Graffiti Detection & Drones

Western States Rural Transportation Technology Implementers Forum

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June 2025

Julie Meredith, Secretary of Transportation

Mike Gribner, Deputy Secretary of Transportation

Glossary

- WSDOT: Washington State Department of Transportation
- WSP: Washington State Patrol
- TMC: Traffic Management Center
- CCTV: Closed-Circuit Television
- CAD: Computer Automated Dispatch
- MUST: Mobile Unit for Sensing Traffic
- PTZ: Pan-Tilt-Zoom
- RCW: Revised Code of Washington
- UBIT: Under Bridge Inspection Truck
- AI: Artificial Intelligence
- LAANC: Low Altitude Authorization Capability
- C of A: Certificate of Authorization
- T/C: Traffic Control

Graffiti...A big deal?

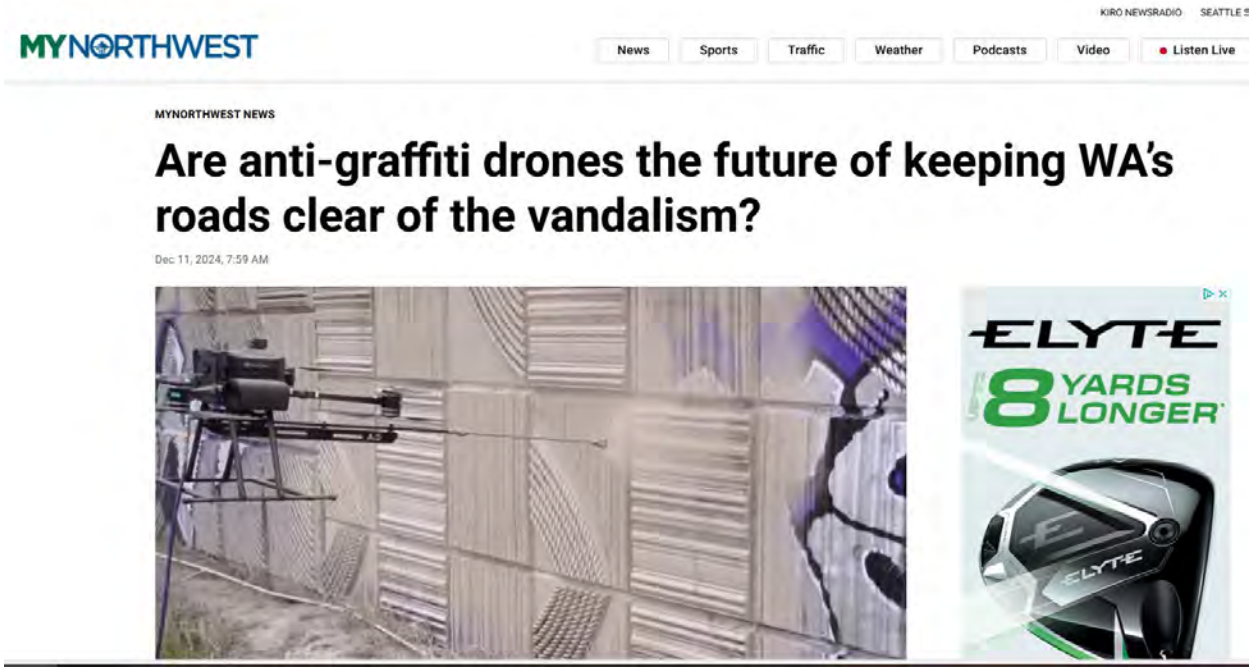
- Removal costs ~ $3,000 per tag
- WSDOT spends $500,000 to $1 million annually on removal efforts
  - limited by available time & resources
  - DOES NOT REMOVE ALL GRAFFITI
- Graffiti removal & enforcement
  - Consumes critical public safety efforts away from WSP & WSDOT maintenance workers
  - Exposes them to safety risks while working near high-speed traffic

Agenda – Graffiti Detection

- History
- Current Project (proviso)
  - Results
  - How successful system works
  - Lessons Learned
  - Challenges
- Other Methods

Agenda – Drones

- Pilot Info
- Graffiti Removal
  - Advantages of drones
  - Drone attributes
  - Lessons learned
  - Aircraft technical data
- Other Applications
  - Bridges
    - Advantages
  - Emergency Response
  - Homeless Camps



Graffiti Detection

Graffiti Detection – Intro & Proviso

Graffiti Detection Intro

- Historically…
  - Informal methods
    - Phone calls
    - WSP requests
    - TMC observations during traffic management duties (>1500 cameras)
- Legislative Proviso
  - July 2024 – June 2025
  - Report submitted Dec 2024
  - $1M
  - Detection Systems
  - Graffiti Removal
    - Drones
    - Traditional
- Next Steps
  - Funding Unknown

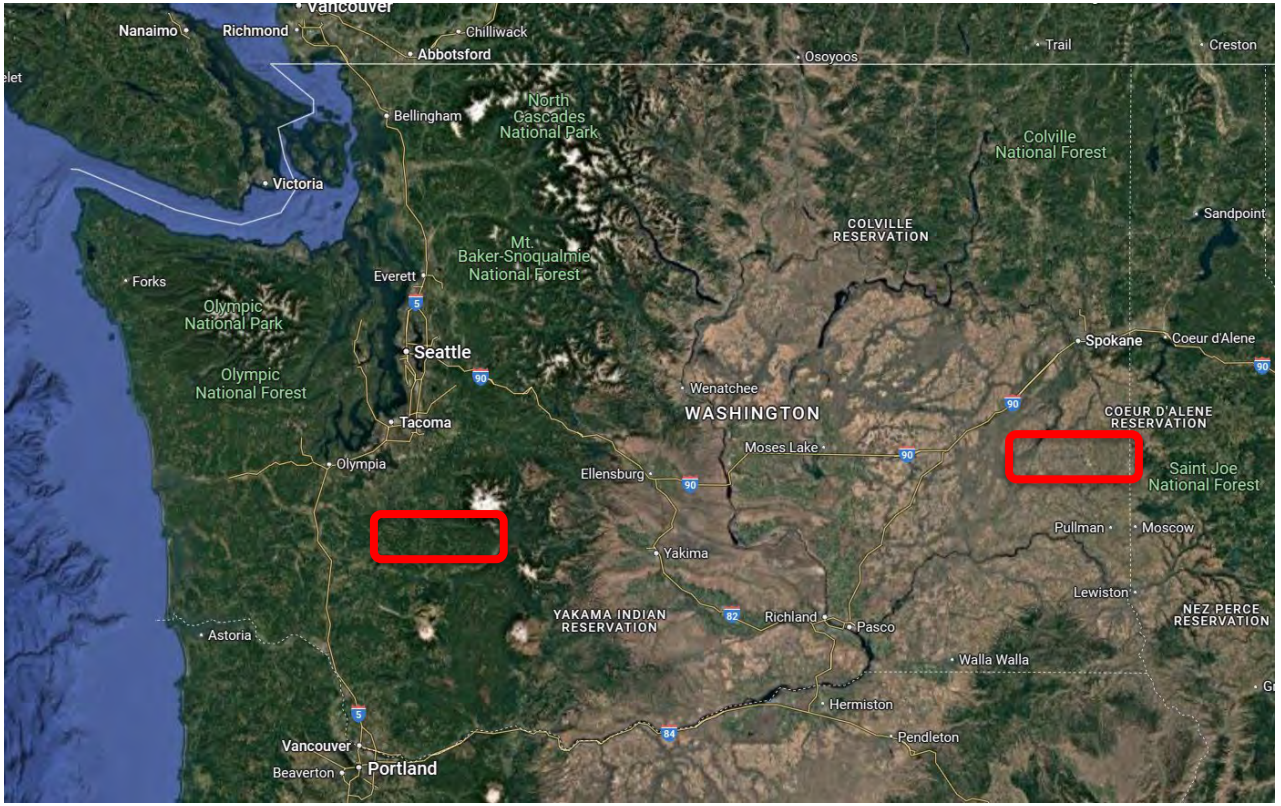
WSDOT Northwest Region TMC

Graffiti Detection Proviso - Vendors

- WSDOT currently exploring 4 vendors
  - Cameras, radar, or both
  - Software uses artificial intelligence/machine learning components to recognize graffiti taggers
  - Used Modems
    - No vendor had access to WSDOT's network
    - Some vendors have capability to use Wi-Fi or Bluetooth as well
  - Systems notify TMC
  - TMC verify with CCTV & notifies WSP
  - Some systems can be powered with solar
  - Depending on vendor, images/video can be stored on WSDOT servers, vendor servers, or both

Proviso – Communications & Map

- To streamline data captures for taggers:
  - WSP added new CAD code
  - WSDOT added new “event type” in the TMC documentation database
- 2 Cities
  - Tacoma
  - Spokane



Proviso –Spokane Locations

Figure 1. Spokane's AIWaysion and Omnisight installation location & tagger watch area

Figure 2. Spokane's Navtech installation location & tagger watch area

Proviso – Tacoma Locations I

Figure 3. Tacoma's Aquiline Drones installation location & tagger watch area

Figure 4. Tacoma's Navtech installation location & tagger watch area

Proviso – Tacoma Locations II

Figure 5. Tacoma's AIWaysion installation location & tagger watch area

Figure 6. Tacoma's Omnisight installation location & tagger watch area

Graffiti Detection – Proviso Results & System Overview

Proviso Results

- 1 vendor's product very successful (AIWaysion)
  - Results from 10/09/2024 – 03/08/2025
    - 5 tagger events detected
    - 1 arrest
    - Handful of missed events or false alarms
      - Tacoma: 1 was on the edge of the detection zone & lighting was poor
      - Spokane: 1 was under the bridge at night
      - Machine learning aspects used is expected to improve the detection rate over time
- Costs for AIWaysion
  - $5k-10k / unit
  - $40-50/month/unit cellular SIM & data management dashboard
- Will go into detail on AIWaysion's system now

AIWaysion – System Overview

- Camera + AI/ML
- System identifies person vs tagger
- Confidence scores
- Detection range ~500 ft
- Device called MUST (Mobile Unit for Sensing Traffic)

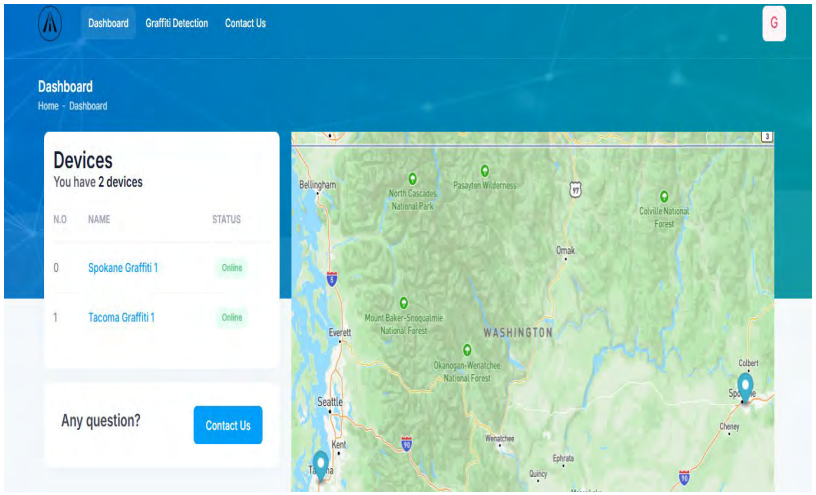
Figure 8a. AIWaysion device installed

Figure 8b. AIWaysion identification

Figure 8c. AIWaysion confidence score

AIWaysion – MUST Device

- High-definition PTZ camera w/ IR night vision
  - Can be remote controlled to change view
  - Can automatically rotate to scan
- Edge computing unit (CPU & GPU)
  - Advanced computer vision algorithms continuously analyze images & video
  - System flags events when it detects motion patterns, objects, tools, or behaviors characteristic of graffiti tagging
  - Alert is generated containing location, time, alert type, & snapshots or video clips - depending on the configuration
  - Web dashboard for device management, real-time monitoring (including live streaming of camera), & alerts
    - Provides historical data analytics to track graffiti tagging events and trends, identify high-risk locations, and make prediction (Not used by WSDOT)



AIWaysion - Alerts

[EXTERNAL] URGENT: Graffiti Tagging Detected

AN Alwaysion Notification <noreply@aiwaysion.com>
To George Ma; Wen Sun; WSDOT OR Tacoma TMC

Retention Policy Delete from Deleted Items (90 days) Expires 3/29/2025

If there are problems with how this message is displayed, click here to view it in a web browser.
Click here to download pictures. To help protect your privacy, Outlook prevented automatic download of some pictures in this message.

WARNING: This email originated from outside of WSDOT. Please use caution with links and attachments.

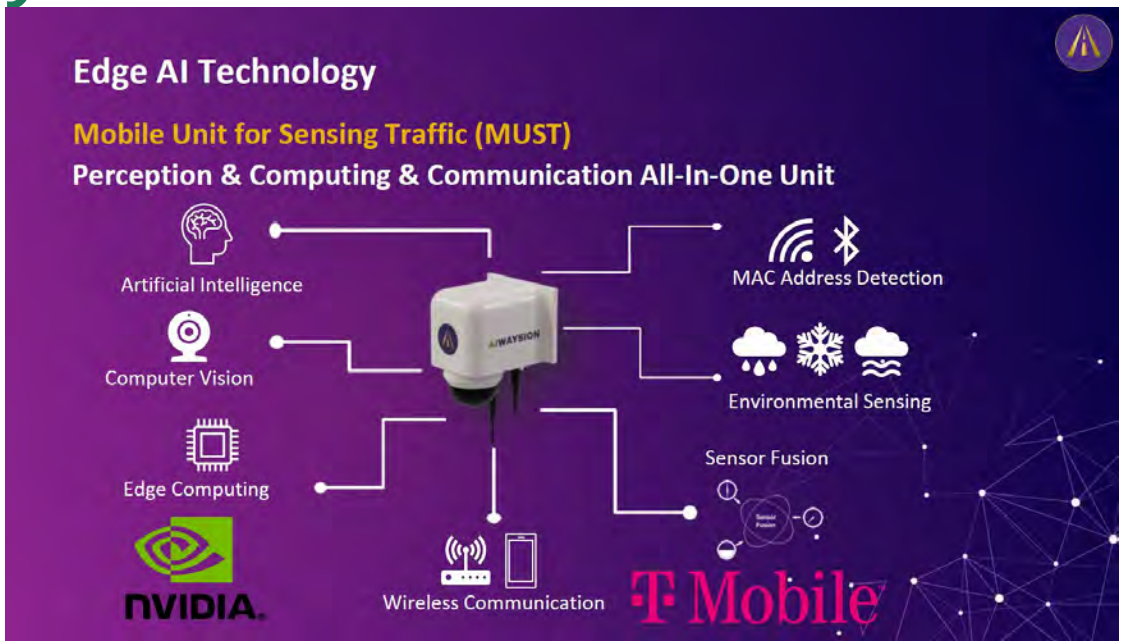
AIWaysion's MUST device has detected the following suspected tagging activity.

Event Details:

- **Date:** 2024/12/29
- **Time:** 00:31
- **Location:** Tacoma, WA

For further information, including access to surveillance footage, please contact us at george@aiwaysion.com.

AIWaysion – MUST Device

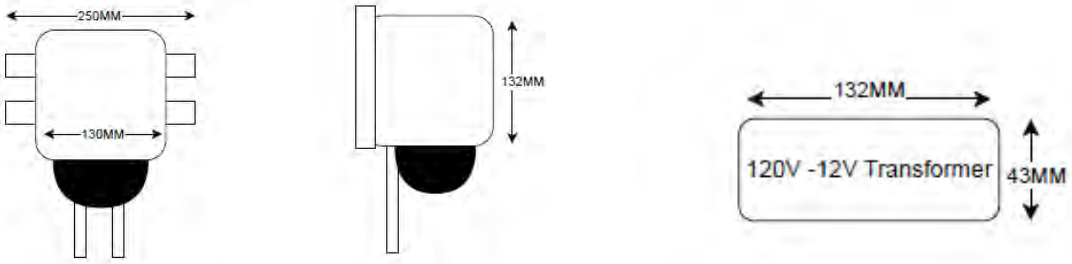


- Cellular router
- MAC Address detector Bluetooth/Wi-Fi
- Environmental sensors
  - Temperature, humidity, air quality, etc.
- Solar panel and battery option
  - limited functions: basic traffic data collection, parking management, graffiti tagging detection, etc.
- Real-time video processing & detection
- Cellular connectivity allows seamless communication with TMCs & law enforcement for immediate notification & response
  - Notifications can be delivered through text messages, email, web dashboard, or API that connects directly to the TMC's own server or dashboard
- System is designed to be plug-and-play

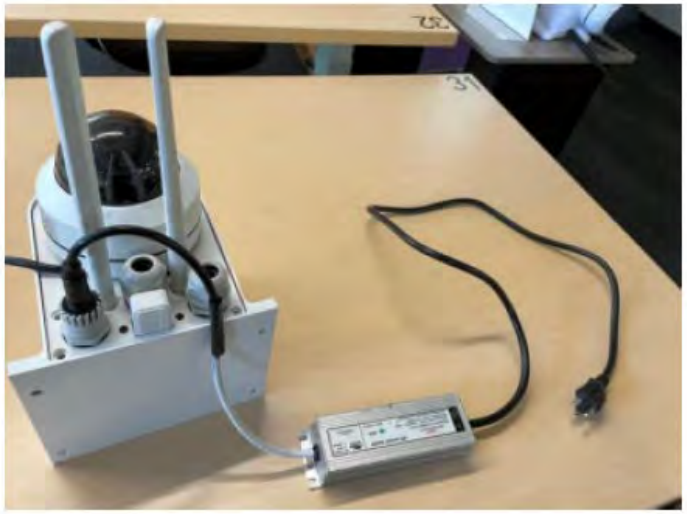
AIWaysion – MUST Device

SPECIFICATIONS

Operation Temperature	-40°C ~ 70°C (-40°F to 158°F)
Operation Relative Humidity	5% ~ 95%
Ingress Protection	IP 65
Power Supply	12V(DC)
Energy Consumption	< 35Watts
CPU	ARM1176JZF-S 700 MHz
GPU	128-Core Maxwell 1600MHz
Communication	3G/4G/5G, Ethernet
Operation System	Linux
Local Data Storage	Micro Secure Digital (SD) Card
Weight	10 pounds
Dimensions	170 mm (length), 170 mm (width), 300 mm (height)
Camera	Resolution: 5MP HD (2560x1944); PTZ: 355°/90° rotation, 5X optical zoom; IR Night Vision; IP66 Weatherproof



AIWaysion – MUST Device



AIWaysion – MUST Device - Installation

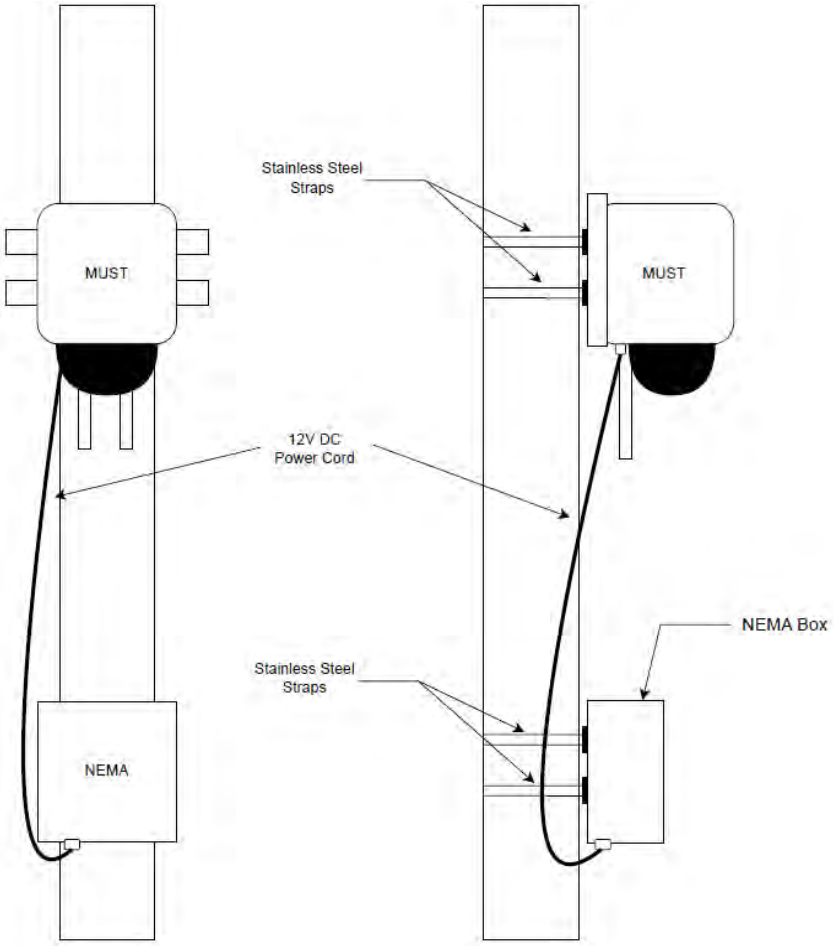
Installation: mounted on the pole with hose clamps using bucket truck

Installation height: 20 – 30 ft (depending on the use cases and required field of views)

Power: Our device operates on 12V DC. If only AC power is available, we provide an outdoor AC to DC transformer, typically housed in a NEMA enclosure mounted on the pole (as shown in the photo below), that converts 120V AC to 12V DC.

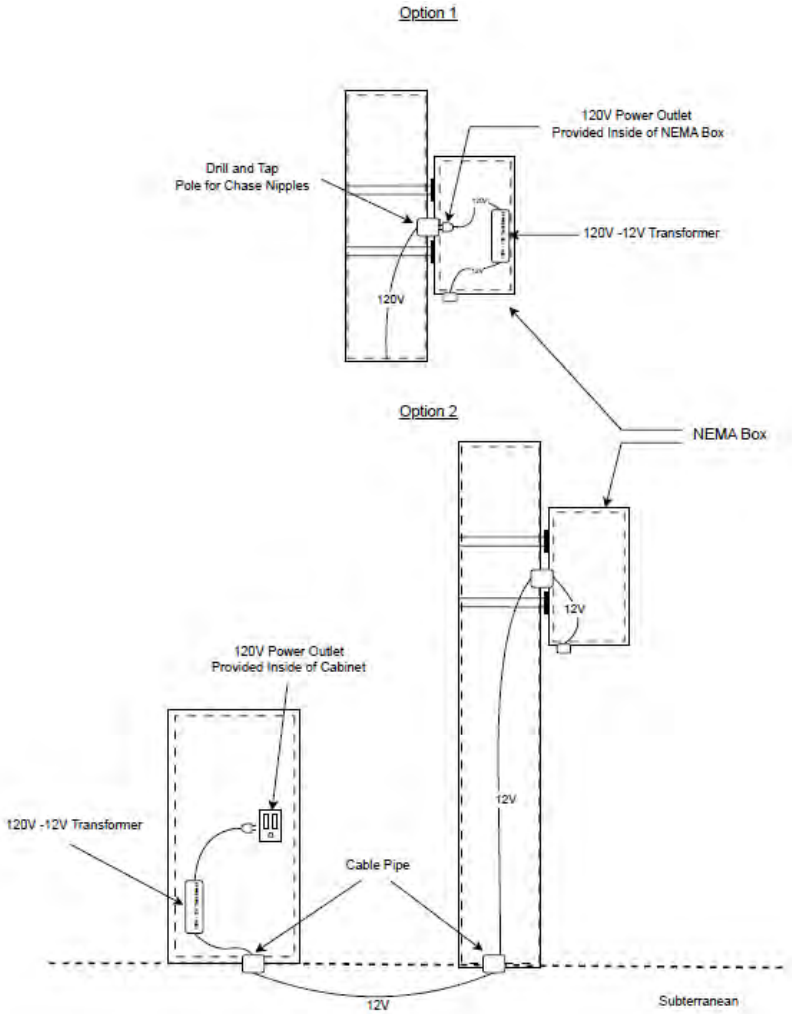
Communication: Cellular SIM card inside the device

AIWaysion – MUST Device - Installation



FRONT VIEW

SIDE VIEW



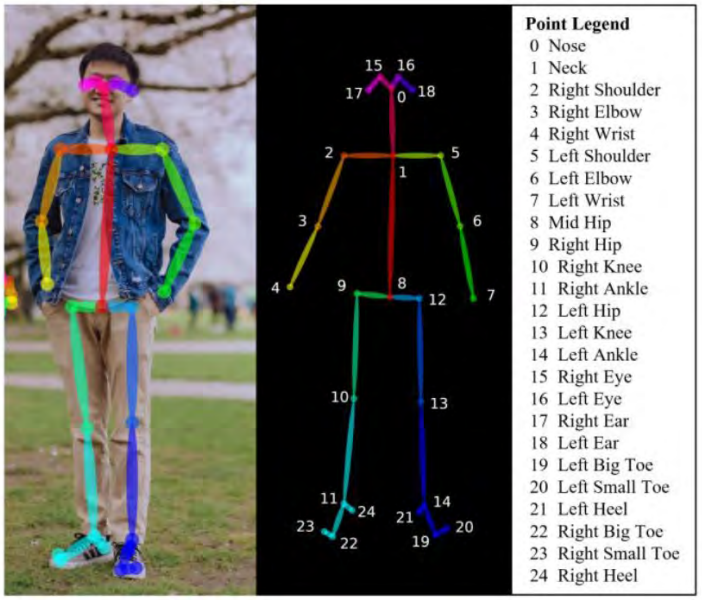
ENCLOSURE MOUNTING DETAIL

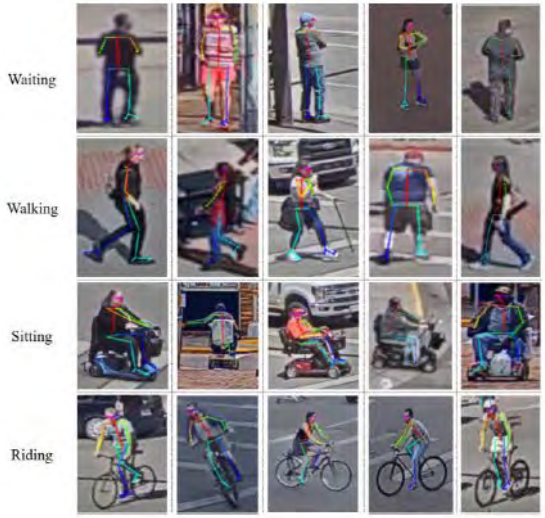
AIWaysion – MUST Device - Installation

AIWaysion – Calibration

- System can be deployed & operate immediately
- Calibration process can enhance its accuracy based on the specific location & environmental factors
  - Lighting conditions, camera angles, environmental noise, etc.
  - Typically 1-2 days
- Followed by real-time testing to validate detection accuracy
- Detection algorithms will continually improve
- Accuracy rates reported by AIWaysion
  - Pedestrian Detection (Suspected Activity Alerts): Over 95%
    - Occasionally trigger false alarms, such as bystanders
  - Graffiti Tagging Detection (Confirmed Graffiti Tagging Alerts): 85-90%
    - Combines human pose estimation, tagging behavior classification, & graffiti detection
    - Significantly reduces false alarms

AIWaysion – Graffiti & Human Pose Estimation





Bystander/Passerby

Suspected Graffiti Tagger

AIWaysion– Device Additional Benefits

Traffic Data Collection

01

Vehicle volume, speed, classification, travel time measurement, etc.

Pedestrian Data Collection

02

Counting and classification (pedestrian, cyclist, scooter, wheelchair, etc.)

Environment Conditions /Weather Station

03

- Environmental conditions (i.e., temperature, humidity, air quality)
- Road surface conditions (i.e., dry, wet, ice, snow)
- Visibility conditions

AI-Powered Applications

Safety Applications

04

- Collision and near-miss events
- Hazadous conditions (low visiblity, snow and ice covered road surface, etc.)
- Dilemma zone
- Stopped vehicle
- Wrong way driving
- Speeding

Connected & Autonomous Vehicles

05

- Vehicle-to-Infrastructure (V2I) communication
- Pedestrian-to-Infrastructure (P2I) communication

Parking & Curb Management

06

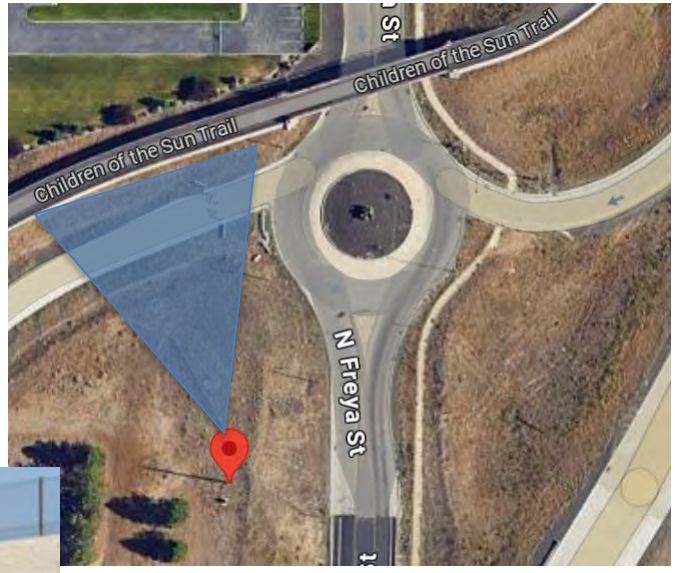
- Parking events (i.e., vehicle type, location, duration, ingress/egress time)
- Availability & occupancy

AIWAYSION

Graffiti Detection – Lessons Learned & Challenges

Graffiti Detection Lessons Learned

- Some Vendors generate lots of false alarms (Up to 7 per day)
  - Radar problems with wall in background
  - Bystander vs tagger
  - Other?
- 3 of the vendors yet to produce 1 positive tagger detection
  - Long calibration period?



Graffiti Detection Challenges

- Funding: WSDOT does not have funding to purchase dedicated graffiti detection devices after June 30th
  - Especially considering the # of devices needed to prevent tagging on all its highway infrastructure
  - Without broad installation, graffiti taggers could simply move their activities to another area

Graffiti Detection Challenges

- Staffing: WSP does not have staffing necessary to consistently respond to graffiti tagging activities
  - Troopers are either not in the vicinity of the tagger or are responding to a higher priority and are unable to divert
    - Out of 5 Detections…
      - 1 event, tagger left before WSP arrived
      - 1 event, WSP did not have units available
      - 1 event, Unit enroute diverted to wrong way vehicle
  - Overall graffiti tagger apprehension rates are low

Graffiti Detection Challenges

- Prosecuting: Washington State Patrol indicated graffiti tagger property crimes have a low rate of being prosecuted
  - This can affect law enforcement response prioritization
  - Placing graffiti on WSDOT property by law (RCW 9A.48.070 – 9A.48.090) is malicious mischief and ranges from a gross misdemeanor to a class B felony

Graffiti Detection – Other Methods & Summary

Other Methods

- Other methods of discouraging graffiti activity include:
  - Sprinklers – Activates when a tagger is detected, causing the tagger and/or the wall to become wet
    - Potentially deter tagger & make the wall more difficult to paint
  - Vegetation as a deterrent
    - Use of plants to make it more difficult to reach the wall
    - Tags are not as noticeable
  - Anti-Graffiti Coatings – Prevents paint from absorbing into wall/sign
    - Quicker to clean

Graffiti Detection Summary

- Technology exists
  - Effective at real-time notifications
  - Led to an arrest
- Challenges
  - Results vary by vendor
  - Funding

Drones

Drones – Pilot Training and Certification

Pilot Certification and Training Online Study course $179.00

Video	Run-time
1.1 Part 107 Eligibility	2:30
1.2 Part 107 Definitions	3:17
1.3 Remote PIC Responsibility	5:55
1.4 Required Documentation	6:57
1.5 Night Operations	5:03
1.6 Visibility and Cloud Clearance Requirements	1:57
1.7 Maximum Speed and Altitude	2:58
1.8 Right of Way Rules	2:24
1.9 Operations Over Non-Participants	2:47
1.10 Operations From a Moving Vehicle	3:41
1.11 Weight Limitations	1:09
1.12 Certificate of Waiver	4:38

REMOTEPILOT101.COM

Learn Exactly What's on the FAA UAS Knowledge Test and See Actual FAA Test Questions

FAA TEST FEE $175

LAANC Airspace Authorization and C of A

LAANC is for designated controlled airspace

C of A is for all other controlled airspace

Drones– Graffiti Removal

Graffiti Fighting Drone

Historically we used bucket trucks and fall protection

For hard-to-reach locations

Graffiti Drone advantages

- Graffiti removal
  - Difficult to reach places
    - bridges
    - signs
    - steep slopes
  - Improves Safety: No painting high off the ground or on uneven footing
  - Lowers Cost: Quicker
  - Improves Traffic Operations: Shortened time for T/C
  - Simpler Equipment: Frees up special equipment (UBIT)
- Tethered
  - Can get caught (billboards)
- Non-Tethered
  - WSDOT/supplier developing self-contained unit
    - 1-2 gallons of paint

Capitol Blvd. over I-5
Near Washington State Capitol

- UBIT - 3 Man Crew
- Capitol Blvd Lane closure: Flagging operation 2 trucks and 2 Maintenance personal
- Multiple Coordinated I-5 rolling slow downs both directions total of 8 lanes: 4 TMA Road Warriors, 4 Maintenance workers and 2 WSP Units
- Total operation time about 6 hours
- Total operational cost about $8,000
- Using the drone requires I-5 T/C but none on Capitol Blvd
- No need for fall protection or UBIT
- Total operational cost was approximately $2,000

Why use a Drone?

- Allows access to hard-to-reach locations
- No need for fall protection
- No need for bucket trucks, ladders, repelling, Etc.
- Reduces manpower in most locations
- Minimizes impacts to traffic

Drone Lessons Learned

1. Upgraded collision avoidance system from forward looking to multi-directional collision avoidance
   - Greatly assisted aircraft positioning awareness in GPS declined locations
   - Aircraft more stable and controlled
   - Include adjustable ranging capabilities
2. Putting aircraft in “Loiter” mode during all-paint operations was helpful
   - Using “Altitude Hold” mode disengaged the GPS, causing lack of special orientation – leading to a lack of directional control
     - I consider this a flaw in the software & the manufacturer is working on changing it
3. Adding a dual GPS receiver
   - Increased the ability to get a GPS lock in GPS declined locations
   - Increase pilot control of the drone while the drone is producing thrust from spraying paint
4. Using recycled paint to cover graffiti caused clogging issues that required the aircraft to land to clear the clog
   - Drone performed better when the paint was upgraded to a mid-quality non-recycled paint

Drone Lessons Learned

5. The aircraft should have folded or retractable motor arms
   - removable arms: Difficult to transport the aircraft when arms attached
   - Connections wear down each time the drone is assembled and disassembled
6. Coat entire aircraft with a hydrophobic coating
   - Helps with removing paint from aircraft at the end of day
   - System MUST meet all U.S. State Department criteria for “The Blue List”
   - Pre-approved list of systems for data collection regarding national security
   - Currently no Chinese manufacturers that meet the criteria
7. Tethered payloads is removable to allow for NON-Tethered payload (In Development) as well as pressure washing payload for overhead sign washing
8. Use a common spray tip that can be purchased at hardware store or paint supplier
9. Use only clear sine generator to recharge batteries in the field
10. 3 full sets of batteries for continuous operation


SOUTH
NORTH

Graffiti Drone – Aircraft Technical Data

Safety Systems & Environmental Resilience

1. **Aircraft Requirements:**
   - Maximum Aircraft Weight: 11 kg (24.25 lbs.) without battery
   - Minimum Payload Capacity: 15 kg (33 lbs.)
   - Minimum Flight Time:
     - 40 minutes (no payload)
     - 25 minutes at an altitude of 100ft

2. **Environmental Durability:**
   - Wind gusts: 55 mph
   - Operate in moderate rain & snow
   - Temperature tolerance: -20°C to 50°C (-4°F to 122 °F)
   - Drone can operate within 10ft of metallic structures, cell phone towers, antennas, & power lines

Safety Systems & Environmental Resilience

3. **Safety Features:**
   - Forward & downward-facing collision avoidance system with an on/off activation via the controller
   - Emergency stop in the event of an emergency
   - Return-to-home (Home location/take off location) capability triggered by the following scenarios:
     - Loss of GPS signal
     - Loss of remote controller signal (either due to distance or dead controller battery)
     - Low drone battery
     - Pilot activated/induced

Material & Manufacturing Standards

1. **Manufacturing Location:**
    - Manufactured in the USA or be listed by the US State Department as acceptable for Data Collecting

2. **Critical Components Sourcing:**
    - Flight controller, radio, data transmission device, camera, gimbal, ground control system, software, network connectivity, & data storage must not originate from covered foreign countries or their domiciled entities

3. **Product Composition:**
    - Frame: 100% carbon fiber with anodized aluminum fasteners
    - Hydrophobic coating for enhanced durability in wet conditions

Propulsion System & Modular Design

1. **System Features:**
    - Dust-resistant & waterproof (IP45)
    - Anti-corrosion components for extended operational life
    - Co-axial octocopter design for enhanced stability & reliability
2. **Portability & Maintenance:**
    - Modular structure with removable arms & landing gear for simplified transport & assembly
    - New version available with folding arms for faster deployment
3. **Sustainability:**
    - Powered by sustainable electric technology, emitting zero CO2 during operation

Payload

1. **Tethered Painting Wand**
    - Pressure & Flow Requirements:
        - Minimum operating pressure: 3300 PSI
        - Minimum flow rate: 1.2 GPM
    - Remote Control Functionality:
        - The painting wand must allow on/off operations through a remote-control system
    - Modular Design:
        - The wand must have a removable/detachable payload option to facilitate easy assembly & transportation

Payload

2. **Untethered Painting System (in development)**
    - Compatibility:
        - Minimum capacity: 1 gallon (in development)
    - Remote Control Functionality:
        - Remote on/off activation via the controller
    - Minimum Carrying Capacity:
        - Minimum 1 gallon of paint


5
NORTH
Seattle
705
NORTH
City
Center
7
SOUTH
E 26 ST
38TH ST
TACOMA
DOME

Graffiti Drone Demonstration

This video was produced during the research phase of this project.

Que Video

https://www.youtube.com/watch?v=egQmrmwaiEI

Drones for Bridge Inspections

Bridge inspection with less risk

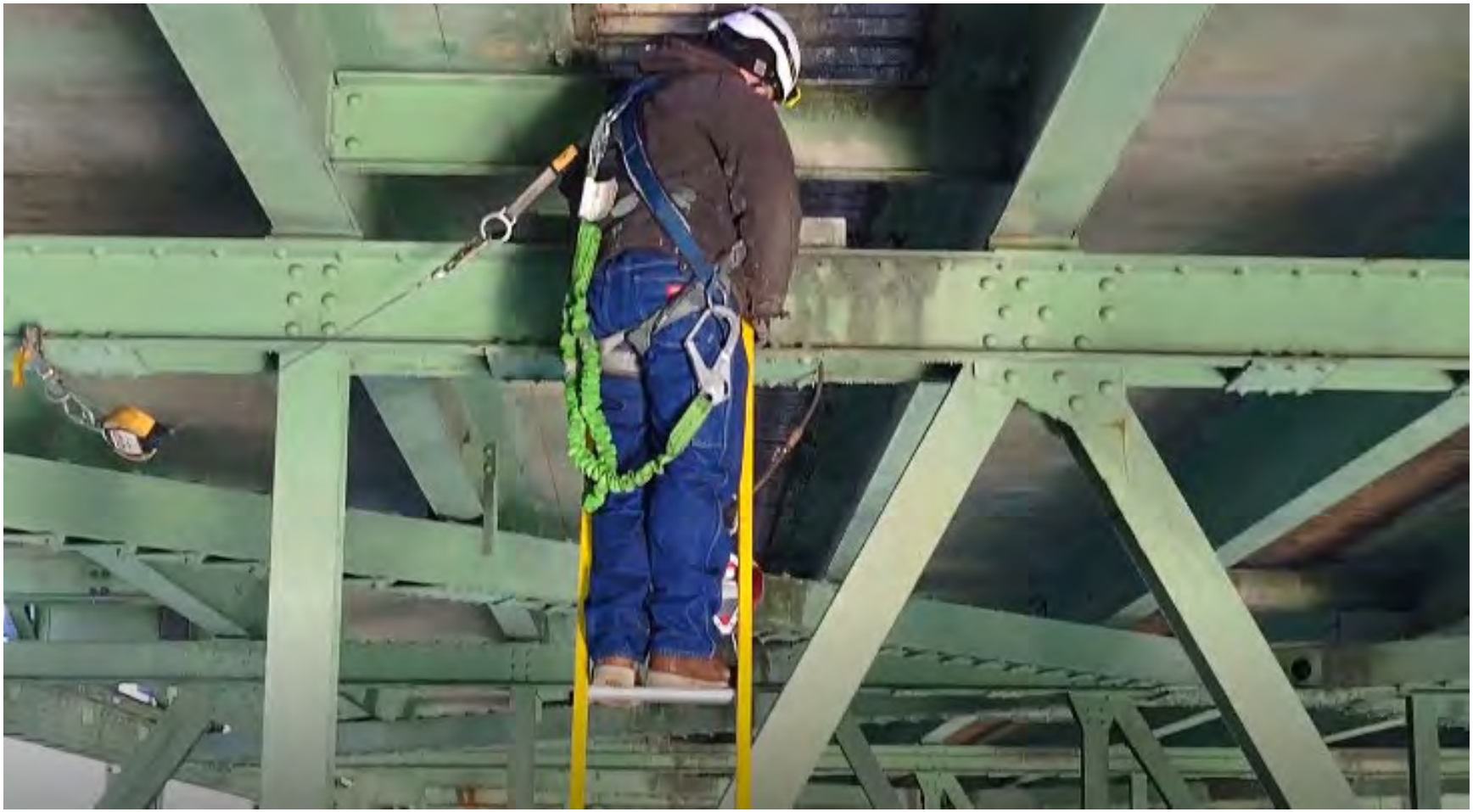
- Inspections are safer for workers & the public
- Less impact to traffic
- No fall protection needed
- Allows for detailed review for repair decision making
- Quicker than traditional bridge inspections

Using a drone reduces the need for fall protection

Lifts and harnesses

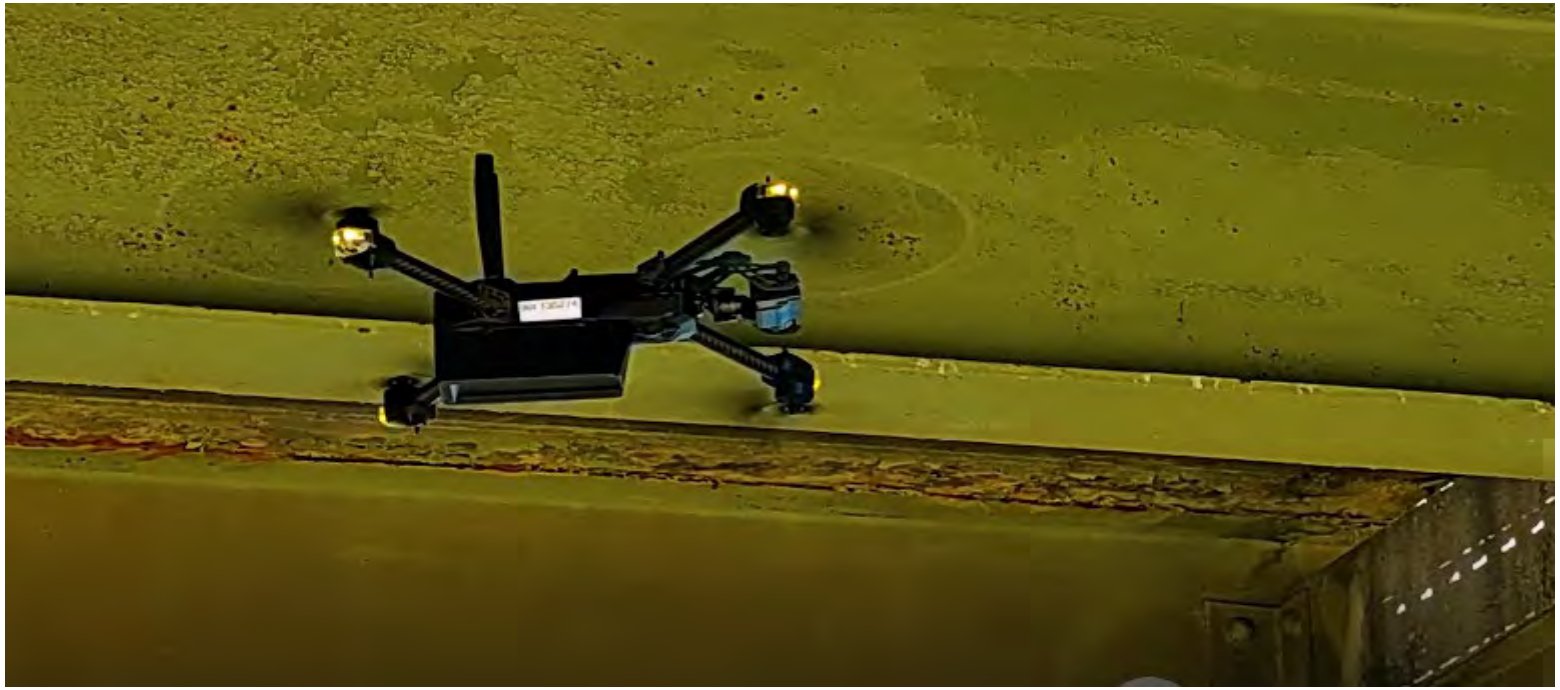
Our people are given the best training and equipment that money can buy. They are experts

But we consider every operation as Hazardous

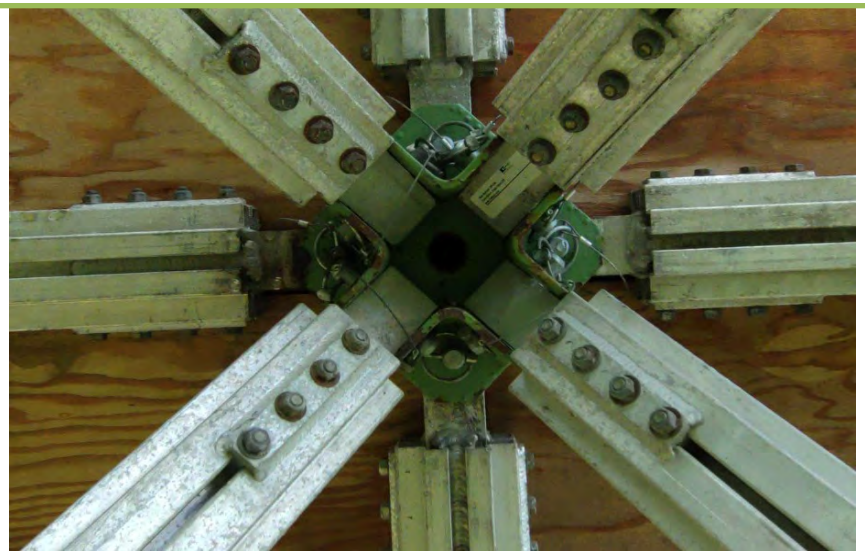


Drones don't replace bridge inspection trucks, but they can lessen the workload for them.

A Drone reduces the number of inspections that require fall protection or specialized equipment

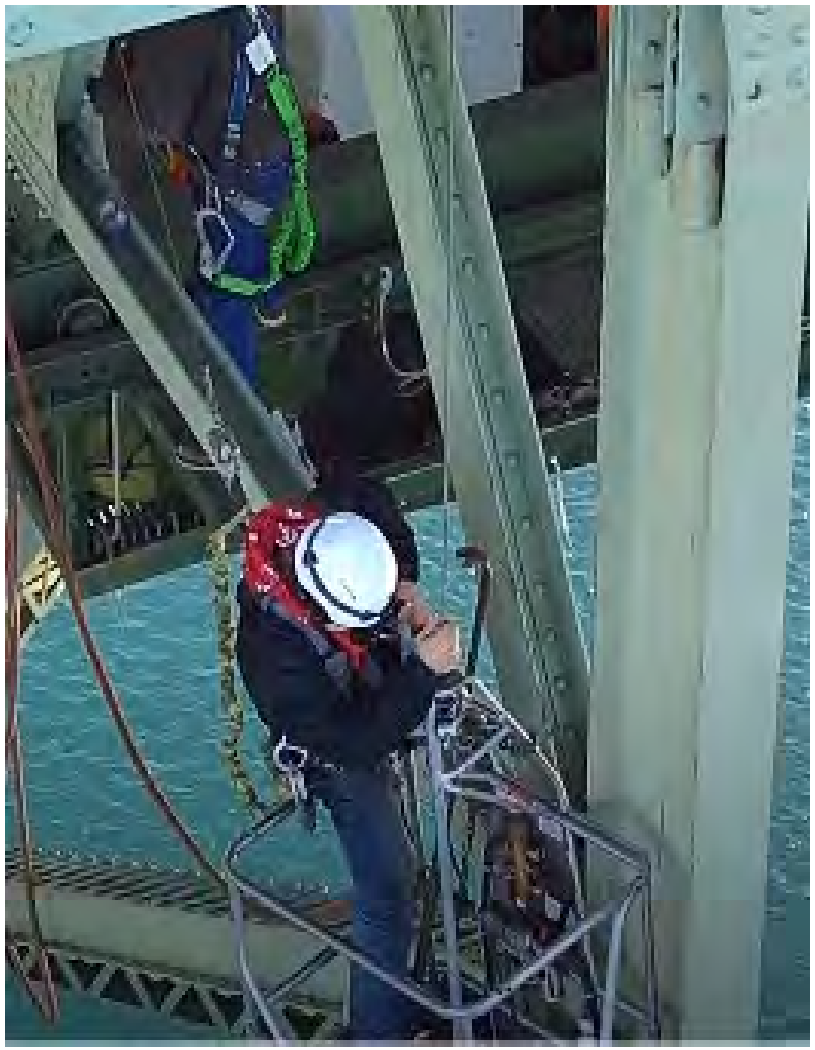


AI equipped collision avoidance makes it easy to fly in confined spaces



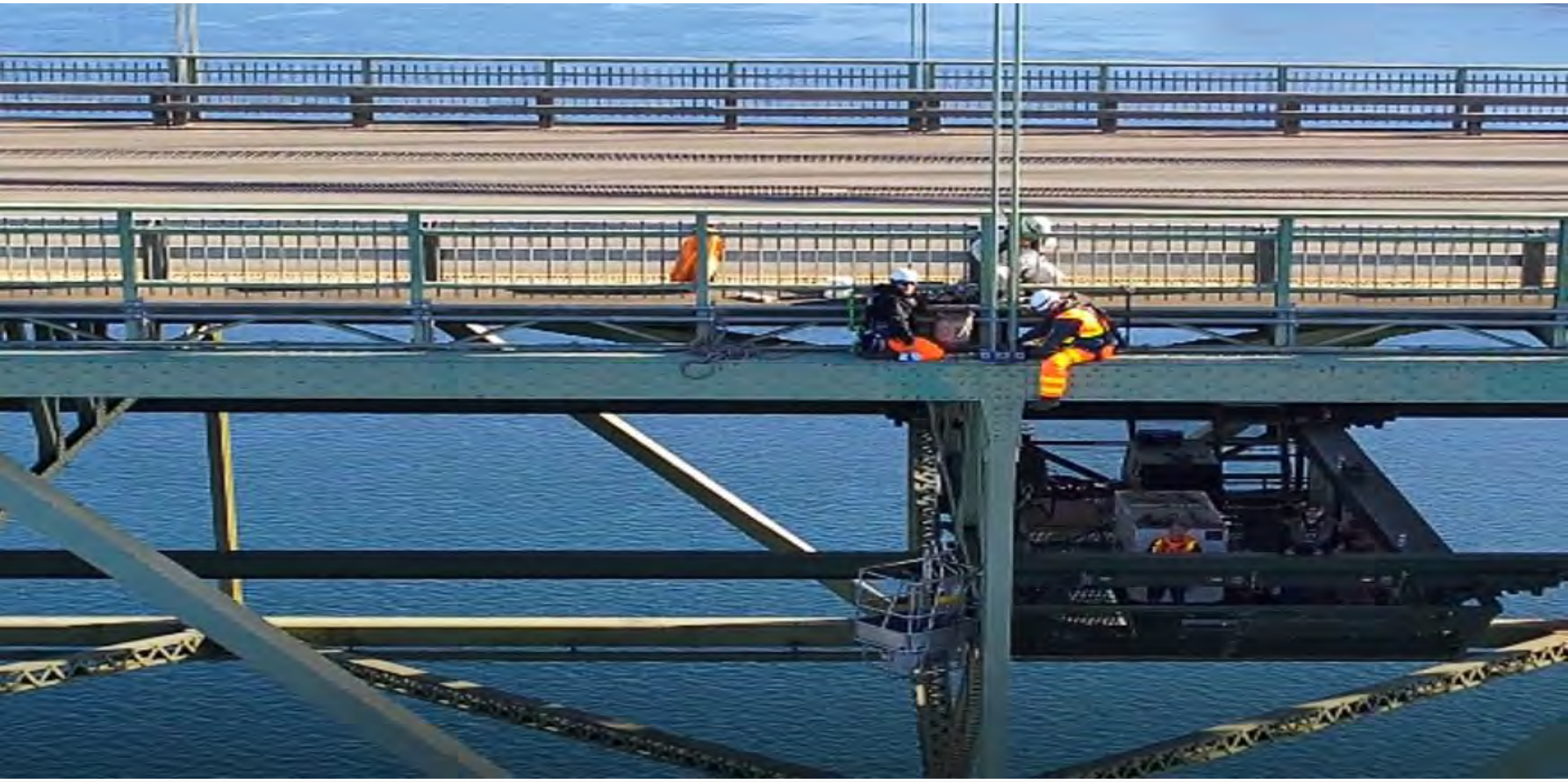
Using Fall protection is very time consuming

And adds an element of risk



It's hard to imaging doing this just so you can look at something

Fall protection is Labor intensive and takes time to do it right



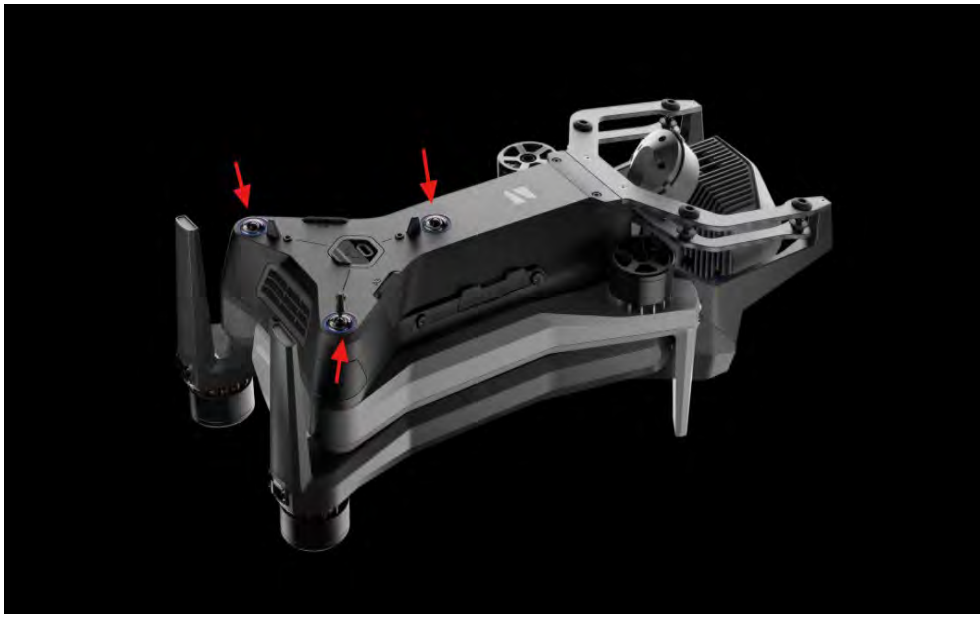
Using a drone is very efficient

And offers better opportunities to identify maintenance needs

Without the risk

Combining drone technology with AI some drones navigate tight spaces better than others

Skydio X-10 uses AI coupled cameras for collision avoidance instead of radar



Skydio X10

Technical Specs

Aircraft

Startup Time	**Under 40 seconds**
Dimensions (unfolded, with propellers)	**31.1” x 25.6” x 5.7”**
Dimensions (folded, without battery)	**13.8” x 6.5” x 4.7”**
Weight (incl. batteries)	**Connect SL: 2.11 kg / 4.65 lbs.** **Connect SL + 5G: 2.14 kg / 4.72 lbs.**
Max Takeoff Weight	2.49 kg / 5.49 lbs

Controller

Controller Dimensions	**10.5" x 5" x 3"**
Screen	**6.6" Dynamic AMOLED touchscreen 120Hz Adaptive Refresh Rate Resolution: 2340 x 1080 pixels Brightness: 1750 nits (outdoor peak) 392ppi**
Dimensions	**10.5" x 5" x 3"**
Weight	**1135 grams**
Max Range	**Connect SL: 12km / 7.5 miles Connect 5G: Unlimited (wherever cellular coverage is availa ble)**
Operating Frequencies	**Connect SL: 2400-2483.5MHz 5150-5850MHz Connect 5G: 600MHz-4400MHz**
Transmitter Power (EIRP)	**Connect SL: 34.7dBmi (2.4GHz) Connect SL: 35.9dBmi (5GHz) Connect 5G: 20dBmi**
Ingress Protection Rating	**IP54**
Operating Time	**Approx. 5 hours**
Battery	**9600mAH**
GNSS	**GPS + Galileo + GLONASS + BeiDou**

Drones – Emergency Response

Emergency responses

- Examples:
  - Land slides provides improved safety by conducting the initial inspection instead of sending geotechnical engineers onto the slide area for the inspection
  - Incident investigation- when things don’t go as planned

Getting a look before deploying personal or equipment is a game changer

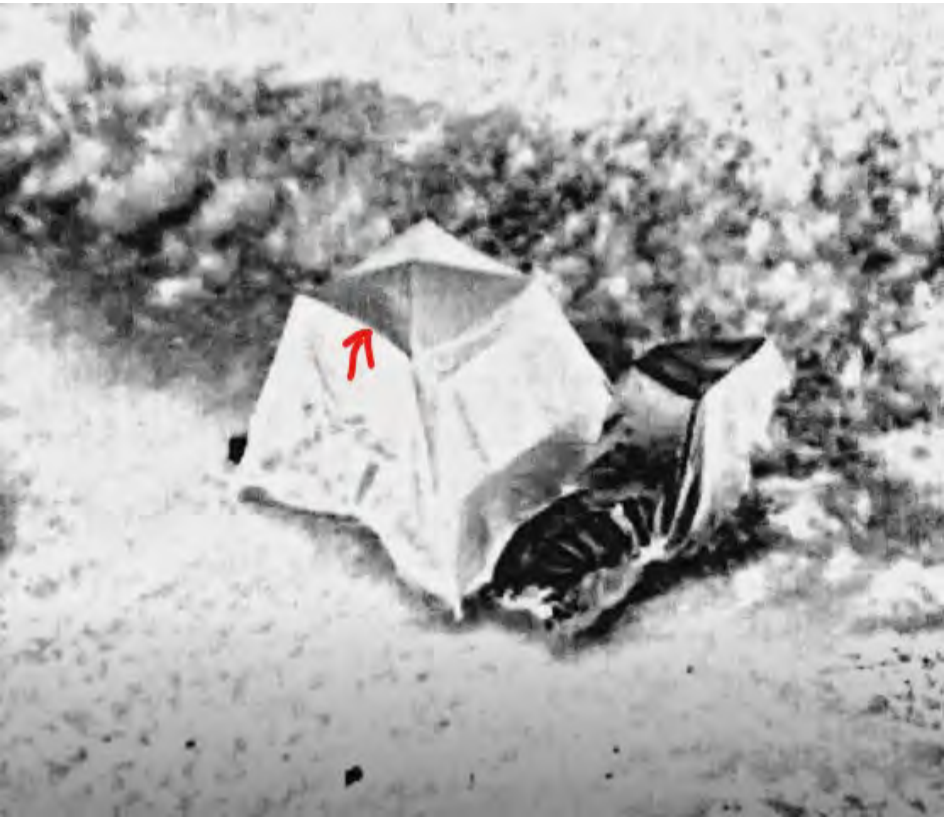
Reducing risk and improving operational planning opportunities

When a plan goes wrong a drone helps to tell the story

Drones – Homeless Camps

The Drone make it easier to plan operations. It's good to know the lay of the land. Law enforcement and other partners appreciates having some idea of what they might be walking into.

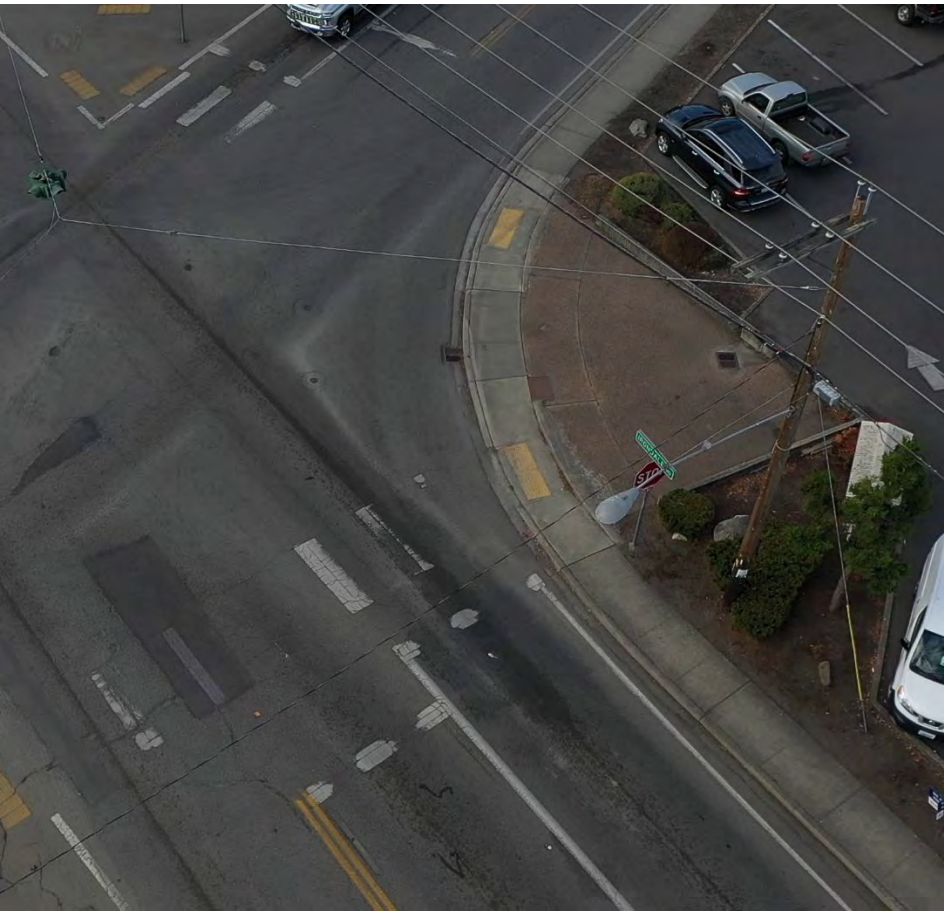
Infrared Camera because everyone living on the R/W has a right to privacy



Drones – Summary

To summarize:
Drones are a great tool to reduce risk to our staff, increase efficiency, and tell our story

Before



After

Contact Info & Thank you

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