John and Nandhumon K R et al. proposed a system in which the system is consisted of GSM, GPS, IR sensor. The principle involved in method to detect cracks in railway tracks has been presented using IR sensor. In which integrating an infrared red (IR) crack sensing module and a communication module based on GSM technology is used by which information about the location of the crack can be conveyed to a central location for the immediate attention. Working Principle of the system is that there are two set of IR sensor units fitted to the two sides of the vehicle. If there is any crack in the track GSM transmitter unit is used to activate/deactivate unit.The IR transmitter and IR receiver circuit is employed to sense the cracks.It is fixed to the front sides of the vehicle with a suitable arrangement [2].

- Crack detection using Video camera

Aliza Raza Rizvi and Pervez Rauf Khan proposed system in which system consist of Railway Track, Cracks, Manual inspection, Image Processing, Computer Vision. The principle involved in method is to detect cracks in railway tracks has been presented using image processing techniques. In that they replace manual inspection of the track section, by automatic inspection. A video camera is installed in separate sections of the track to take images of the track section and that images are input to the suggested system to detect any cracks in the track section. This process helps to detect cracks immediately and reduce the possibilities of any mis-happening. Since the system would be automatic and it requires less manual intervention, so the system is almost efficient [3].

III. SYSTEM DEVELOPMENTS

A. System Overview:

In proposed system, a fault detection of railway track is done by different sensor modules mounted on the robot. The faults detected by robot are:

1) Crack detection using vibration sensor

2) Crack detection using conductive probe i.e. conductivity or discontinuity in track

3) Obstacle detection using ultrasonic sensor

The proposed system involves the design of crack finding robot for finding cracks in railway track. The proposed scheme has been tested by placing robot on an actual rail track. The system uses micro controller for interfacing the robotic vehicle, crack detection sensor i.e. vibration sensor, ultrasonic sensor, GSM, LCD, motor driver and Wi-Fi module. The sensor senses the input and send to the micro controller. Vibration sensor senses vibration and then it gives the signal to the micro controller. The micro controller checks the voltage variation between measured value and threshold value and controls the robot. If any crack occurs in the rail the robot will stop and then alarm will be raised. Conductivity of a track is continuously checking by using conductive probe if there is crack then probes gives discontinuity in track. For obstacle detection ultrasonic sensor is used, if it detects obstacles then robot will stop and alarm will be raised.

GPS is used for providing location of crack. HC12 is used for transmitting data on Lab view. Crack detected message will display on LCD. L293d motor driver IC allows dc motor to drive an either forward direction. And two dc motor control the wheel of robot or used to control speed of robot. An IOT page data will display if crack is detected.

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B. Proposed Block Diagram:

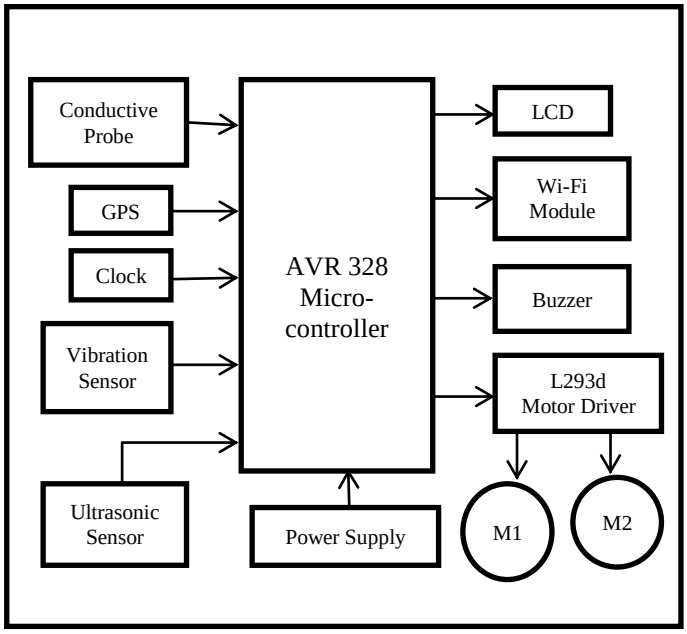

Figure 3.1 Block diagram of Fault detection of Railway track system

C. Circuit Description:
It consist of component Power Supply, Microcontroller Atmega328, LCD (Liquid Crystal Display), Vibration sensors, Conductive probe, Ultrasonic sensor, GPS,WIFI MODULE, ESP8066, Buzzer, Motor driver IC, DC MOTOR

1) Microcontroller Atmega328:
It is upgraded & more advanced chip. It is a 8 bit microcontroller. It has 28 pins. There are 20 pins which are works as I/o ports. It has 32k flash memory, 1k of EPROM, & 2K of internal SRAM. It has inbuilt ADC (10 bit ADC). For oscillator circuit two capacitor of 22pf and one crystal oscillator of 16MHz used. Crystal oscillator used for generating frequency. This circuit is used to reduce the noise of upper peak level and lower peak level.
Using this controller we interface all this devices to the microcontroller.

2) Vibration sensors:
Piezoelectric vibration sensor is used. It is analog vibration sensor. Piezoelectric vibration sensors used for police work vibrations from varied vibration sources square measure typically classified into 2 massive varieties, resonant kind and no resonant kind. Vibration sensors square measure many varieties. Before selecting vibration sensors must consider five factors.1)It's measuring range, 2)Frequency range, 3)Accuracy, 4)Transverse sensitivity & 5)ambient conditions.

3) Ultrasonic sensor:
HC-SR04 Ultrasonic (US) sensor is a 4 pin module, whose pin names are VCC, Trigger, Echo and Ground respectively.

This detector could be a very fashionable detector employed in several applications wherever measurement distance or sensing objects square measure needed. The module has 2 eyes like comes within the front that forms the inaudible transmitter and Receiver. The detector works with the easy high school formula that Distance = Speed × Time. The inaudible transmitter transmits Associate in Nursing inaudible wave, this wave travels in air and when it gets objected by any material it gets reflected back toward the sensor this reflected wave is ascertained by the inaudible receiver module as shown within the image. Now, to calculate the distance using the above formulae, we should know the Speed and time.Since we have a tendency to square measure victimization the inaudible wave we all know the universal speed people wave at space conditions that is 330 m/s. The circuitry inbuilt on the module will calculate the time taken for the US wave to come back and turns on the echo pin high for that same particular amount of your time,this fashion we are able to additionally apprehend the time taken. Now simply calculate the distance using a micro controller.

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4) GPS:

SIM Com presents a high performance and reliable assisted GPS module-SIM28. GPS will stretch the info of constraints like longitude, latitude and attitude. With the help of these parameters one can easily locate the position of some item. In this GPS equipment, the communication takes place between GPS transceiver and GPS satellite.

5) Wi-Fi Module:

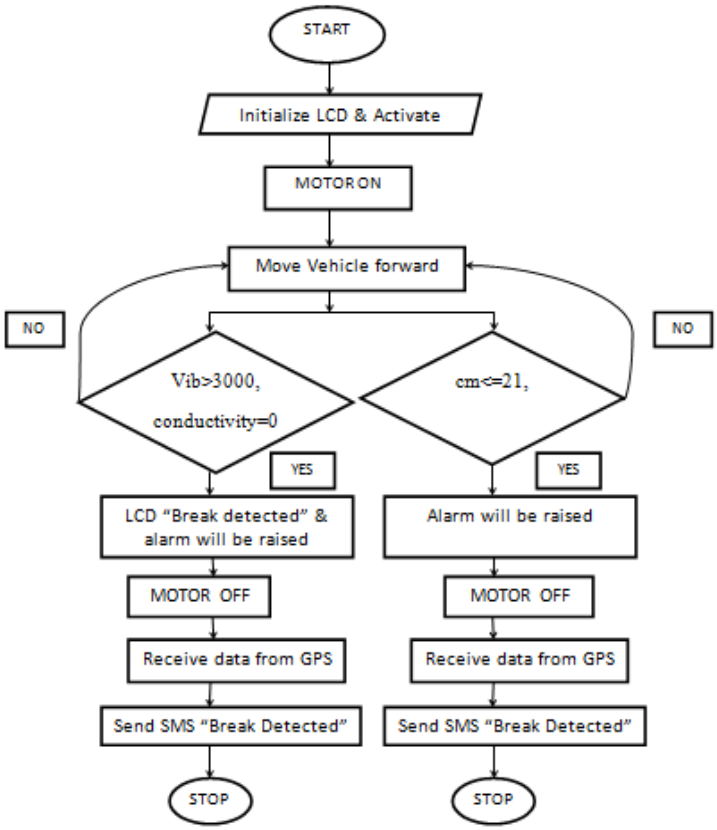
HC-12 wireless port communication module may be a new-generation multichannel embedded wireless information transmission module.

Its wireless operating waveband is 433.4-473.0MHzThe most transmittal power of module is 100mW (20dBm), and also the communication distance is 1000 m in open house. There is MCU inside the module, and user don't need to program the module separately, and all transparent transmission mode is only responsible for receiving and sending serial port data, so it is convenient to use.

D. Algorithm:

1) Interfaces all devices to the micro controller i.e. LCD, Vibration sensor, Ultrasonic sensor, GPS, HC12, Buzzer, Motor driver IC.
2) Power up supply to the system.
3) Activate all sensors.
4) Move vehicle forward.
5) If crack detected due to vibration sensor when vibrations are >3000, then vehicle stop and Alarm will be raised. If crack detected due to dis-conductivity in track i.e. brkpin=0 then vehicle stop and Alarm will be raised.
6) GPS track the location. And all data send to the server as well as LabView.
7) Break detected message displayed on LCD.
8) Activate SMS.
9) When Obstacle detected when distance is <=21 then vehicle stop, Alarm will be raised.
10) GPS track the location. And all data send to the server as well as Labview.
11) Activate SMS.

E. Flow chart:



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IV. RESULT AND ANALYSIS

A. Result analysis according values of sensors in the Table form:

1) General Analysis:- Standard values if there is no fault

If there is no crack then vibration sensor gives value greater than 3000 Hz and conductivity of track gives value 1. If there is no obstacle then ultrasonic sensors value will be greater than 21 cm.

Table 4.1 Standard values if there is no fault

Sr. No.	Ultrasonic sensor value(cm)	Conductivity value	Vibration sensor Value(Hz)
1	128	1	1318
2	120	1	2352
3	100	1	1259

2) If Fault detected then the values of sensor as follow:

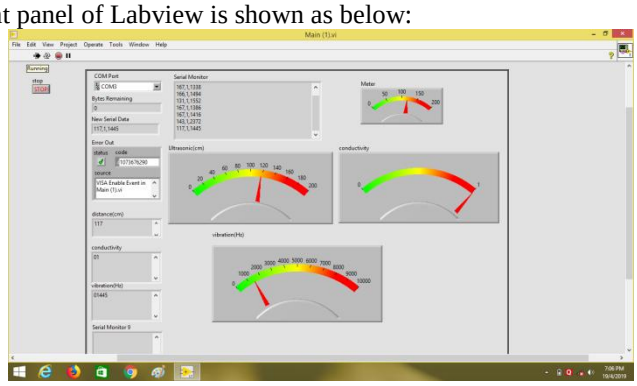
Fault detected due to discontinuity of track, Then it gives output value 0 And there is a conductivity in track then it gives 1.If Fault detected due to vibration sensor then the vibration sensor values are greater than 3000 Hz. If there is obstacle detection then values of ultrasonic sensor are less than 21cm.

Table 4.2 Fault detected then the values of sensor

Sr. No.	Ultrasonic sensor value(cm)	Conductivity value	Vibration sensor Value(Hz)
1	128	0	1318
2	120	1	4832
3	8	1	1259

B. Result displayed on Labview:

1) if there is no fault then front panel of Labview is shown as below:



2) If there is fault detected due to discontinuity of track then front panel of LabView shown as below. Where, it gives 0 value on conductivity meter.

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3) If fault detected due to vibration sensor then front panel of LabView shown as below. Where, it shows greater than 3000 value on vibration sensor meter.

4) If there is fault due to obstacle detection then front panel of LabView shown as below. Where, it shows on ultrasonic sensor meter less than 21 value.

C. Result displayed on IOT server:

If fault is detected then data will send to the IOT Server. The values of vibration sensor, ultrasonic sensor, latitude longitude are sent to the server which is shown in tabular form on IOT server. The link is www.iotsystem.in/index18091.php on which data is sent and shown as below.

Vibration	Distance	Conductivity	Latitude	Longitude	Date	Time
10000	83	1	19.8601742	75.3490372	15/03/2019	10:18:37pm
9796	43	1	19.8601742	75.3490372	15/03/2019	10:18:52pm
9688	122	1	19.8601742	75.3490372	19/04/2019	07:12:30pm
1620	152	0	19.8601742	75.3490372	19/04/2019	07:13:48pm
20	122	0	19.8601742	75.3490372	19/04/2019	07:16:03pm
2528	120	0	19.8601742	75.3490372	19/04/2019	07:16:10pm
10000	88	1	19.8601742	75.3490372	19/04/2019	07:18:58pm
2069	156	1	19.8601742	75.3490372	19/04/2019	07:21:57pm
10000	82	1	19.8601742	75.3490372	19/04/2019	07:22:57pm
2323	2	1	19.8601742	75.3490372	19/04/2019	07:23:33pm
1581	82	0	19.8601742	75.3490372	19/04/2019	07:23:48pm
10000	82	1	19.8601742	75.3490372	19/04/2019	07:24:03pm
10000	68	1	19.8601742	75.3490372	19/04/2019	07:25:22pm
7259	67	1	19.8601742	75.3490372	19/04/2019	07:25:34pm

D. Result displayed On LCD display and Mobile:

When there is crack detected due to vibration sensor and due to dis conductivity in track then “Break Detected” Message is displayed on LCD as well as SMS is sent to the concern authorities as shown in below.

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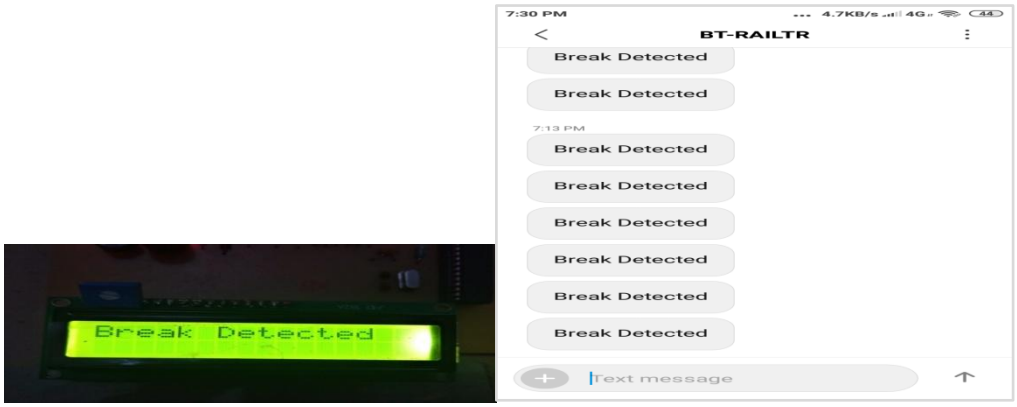

V. CONCLUSION

The fault detection of railway track system uses the advance features of micro controller with vibration sensors, ultrasonic sensor, HC12 Wi-Fi module and IOT communication technique. Vibration produces noise. Information about a fault features of the equipment are built in vibration signal. So analysis of vibration is required for the fault detection of railway track. Saving human life, protection against accidents and the communicable electronic systems are the silent features and the added advantages of the proposed system. From the above discussion and information of the system, we know that it is highly reliable, effective and economical. It gives certainly a considerable benefit to us.

A. Advantages:

There are several benefits with the projected system when put next with the normal detection techniques.

- The system is low cost.
- Low power consumption.
- Required time for analysis is i.e. less analysis time.
- Reduce human error.
- Transmitting signals are immediately transfer therefore accident reduces.
- Quick response is achieved.
- Simple in construction.
- Easy to maintain and repair.
- By the proposed system the exact location of the faulty rail track can easily be located.

B. Future scope:

In the proposed system we are using vibration sensors, Ultrasonic sensor, GPS, Wi-Fi module, Motor driver for detecting the cracks. In future speed of the vehicle can be improved by changing the motor speed. To power up the device, solar panel can be introduced.

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