June 19 - 20, 2025
Hollywood, FL

TRANSPORTATION SYMPOSIUM

AI and Crash Mitigation in Work Zones

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Roadmap

Work Zone Safety Challenges

AI Background

AI Tools

AI Applications in Work Zone Safety

Ideas for AI Use

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Work Zone Safety

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Physical TTC Changes

Channelizing Devices

Barrels, cones, and barriers guide traffic through work zones

Lane Shifts

Temporary geometry changes demand driver attention

Shoulder Closures

Reduced recovery space increases risk

Temporary Pavement

Surface changes affect vehicle handling characteristics

Temporary Traffic Control (TTC) elements physically alter the roadway environment. These changes significantly influence driver behavior and expectations.

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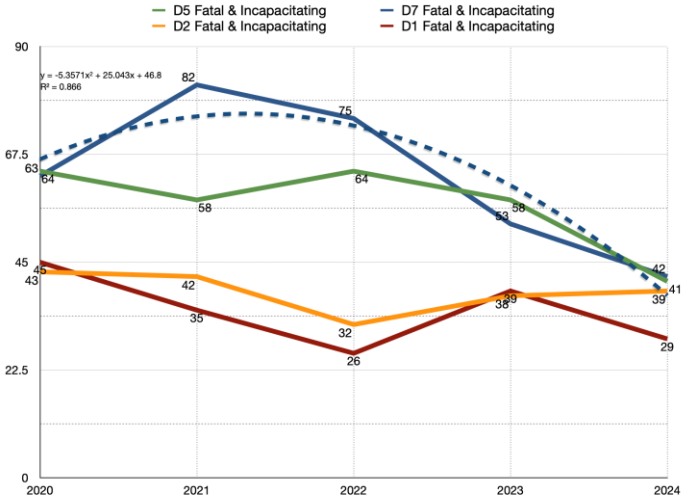
Work Zone Fatal and Incapacitating Crashes



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Tampa Bay Work Zone Safety Progress (2025)

Early 2025 data shows promising trends in the Tampa Bay area, outperforming national averages.

Metric	Jan-May 2025	Annualized	Progress
Total Crashes	510	1,275	Below baseline
Fatalities	3	8	Below baseline
Incapacitating Injuries	14	35	Below baseline

Outperforming National Trends

Tampa Bay area shows better safety metrics than national averages.

Below Baseline Metrics

All three key measurements trending below historical baseline levels.

Continued Vigilance Needed

Efforts must continue to sustain this decline to reach our Target Zero goal for severe injuries and fatalities.

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D7 Work Zone Crash Analysis

Work zone crashes remain a significant safety challenge for District 7, particularly on Interstate highways.

716

Rear-End Crashes

Total rear-end crashes in D7 work zones last year

470

Interstate Incidents

Rear-end crashes occurring specifically on Interstate highways

38.4%

Fatal Crash Rate

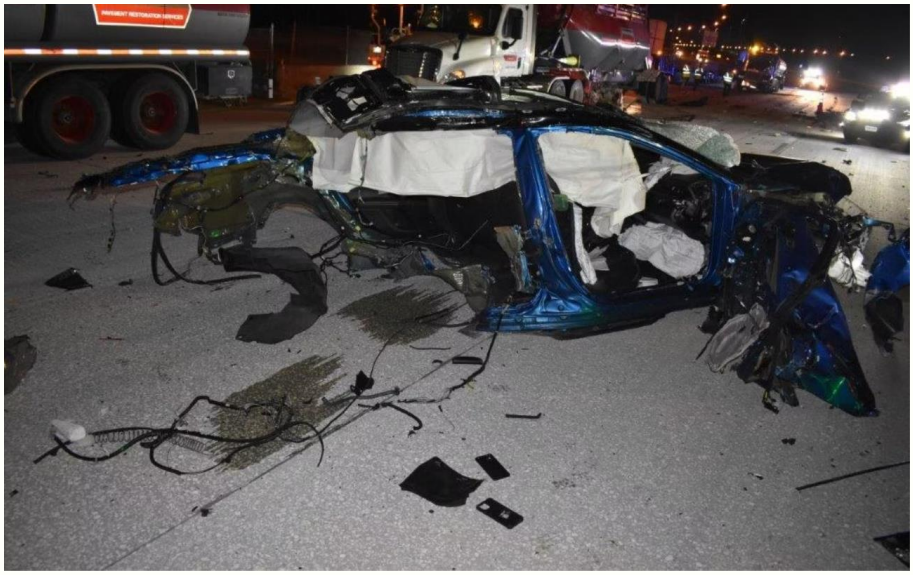
D7 Interstate fatal work zone crashes as percentage of all D7 fatal work zone crashes

884

2024 Interstate Total

Total work zone crashes on Interstate highways in 2024

8



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5 injured after car going over 100 mph in I-4 construction zone causes major crash: FHP

April 2024

> The Florida Highway Patrol said a trooper witnessed a sedan traveling west on I-4 at 102 mph. When troopers attempted to initiate a traffic stop, the driver attempted to flee, reaching 130 mph.

> Troopers said the car continued west until reaching an active construction zone, where all lanes except for one were closed off. It then entered the closed portion of the work zone and collided with two tractor-trailers inside the construction zone.

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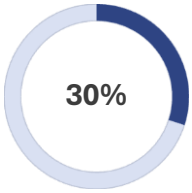
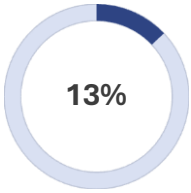
Work Zone Safety: Injuries & Potential Solutions

According the Associated General Contractors of America **(AGC)** Survey released May 2025, Nationally:



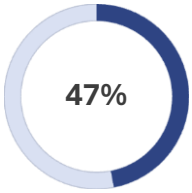
Injury Statistics

30% of contractors experienced worker injuries from collisions. 71% reported driver or passenger injuries.



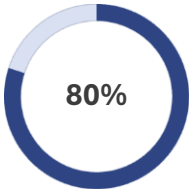
Fatality Reports

13% of contractors reported at least one worker fatality. 24% noted driver or passenger deaths.



Increasing Risk

47% of contractors believe work zones are more dangerous than a year ago.



Recommended Solutions

- Greater police presence (80%)
- Stricter enforcement of existing laws (70%)

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What is AI?

Definition

Artificial intelligence (AI) is the ability of computer systems to perform tasks that normally require human intelligence like learning, reasoning, perception, or decision-making.

Historical Origins

The field's origins trace back to the Dartmouth Conference in 1956, which is widely considered the founding event of AI as a formal academic discipline.

How AI Works

AI systems work by processing large amounts of data, recognizing patterns, and making decisions with minimal human intervention.

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AI Milestones & History

1956 - Birth of AI

"Every aspect of learning or of intelligence can in principle be so precisely described that a machine can be made to simulate it."

1960s - Early Systems

Joseph Weizenbaum developed one of the first chatbots, using simple pattern-matching rules to simulate conversation.

1980s - Expert Systems

Expert systems showcased AI's commercial potential by encoding domain knowledge as complex if-then rules.

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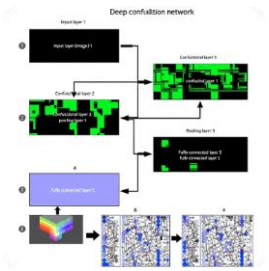
AI Milestones & History - II

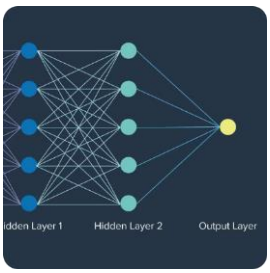
1997 - Deep Blue

IBM's Deep Blue, a massively parallel specialized chess computer, defeated reigning world champion Garry Kasparov in a six-game match.



2012 - AlexNet and DL

Alex Krizhevsky, Ilya Sutskever, and Geoffrey Hinton trained AlexNet, a deep convolutional neural network (CNN), and won the ImageNet LSVRC.



2022 - LLMs Emerge

OpenAI released GPT-4, a transformer-based LLM with over 100 billion parameters, capable of zero-shot and few-shot learning in natural language.

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Some Common Terminology

Learning from Examples = Machine Learning

Layered Pattern-Finding = Deep Learning

Seeing the World = Computer Vision

Reading & Writing Like Humans = NLP and LLMs

Learning by Practice = Reinforcement Learning

Task-Chaining Helpers = AI Agents

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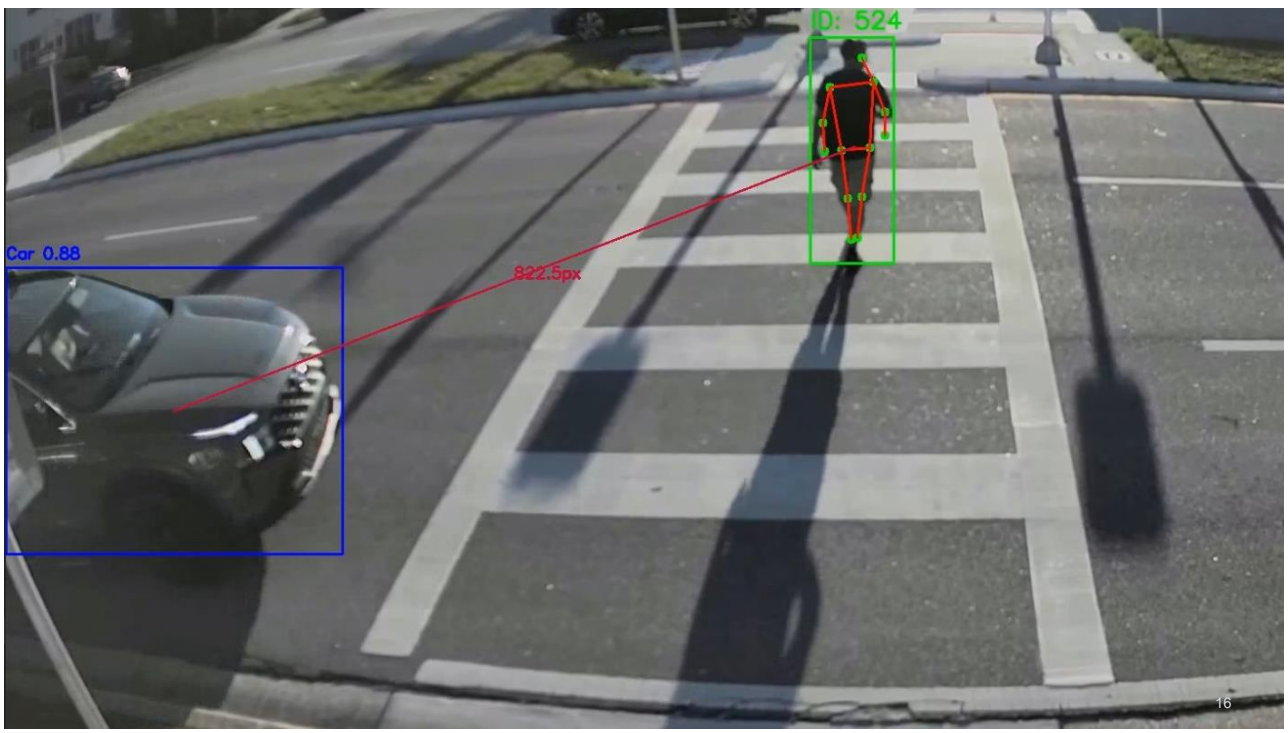

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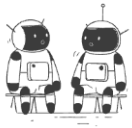
AI Today

Scaling Laws

Model size, data volume, and compute power guide performance gains

Model Context Protocol

Enables AI agents to autonomously select and invoke appropriate tools based on context and goal



Autonomous Agent Paradigms

Leverage MCP-like frameworks to orchestrate multi-step workflows

Self Supervised Learning

Leverages unlabeled data

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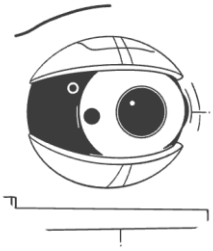
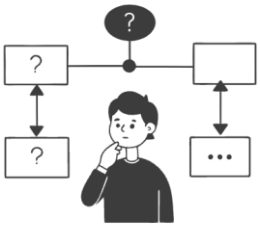
AI Today



Multimodal AI

Models like CLIP and DALL·E fuse vision and language



Reasoning & World Modeling

Future architectures with "common sense"

Edge & On-Device Intelligence

Advances in compute efficiency (compute-optimal design) enable real-time inference on edge devices

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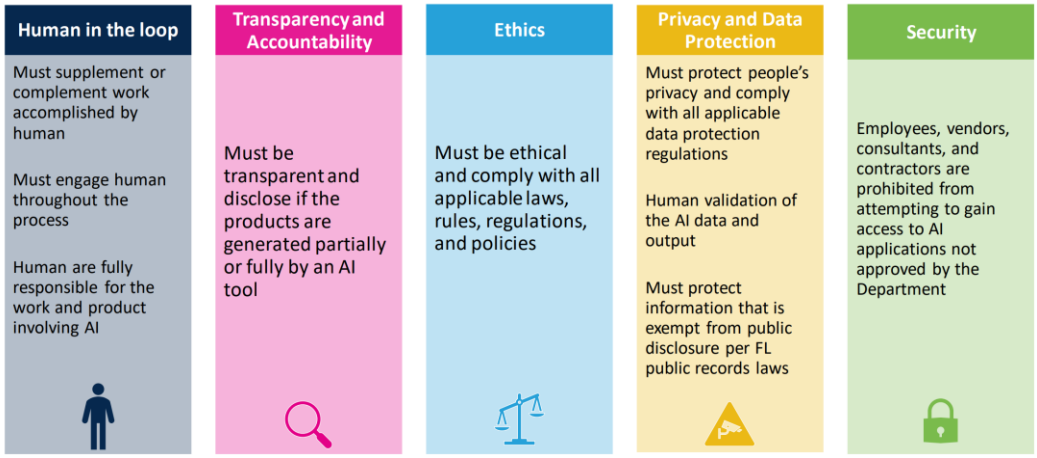
FDOT's AI Policy - Overview



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The Project Lifecycle

Planning

Intelligent pavement management, safety studies, systemic analysis

Design

Planning tools, TTC design tools, safety reviews

Post-Construction

Safety monitoring, before after studies, generate reports

Project Inception

GIS analytics, intelligent estimates based on historic data, draft scheduling

Construction

Work zone AI, tools and strategies for construction monitoring

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Traditional Issue Identification in Work Zones

Current methods rely heavily on reactive rather than proactive approaches:

Field Reviews / RSAs

Manual inspection by engineers and safety personnel / formal reviews by multidisciplinary teams

Public Feedback

Complaints and concerns reported by road users

First-Responder Reports

Information gathered from emergency personnel attending incidents

Crash Analysis

Statistical analysis of crashes after they occur (reactive, not proactive)

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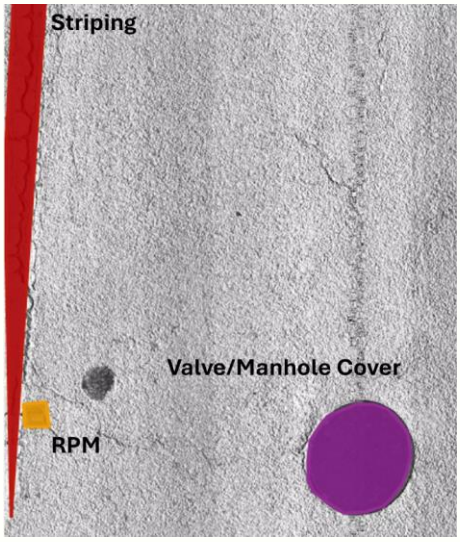

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Camera and Sensor Deployment Types

Static Cameras and Sensors

Portable Camera Systems

Smart Work Zone Systems

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Where is the data processed?

Processing Services

TMC-Side Processing

Devices with Edge Processing

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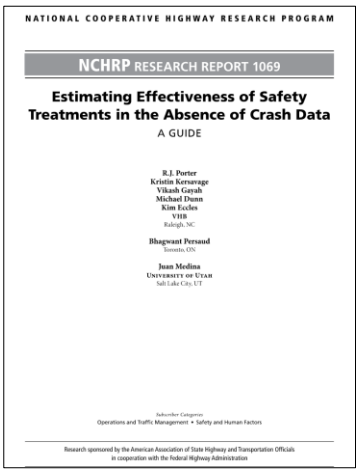
Surrogate Safety Use

What Are Surrogate Measures?

Quantifiable “near-miss” indicators (e.g., Time-to-Collision, Post-Encroachment Time, speed variance) that identify potential conflicts or hazardous behaviors before an actual crash occurs.

Why Not Rely Solely on Crash Data?

Work zones often have low crash frequencies and rapidly changing layouts, making multi-year crash analyses impractical. Surrogates provide early, behavior-based insights when crash counts are insufficient.


NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

NCHRP RESEARCH REPORT 1069

Estimating Effectiveness of Safety Treatments in the Absence of Crash Data

A GUIDE

R.J. Porter
Kristin Kersavage
Vikash Gayah
Michael Dunn
Kim Eccles
VHB
Raleigh, NC

Bhagwant Persaud
Toronto, ON

Juan Medina
University of Utah
Salt Lake City, UT

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Volume and Speed Estimation

Traffic Monitoring & Flow Analysis

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Trajectory Recording & Heatmaps

Traffic Monitoring & Flow Analysis

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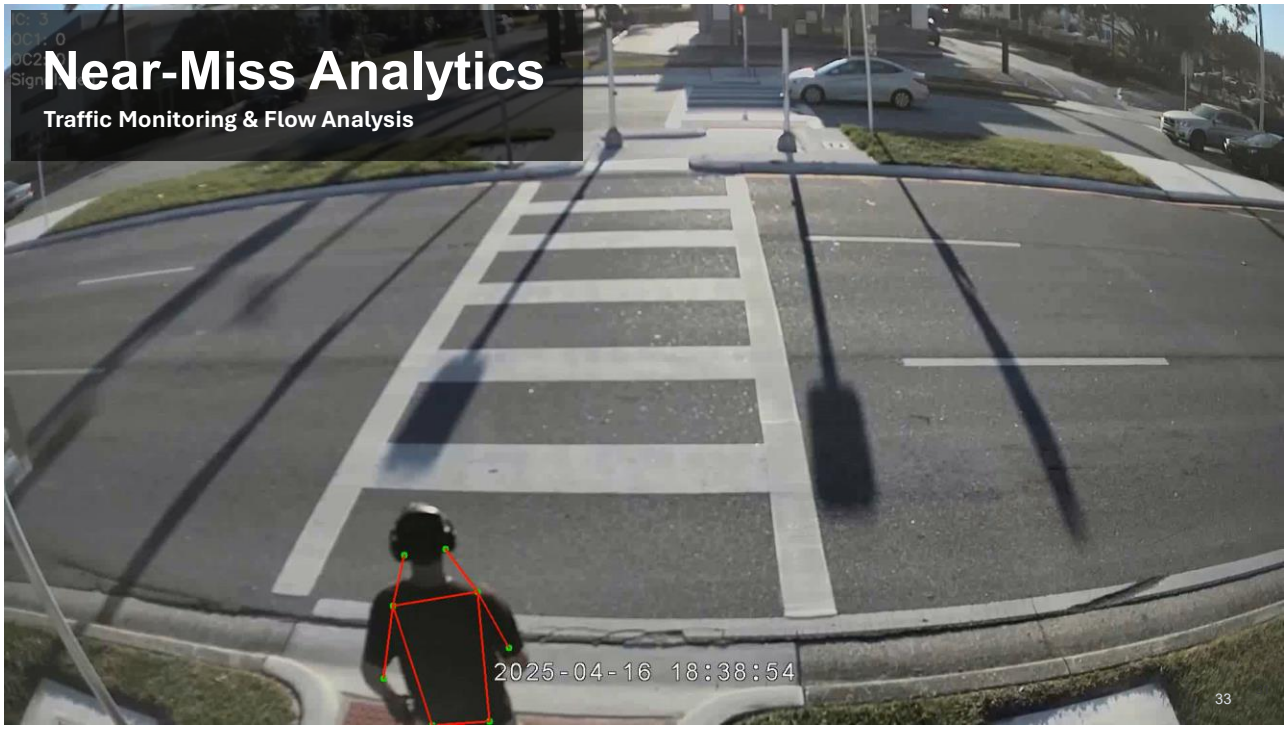
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Traffic Monitoring & Flow Analysis
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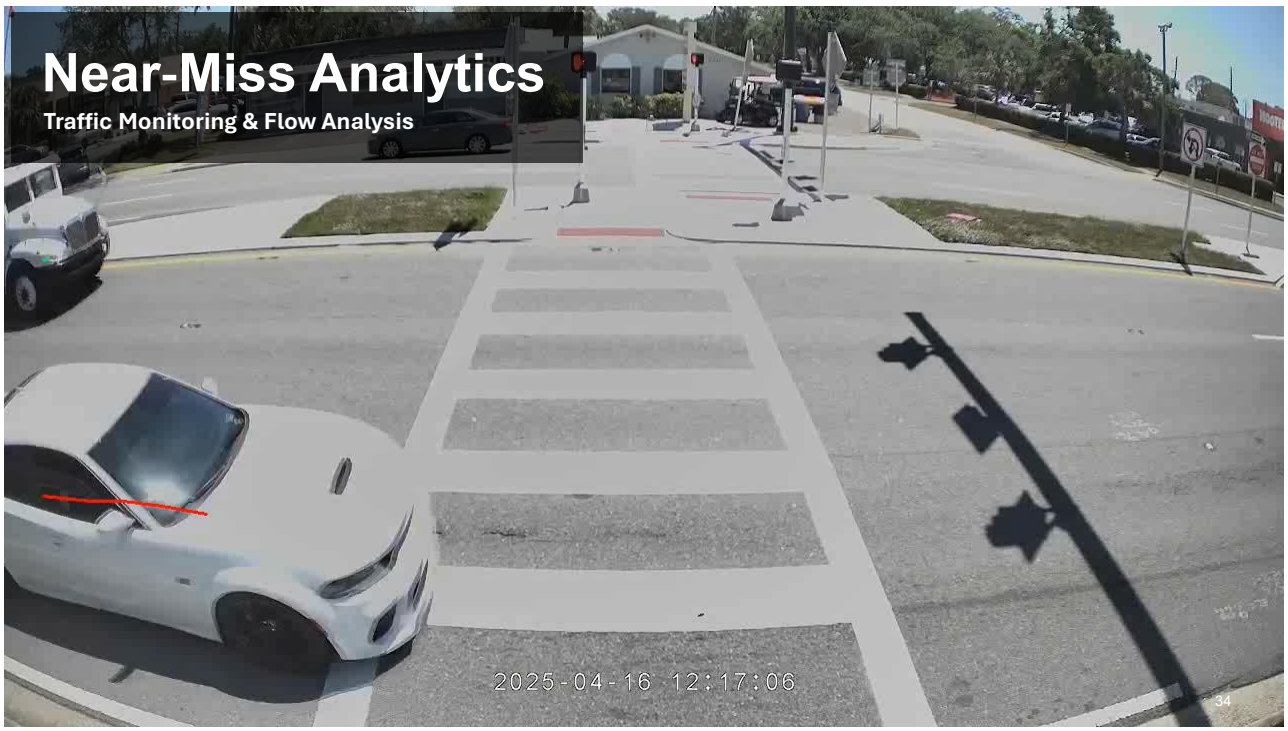
Near-Miss Analytics
Traffic Monitoring & Flow Analysis
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Identifying Unsafe Behavior

Traffic Monitoring & Flow Analysis

US 301 CL Analysis

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Entrance/Exit of Construction Equipment

Work Zone and Worker Monitoring

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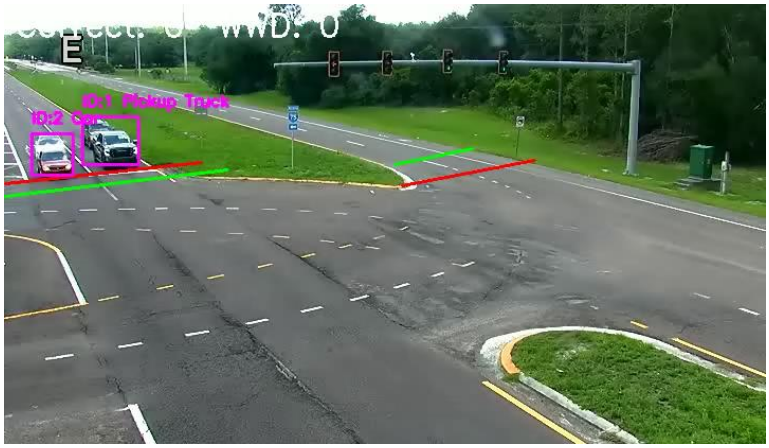
Wrong Way Driving & Work Area Violations

Work Zone and Worker Monitoring



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Worker Presence & PPE Detection

Work Zone and Worker Monitoring

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Encroachment & Intrusion Alerts

Work Zone and Worker Monitoring

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Smart Work Zones Overview

1. Dynamic Lane Merge
2. Queue Detection and Warning
3. Speed Harmonization
4. Variable Speed Limit
5. CV & AV Operations in Work Zones
6. Speed Safety Cameras

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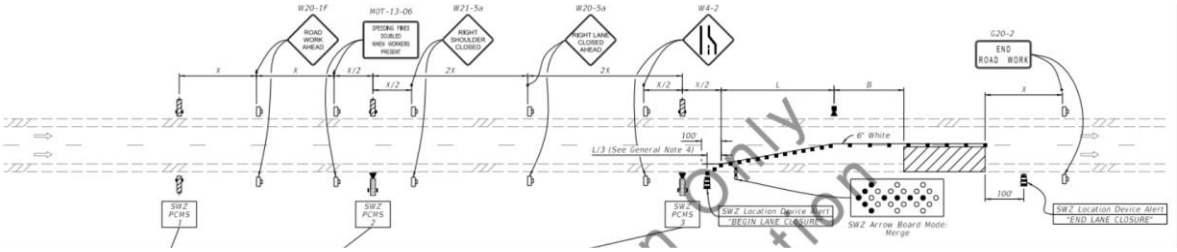
Dynamic Lane Merge

Smart Work Zone Overview



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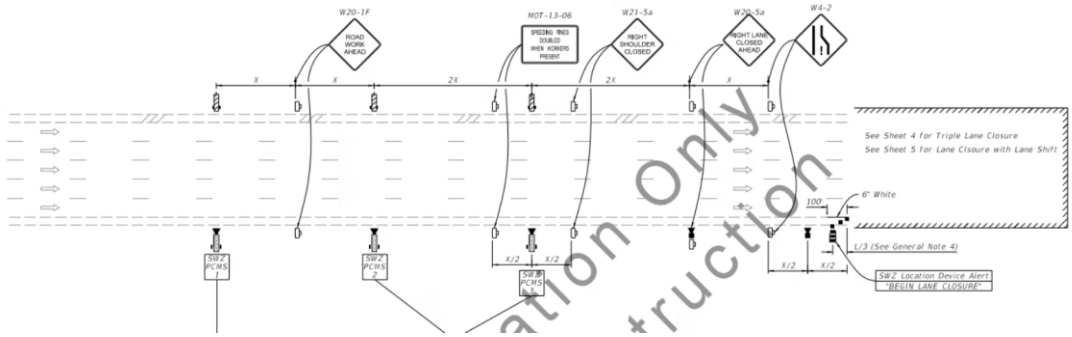
DYNAMIC QUEUE DETECTION AND WARNING

Smart Work Zone Overview



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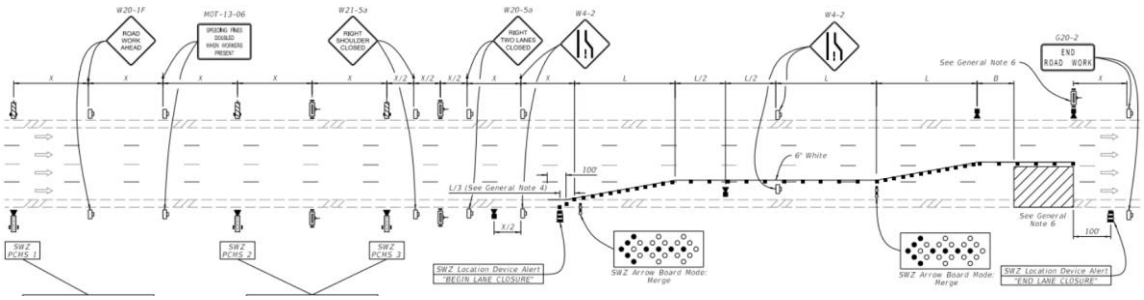
Speed Harmonization

Smart Work Zone Overview



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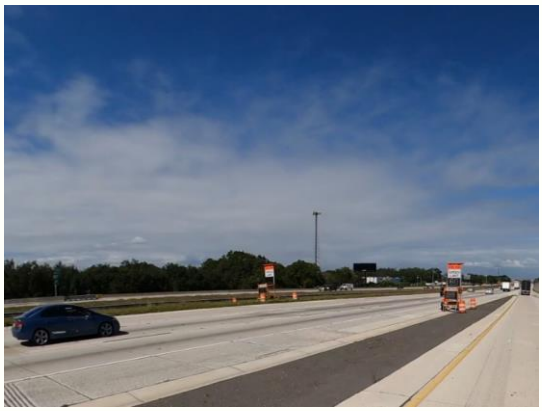
Variable Speed Limit (VSL)



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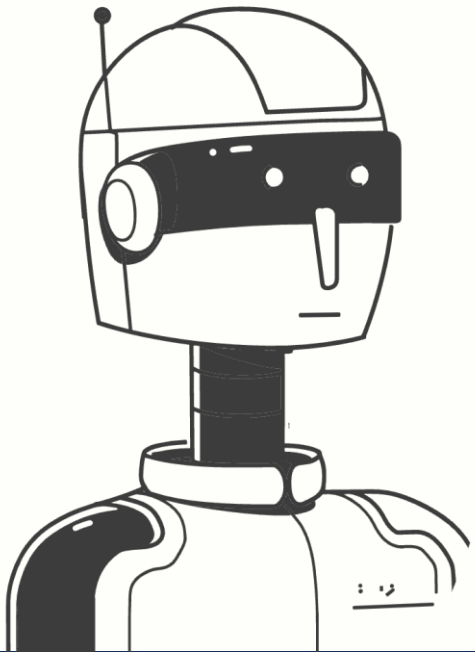

Agentic Workflow Ideas

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Agentic Workflow Ideas

Crash Data Narratives

Just a scan?

Narrative Summaries

LLMs review the context and the narrative, they can extract key metrics from the descriptions

Multimodal FMs

Can offer intelligence into the crash diagram

Large Language Models (LLM)
Optical Character Recognition (OCR)

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Agentic Workflow Ideas

Processed Crash Data and Data Feeds

1

Intelligent Crash Reviews

Summaries, circumstances and probable cause suggested by reasoning model

2

Metrics from Sensor Data

Agentic workflows connect data sources to an orchestrator node, enabling efficient cleanup and verification

3

Project Knowledge Base

Can enable plain language question and answers by stakeholders, simply ask: what has been the most common crash type last week?

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What can we do with this system?

Send out Alerts

A new crash event is immediately detected to be within the work zone.

Send out Progress Summaries

Automate drafting and sending weekly updates with crash data, work zone performance metrics or more.

Quickly Identify Problem Areas

An LLM can review crash frequencies, crash rates and circumstances and flag outliers for manual review

What other use cases can you think of?

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Key Takeaways

AI Technologies Offer New Solutions

Computer vision, sensors, and AI analytics can detect issues in real-time, providing valuable data for safety improvements in work zones.

Smart Work Zone Systems Show Promise Promise

Dynamic queue detection, speed harmonization, harmonization, and variable speed limits help help manage traffic flow and reduce crash risks in risks in construction areas.

Agentic Workflows Enhance Data Processing

LLMs and intelligent systems can analyze crash data, generate reports, and identify problem areas more areas more efficiently than traditional methods.

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Questions & Answers

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Safety Message

Drive Sober or Get Pulled Over!

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