drover

AI-Powered Computer Vision for Micromobility

PRIVATE AND CONFIDENTIAL

PathPilot AI Software

PathPilot is pioneering Advanced Rider Assistance Services (ARAS) technology that leverages edge-based computer vision and AI to deliver a variety of safety and compliance features that enhance the micromobility experience.

Regulatory Compliance

Enforcing proactive compliance with existing riding and parking regulations to help meet city expectations for micromobility behavior.

Operational Efficiency

Providing real time data and insights coming from AI inferences, enabling more efficient ops decision making and reduction in exposure to fines and violations.

Rider & Pedestrian Safety

Delivering a riding experience that keeps the rider safe and in compliance with rules, while avoiding negative interactions with other users of the public right-of-way.

Rich Data Telemetry

Providing access to insights and reporting with unique context derived from camera AI inference, that can be shared with cities, insurers and other stakeholders.

Innovating with ARAS

Leveraging AI-powered cameras and other onboard sensors to deliver cutting edge rider assistance services at a low price point.

Sidewalk & lane detection

PathPilot is the first tech of its kind deployed at the edge, able to detect sidewalks, streets and bike lanes, which enables unprecedented control over vehicle/rider behavior and regulatory compliance.

- Edge-based inferencing with real-time detection
- Ability to control vehicle speed in response
- Customizable audio and dashboard alerts
- Works even in the absence of GPS or cellular signals
- Excellent ‘out of the box’ performance, and only minimal training required for new environments
- No ‘groundtruth’ required to function
  - No extensive pre-mapping
  - No extensive image/video collection
- Ability to train and update AI models OTA
- MDS 2.0 compliant

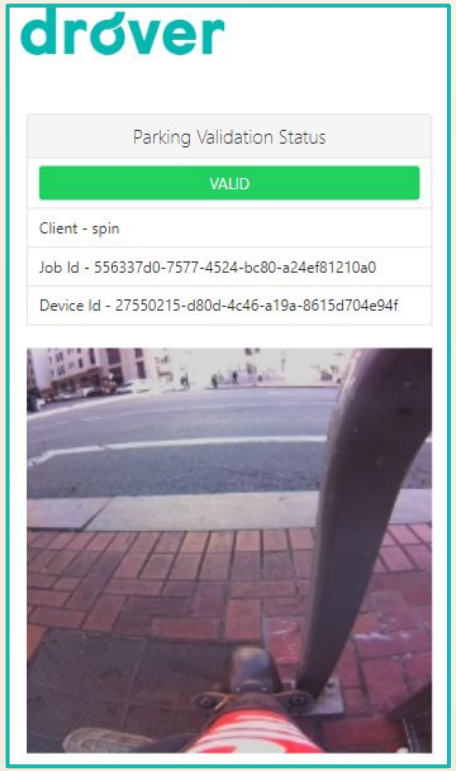
Parking detection & validation

At the end of a ride, PathPilot shifts from sidewalk detection to parking validation, reducing friction from the user experience and ultimately helping ensure better outcomes.

- PathPilot is trained to look for 3 valid parking categories
  - Inside a designated marked corral
  - Within ~2ft of the edge of the sidewalk
  - Within ~2ft of a bike rack
- All other outcomes are invalid with the ability to prioritize invalid outcomes
- Video and AI score of every parking outcome available to operator which helps prioritize operational response to parking outcomes that might need attention
- Opportunity to create a new ‘end of ride’ user experience that doesn’t rely on smartphone photo
- MDS 2.0 compliant

Parking validation API

PathPilot provides the ability to have insight into the end of ride outcome 100% of the time without relying on a user generated photo. Drover's parking validation algorithm will rate each end of ride outcome and allow operators to take any necessary action.



For more info, contact: alex@drover.ai

Tip Over Detection

IMU-based detection of tip over events as well as correction of such events, combined with image verification to confirm the IMU detection and event

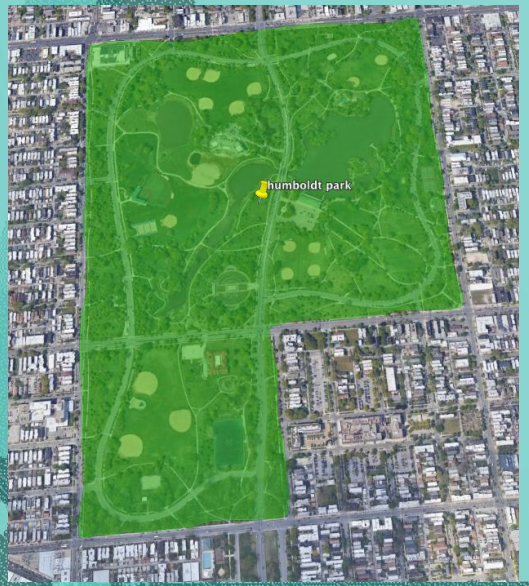
PathPilot detects scooter tip overs at any time:

- Especially **after ride is completed.** Tip over alerts are sent to operator via MQTT feed or other channels
  - Time stamp included
  - Photo evidence provided
  - GPS coordinates
  - Device ID
  - Tip over status: tipped over vs corrected

Edge-Based Geofencing

PathPilot can host and manage hundreds of geofence files onboard and Drover can create ‘Exclusive’ or ‘Inclusive’ geofences with distinct PathPilot behavior corresponding to regulatory or operator needs. Real-time response with no network related latency.

Inclusive	Establish a restricted zone within which PP is active. • Ex: dense downtown area, pedestrian zones • Reduce speed on sidewalks • Makes audible sound • Surface in-app messages/warnings • Enforce specific parking rules
Exclusive	Establish a zone in which PP is deactivated. • Ex: parks, multi-use trails • Silence PP sounds • No speed control even on ‘pedestrian’ looking areas • No parking enforcement • Telemetry is still active



For more info, contact: alex@drover.ai

Parking garage & building detection

PathPilot has been trained to detect when a vehicle has entered a parking garage or building which has significant operational value.

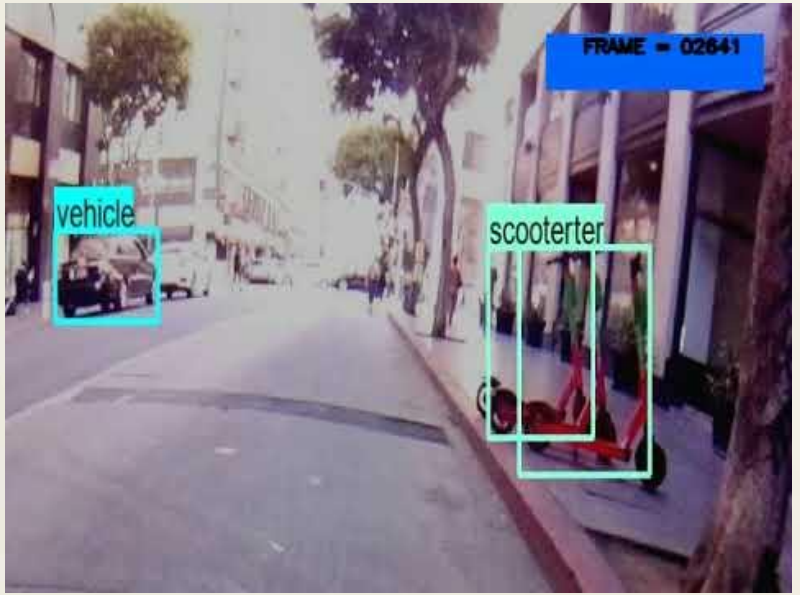
Without PathPilot	• GPS signal is compromised • Time and $$ spent searching for vehicles • Potential loss of vehicle if not found quickly
With PathPilot	• Real-time notification that vehicle has entered a structure at a certain GPS location • Ability to shut vehicle down to prevent further entry • Saves time and $$ on vehicle recovery • Ability to request an image from PathPilot to pinpoint location

For more info, contact: alex@drover.ai

Person & object detection

In tandem with infrastructure distinction and parking validation, PathPilot's computer vision can be used for a wide range of additional functions.

- Vehicle, bike, scooter detection
  - Downed scooter detection
- Person detection with redacted faces
  - Automated audio alert when persons detected
- License plate recognition
  - Cars blocking bike lanes
  - Curb management
  - Parking enforcement
- Infrastructure detection
  - Bollards, bike racks, signs, etc
- Infrastructure surveying
  - Condition of sidewalks



Real Time MQTT Telemetry Feed

Drover provides customers with API access to telemetry coming from vehicles running PathPilot.

- PathPilot provides real time feeds for various and customizable events including:
  - Valid/Invalid parking
  - Sidewalk riding
  - Bike Lane riding
  - Tip over & tip over correction
  - Parking garage
  - GPS geofence
  - Accident/incident detection with flagged images
- Feed can be integrated into customer's backend via API
  - In-app user notifications (SW riding, parking, etc)
  - Assist with creation of rider profiles (risk based)
  - Produce more granular trip and fleet visualizations
  - Produce reports with detailed view of infrastructure use and rider behavior

Event & Alert reporting tools

In addition to the MQTT feed, Drover provides user friendly tools that customers can use to monitor and respond to events: Slack integration and Drover Corral.

Slack alerts can be customized to support ops teams in specific markets.

parking validation

customer
`spin`
device id
`018163eb-9649-4a14-9483-0a85bc9cfae6`
parking status
`invalid`
parking datetime
`11/21/2022 00:37:04`
2cb1441d-21ea-411e-b03c-59f556094291

pathpilot-notification-app APP
Today at 10:46 AM

vehicle tip over status

customer
device id
`voi`
`f9c3d473-b5a6-46c7-al`
tip over status
event datetime
`tipped over`
`2023-07-27 17:44:58`
location

pathpilot-notification-app APP
Today at 10:51 AM

vehicle tip over status

customer
device id
`voi`
`f9c3d473-b5a6-46c7-ab0e-288824f2afff`
tip over status
event datetime
`corrected`
`2023-07-27 17:50:19`
location

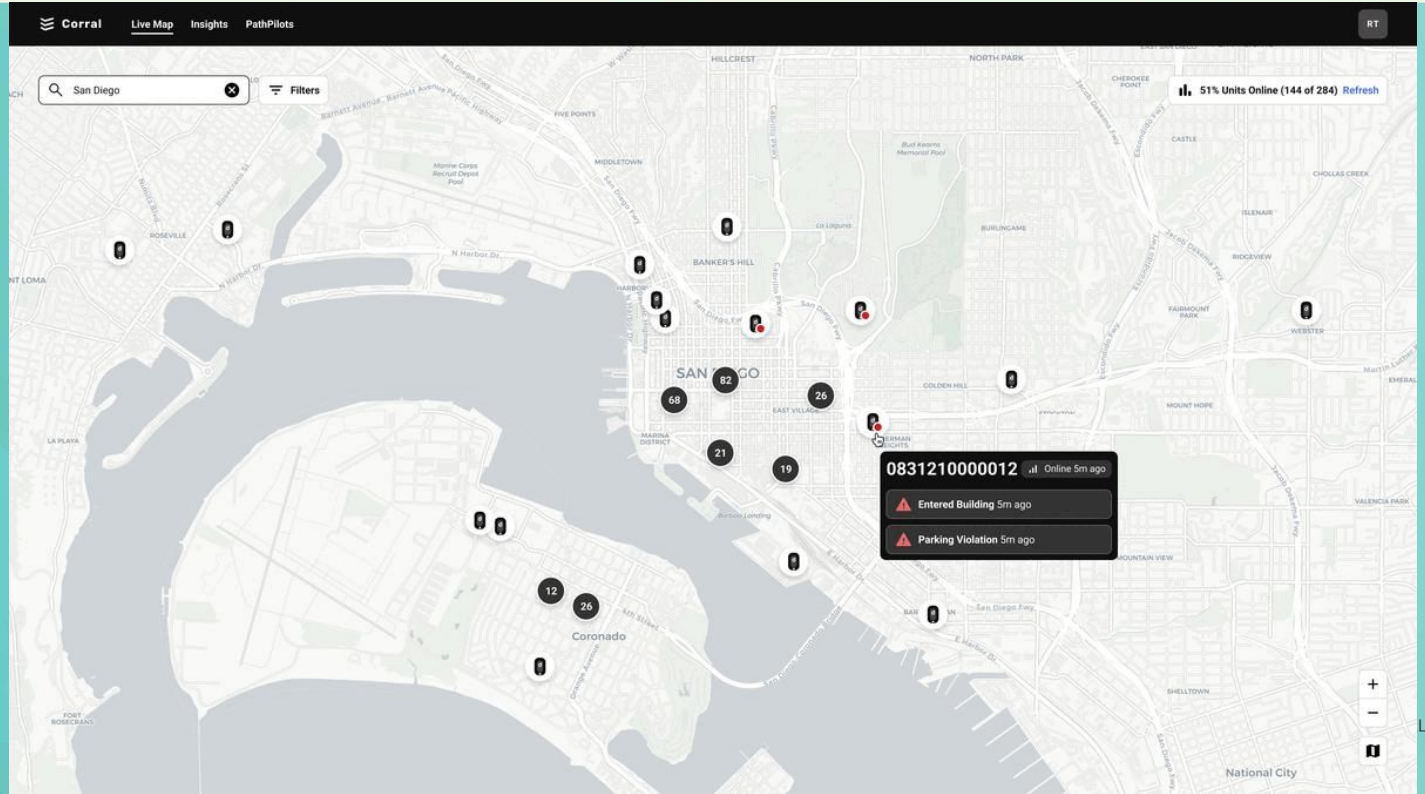
pathpilot-notification-app APP
Apr 4th at 12:18 PM

garage entrance detected

customer
device id
`beam`
`6eaed4a0-ca17-4b36-8f3e-87f967c93103`
event location
event datetime
location
`04/04/2023 19:18:12`

Drover Corral

MDS 2.0 location telemetry, combining GPS data with visual inference to provide an unparalleled understanding of fleet and user behavior.

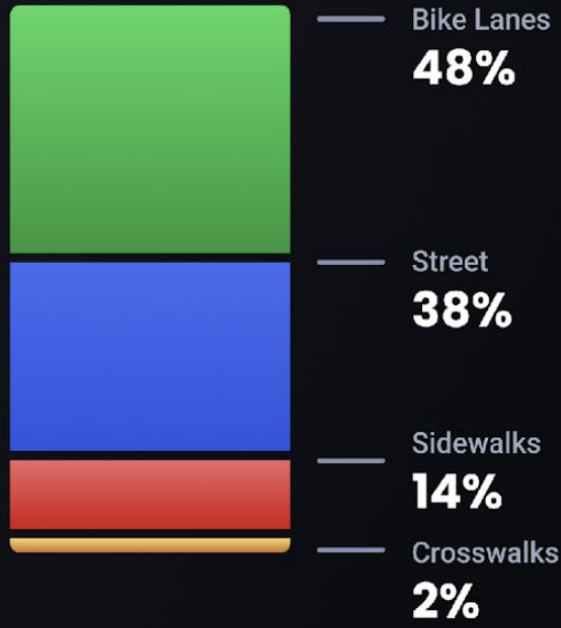



infrastructure type
street
sidewalk
bike lane
crosswalk
bike rack
parking corral
curb
RABBEN
LYBEKK
HOVSETER
HOLMEN
GAUSTAD
BERG
NYDALEN
GREFSEN
MAKRELLBEKKEN
Dalsveien
VINDEREN
BLINDERN
University of Oslo
BJØLSEN
Aker University Hospital
SMESTAD
MONTEBELLO
MARIENLYST
SINSEN
HOFF
Frognerparken
ULLERN
SKØYEN
BESTUM
VÆKERØ
BYGDØY
FILIPSTAD
TØYEN
ULVEN
ALNABRU
BREIVOLL
TEISEN
HELSFYR
BRYN
JORDAL
HØYENHALL
SVERRESBORG
OLD TOWN
KVADRATURET
Låveveien
Smalvollveien

Trips by Infrastructure

Include Riding On

Total Ride Time On



drover + MDS MOBILITY DATA SPECIFICATION

OMF OPEN MOBILITY FOUNDATION

The recent release of MDS 2.0 in May 2023 features 3 elements directly related to Drover capabilities:

- Qualitative description of vehicle position based on surface type
- Parking validation with visual evidence
- Tip over reporting via MDS

Advanced Rider Assistance Services (ARAS)

Building on our existing AI/CV platform and capabilities, Drover is developing a suite of rider safety features that can be integrated into all manner of Light Electric Vehicles (LEVs).

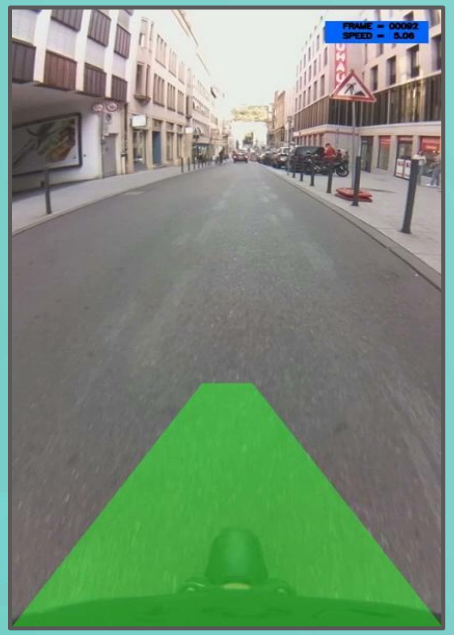
What is ARAS?

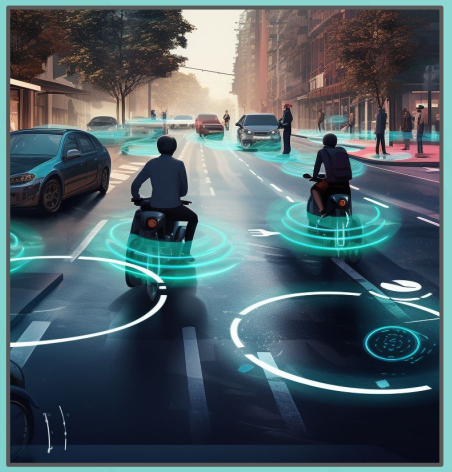
- "ADAS for Two-Wheelers"
- Unique challenge compared to ADAS
- Requires high-accuracy at a low cost
- Sensor fusion of camera + radar

Primary Features

- Forward/Rear Collision warning
- Blind Spot Monitoring
- Pothole detection/V2V reporting
- Lane Change Assist
- Pedestrian Detection

Forward collision warning
Available in Beta



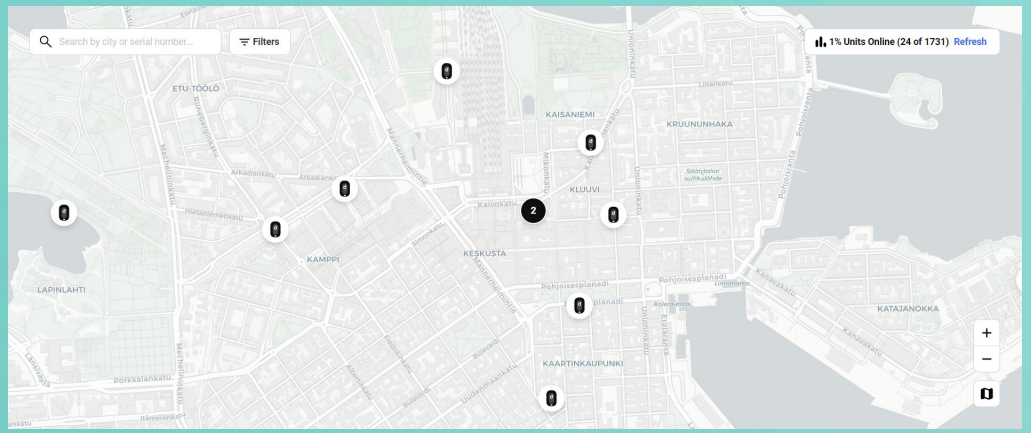


Helsinki E-Scooter Case Study

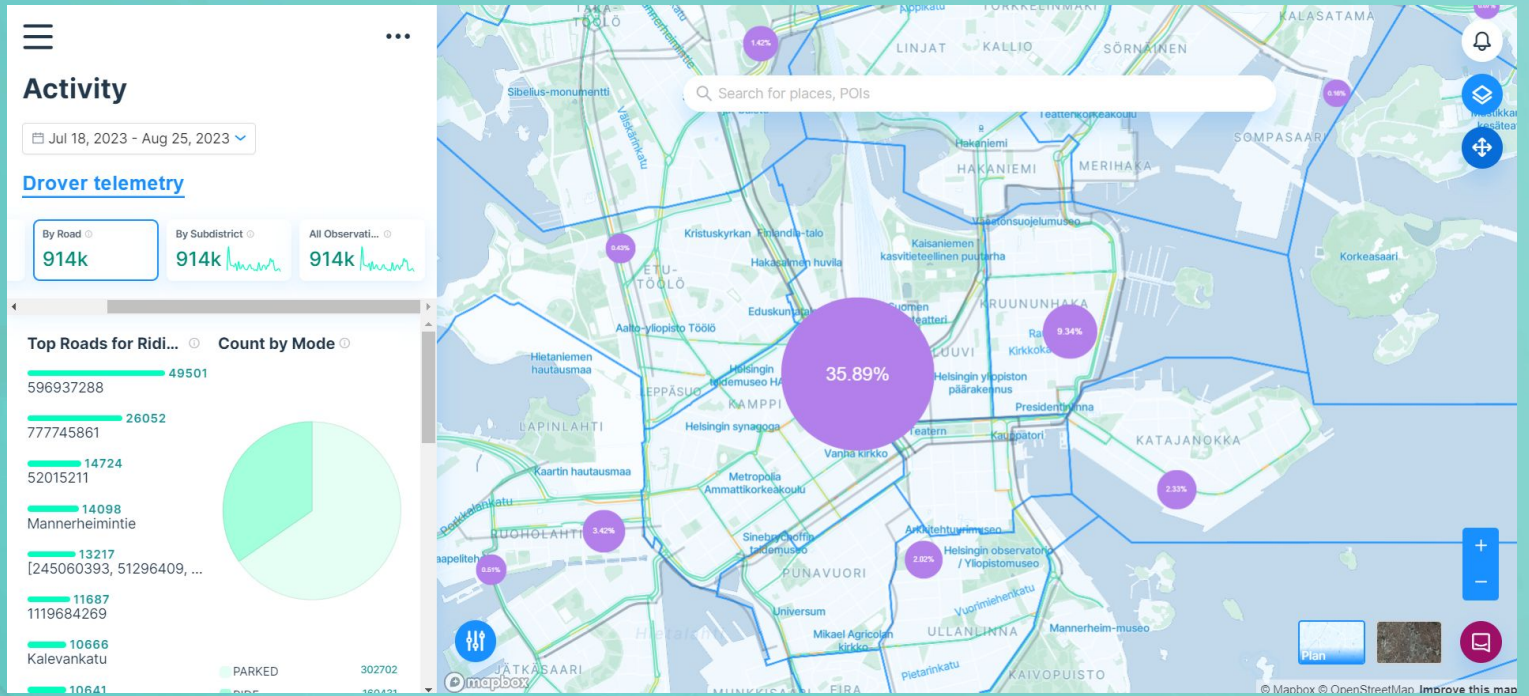
Case Study Scope

Helsinki Case Study:

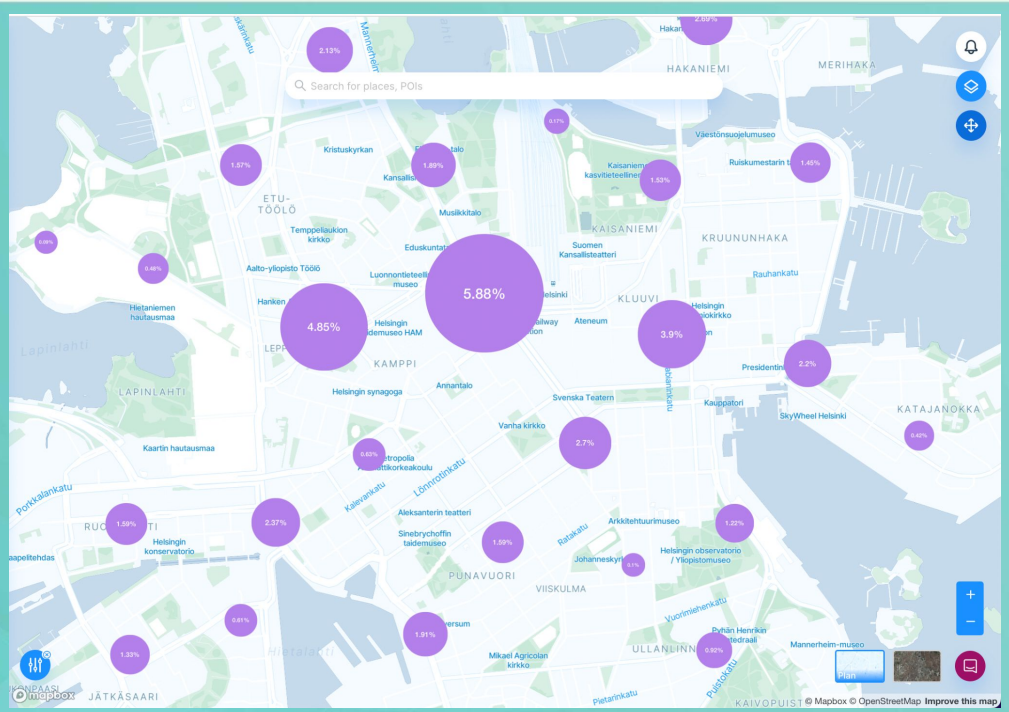
- Three month case study
- Two Phases (Sounds Off and Sounds On)
- 25 unit fleet deployment
- 5 zone distribution (including city center and train station)
- Real time behavior nudges
- Audio sounds (sidewalks and bike lanes)
- Geofence zone for multi use paths
- Granular telemetry data collection
- Pothole and infrastructure quality survey



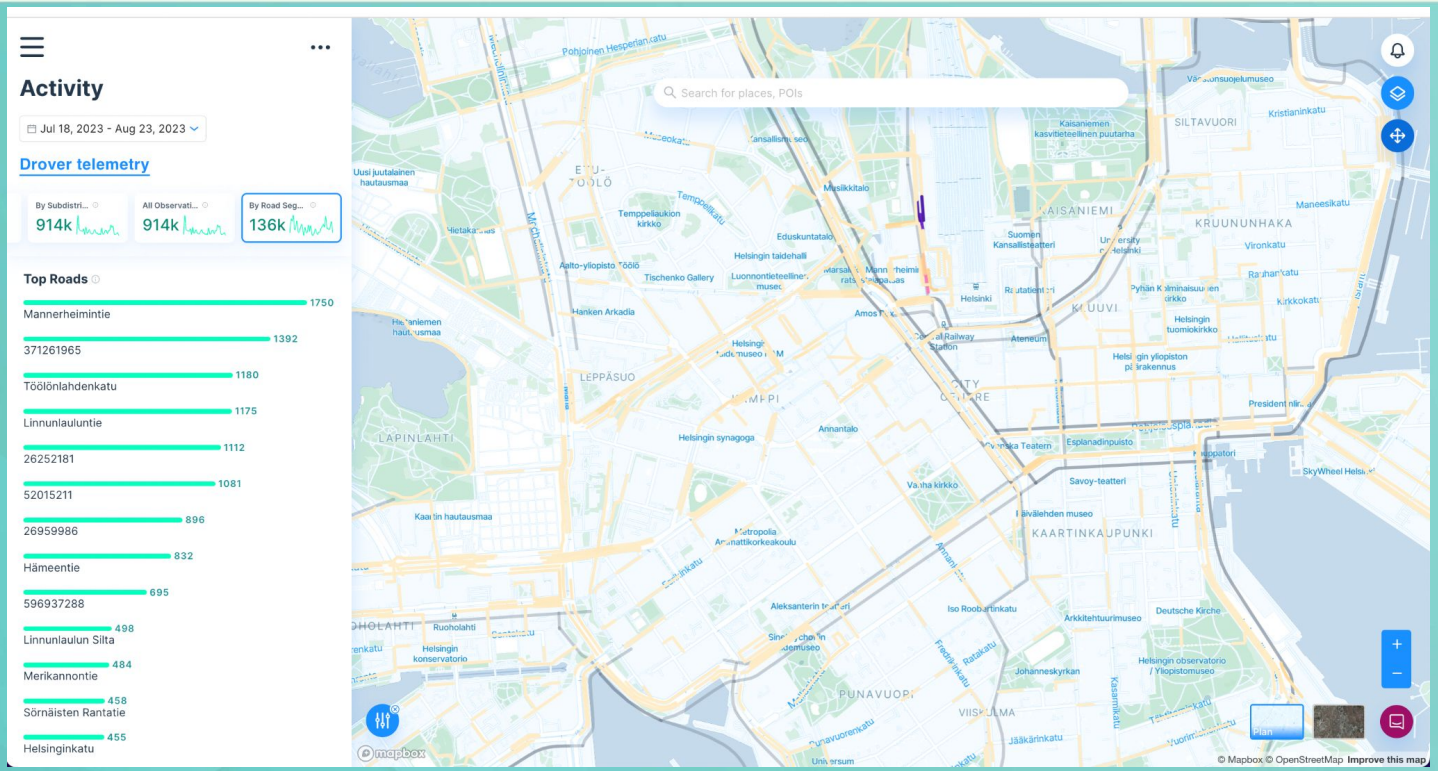
Phase 1 Activity (Top Roads for All Riding)



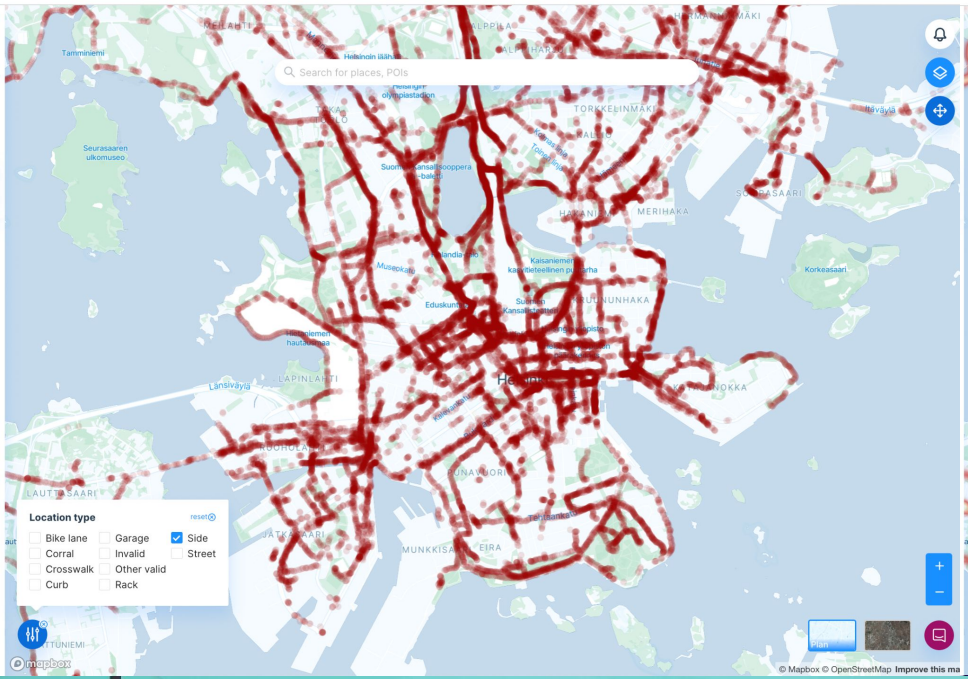
Phase 1 Activity (Pavement Riding by Zone %)



Phase 1 Activity (Top Roads for Pavement Riding)

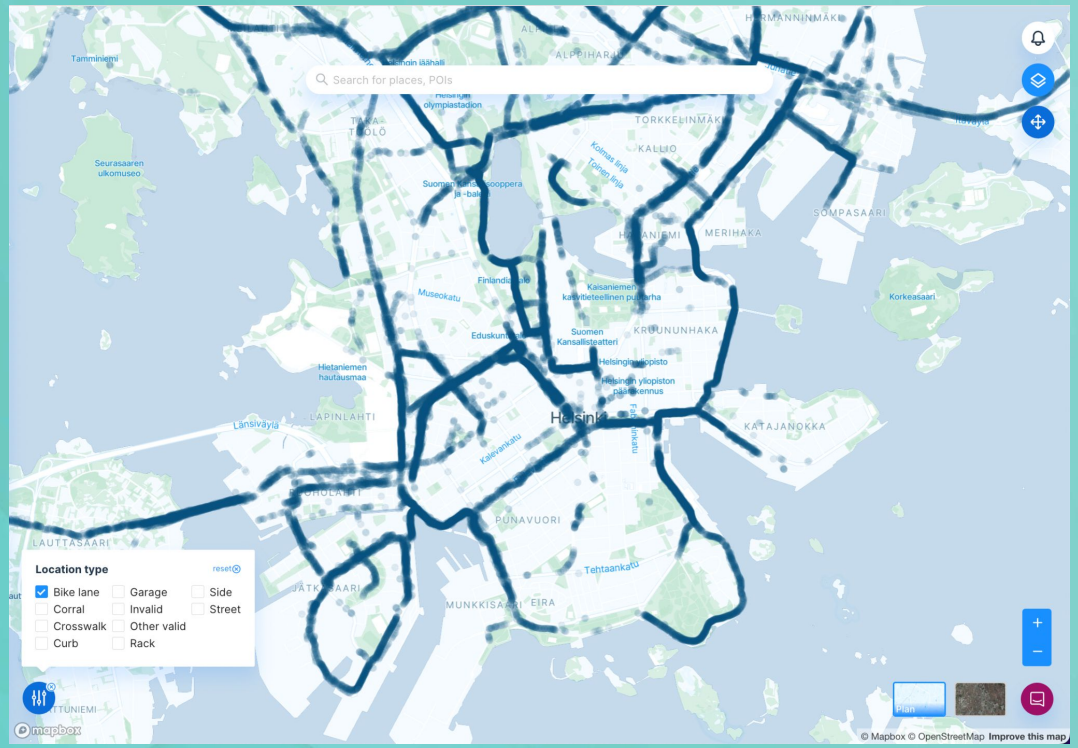


Phase 1 Activity (Pavement Riding - Telemetry & Heat Maps)

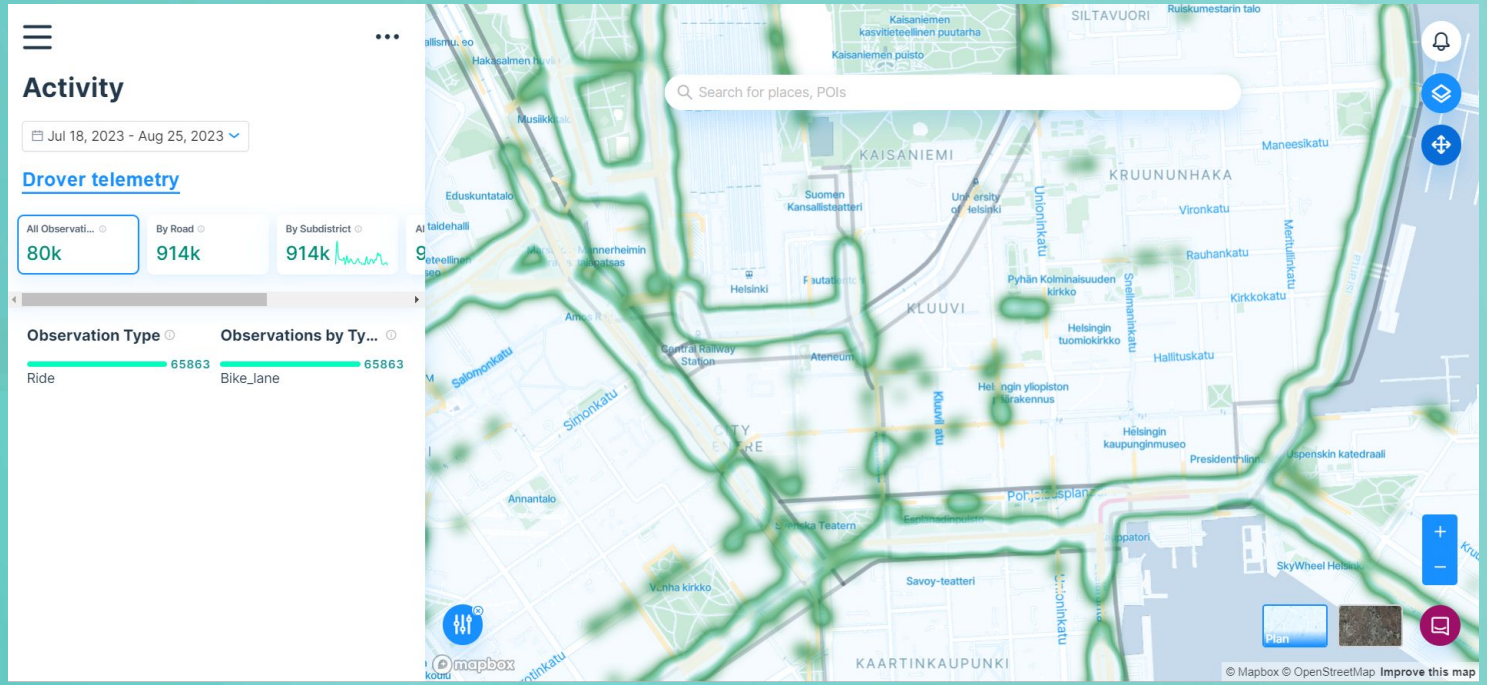


Phase 1 Activity (Street Riding)

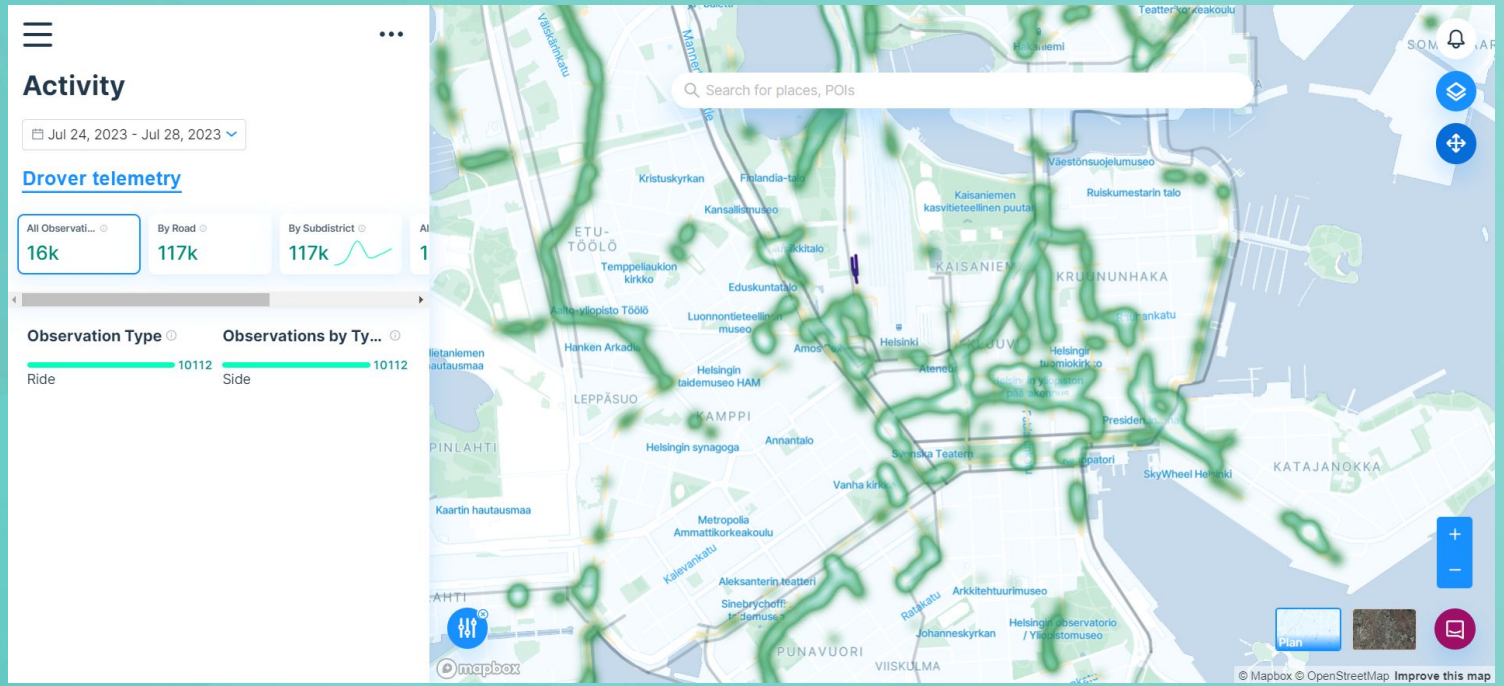
Phase 1 Activity (Bikelane Riding)



Phase 1 Activity (Bikelane Riding & Infrastructure)

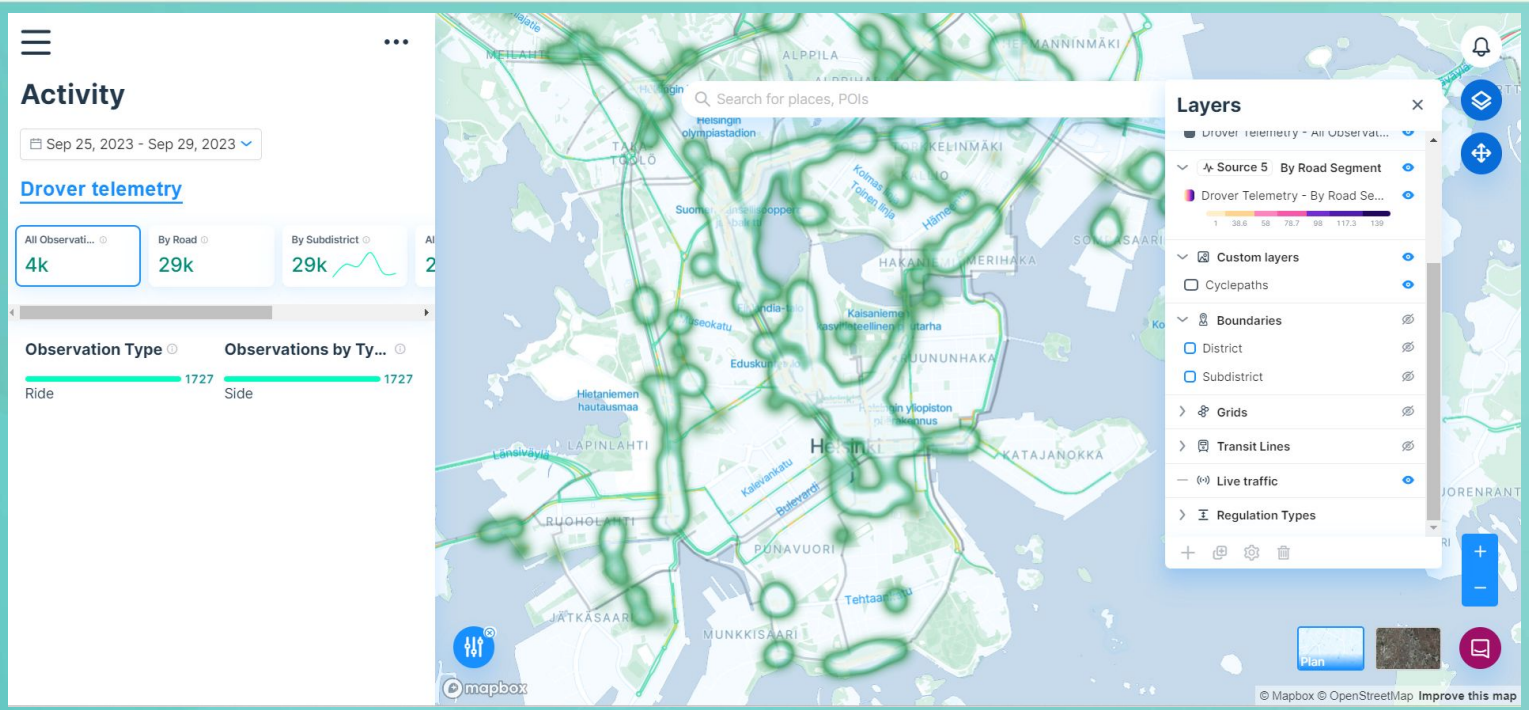


Phase 1 BEFORE (Pavement Riding Behavior)



Phase 2 AFTER (Pavement Riding Behavior)

Infrastructure and Safety Survey



Case Study Next Steps

Helsinki Case Study:

- Finalize Phase 2 data collection (Oct 20)
- Download Phase 1 and Phase 2 data
- Review potholes and infrastructure quality (survey)
- Phase 1 and Phase 2 data analysis and visualizations
- Draft and final white paper
- Publish paper and present findings
- Policy and planning tool for cities
- Playbook for similar pilots and case studies
- Present at Smart City Expo World Congress, AutoTech Europe, POLIS Conference, and others in 2024,

Thank You!