DRISI

CALTRANS DIVISION OF RESEARCH, INNOVATION AND SYSTEM INFORMATION

TRANSFORMING IDEAS INTO SOLUTIONS

Research Notes

Smart Highway Construction Site Monitoring Using Artificial Intelligence

Caltrans would like to detect, monitor, and track the trajectory of various construction elements by machine vision analysis of videos captured on construction and maintenance sites, and use the data for inventory, resource allocation and improving work zone safety and productivity.

Traffic Operations

MAY 2025

Project Title:
Measuring Non-Recurrent Traffic Congestion

Task Number: 3526

Start Date: January 1, 2024

Completion Date: December 31, 2024

Task Manager:
Abdullah Faiyaz
Transportation Engineer, Electrical
Abdullah.Faiyaz@dot.ca.gov

WHAT IS THE NEED?

Caltrans is focusing on improving the work zone safety measures and extending the life of transportation infrastructure by ensuring high-quality construction, maintenance, and rehabilitation. Access to the data-driven performance monitoring and safety enhancement measures are among the key elements at highway construction and maintenance sites. There is need for a smart construction site monitoring tool that can provide performance metrics and enhance the process productivity while reducing the safety risks.

WHAT ARE WE DOING?

Our proposed research project aims to develop and deploy a robust algorithm that can identify, detect, classify, and track different objects in the videos and images captured from the construction and rehabilitation sites, which will be collected from actual construction and rehabilitation projects in collaboration with Caltrans.

The second part of the project will focus on training the deep learning models and improving the accuracy of the classification and detection algorithms.

WHAT IS OUR GOAL?

The main goal of this project is to develop a method to detect, classify, monitor, and track the equipment, workforce, and other surrounding objects during construction, maintenance, and rehabilitation of transportation infrastructure by using artificial intelligence and a deep

Caltrans

DRISI provides solutions and knowledge that improves California's transportation system.

ADA Notice: Users with accessibility issues may contact the California Department of Transportation, Division of Research, Innovation and System Information. For TTY assistance, call the California Relay Service at 711, email: pm2.communications@dot.ca.gov or write Caltrans, DRISI – MS-83, P.O. Box 942873 Sacramento, CA 94273-0001

learning approach. The project goal is in alignment with one of the Senate Bill 1 (SB1) (California Road Repair and Accountability Act of 2017 (SB1, Beall, 2017) high priority research areas related to the maintenance/rehabilitation of road and bridge infrastructure.

WHAT IS THE BENEFIT?

The applications of the developed algorithms in this study include, but are not limited to, improving construction efficiency, advancing the construction monitoring process, and improving work zone safety measures. The outcomes of this project can be integrated into other construction monitoring systems such as Building Information Modeling (BIM) for transportation infrastructure projects.

WHAT IS THE PROGRESS TO DATE?

Contract has ended as of December 2024; Final report has been reviewed and is currently in the closeout process. This research developed and evaluated an AI and deep learning-based method to detect, classify, and monitor construction equipment during transportation infrastructure projects, using a newly created, comprehensive dataset of annotated ground-level images. The trained models demonstrated high accuracy and precision, achieving high confidence scores and showing strong performance in detecting various machinery like dump trucks and graders. While the results highlight the method's potential to enhance safety and efficiency in highway construction, its application is currently limited to ground-level data, with future work needed for drone imagery. Final report is available on the MTI Website: Smart Highway Construction Site Monitoring Using Artificial Intelligence.

The contents of this document reflect the views of the authors, who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the California Department of Transportation, the State of California, or the Federal Highway Administration. This document does not constitute a standard, specification, or regulation. No part of this publication should be construed as an endorsement for a commercial product, manufacturer, contractor, or consultant. Any trade names or photos of commercial products appearing in this document are for clarity only.

© Copyright 2025 California Department of Transportation. All rights reserved.