SMART INDIA HACKATHON 2024

➤ **Team: TopCoders**

- **Problem Statement ID:** 1584

- **Problem Statement Title**: AI based acoustic wave monitoring of rail defects like cracks, fracture and prediction for rail wear, quality along with other parameter.

- **Theme:** Transportation & Logistics

- **Category:** Hardware

- **Team ID:**

- **Team Name:** TopCoders

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TEAM MEMBERS

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PROBLEM STATEMENT

Rails are used for the movement of trains and if there are major defects in the track then accident may happen or passenger comfort in train may be compromised. Rail defects such as cracks, fractures, and wear are critical issues in the railway industry, leading to safety hazards, operational disruptions, and increased maintenance costs. Early detection and prediction of these defects are essential for ensuring the reliability and safety of railway infrastructure.

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1 The general public, commuters, and tourists all travel by train, and their safety is compromised if railway tracks are unfit for day-to-day operations

2 Similarly, freight safety and dependability are critical components of the supply chain, necessitating fault-free and fault tolerant railway tracks.

3 A lack of regular visible maintenance, preemptive inspections, delayed problem detection, all generate severe concerns about the security of rail transit operations in India

4 Manual methods are laborous, and inefficient. Hence, automating the process is essential in order to increase the efficiency and ensure smooth and regular check ups of the tracks.

5 Integrating AI to the task enables prediction and prevention leading to better maintenance and smooth repairing at budding stages of arising problems

TECHNICAL APPROACH

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Develop a tool that is able to uses the acoustic based systems for detection of defects in the tracks and make it compatible with the speed of trains.

Integrate IoT and Cloud based services for seamless and real time communication of data and its processing.

Using AI-ML technology to observe patterns through various times, seasons and locations in order to predict and prevent damages along the tracks. It should also be able to suggest measures to tackle the situations over time.

Creating a software to alert the railway men if any new defects are either detected or predicted and take suitable action depending on the severity, location and type of defect.

PROCEDURE FOR FINDING DEFECTS USING ACOUSTIC WAVES & AI

- The idea is to install a comprehensive acoustic system onto the trains which will be IoT enabled linking it to a cloud service.
- The device will be transmitting and receiving narrowband Rayleigh waves at high frequency and sharing the received signals, location and timestamp to the cloud for real time processing.
- The ML algorithm analyses the their velocity, attenuation, scattering, resonance, and frequency absorbing properties and looks for any defects.
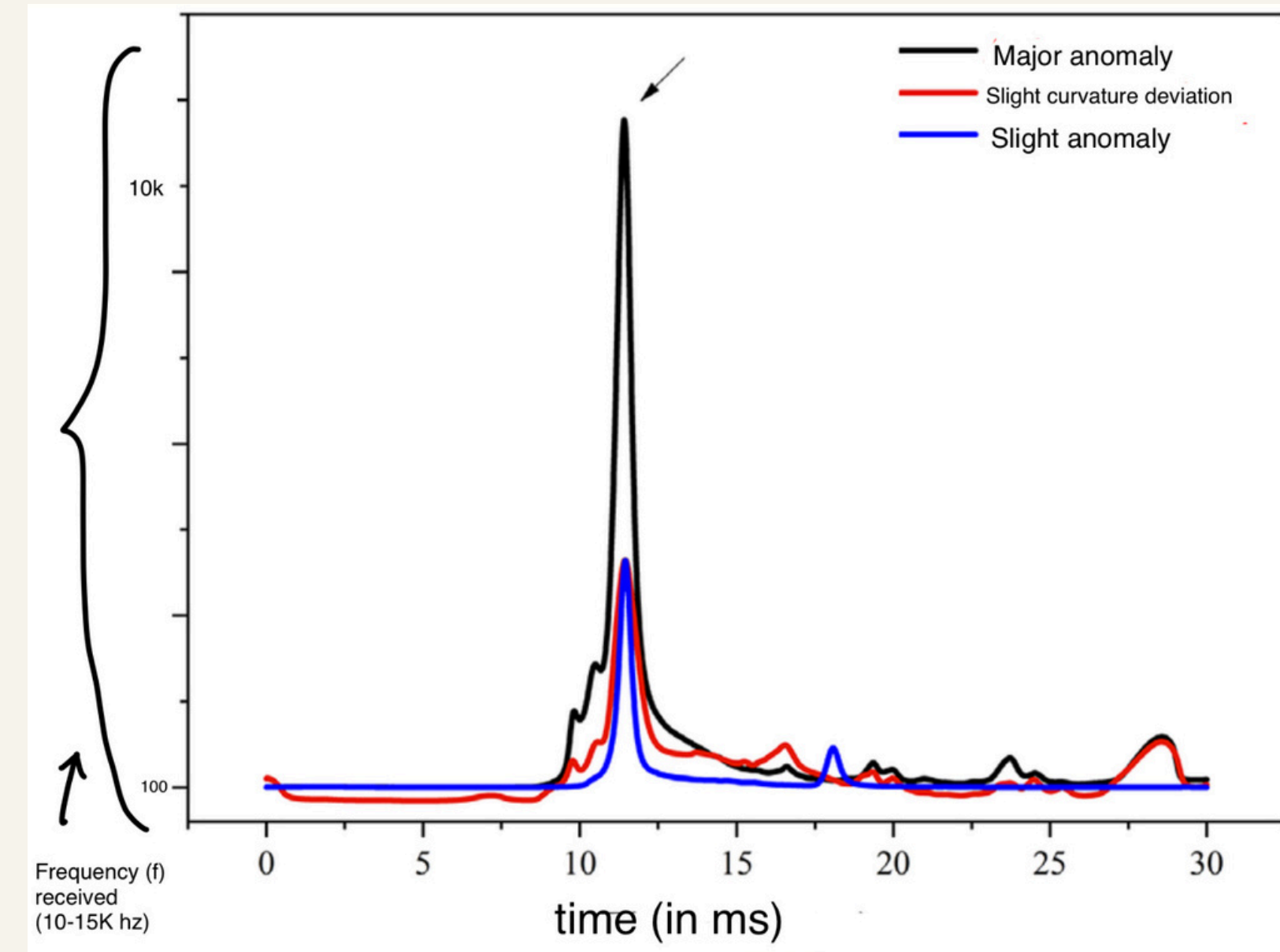
- Neural network models like perceptron will be used to filter out the false positive to increase efficiency of the model.

- Models such as Logistic Regression will be integrated. Artificial intelligence will be integral in forwarding the results to the nearest station and looking for the best course of action if any contingencies are detected .

- We will take in consideration the weather conditions while training the models, further increasing the efficiency of accident and defect predictions based on seasonal patterns as well. Hence we'll be able to prevent collisions as well.

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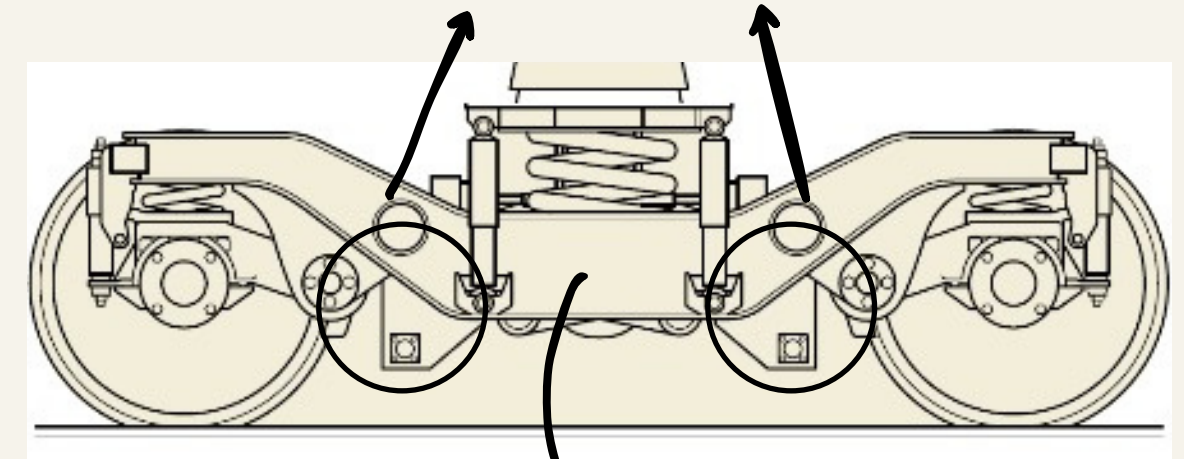
COMPONENTS INVOLVED

- **Piezoelectric transducers with comb adapters** - For transmitting and receiving surface acoustic waves.

- **Arduino:** For IoT integration.

- **NEO-6M GPS receiver module:** tracking the location

- **DHT11 :** temperature and humidity sensor for monitoring weather conditions.
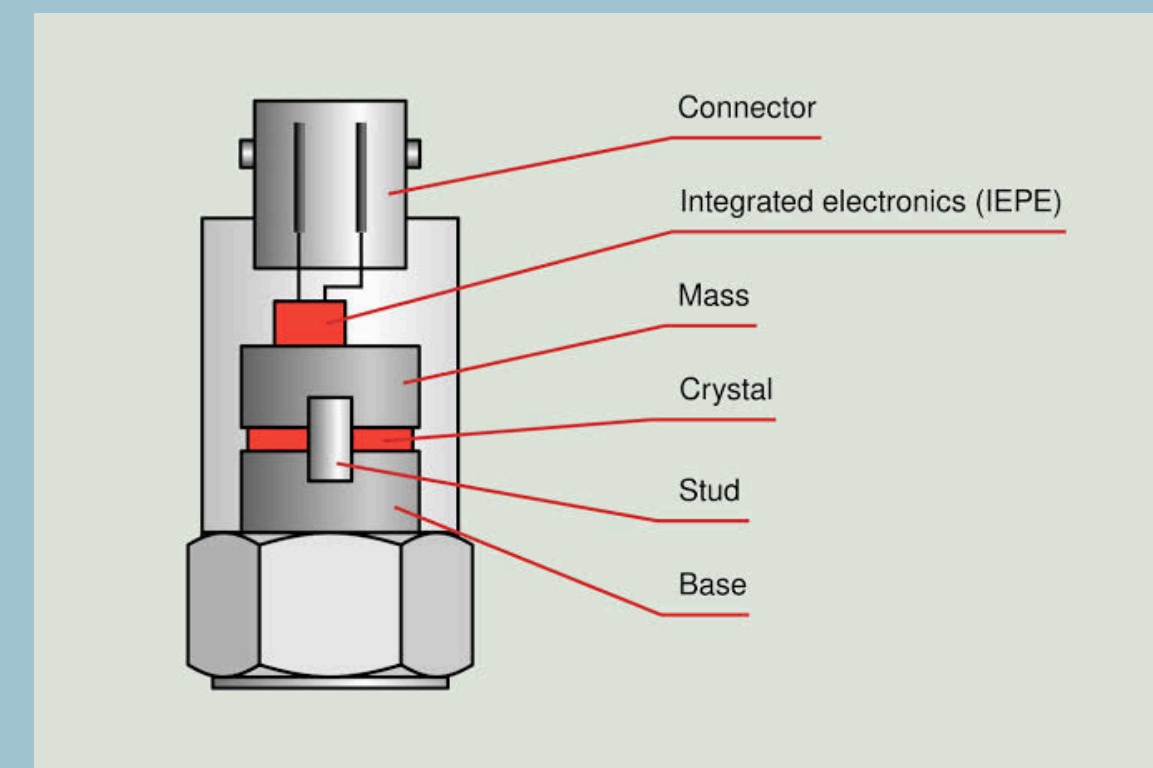
- The circuit along with the transducers are embedded in a closed system and are mounted onto both sides of the train, preferably on one of the initial carriages.

- The surface acoustic waves are transmitted longitudinally onto the tracks and received after reflection. The received waves are sent to the cloud (along with location and time stamp).

- The ML algorithm analyses the signals and looks for defects

- In case a defect is detected, the nearest station master is alerted with suggested measures to be taken as well by the AI algorithm.

point is installation of reciever

point is installation of Transducer

Permanent mounting

Mounting base with adhesive

Electric motor mounting base with adhesive

Screwed to the surface

Centre pin
Side bearer
Bogie bolster
Wheelset (Axle and wheels)
Cast steel side frame
Brake beam
Bolster springs