Compact Railway Monitoring System with Cloud Database and Collision Evasion Using IOT

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Abstract

Numerous accidents are caused due to human inattentiveness and errors leading to loss of life and properties. Our proposed system uses three modules. In first module, multiple sensors from which data are collected and updated in cloud storage which is easily accessible to the authorised persons. The data being uploaded to cloud database and the graphs obtained can thus help us in knowing any abnormality that might exist in the track. In second module we use a number of IR sensors which are fixed on railway track. Minimum of two IR sensors are placed on a single track at a safe distance which alert us when two different trains arrive on the track at same time and a SMS will be sent by the system to control room through IOT. In the Third Module
a railway engine is demonstrated. A signal is also sent to module 3 from module 2 through remote Zig-Bee communication. Anti-Collision signal is detected in third module train engine slows down. This paper concerns about collision avoidance prior to a safe distance where the train will be slowed down if a collision is detected. By simultaneous use of IR sensor and IOT a prior message is being sent instantly to the control room. It is possible to all users to supervise the railways system in real time through internet. The system has been implemented experimentally and the accurateness of designed idea and feasibility of monitoring method have been proved with test results and graphs.

Key Words: Keywords: Inattentiveness; accessible; data acquisition; IOT SMS; accidents; anti-collision

1 INTRODUCTION:

Due to persistent increase in the number of trains which travels at a high velocity which makes the management difficult to monitor. As per the former methods of the railway, the maintenance of the track and surveillance is being performed manually. Not only this process is time consuming but also requires lot of unnecessary hard work and human labour, which is not convenient [1]. The employs who handle the work unheedingly results in delayed traffic and to make spontaneous decisions. These errors cause lead to irregularities in track and accident, reducing the overall safety of railway network. High velocity of moving trains causes wear and tear of railway track, which is difficult to recognize manually. This makes the monitoring of the track an important role. This paper emphasises a major concern in monitoring of the track and avoiding collision. The upgradation of the former system with automatic monitoring and data acquisition helps in avoiding future unsafe situations.

2 EXISTING SYSTEM:

Major problem in the existing system are increased train frequencies which might cause collision and severe climatic conditions like thunder storms, avalanche, rain, fog, snow, dust, land-slides leading to vandalism in railways. In preceding system, it shows some
restrictions while surveying the track. It consumes more time and human labour force, personnel. Lack of proper service causes crack on railway tracks. The most challenging problem is the detection of cracks in railway tracks for which much research endeavour in progressive crack detection methods used in the service rail tracks frequently. Using the eddy current method in crack detection of the rail head and shear web is achieved, no methods is precisely effective for the cracks detection in the rail. In Indian railways all operating methods and system is performed through man power. A major cause in train derailment is the presence of breaks that exist on the track. A major flaw known is kidney defect in which crown of the rail is cracked forming a 70 angle along the horizon line approximately. The separation that exists in rail cracks might vary from a narrow crack to wide ones. In some cases, during manufacturing process the cracks present in the rail track [2]. In this present time major problems faced are: 1. time consumption 2. energy consumption 3. Manual operating difficulty. Collision is a frequent drawback in railway networks. It might lead to terrible accidents. Due to worst condition of rails and monitoring which collision occurs mostly at crossings. After the crack occurs in the track they expand horizontally on the metal plate. To bring the train to halt is very tough as it moves at a high speed taking some time before it completely stops. Faults in monitoring and surveillance can result in many types of collisions which are avoided in proposed system.

3 PROPOSED SYSTEM:

In proposed system we are using wireless nodes with sensors for monitoring the train track and also
avoids collision. Railway track is equipped with specific sensors used for detecting different faults on the track. Infrared sensors are used for train identification. Wireless data sharing of between control room & railway station using Zig-Bee and Wi-Fi. Alertness of train collisions by giving an alert to concern unit by sending a message using IOT [3].

Here we propose a monitoring system using ultrasonic sensors, MEMS accelerometer and peizo electric sensors. Ultrasonic sensor used to detect the obstacles in track. MEMS accelerometer used to detect bend in the railway track and peizo electric sensors used to detect the cracks in the rail tracks. When any break/bend appears on the track the angle of specific bent axis is recognized by MEMS sensor. Whereas, by variation of voltage generated by peizo electric sensor when every train passes and due to change in vibrations on the track helps to detect the anomalies. The data being acquired from the sensors is uploaded to internet wirelessly. The variation in different values obtained along with time is shown through graphical representation. By using the graphical simulation trends and variations that occur can be easily seen and even predicted in future.

The Anti-collision module consisting of many IR sensors used where on detecting various trains on same rail route along specific time interval alerting to control office by SMS. Once the SMS which is being sent through IOT, alerts the authorized person or patrol officer immediate measures are to be taken. In case the control room fails to take actions, the anti-collision signal is sent to a particular train. Here after receiving the anti-collision signal, engine of the train is slowed down to halt.

4 SYSTEM ARCHITECTURE

Here we are designing the Railway monitoring system using Zig-Bee and Wi-Fi helping us in avoiding train collision and delay caused by traffic. There are multiple sensor types used in the monitoring the conditions in railways for analysing different aspects of infrastructure and system. Transducers help us to convert energy from
one form to another. Sensors being used here help us in converting the mechanical energy obtained into the electric energy. In the first module, number of sensors are connected with train track and platform which continuously record the data and store it [4]. Data being recorded on cloud, to modifying the railway system and hence predicting errors at all costs. In the second module, a node is created to avoid collision, thereby preventing this incident from happening by giving an alert to concern unit by sending a message using IOT. In the third module when a collision is detected, train engine slows down and led indication is shown.

A. Module 1: Sensor node for data acquisition

![Block diagram of sensor node-1](image)

Fig-2: Block diagram of sensor node-1

This module plays a major role in data acquisition and keeps record of it helping us to constantly monitor the data. As shown in Fig-2, Sensors like peizo electric sensor, MEMS accelerometer and ultrasonic sensor are the composition of this module. Sensor design should be such that it provides high functionality with low power consumption; these types of conditional monitoring are often positioned in remote areas. The microcontroller used as a backbone in this circuit is Node MCU, which is an open source IOT platform. Majority of sensors used in railway systems come under the category of micro electro mechanical systems.

MEMS accelerometer helps in detecting any inclination/tilt that might occur on the track. Accelerometer detects the angle in a particular axis, for designing a multi axis accelerometer more sets of capacitors are kept in 90 degrees to each other. Ultra sonic sensors used in detecting obstacles by setting the Trigger low. It first sends a high pulse to trigger pin and waits to receive a echo pulse. By calculating the speed and time taken to receive the echo pulse, the
distance of the obstacle is been calculated. The piezoelectric sensor is used for detecting cracks in the rail tracks using the theory of change in stress or pressure with piezoelectric effect and converts it to electrical charge. The force on rail causes stress that generate voltage [5]. With the help of voltage signal variation MEMS sends the data to node MCU. Here node MCU helps transmit the data obtained wirelessly to cloud database through internet. This data being uploaded can be represented in the form of graphs which keeps updating and recording data and detection of any abnormal activity can be easily noticed in the graph which is updating for every 16 seconds.

**B.MODULE 2: Collision evasion node**

![Fig-4: Block diagram of sensor node-2](image)

This module as shown in Fig-4 uses IR sensors placed on the track to detect the arrival and departures of train. For example in track 1 two IR sensors are placed at a safe distance of 1 to 2 km. The overall operation is controlled by micro controller like Raspberry Pi. When a train enters the track from one side then corresponding led
of first IR will glow and similarly the second IR becomes high when train comes from corresponding side. If both the trains enter at same track simultaneously then first and Last IR pairs are detected then red signal will be given which updates the information to the station and a message is being sent to the concerned train by using Zig-Bee throughout [6]. This helps the train pilot to take spontaneous decision as required. Every second trains status updated at the station, so we can predict accidents and we can navigate them to congestion free travelling.

C. MODULE 3: Remote train engine node

In this module as shown in Fig-5, railway engine is being demonstrated. When both the IR sensors of the same track is detected simultaneously, a signal is being sent from node 3 to node 2 through wireless Zig-Bee communication. This signal being detected by Zig-Bee module of node 3 forwards it to node MCU resulting in slowing down of train automatically and also decreasing the intensity of LED indication. Sensors for crack detection and damages in the railway track.

![Fig-5: Block diagram of sensor node 3](image)

<table>
<thead>
<tr>
<th>Sensors</th>
<th>Pace electric (mV)</th>
<th>MEMS Accelerometer (degrees)</th>
<th>Ultrasonic sensor (CM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.00</td>
<td>100</td>
<td>450</td>
<td>205</td>
</tr>
<tr>
<td>21.15</td>
<td>0</td>
<td>408</td>
<td>97</td>
</tr>
<tr>
<td>21.30</td>
<td>0</td>
<td>432</td>
<td>212</td>
</tr>
</tbody>
</table>

TABLE-1: Data Acquisition by Sensors
5 RESULTS:

The data which is obtained in Table-1 through the entire process by the sensors is stored at the cloud database and updated every 16 seconds using Thingspeak cloud database online service. The data being recorded is represented in a graphical format, where any change in surrounding or defect in the railway track can be easily noticed in the graph plotted on the x and y axis.

![Fig-6: Pressure variations measured on the rail tracks](image1)

In the Fig-7 graphs plotted for MEMS accelerometer with Y axis representing degrees and X axis representing the time interval. The sudden decline in the graph plots represent the sudden tilt in degrees which has occurred on the track between 21:00 hrs. to 21:30 hrs. and also helps us to predict how much severe the situation is. In Peizo electric sensor as in Fig-6, the x axis represents the time period and y axis represent...
the values of pressure. As the piezo sensor the pressure variance on it which occurs when train passes through it creates a voltage variation which is represented in the graph. The sudden shifts in voltage variation which has occurred on the track between 21:00 hrs. to 21:30 hrs. help us recognise how much break exists in the track. In ultrasonic sensor as in Fig-8, the x axis represents the obstacle distance measured by the ultrasonic sensor which has occurred on the track between 21:00 hrs. to 21:30 hrs. Thus ultrasonic sensor not only helps in detecting obstacles by sending the trigger and receiving the echo but also helps us in knowing the acceleration of the approaching obstacle and how close it is to the track. Using these three sensors, the most frequent and majorly occurring accidents and collisions like train derailment and collision is avoided by not only detecting and graphically representing data on the cloud but also by evasion of collision through use of interface of sensors and IOT. Thus overall avoiding and reducing the probability of accidents occurring in future to a bare minimum.
6 Conclusion:

The system successfully designed here ensures the well-being of passengers and also increases the service time of the track, decreasing the inspection that often causes train delays and congestion. The major probability causes of which accidents occur are eliminated by using sensors which measure different irregularities that are present in the track. With data acquisition data is safely uploaded to internet which can be accessible at any time by respective authorities. Thus while protecting the durability of rail track, we prevent collisions using our collision evasion module which alerts us beforehand of any possible railway collisions that occur by sending SMS using IOT to the concerned authority. This system can reinforce and reform the integrity of railway systems through and ease its functioning without damage of life and property.

7 FUTURE WORKS:

Further research to improve conditional monitoring. Providing real-time information this research idea can move towards the systems which gives information and also designing a security firewall prevent data log from unauthorised use. An integrated multifaceted approach which can improve prediction quality.

References


