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Exploring the Impact of Perceived Travel Environment on E-scooter Riders' Stress Level

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Prepared for DVRPC Regional Safety Task Force (RSTF) Meeting

06/23/2022

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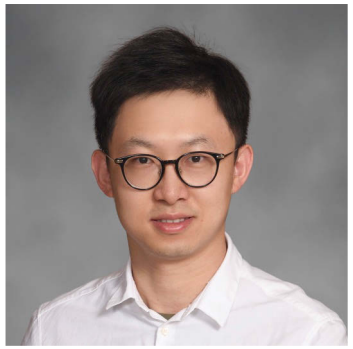

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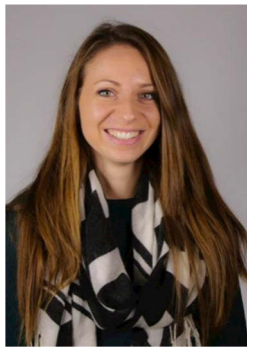

Hannah Younes

Hailey Hensley

Plus Shuxin Zhong, Zhiying Zhu, Kelcie Ralph, Evan Bregenzer

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Motivating Questions

- How do we increase the quality and quantity of data on pedestrian & micro-mobility risk?
- What factors increase the risk of vulnerable road user near-miss conflicts?
- How do we drive vulnerable road user fatalities to **zero** for all road users?

Project Timeline & Locations

Task Timeline (Leader)	2020	2021				2022				2023		
Dxx = deliverable	4	1	2	3	4	1	2	3	4	1	2	3
Near miss detection capability												
1.a. Baseline data sets (Gong)	D1				D1				D1			
1.b. Training data set (Gong)			D13									
1.c. Computer vision (Metaxas)			D8	D6								
Social experiments												
2.a. Behavioral exp. (Noland)							D10					
2.b. Road redesign exp. (Ralph)							D10					
Technological experiments												
3.a. Pedestrian app (Zhang)				D13								
3.b. Driver app (Zhang)				D13								
3.c. Connected camera (Zhang)					D13							
3.d. Integrated system exp. (Zhang)						D7		D8	D13			
Community deliberations												
4.a. Simulation model (Andrews)						D2			D3			
4.b. Joint fact-finding (planning studio classes) (von Hagen)			D9				D9				D9	
4.c. Reflective workshop (Noland)												D14
Evaluation												
a. IRB protocol approval (Andrews)												
b. Sensor data adequacy (Gong)		D12										
c. Near miss accuracy (Metaxas)				D12								
d. System connectivity (Zhang)						D12						
e. Model validation (Andrews)								D12				
f. Deliberation (von Hagen)												D12
Community partner meetings												D5

Studio

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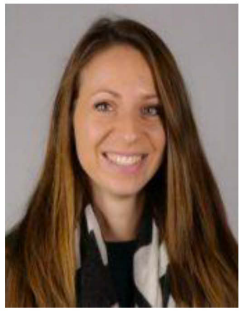
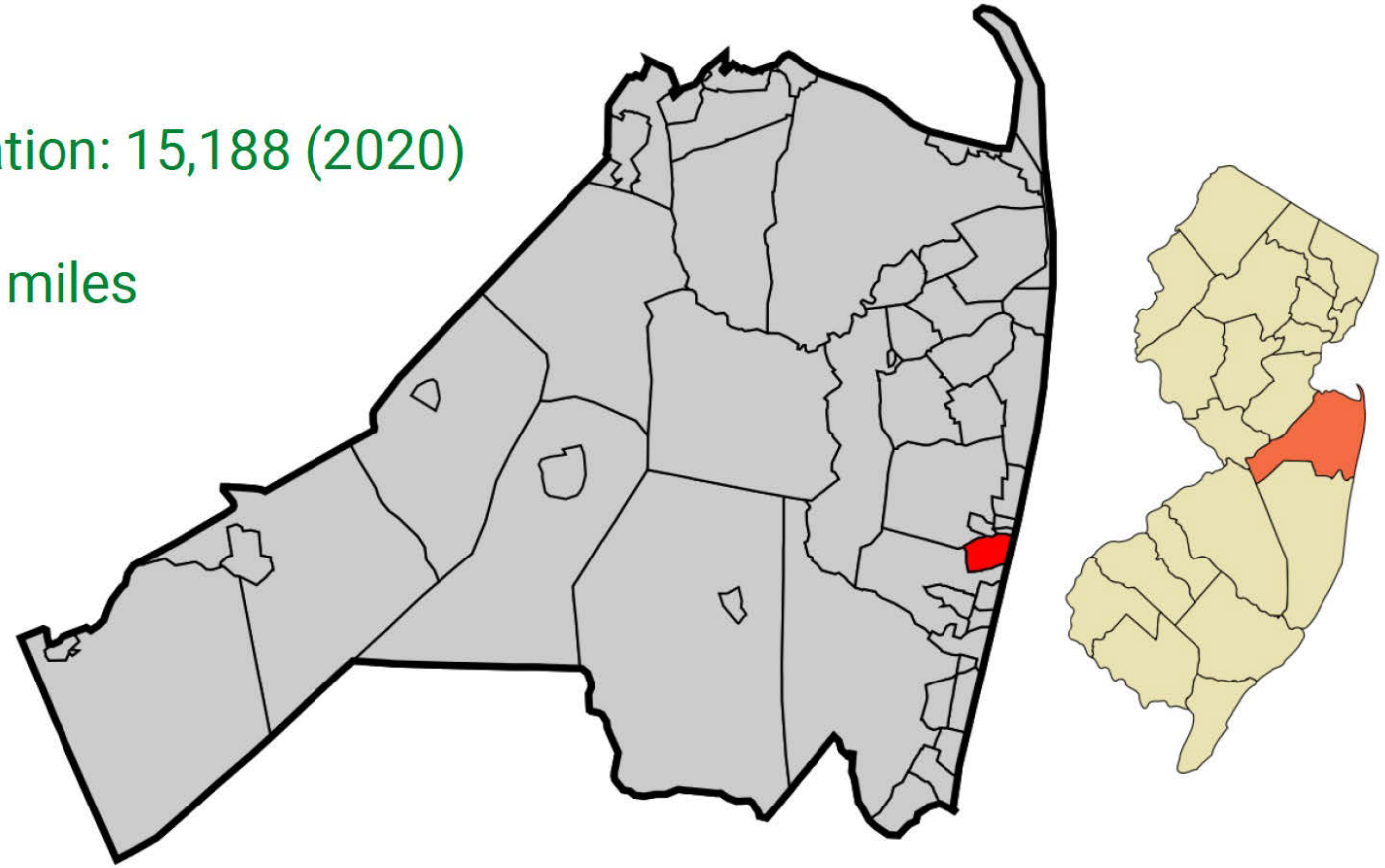


Hannah Younes
Ph.D.

About Asbury Park

Total population: 15,188 (2020)

Size: 1.6 sq. miles



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Pop-up Bike Lane Experiment

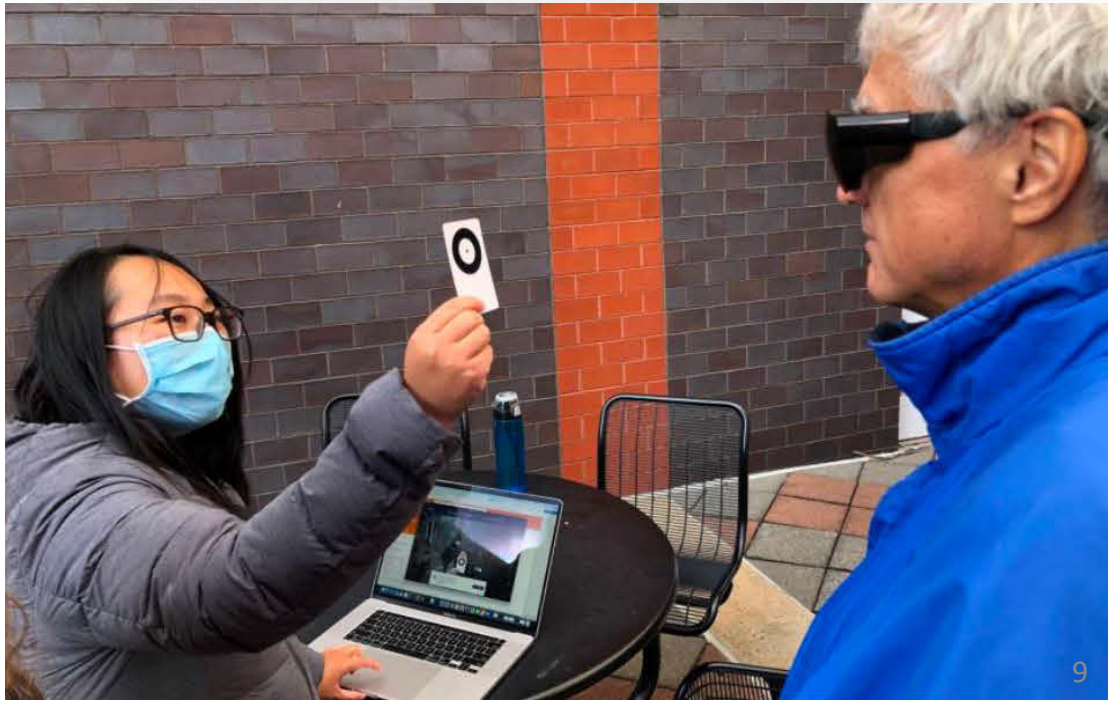
Study Objective

- Explore how e-scooter riders perceive their travel environment using biometric sensors
  - What have they paid attention to?
  - Are travelers focusing on objects that are found to be associated with incidents?
  - Head turning movement patterns?

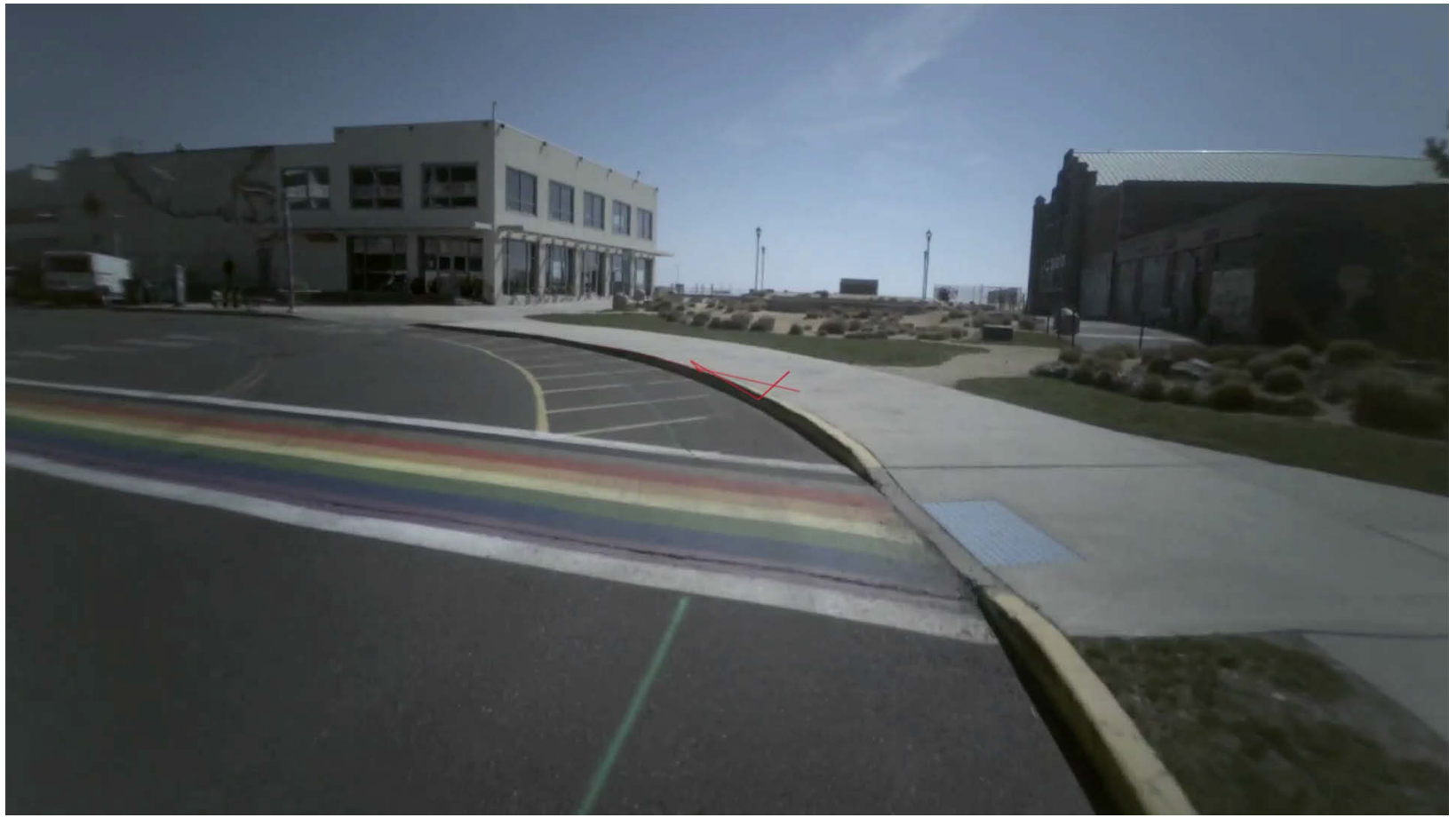
- Is there any association between the perceived travel environment and travel stress level?

Eye-tracking Glass

- Tobii eye tracking glass 3
- Data collected:
  - Eye movement (fixation, 100hz, what have riders been focusing on)
  - Pupil dilation (100hz, track attention)
  - Front facing video (50hz)
  - Sound
  - Head movements



Eye-tracking Glass – Results Demo

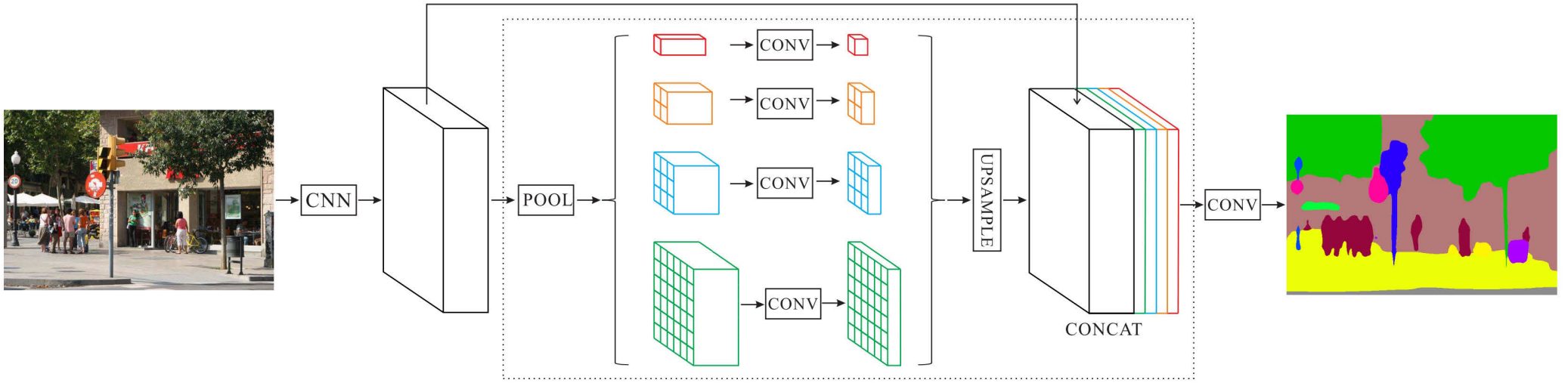


Limitations in eye tracking data collection in the field

- Pupil dilation also influenced by shading
- Eye tracking rate drops when the rider moves towards the sun
- The glass only works for people who don't need glass or can wear eye contacts.

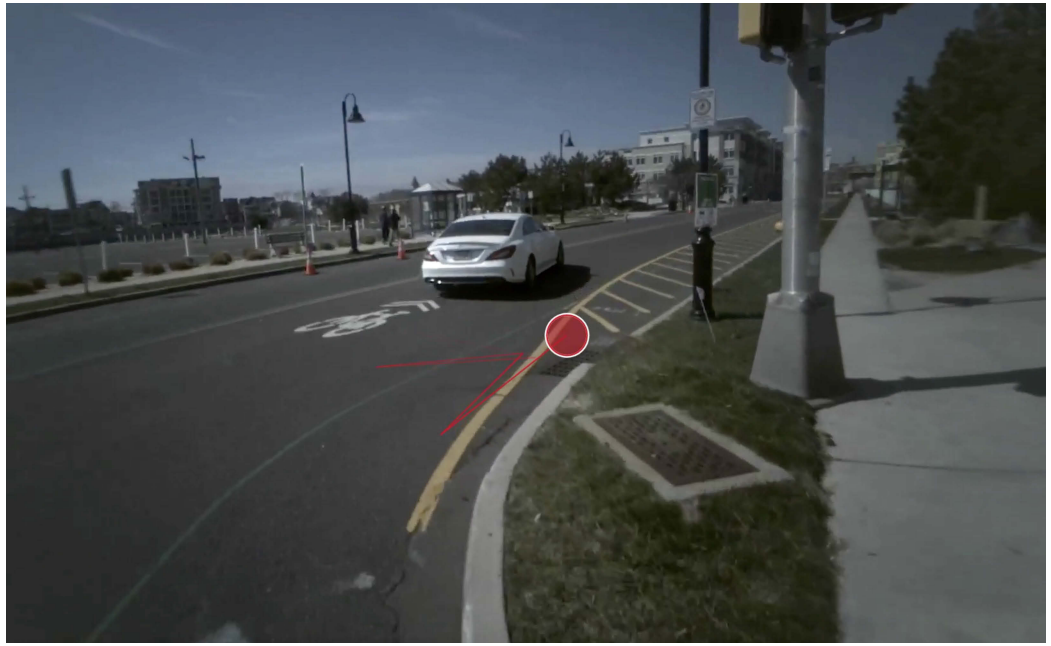
Computer Vision

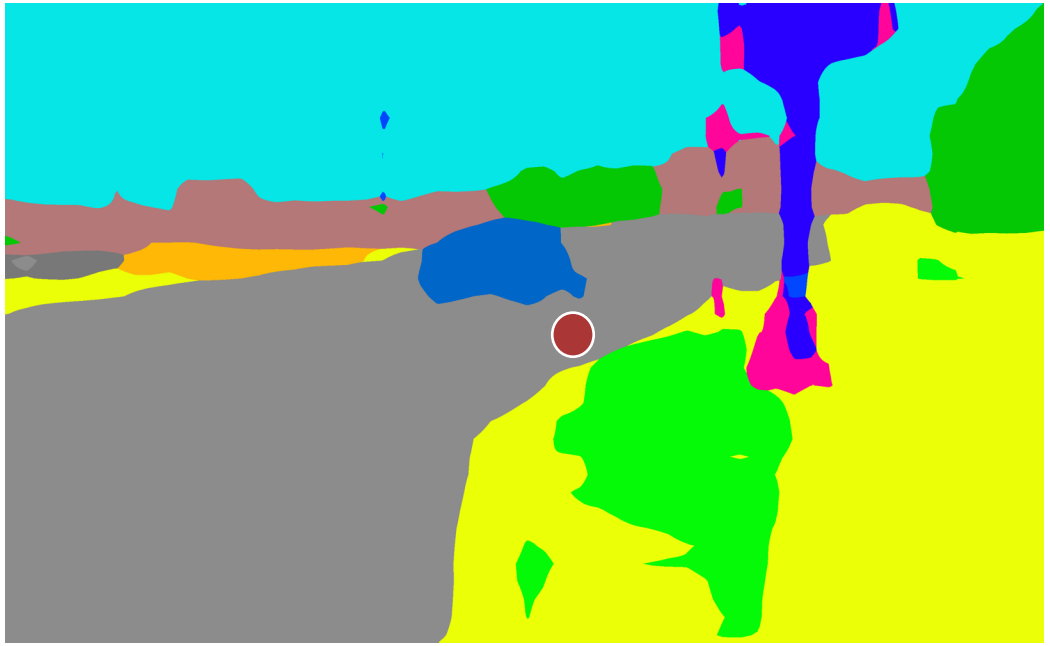
- Image segmentation algorithm – PSPNet



Source: Zhao, H., Shi, J., Qi, X., Wang, X., & Jia, J. (2017). Pyramid scene parsing network. In *Proceedings of the IEEE conference on computer vision and pattern recognition* (pp. 2881-2890).

Eye-tracking data & Computer Vision

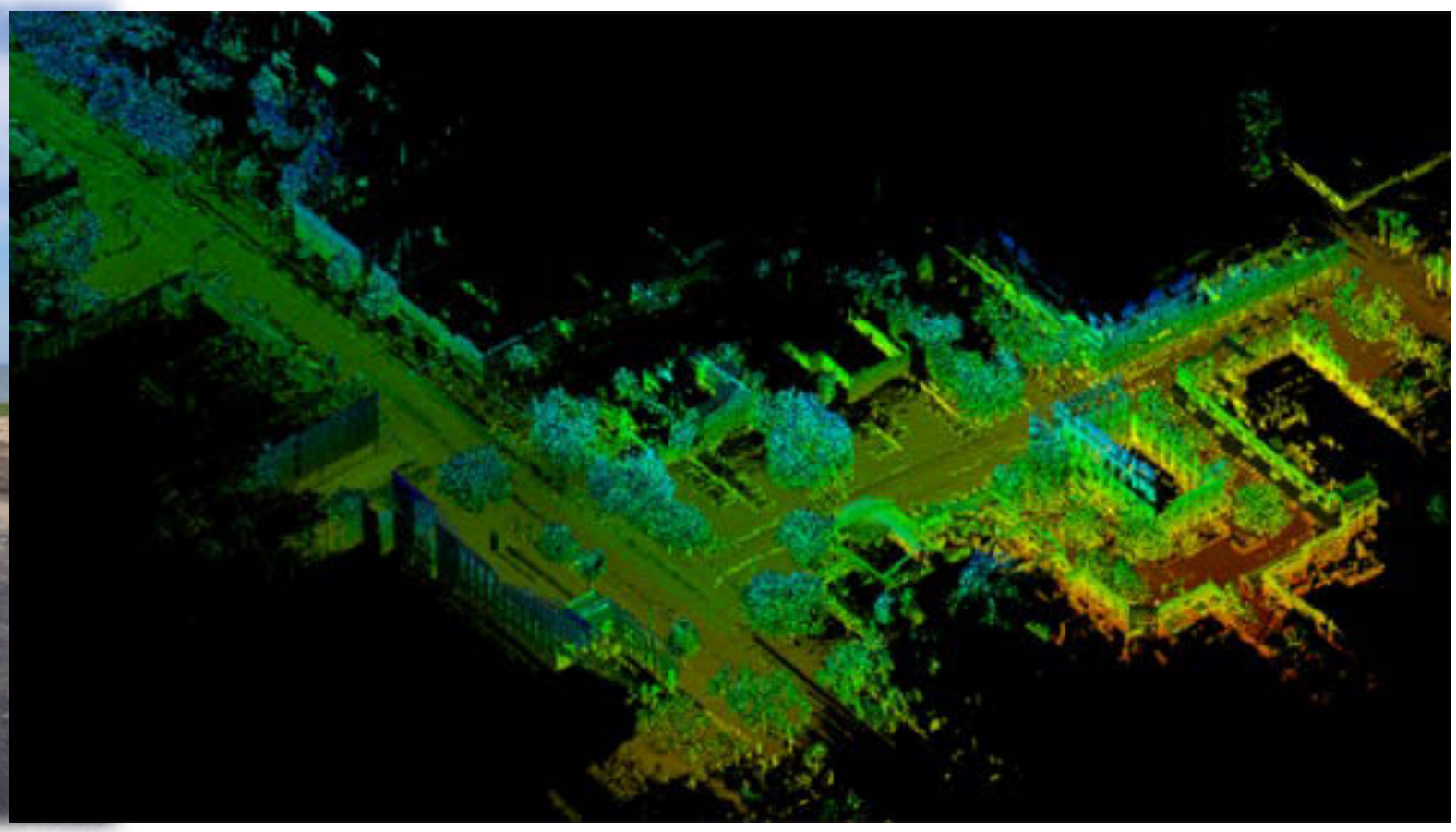




93.4% of fixation overlays with road and traffic-related objects:

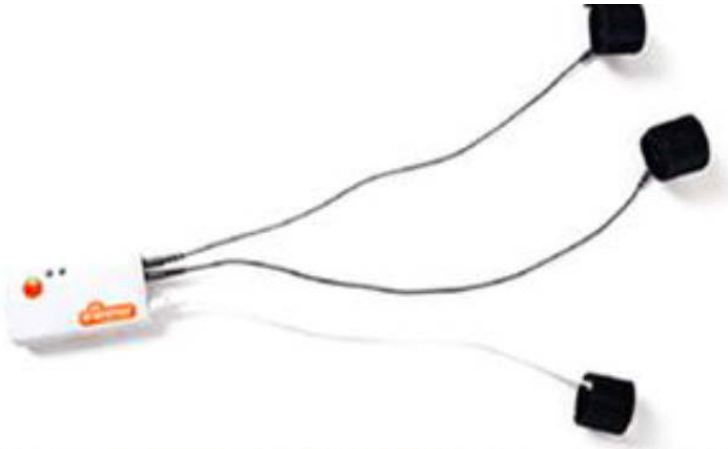
road, sidewalk,
car, van, truck, pedestrians, bicycle, bus…
streetlight, traffic light, signboard

Next step: Eye-tracking data & LiDAR data

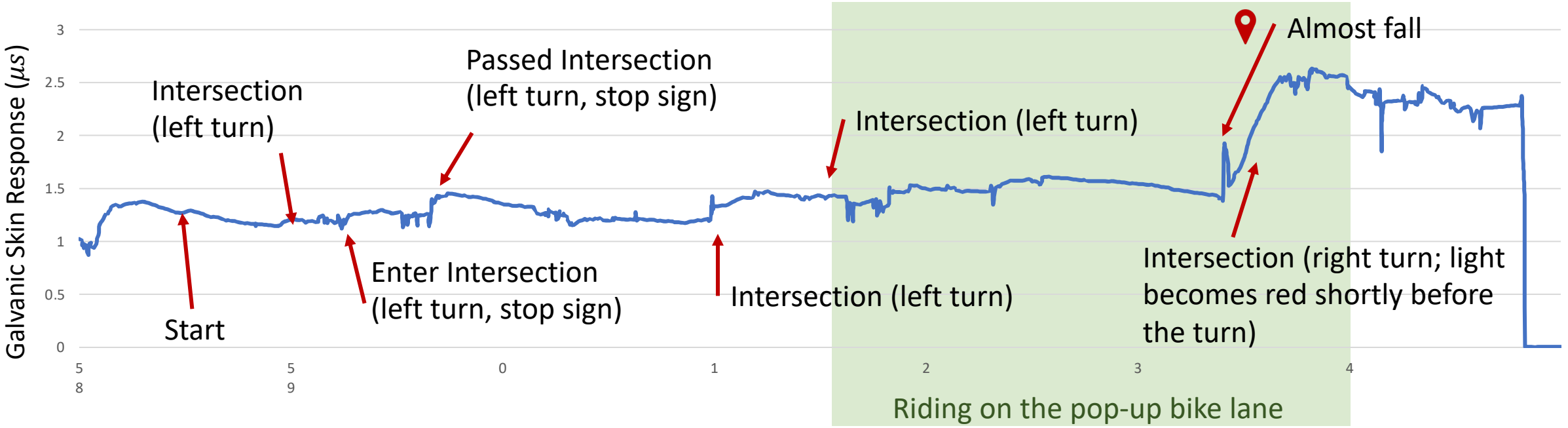


Galvanic Skin Response Sensor

- The galvanic skin response refers to changes in sweat gland activity that are reflective of the intensity of our emotional state, otherwise known as emotional arousal.
- The sensor has been frequently used to measure stress level



Galvanic Skin Response Sensor - Demo



Limitations in GSR data collection in the field

- Weather condition matters
- Noises can be introduced by hand gesture and turbulations.
- Next step is to pair it with heart rate tracker to remove possible biases.

Synchronized eye tracking & GSR demo

Next steps

- In-depth gaze data analysis
- Develop models to explore possible associations between the perceived travel environment and travel tress level
- More data collection
  - Adding heart rate tracking sensor
  - Collect more sample data on Rutgers Campus or Newark
    - 30 samples of cyclists, pedestrian, and e-scooter rider data
    - Supported by Rutgers internal grant

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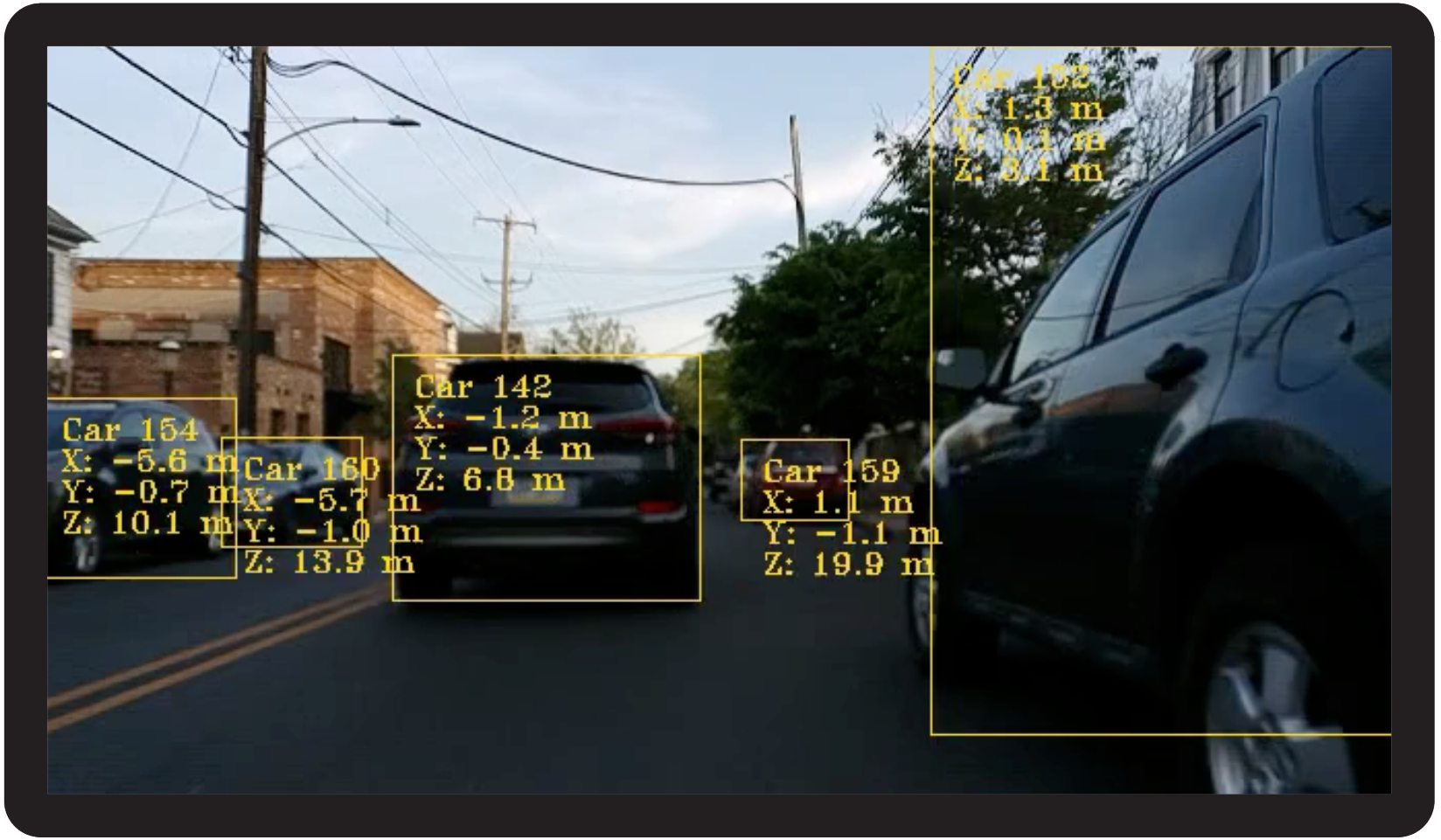

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BRINGING SAFETY AND INSIGHTS TO OUR ROADS!

DVRPC : RSTF & IREG JOINT MEETING

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NHTSA
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

In 2020 US vehicle crashes...

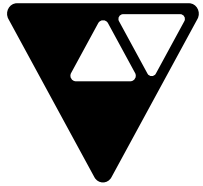
938 cyclists were killed
+9.2% over 2019
highest since 1987

+

42,337 additional cyclist crashes involving serious injury and property damage

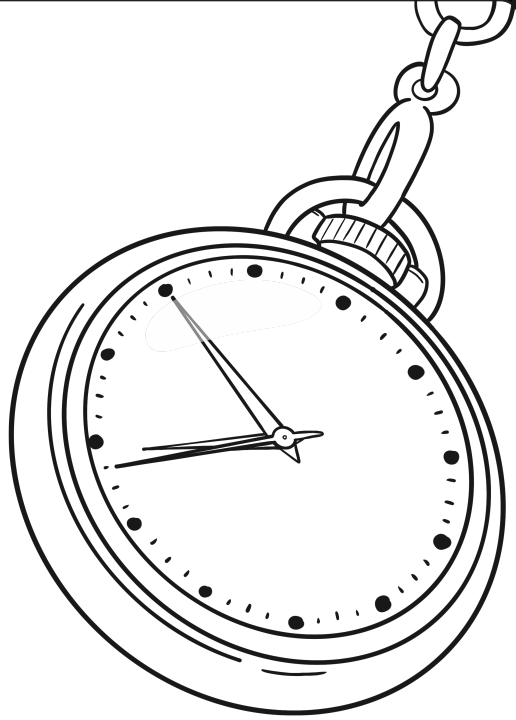
> **"People should leave the house and know they're going to get to their destination safely.**

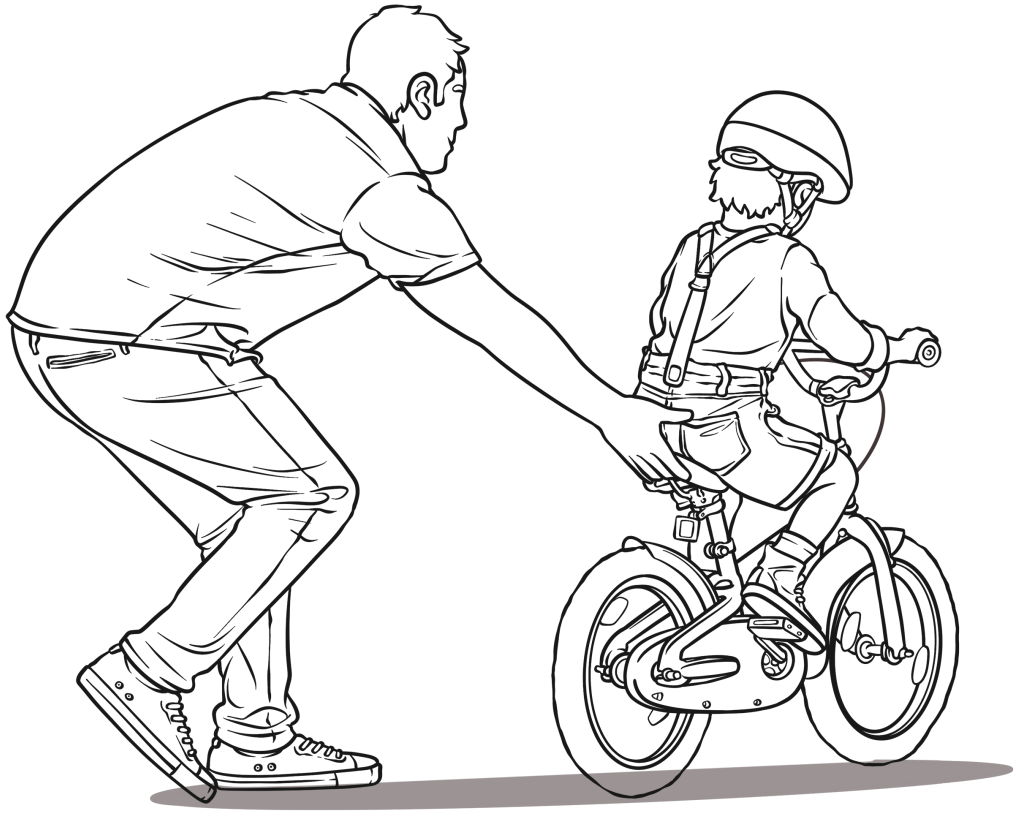
Pete Buttigieg, U.S. Transportation Secretary
NHTSA's March 2022 report (link) & FIRST Tool (link)



“Every 12 minutes and 11 seconds a cyclist and a motor vehicle crash into each other...

and every 9 hours and 22 minutes one of those cyclists dies.





VISION ZERØ

Calculated from NHTSA's March 2022 report (link) and FIRST (link)

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Bringing SAFETY and INSIGHTS to our roads!

- Noroc is a **data feed** and **messaging platform** for riders, cities, OEMS, & operators to **assess, enforce, and educate** people regarding the **safety** of our roads.
- Noroc combines **privacy-first** proximity services with **spatial AI** devices to collect **1. near-miss crash data, 2. bike lane violations,** and offer **3. real-time data feed.**
- By offering ways to connect to every **bike, e-bike, scooter, and helmet** out there —we'll gain insights beyond the blue dot on a map - **IT'S WHAT'S HAPPENING AROUND YOU THAT MATTERS.**

DATA COLLECTION for our "AS-BUILT" world and roads.

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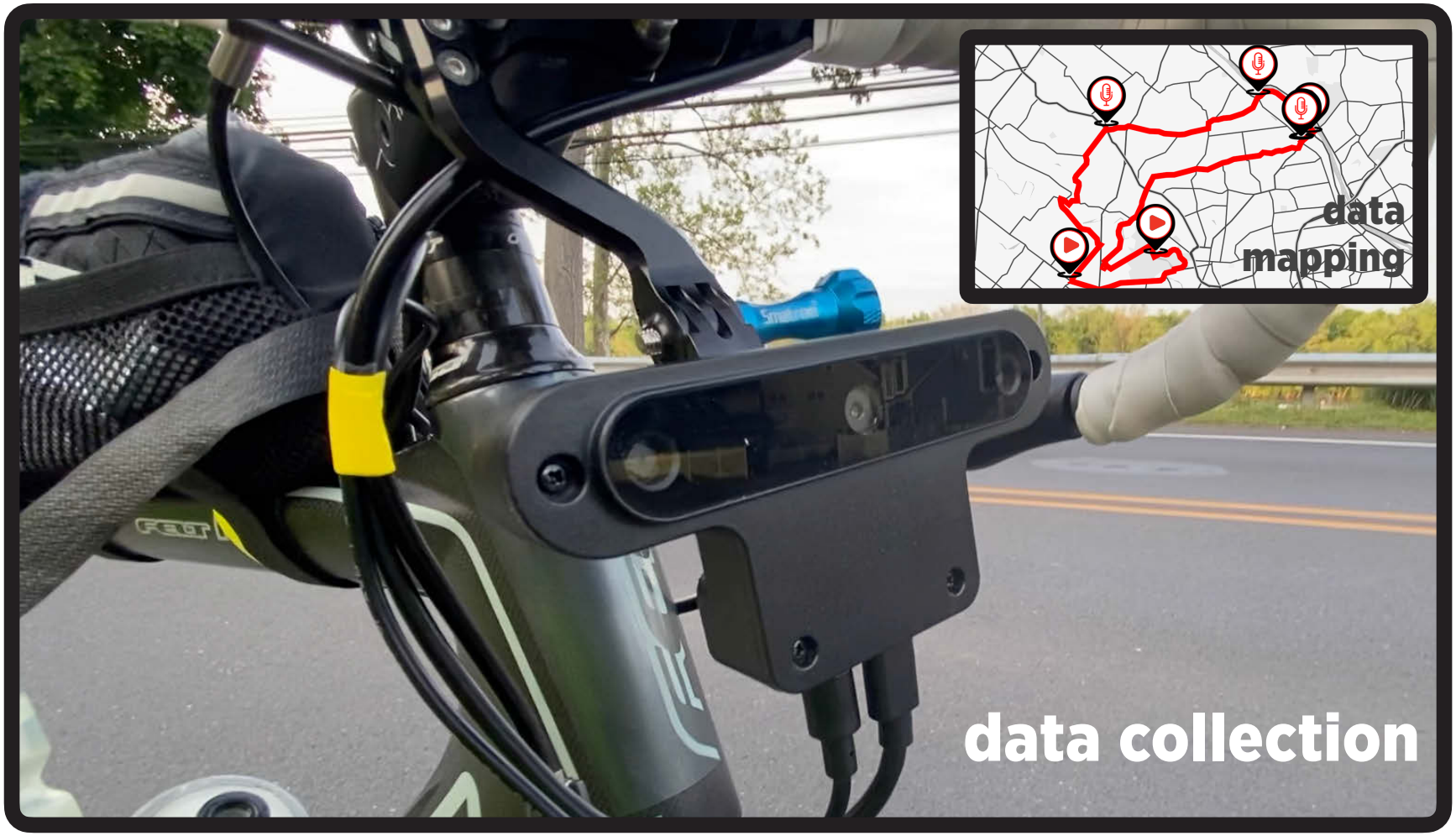
With spatial AI sensors on bikes we're collecting & mapping data to help...



UNDERSTAND & ADDRESS safety problems with enforcement and infrastructure

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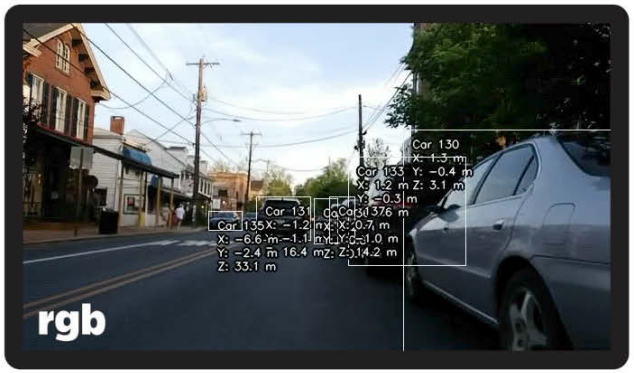
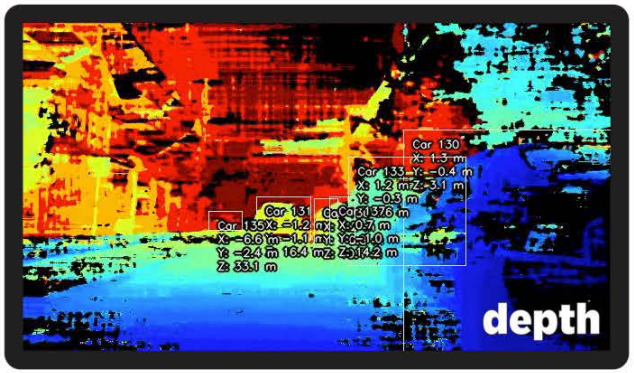
With spatial AI sensors on bikes we're collecting & mapping data to help...





Watch video (link)

UNDERSTAND & ADDRESS safety problems with enforcement and infrastructure

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Just imagine Noroc on shared and owned —bikes, e-bikes and scooters!!!

NYC DOT (link)

NEW YORK rolled out their bus lane enforcement cameras, AKA the "bus lane zapper" to enforce bus lane violations. ***And they're investing heavily in this automated camera enforcement with a whopping $85M from 2020-24!***

Bloomberg CityLab (link)

And IT'S CLEAR that road safety and enforcement is headed this direction

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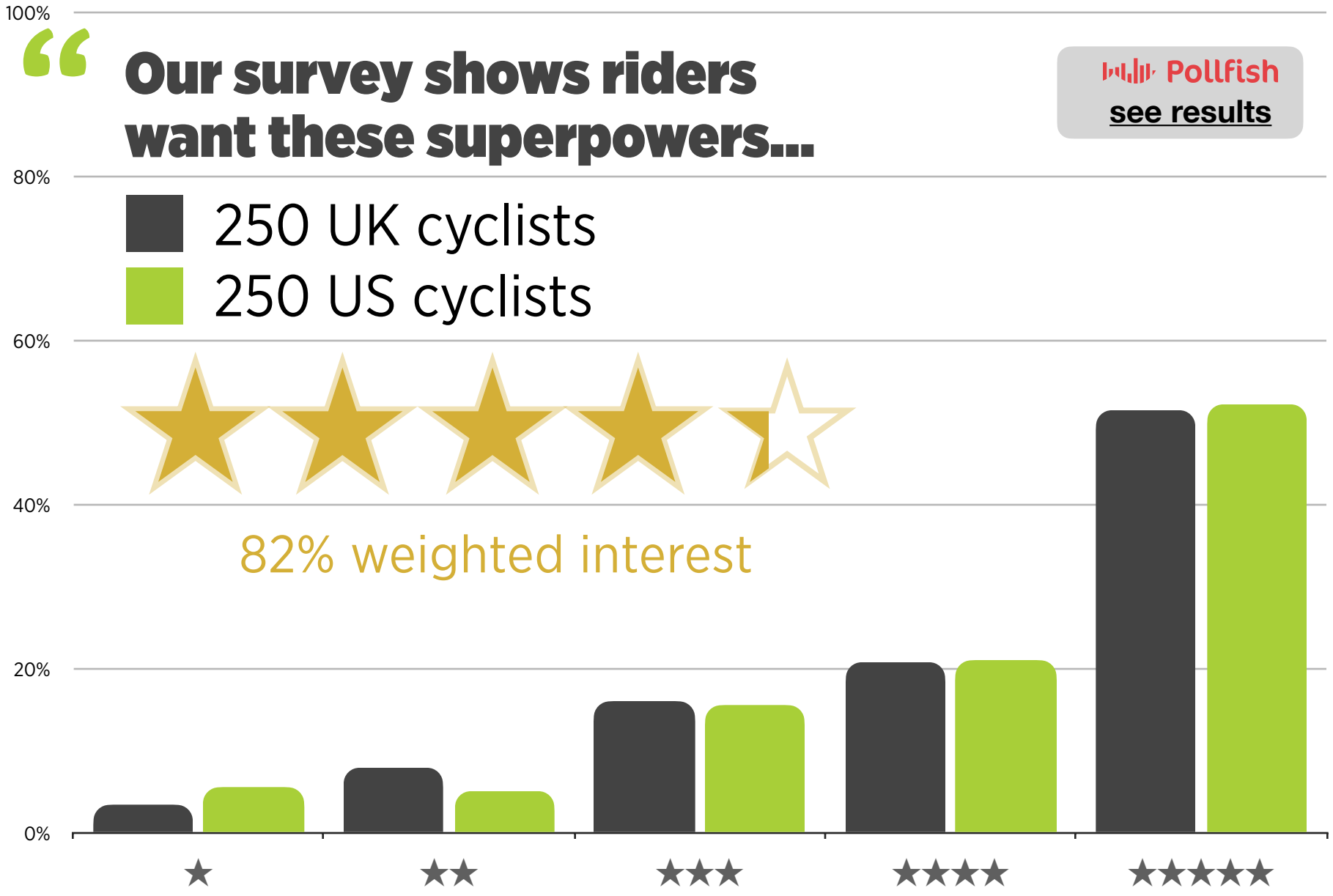
Our survey shows riders want these superpowers...

Pollfish
see results



“Use license plate data to mail drivers a friendly postcard requesting more space.”

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Our turnkey safety projects collect, map, & share data

- Projects are focused on **“safety assessments”** for cities that cover the entire journey of where people ride —free from limitations to any specific road, intersection, or fixed-position sensor.
- This geolocation, object detection, and depth perception data will establish **baseline measurements of Vulnerable Road User safety** and provide the groundwork for enforcement and infrastructure campaigns focused on:
    1. **near-miss crash data**
    2. **bike lane violations**
    3. **real-time safety messages**
- Focused on developing **open standards —we’re offering to extend the definition of SAE’s J2735 to include these new data fields so they can have the most impact across transportation infrastructure.**

★ **offering 20 new data fields beyond SAE’s J2735 specification** ★

SAE INTERNATIONAL®

...unlocking valuable ENFORCEMENT and INFRASTRUCTURE opportunities.

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Noroc, as an app and a service...

1. record **video**, **object detection**[1], and **depth**[2] of all events
2. store the **locations of events**[3] during each activity
3. identify obstructions **in bike lanes**
4. details of **vehicles passing cyclists too close**
5. OCR of vehicle **license plates**

[1] **object detections collected between 30-40Hz**
[2] **depth calculations collected between 30-120Hz**
[3] **GNSS location collected between 1-10Hz**

Focused VRU Safety Data Collection

Safe Streets and Roads for All

ACTION PLANS & IMPLEMENTATION GRANTS

- **data-driven approach to prevent fatalities**
- **equity across all communities and all populations**
- **traffic law enforcement**
- **new vehicle or other transportation-related technologies**
- **mechanisms for evaluating the outcomes**

“With these resources we’ll do everything we can to save lives on America’s roads!

Pete Buttigieg (link)

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DATA COLLECTION

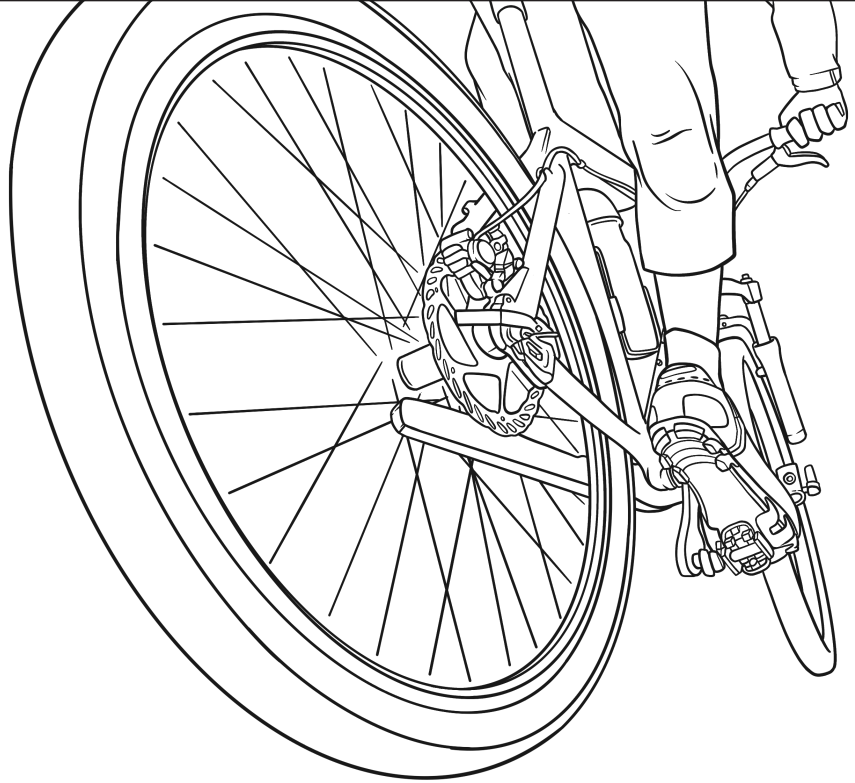
Collect ***near-miss crash*** data, ***bike lane violations***, and offer a ***real-time data feed*** to better understand safety problems

ENFORCEMENT

Calm ***vehicle speeds,*** increase ***passing distances***, and clear the ***bike lanes*** in a fair and equitable manner ***across all communities where people ride***

INFRASTRUCTURE

Maximize the value of ***existing and new infrastructure*** investment decisions



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This is an opportunity to participate and get involved in data collection