



NSF CREST MECIS – Fall 2026 Webinar Series – 11/6/2026

Presentation 1: Elian Cantu (Master's Student), Dr. Jinghao Yang, University of Texas Rio Grande Valley (UTRGV)

Title: Machine Learning-Based Prognostics for Freight Rail Bearing Health Using Vibration Time-Series Data

Abstract:

Tapered roller bearings are critical components within the suspension system of freight railcars and are continuously subjected to demanding operating environments. Heavy cargo loads, high-speed operation, and prolonged service life contribute to progressive wear and increased mechanical stress over time. The failure of a single bearing can cause serious damage to nearby components or to the track. Consequently, railcar bearing condition monitoring plays a vital role in improving railway safety and maintenance efficiency by enabling a transition from reactive repair strategies to prognostic maintenance. Although extensive controlled experiments on freight rail bearings have been conducted, a persistent gap remains between laboratory data and the reliable prediction of bearing health under varying operational conditions. The University Transportation Center for Railway Safety (UTCRS) has developed bearing-tester rigs equipped with onboard accelerometers for continuous monitoring, with the measured vibration response serving as an indicator of bearing health. This study evaluates a stacked long short-term memory (LSTM) network, an encoder-decoder LSTM network, and time-series foundation models for predicting railcar bearing vibration trends. The effectiveness of synthetic data augmentation is also investigated.

Presentation 2: Silvia Flores-Osuna (Master's Student), Dr. Gasser Ali, University of Texas Rio Grande Valley (UTRGV)

Title: Improving Rail-Highway Grade Crossing Safety using Computer Vision and Artificial Intelligence for Traffic Tracking

Abstract:

Every year, the Federal Railroad Administration (FRA) reports thousands of accidents involving pedestrians and vehicles at grade crossings. To reduce these numbers, transportation agencies prioritize safety improvements at crossings by using traffic information. One commonly used metric is the Annual Average Daily Traffic (AADT), which measures traffic at specific road segments or crossings throughout the year. The FRA maintains this information for every crossing. However, many of these records are outdated or missing, which can be attributed to the difficulty and cost of collecting this data. Therefore, there is a need for a flexible and autonomous system that can be deployed to automatically track and keep count of pedestrians and vehicles crossing the tracks. To meet this need, this study proposes an artificial intelligence framework that integrates computer vision with deep learning to monitor traffic at crossings. The developed model can automatically mark rails, detect and track vehicles, and report AADT and potential hazards. The model is intended to be easily deployed at any crossing using regular cameras. The outcomes of this research will support decision-making in the rail industry to improve safety at crossings.



Presentation 3: Amanda Rodriguez (Master's Student), Dr. Jinghao Yang, University of Texas Rio Grande Valley (UTRGV)

Title: Optimization and Field Evaluation of an Optical Crack Detection System for UAV-Based Infrastructure Inspection

Abstract: UTRGV.EDU/MECIS

X This research focuses on the optimization and experimental evaluation of an optical crack detection system intended for future integration with an unmanned aerial vehicle (UAV) for infrastructure inspection. The system uses a 980 nm infrared laser and erbium-doped lithium tantalate nanoparticles, which produce an optical emission near 1550 nm when excited by reflected laser light. Building on a previously developed sensing system, several modifications were implemented to improve its performance, including a higher-power laser, a beam reducer to decrease the laser spot diameter, and an updated optical receiver. The modified system was evaluated under laboratory and outdoor conditions using a motorized linear guide to move the sensor across stationary crack samples at controlled speeds. Experiments were conducted at sensing distances ranging from 0.61 to 2.74 m using crack widths ranging from 0.1 to 10 mm. Experimental results demonstrated the ability to detect cracks as small as 0.1 mm, although detection performance varied depending on crack width and sensing distance. Crack width measurements for cracks 1 mm and larger generally exhibited percentage errors below 10% during outdoor testing. Additional work focused on adapting the sensor electronics to operate using the UAV power system and evaluating wireless data acquisition to support future UAV integration. The results demonstrate the ability of the improved optical sensing system to detect and measure cracks under laboratory and outdoor conditions, providing a foundation for future UAV-based infrastructure inspections.

Presentation 4: Casandra Saucedo (Master's Student), Dr. Constantine Tarawneh, University of Texas Rio Grande Valley (UTRGV)

Title: Toward the Development of a Nanocomposite Gas Sensor Using a Four-Point Probe Resistance Measurement.

Abstract:

This research focuses on the development of a reliable, portable gas sensing system for the detection of carbon monoxide (CO) and carbon dioxide (CO₂). The proposed sensor utilizes a boron nitride/silver (BN/Ag) nanocomposite sensing material integrated with a portable collinear four-point probe (FPP) electrical characterization platform. Experimental data obtained from the FPP measurements are used to evaluate and optimize the sensor's sensitivity and reliability. Upon exposure to target gases, adsorption on the surface of the BN/Ag nanocomposite induces changes in its electrical resistance, which are monitored in real time using the four-point probe technique. The integration of advanced nanocomposite sensing materials with portable electrical characterization enables accurate and efficient gas detection in field environments. This work contributes to the advancement of remote gas sensing technologies and supports applications in industrial safety, critical infrastructure monitoring, and environmental protection.



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