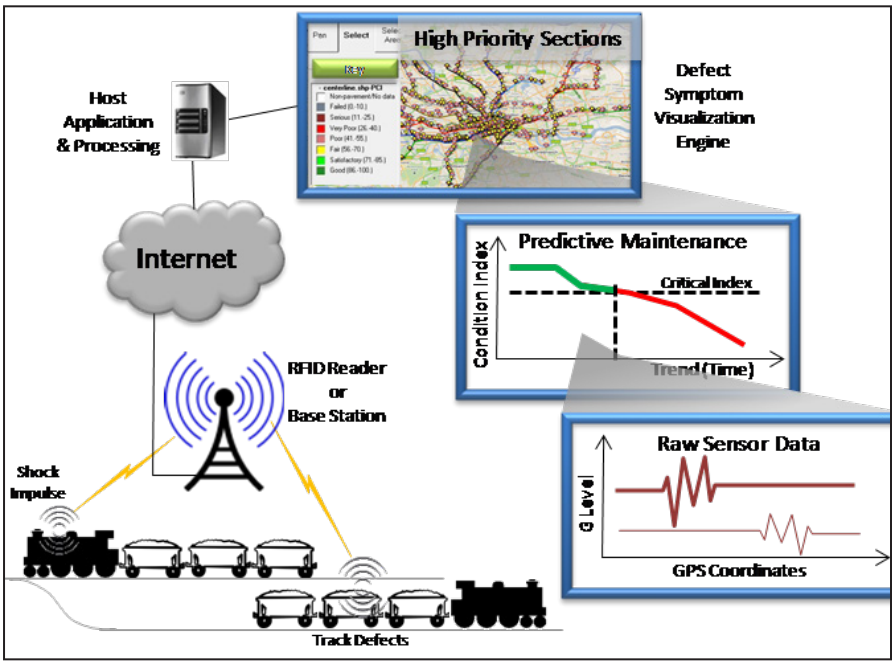
MOUNTAIN-PLAINS CONSORTIUM

RESEARCH BRIEF | MPC 21-445 (project 551) | November 2021

Track Surface Irregularity Position Localization with Smartphone-Based Solution



the ISSUE

Tracks are a critical and expensive railroad asset, requiring frequent maintenance. Railroads rely on the accurate localization and identification of the track anomalies that could cause serious damage to infrastructure, environment, and the traveling public. However, the current method of inspection and maintenance is expensive, slow, increases the safety risk to workers, and requires closing the track. Also, the technical limitations of present methods prevent their network-wide scaling to all railroads.

the RESEARCH

Smartphones have become a flexible and convenient tool in the development and testing of an automated track monitoring system that uses dedicated sensors onboard regular service trains. Therefore, this research introduced a framework that considers a technique called “ensemble average,” which leverages a large number of sensor signals collected from multiple traversals of a railway segment to enhance the signal’s quality and reduce the detection error. Subsequently, the method increases the signal-to-noise ratio and reduces false positive and false negative rates. Moreover, the signal quality improves continuously with the additional data.

The developed technique uses distance interpolation, heuristic, and correlation alignment to align the signals across the traversals. The algorithm then extracts the feature from the aligned and filtered signals. Experiments were conducted to demonstrate the reliability and accuracy of the employed method. Tradeoff analysis found that a window size of 5 meters provided a good balance between data reduction, accuracy, precision, and the consistency of anomaly detection while minimizing the potential for false positives and false negatives. Hence, the framework methods with ensemble averaging can be generalized to any sensor data from multiple traversals.

MOUNTAIN-PLAINS CONSORTIUM REGION 8

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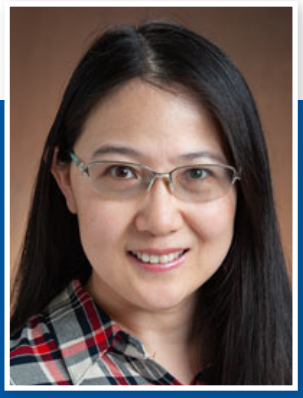

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Project Title

Automated Track Geometry Monitoring System

Sponsors | Partners

Northern Plains Railroad (in-kind support)

USDOT, Research and Innovative Technology Administration

the FINDINGS

The method employed a road impact factor (RIF) transform to extract features from the sensor signals that are proportional to the amount of track geometry irregularity. The method reduces the data by generating RIF features from the rotational rates. The authors validated the accuracy of the method by comparing the estimated positions of detected irregularities with the actual positions of irregularities called ground truth area (GTA), which the railroad inspector observed. It is found that the estimated position of the irregularity is within a reasonable visual distance of the actual position so that it can be seen during a manual follow-up inspection. Moreover, the applied approach suggests that the methods have low computational complexity and are easy to use in practical applications.

the IMPACT

The research enhanced the ability to improve detection and localization accuracy of rail irregularities through ensembled data, which dramatically reduced the needs for more expensive high-resolution sensors. The enhanced detection accuracy will promote users' confidence to adopt the application in the future. Doing so will enhance their ability to monitor track condition automatically and continuously to better allocate resources for safe track inspection and repair.

For more information on this project, download the Main report at https://www.ugpti.org/resources/reports/details.php?id=1049

For more information or additional copies, visit the Web site at www.mountain-plains.org, call (701) 231-7767 or write to Mountain-Plains Consortium, Upper Great Plains Transportation Institute, North Dakota State University, Dept. 2880, PO Box 6050, Fargo, ND 58108-6050.