

# **AI-ENHANCED ACOUSTIC MONITORING FOR PREDICTIVE RAIL MAINTENANCE AND DEFECT DETECTION**

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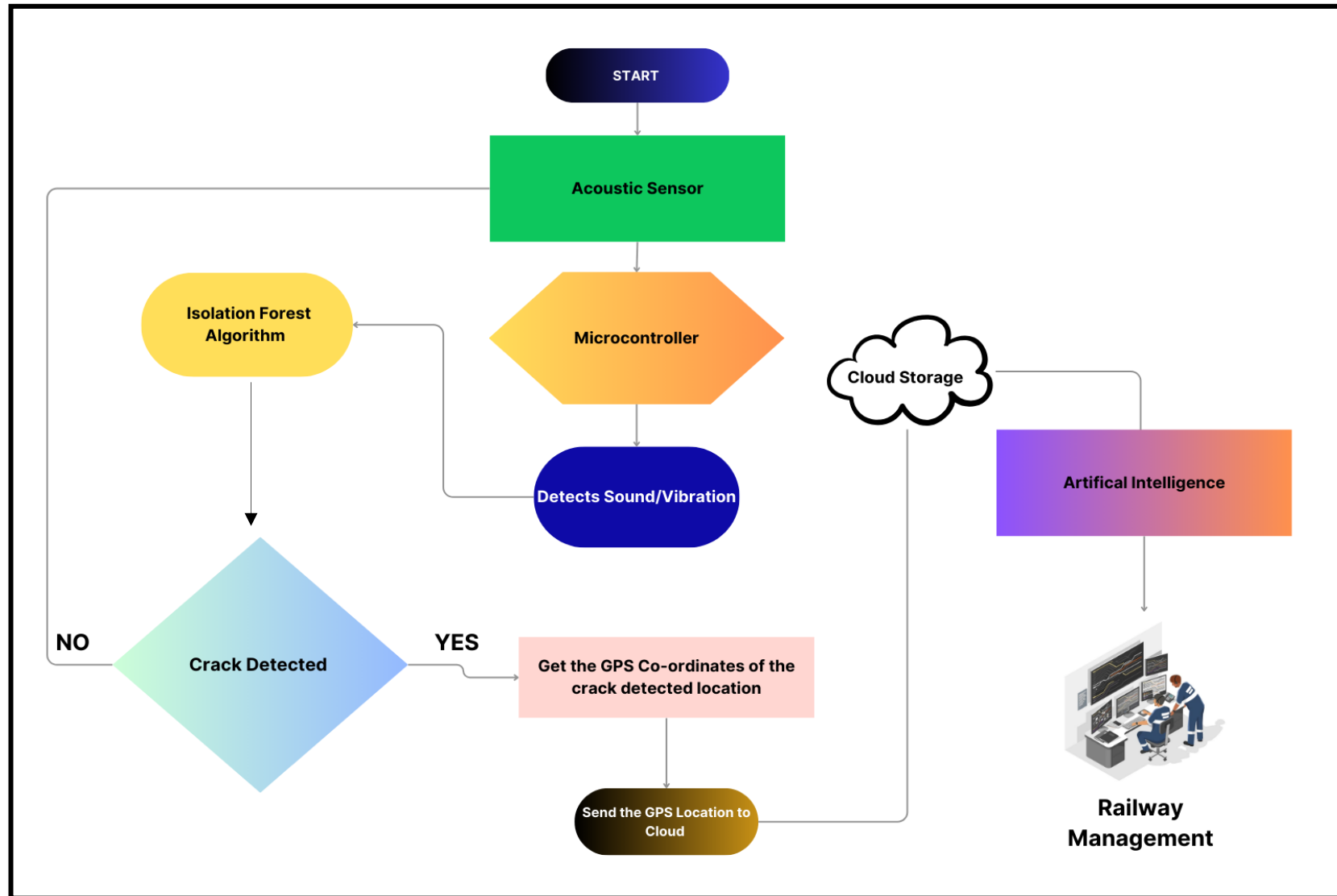
**Electronics and Communication Engineering / Third year**

**R.M.K ENGINEERING COLLEGE**

# PROPOSED SOLUTION

- ❑ In the proposed solution ,We are using **Acoustic sensors** along the rail tracks to continuously collect data.
- ❑ Real-time preprocessing improves signal quality and extracts waveforms by **filtering noise** and normalizing data for accurate defect detection.
- ❑ Advanced ML technique **Isolation Forest algorithm** is used to find unusual patterns or anomalies in data, helping to detect defects in rail cracks.
- ❑ The system sends automatic alerts with **GPS location** details when a crack is detected, and also stores this data in the cloud .
- ❑ Regular updates and maintenance of the **AI models** and sensors ensure the system stays accurate and adapts to changing conditions.

# FLOW DIAGRAM



# TECHNICAL APPROACH

## ❖ Modules and Technology Stack :



### **HARDWARE :**

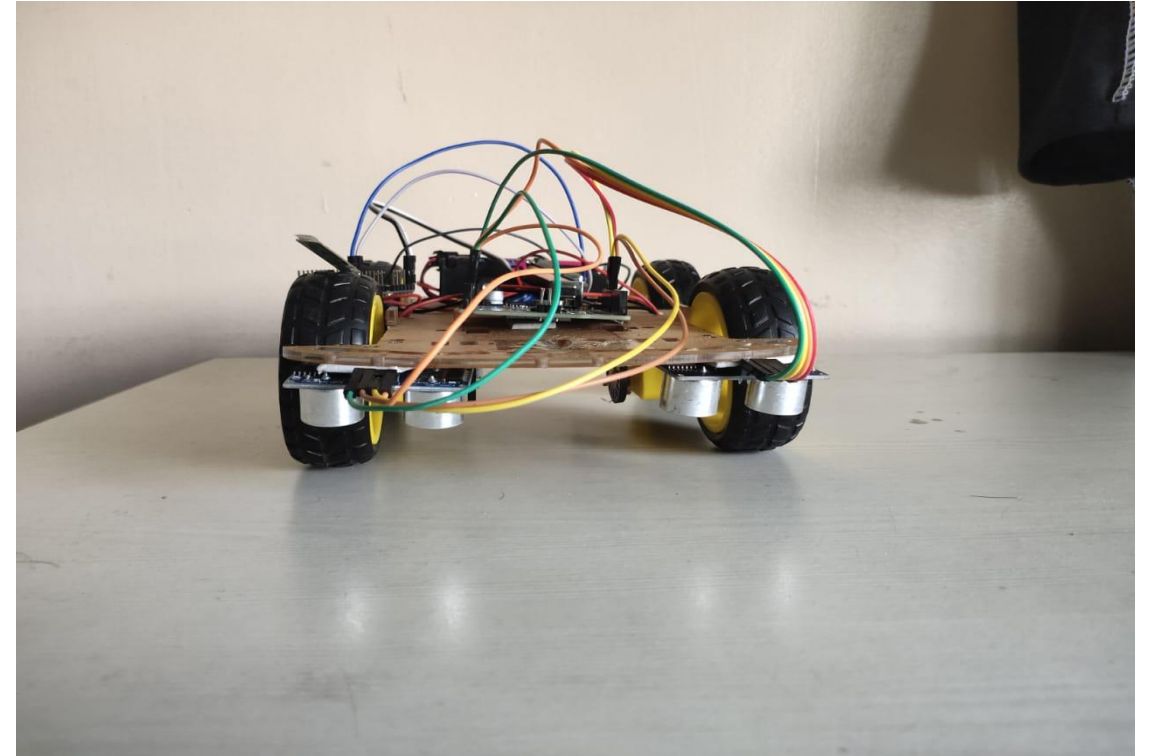
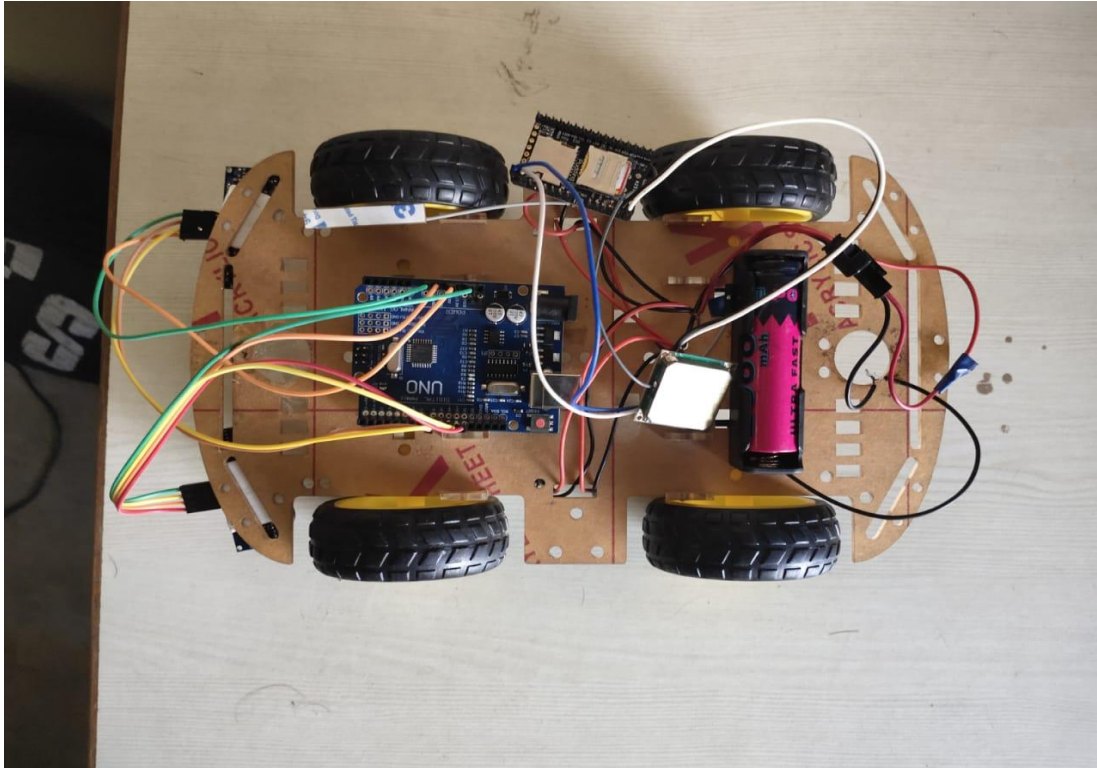
- Microcontroller
- Sensor Module
- A9G Module/GPS Module



### **SOFTWARE :**

- Machine learning algorithm - Isolation Forest
- Cloud Storage - Adafruit IO
- Libraries – scikit-learn library

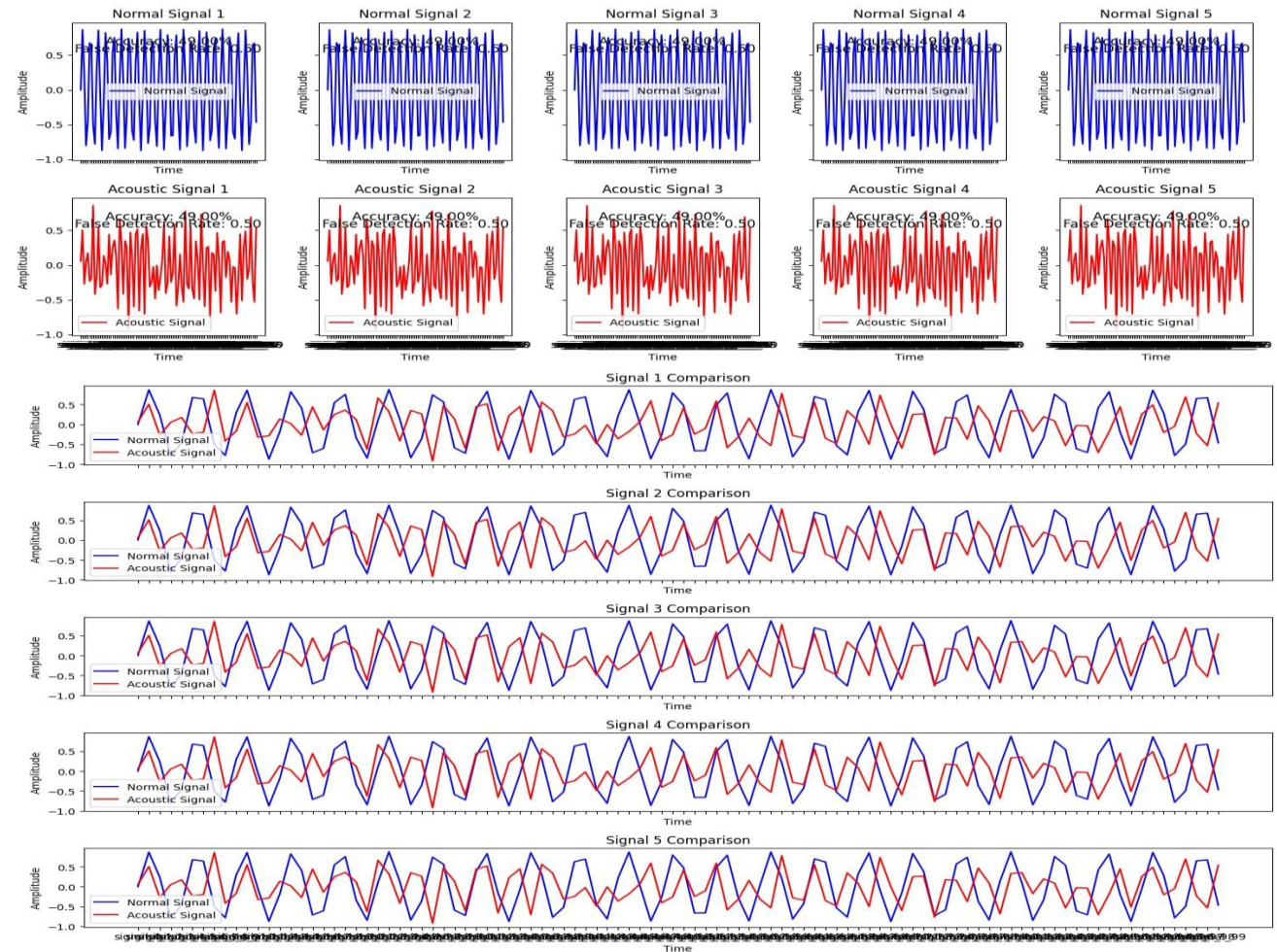
# PROTOTYPE



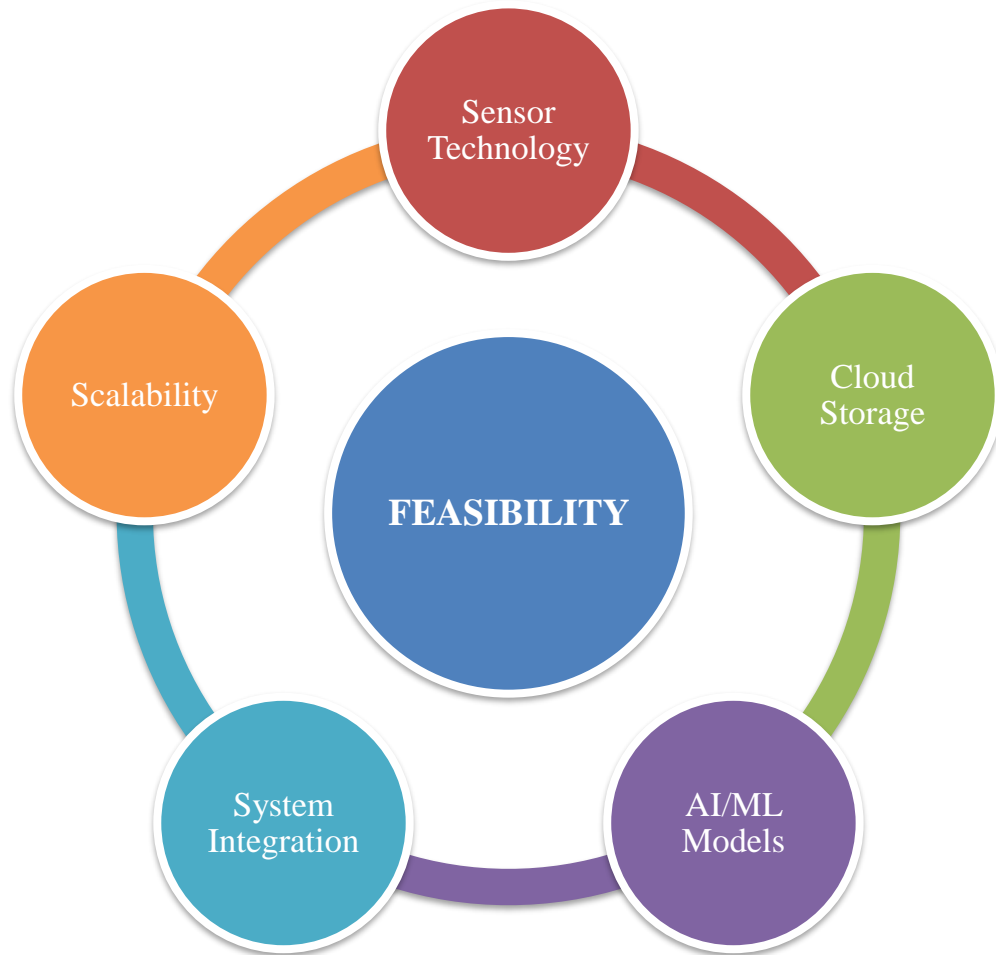


# RESULT OBTAINED BY USING SENSORS AND ML TECHNIQUE

Test Sample 585: No Crack Detected  
 Test Sample 586: Crack Detected  
 Test Sample 587: Crack Detected  
 Test Sample 588: Crack Detected  
 Test Sample 589: Crack Detected  
 Test Sample 590: Crack Detected  
 Test Sample 591: No Crack Detected  
 Test Sample 592: Crack Detected  
 Test Sample 593: No Crack Detected  
 Test Sample 594: Crack Detected  
 Test Sample 595: Crack Detected  
 Test Sample 596: Crack Detected  
 Test Sample 597: No Crack Detected  
 Test Sample 598: No Crack Detected  
 Test Sample 599: Crack Detected  
 Test Sample 600: Crack Detected



# FEASIBILITY AND VIABILITY



# IMPACT AND BENEFITS

- ❑ **Increased Safety:** Early detection of track defects **reduces accident risks**, ensuring the safety of passengers and railway staff.
- ❑ **High Efficiency:** Proactive issue identification minimizes downtime, keeping trains running **smoothly and improving operational** efficiency.
- ❑ **Cost Reduction:** Addressing minor defects before they escalate **saves on repair costs and avoids expensive** disruptions.
- ❑ **Extended Track Life:** Regular monitoring and timely repairs help extend the **lifespan of rail** infrastructure.
- ❑ **Enhanced Reliability:** Fewer unexpected failures lead to more **reliable and consistent** rail service.



# FUTURE ENHANCEMENT

In future developments, **laser Edging** could enhance rail maintenance by detecting and **marking cracks** with precision. When a crack is found, the system would use a laser to **highlight its exact location** on the track. This visible mark would help maintenance crews **quickly locate and fix the issue**, leading to faster repairs and improves safety.

# RESEARCH AND REFERENCES

- ❑ **“A Novel Approach to Railway Track Faults Detection Using Acoustic Analysis”** By Dr. Saleem Ullah , Rahman Shafique and Furqan Rustam (2021).
- ❑ **“Crack Detection System for Railway Tracks by Using Acoustic Emission Sensor”** By R. Swetha and S. Kayalvizhi (2017).
- ❑ **“A Machine Learning-Based Approach for Fault Detection of Railway Track and its Components”** By Johnny Asber (2020).
- ❑ **“An initial investigation on the potential applicability of Acoustic Emission using ML techniques to rail track fault detection”** By Kristoffer Bruzelius and D Mba (2014).