



# **Scene Understanding and Predictive Monitoring for Safe Human-Robot Collaboration in Unstructured and Dynamic Construction Environments**

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# Construction and Accidents



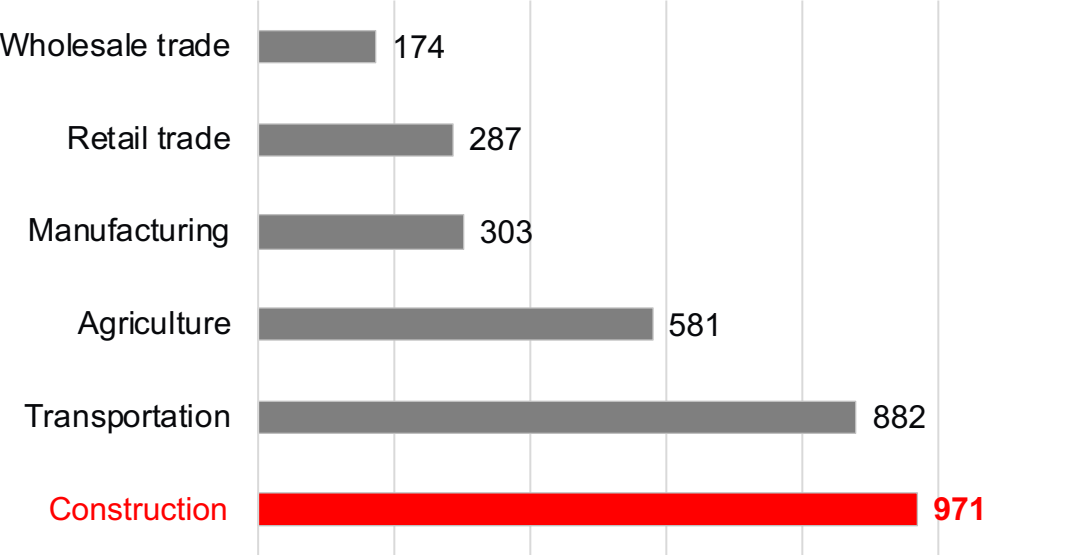
## Unstructured and Dynamic Workplace



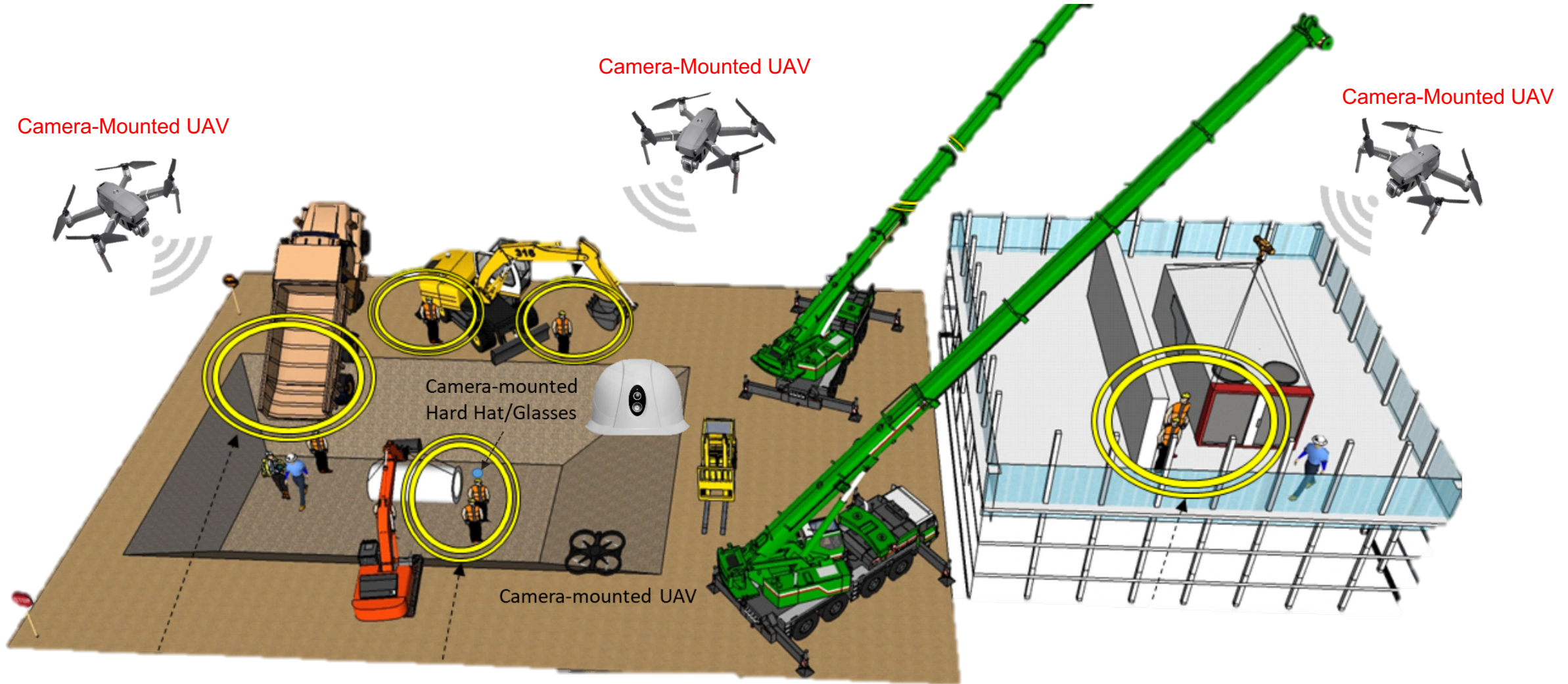
## Significant Occupational Fatalities

US Census of Fatal Occupational Injuries 2017 (Bureau of Labor Statistics, US)

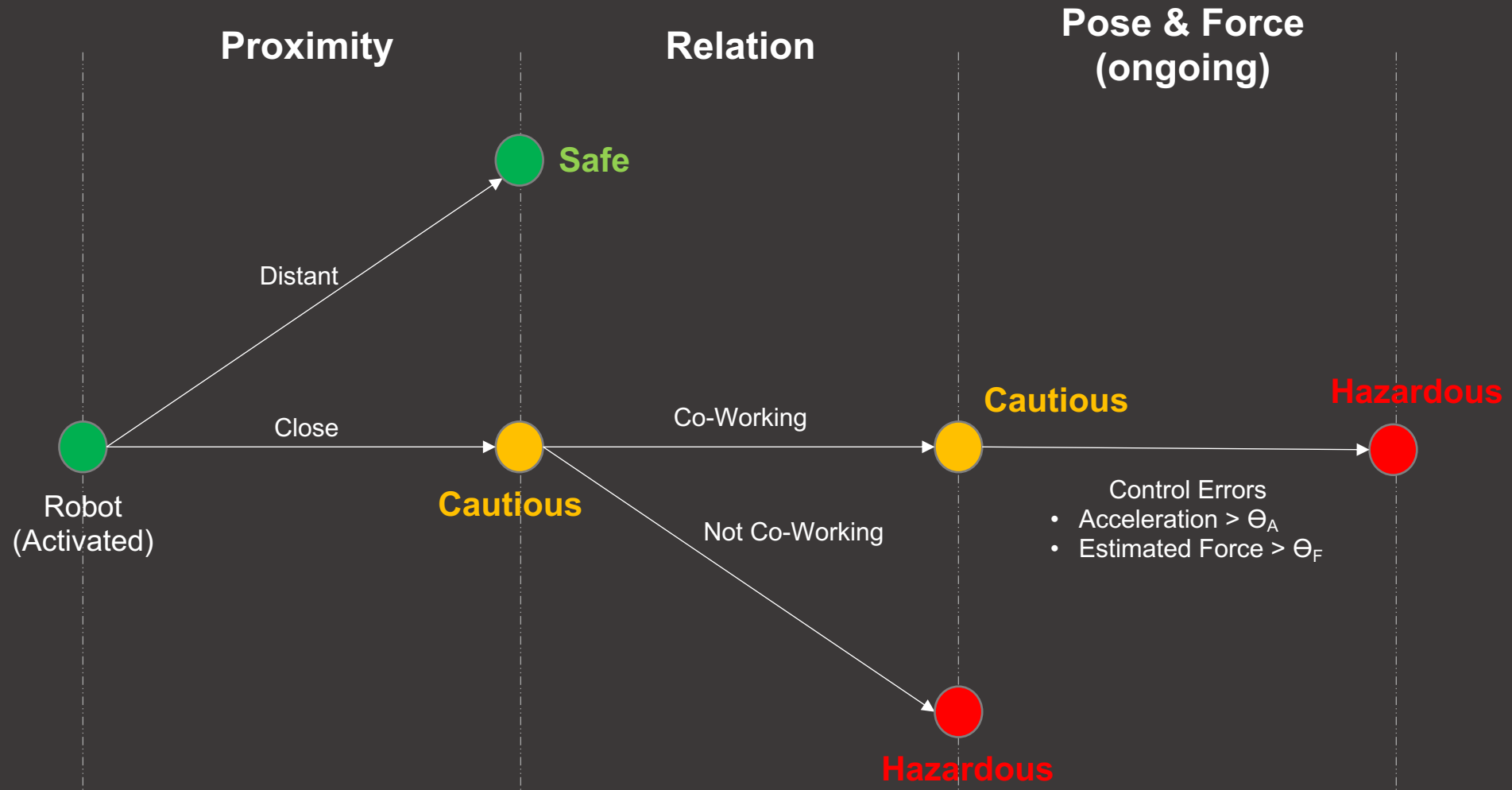
# of Occupational Fatalities



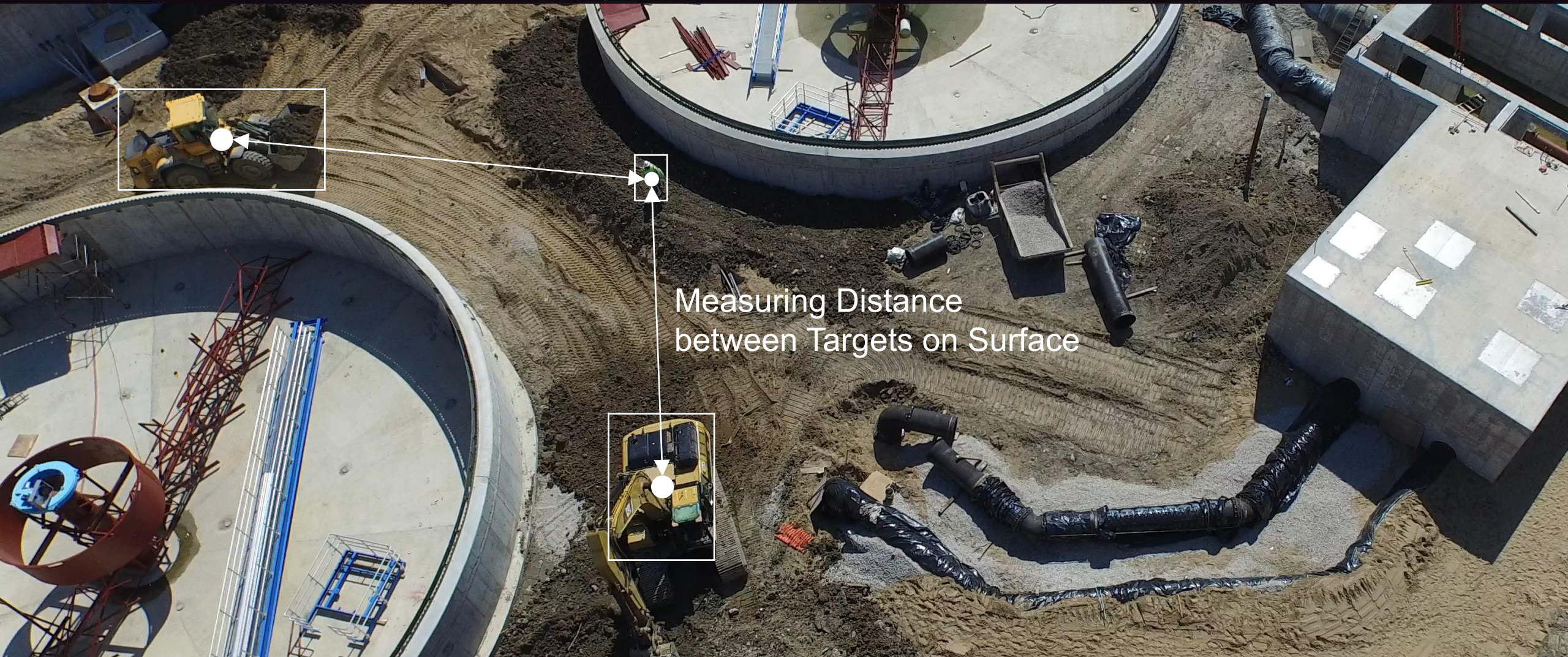
# Human Robot Collaboration: UAVs + Computer Vision for Co-Robotic Hazard Detection



# Co-Robotic Hazards Detection Roadmap



# Proximity Monitoring



# Challenge & Solution

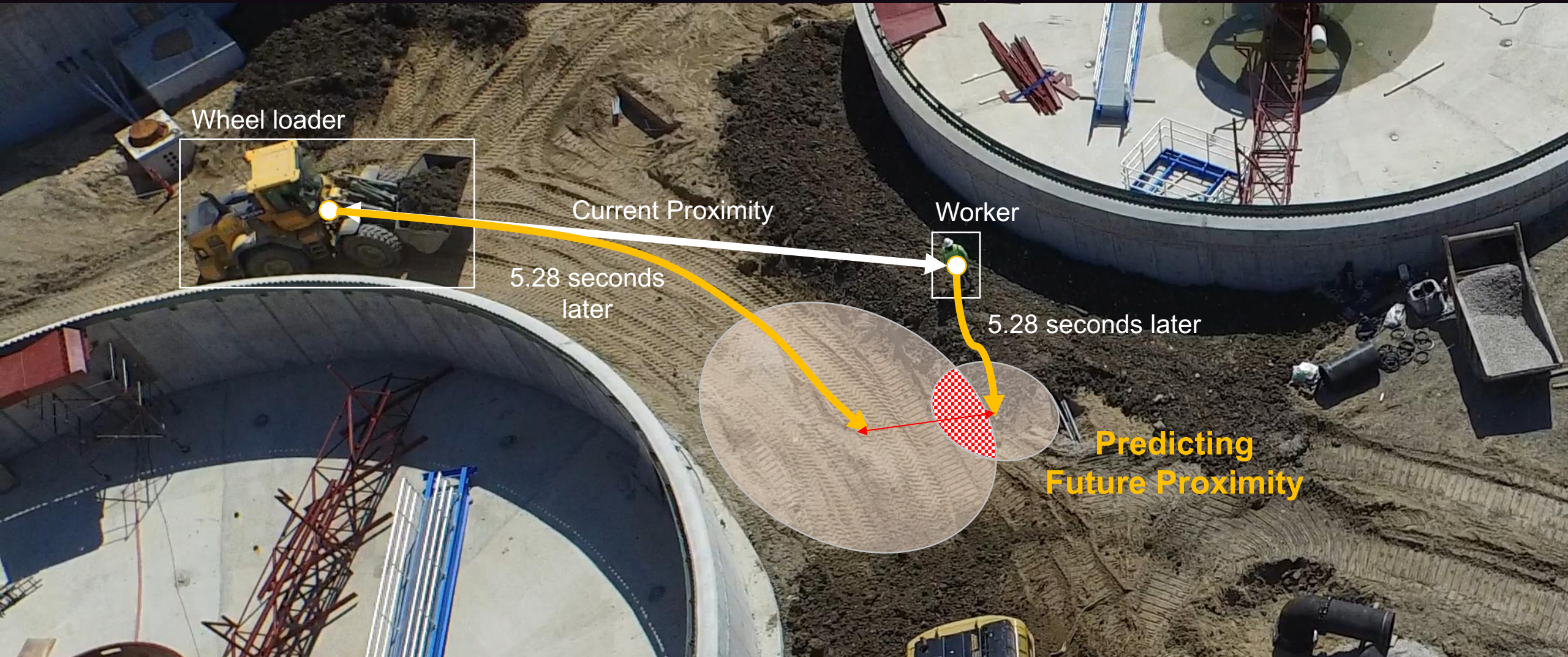


	Challenge		Solution		
	<p><b>Video Streaming</b></p> <p>Target Missing</p> <p>Occlusions</p> <p>Workers Behind</p>	➔	<p><b>Object Detection</b></p> <p>X-Y Coordinates: (562,291)</p> <p>Accurate Fast Invariant</p>	➔	<p><b>Distance Measurement</b></p> <p>Scale Missing Intrinsic Distortion</p>
	<p><b>Solution</b></p> <p>High Mobility Less Occlusion Wide Liner of Sight</p>		<p><b>One-Stage Convolutional Neural Network</b></p> <p>Sequential Convolutional Feature Extractions</p>	<p>Geometric Rectification</p>	

# Proximity Monitoring Demo



# Proximity Prediction





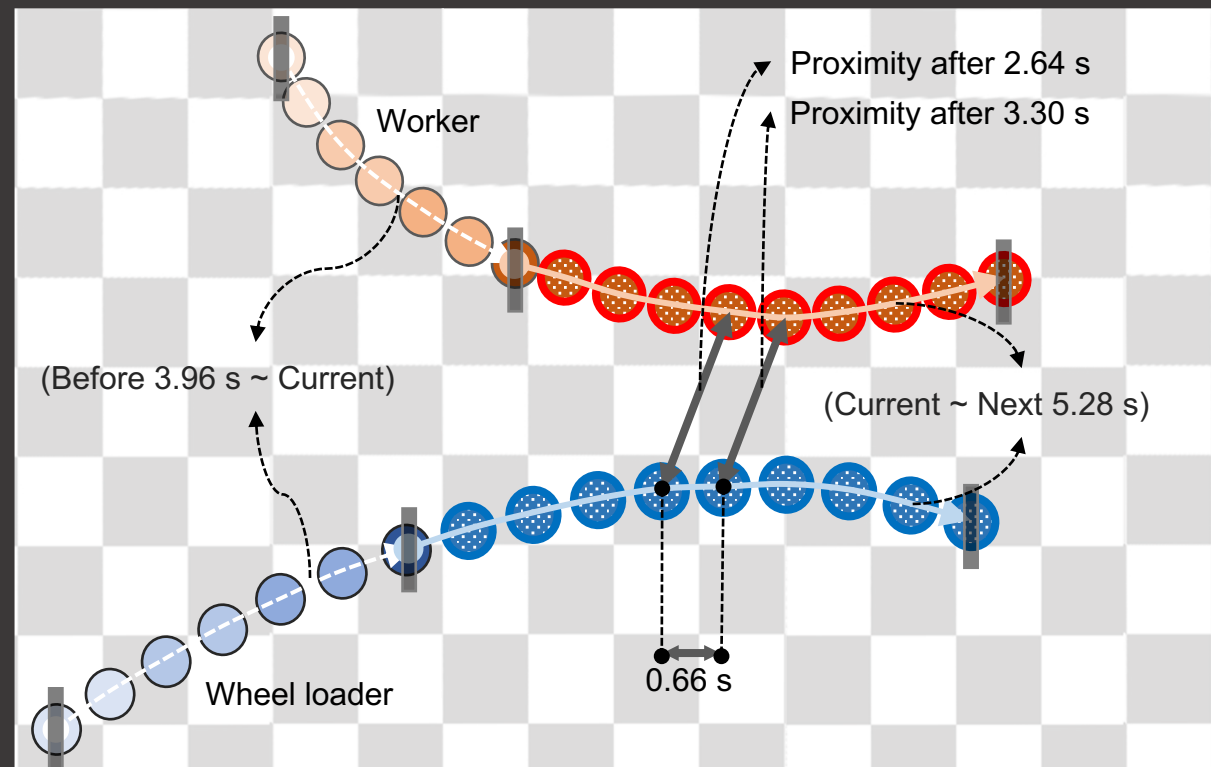
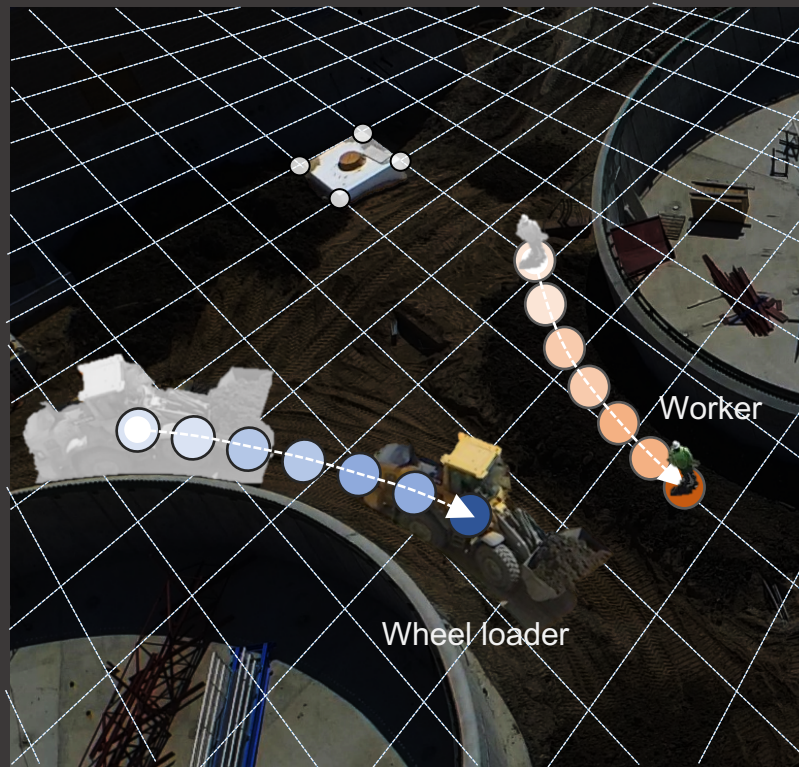
# Proximity Monitoring + Trajectory Prediction



Object Detection Over Time

Coordinates Rectification

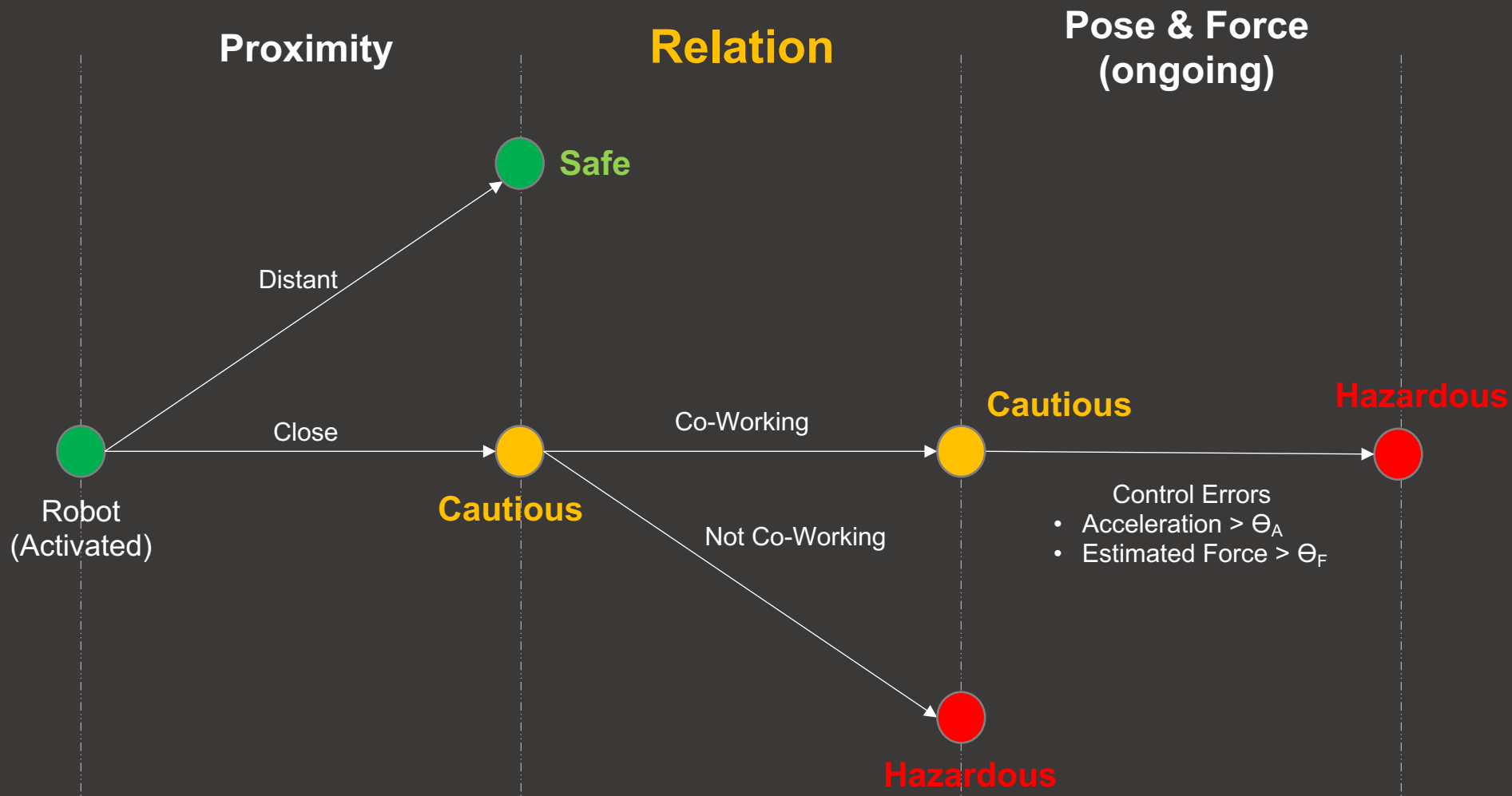
Trajectory Prediction



# Proximity Prediction Demo



# Co-Robotic Hazards Detection Roadmap



# Challenge & Solution

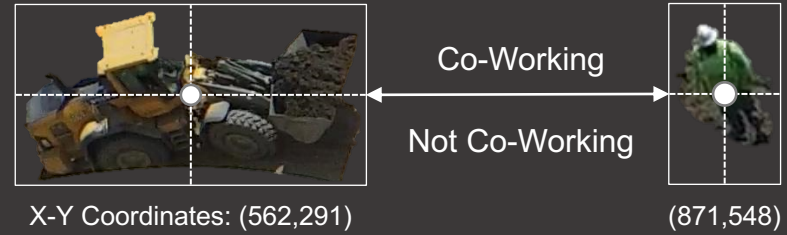


Challenge

## Video Streaming



## Object & Relation Detection

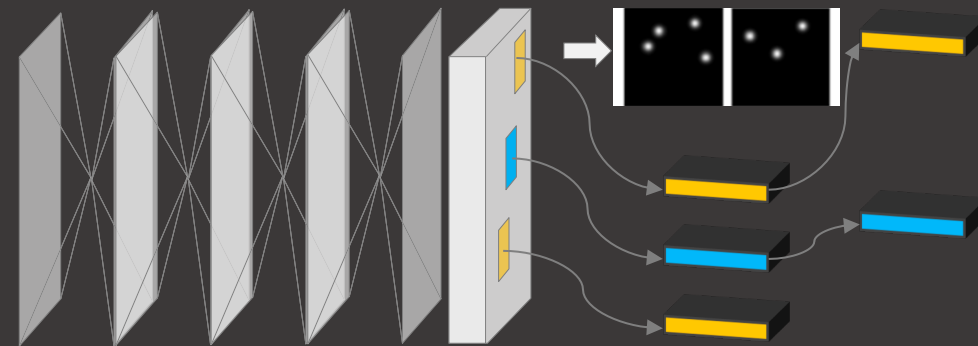


- Hand Engineering-based Inference: Variant to Conditions
- DNN-based inference: Separate Inference Process (Object Detection First / Relation Detection Later) → Limited Reasoning Power

Solution

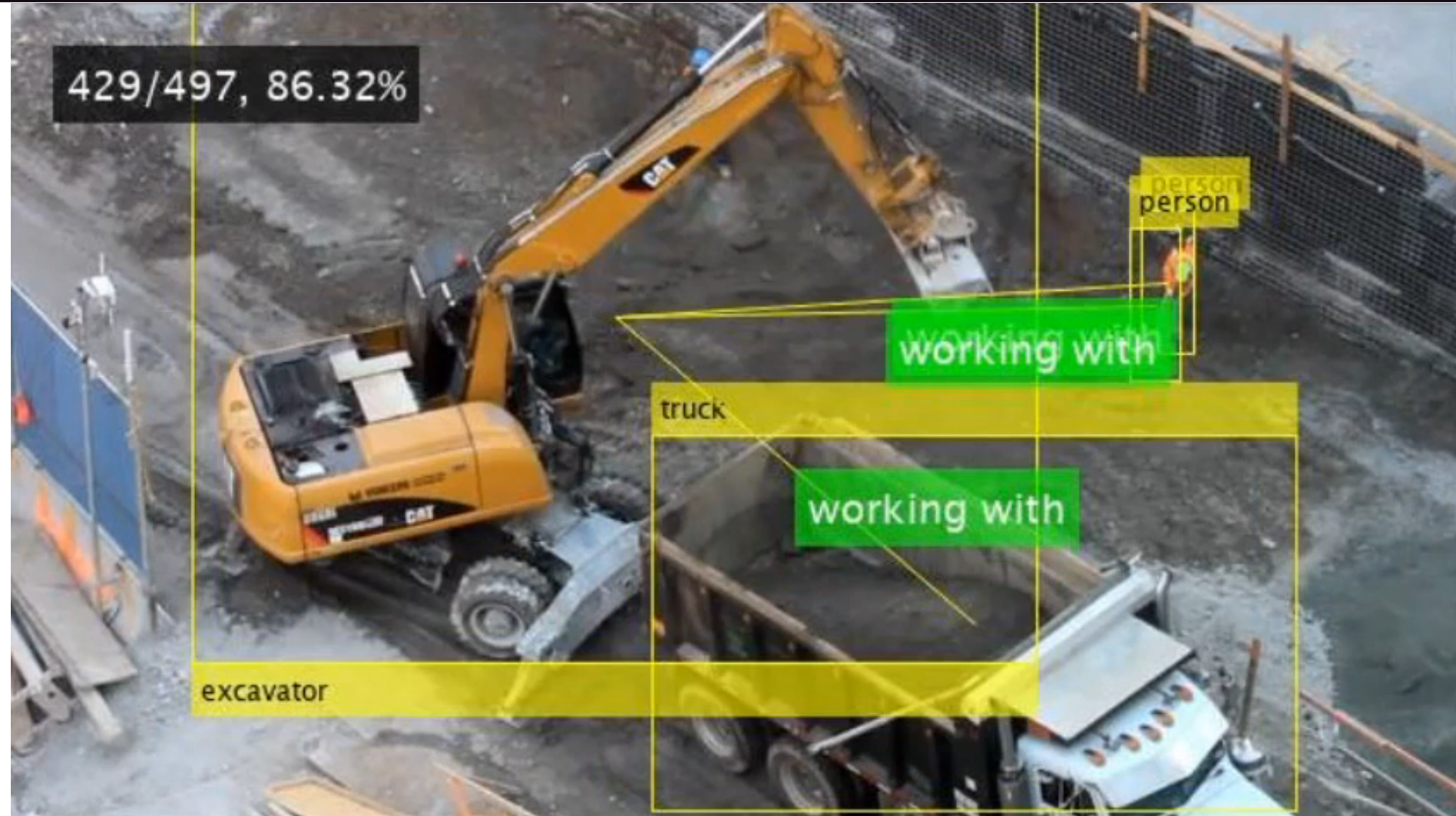


**High Mobility**  
**Less Occlusion**  
**Wide Liner of Sight**



**One-Stage Integrated Deep Neural Network**

# Relation Detection Demo



# Co-Robotic Hazard Detection in Construction

