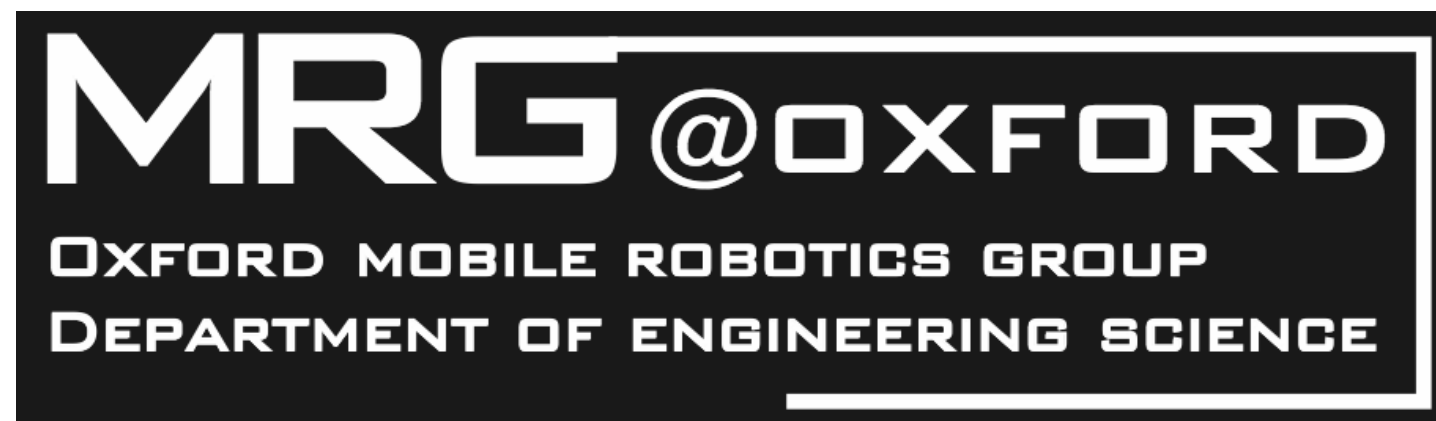


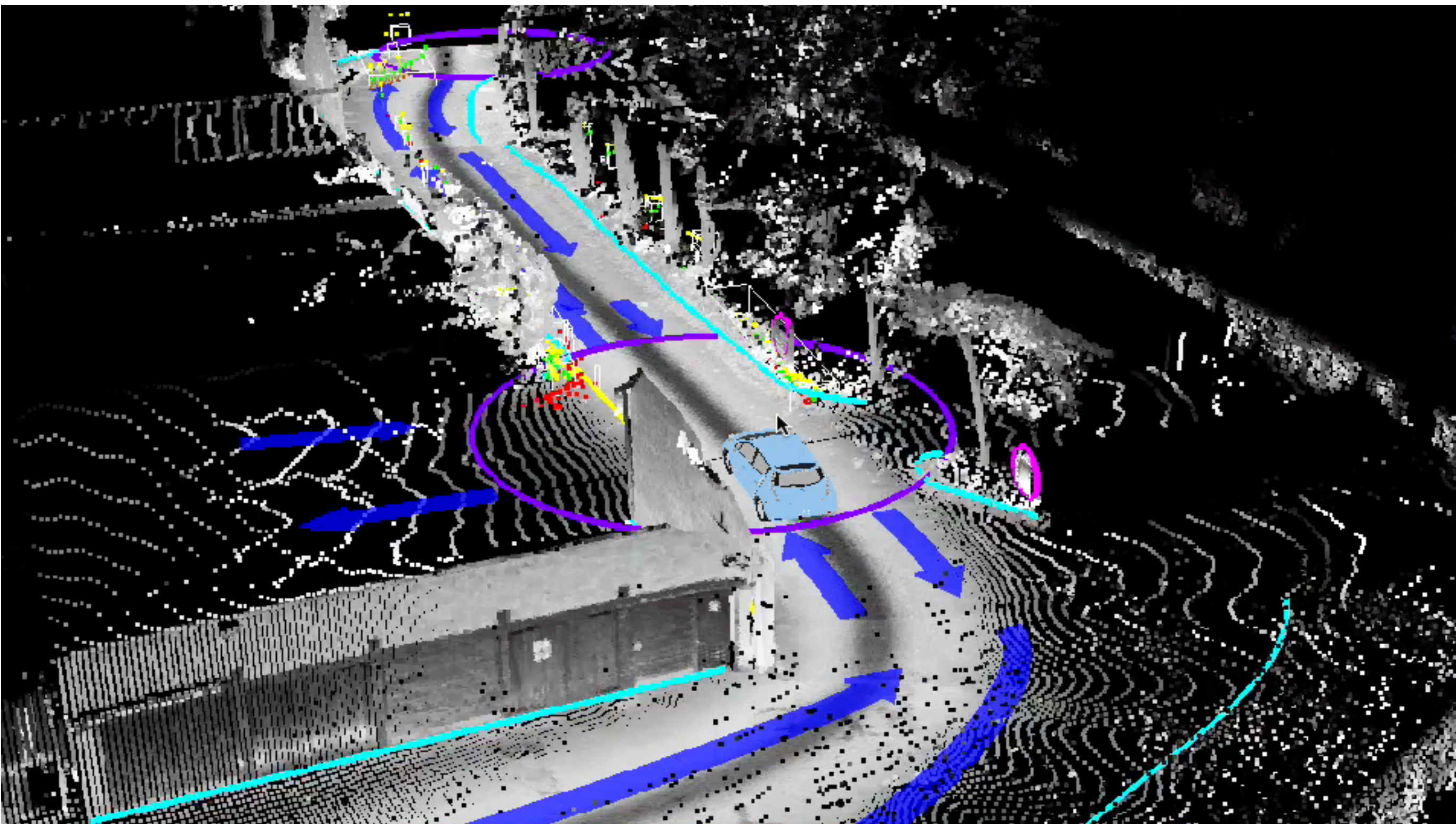
The Oxford RobotCar

Lina Maria Paz





Safety, Efficiency, Access, Quality of life



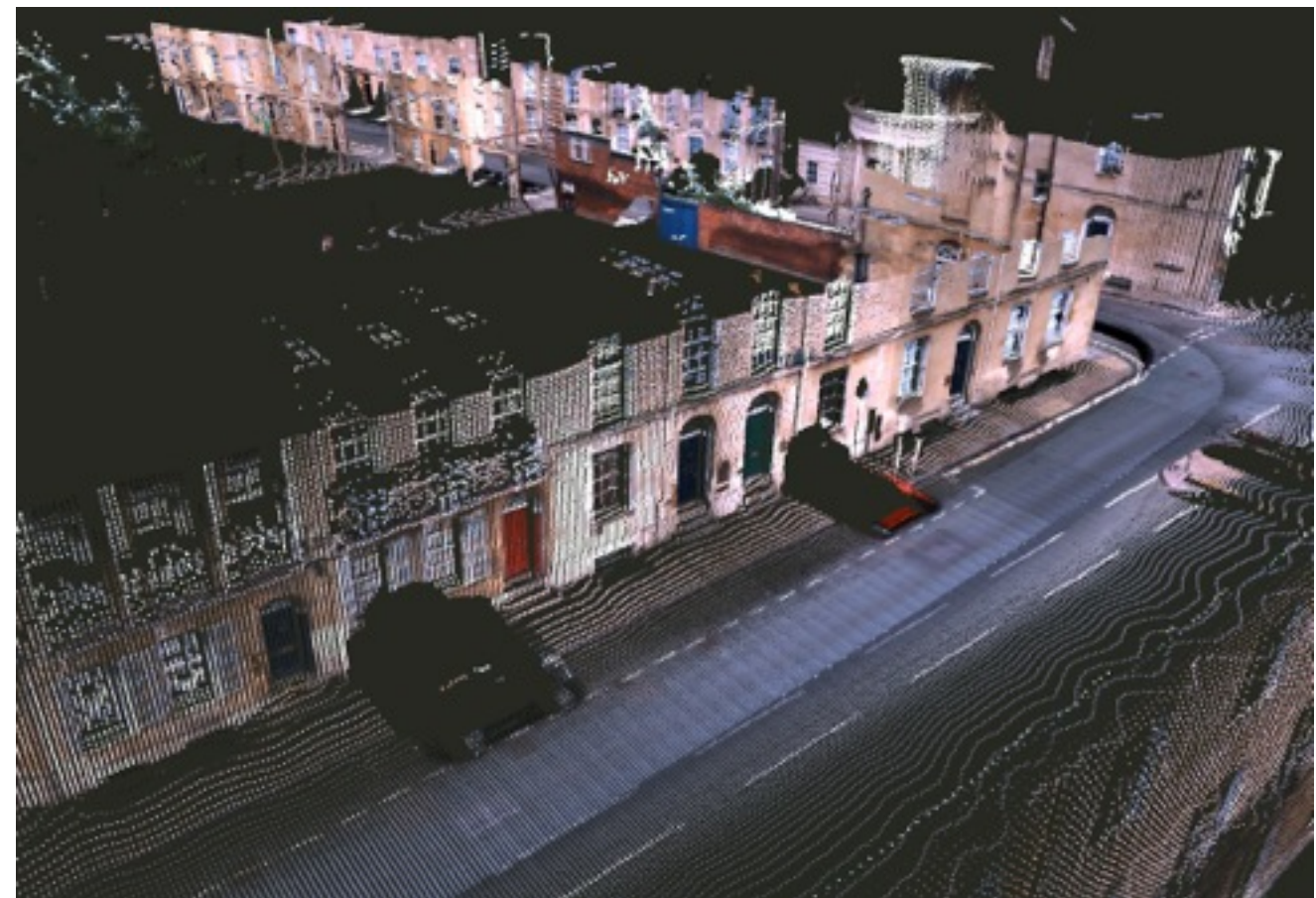
Infrastructure-Free Navigation, No GPS,
Perception and Environment Understanding

Oxford's vision

“Autonomy on offer rather than on demand”

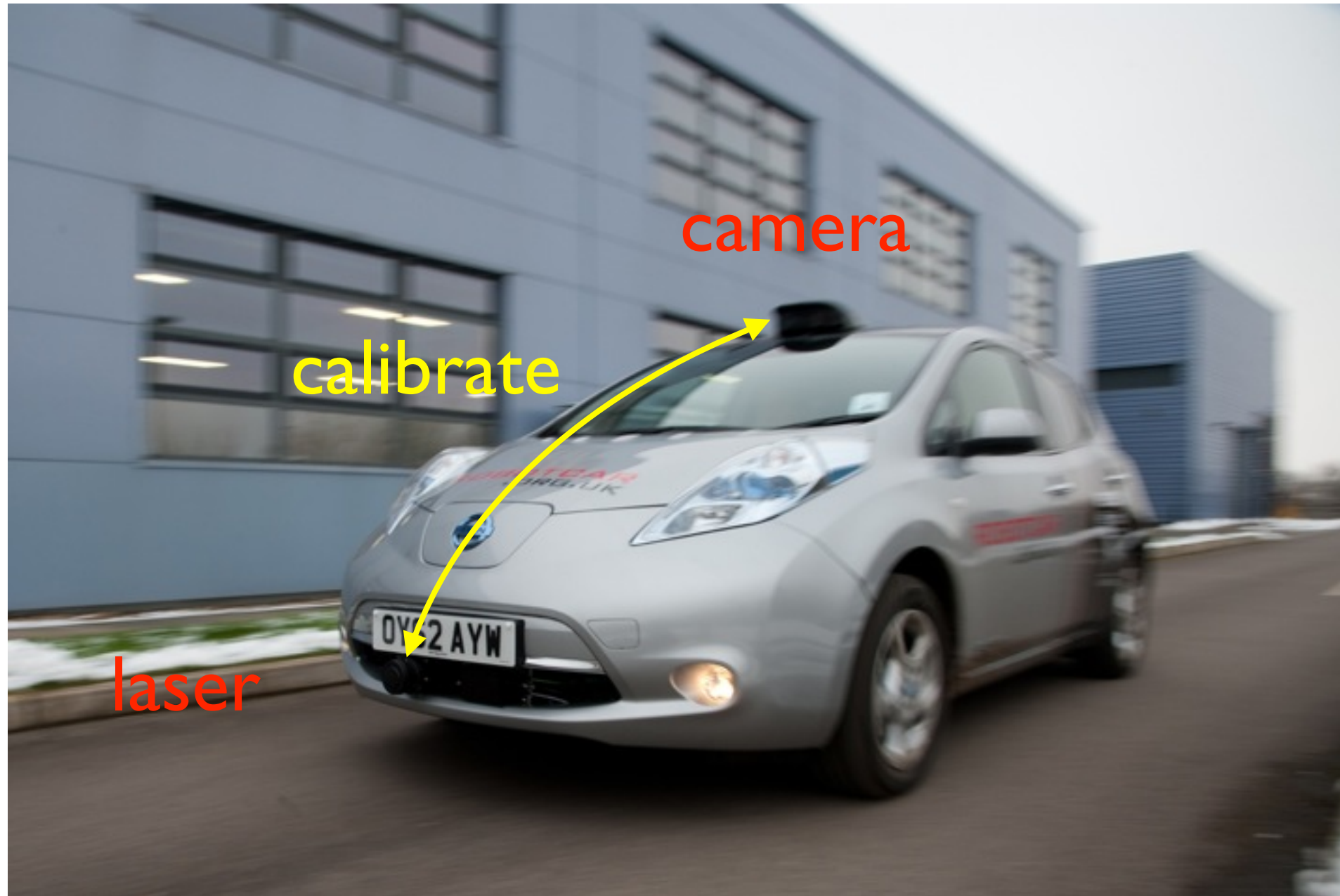
Drive some of the people
Some of the places
Some of the time.

Prior Maps



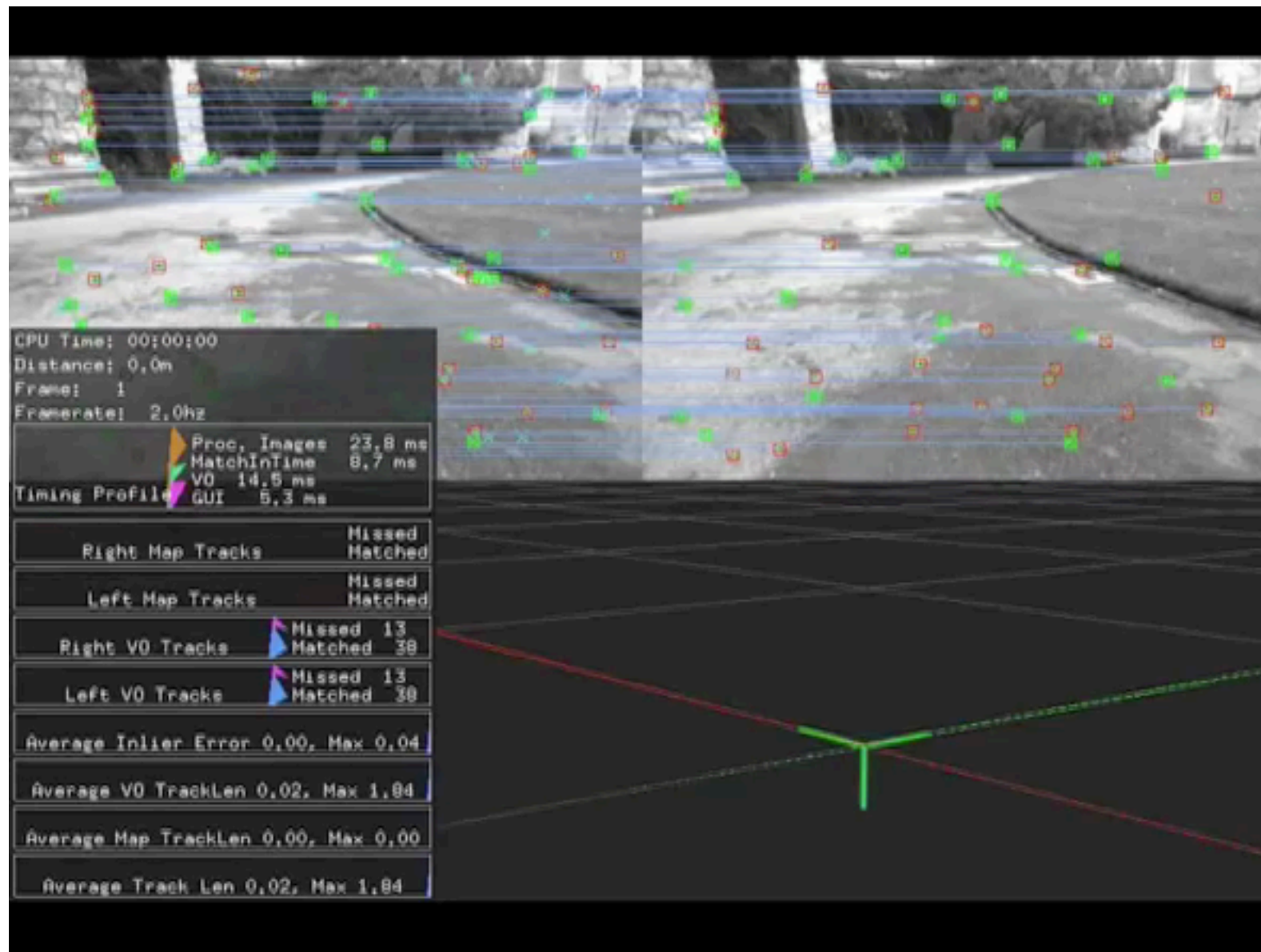
- Build priors with (potentially expensive) survey vehicles.
- Use priors to localise robots with cheap sensors.

Laser Mainly: Scene Priors



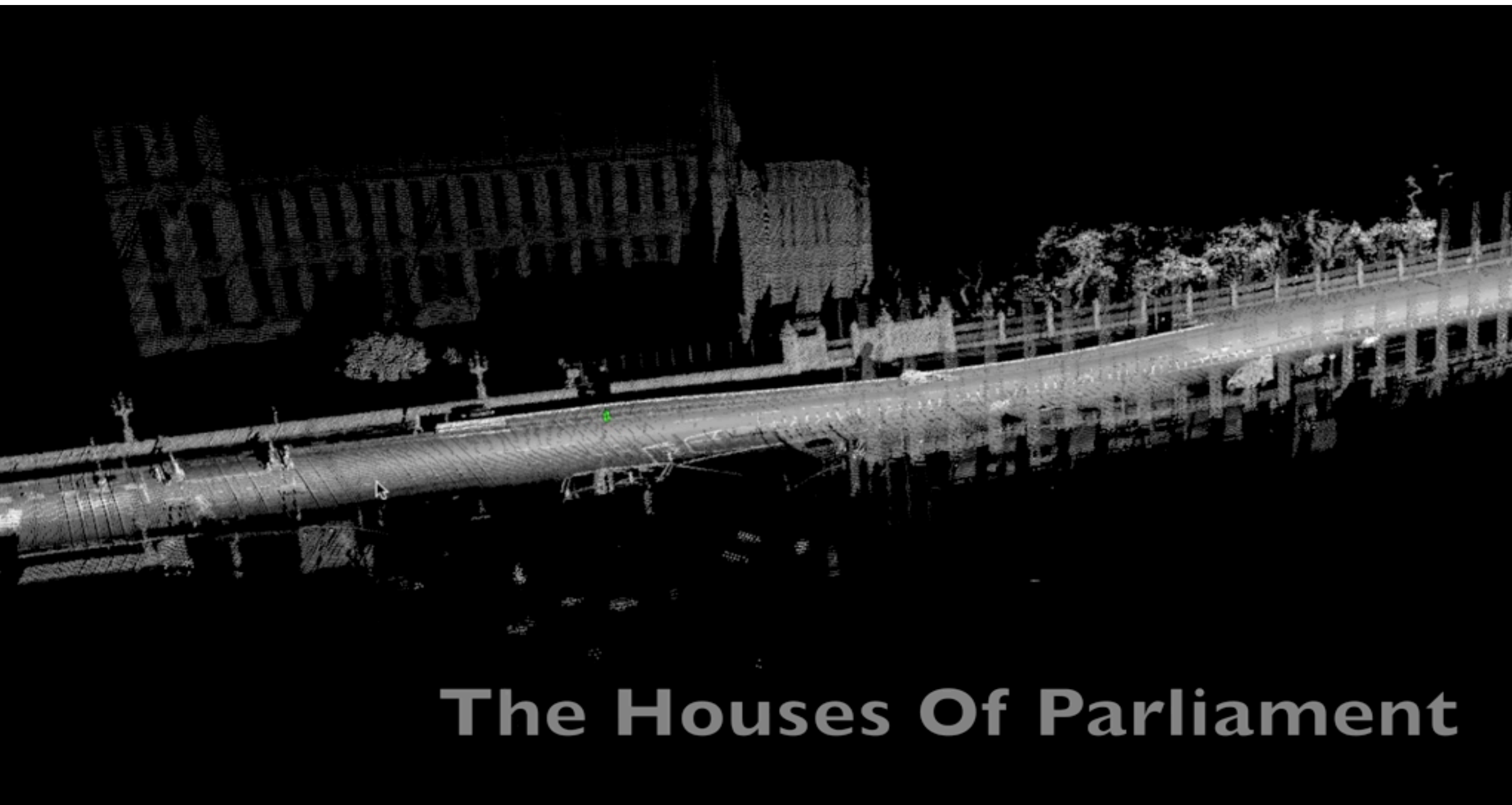
Add laser, timing and extrinsic calibration.

Laser Mainly Priors: Scene Priors



Given just a camera we can understand our motion.

Sibley, Mei, Reid, Newman



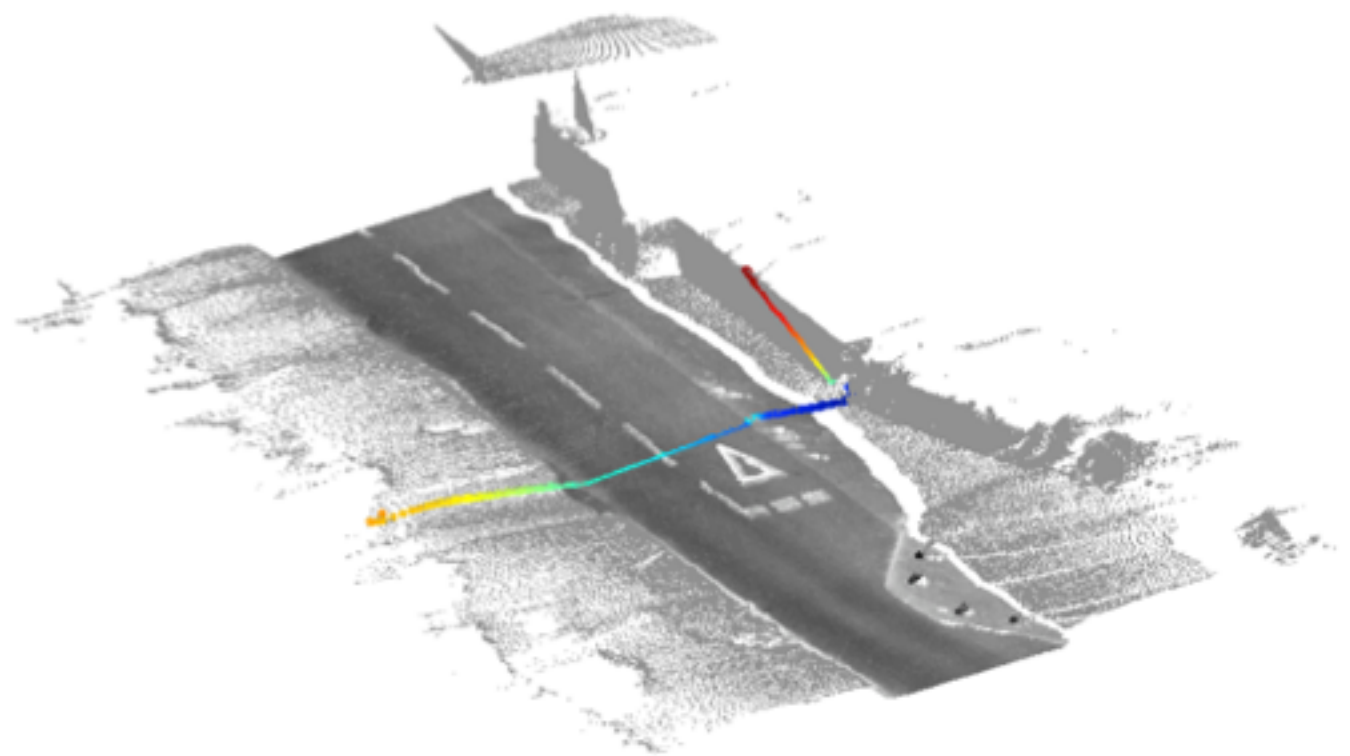
We map cheaply and accurately

Laser based Navigation: L3



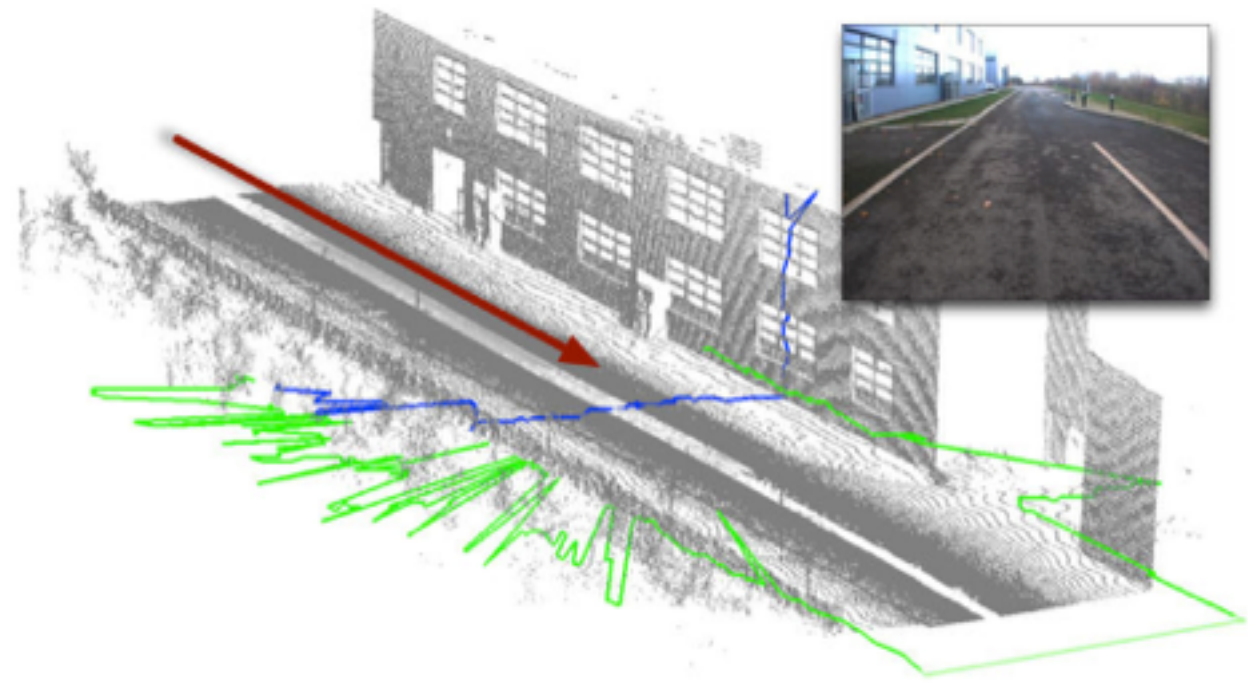
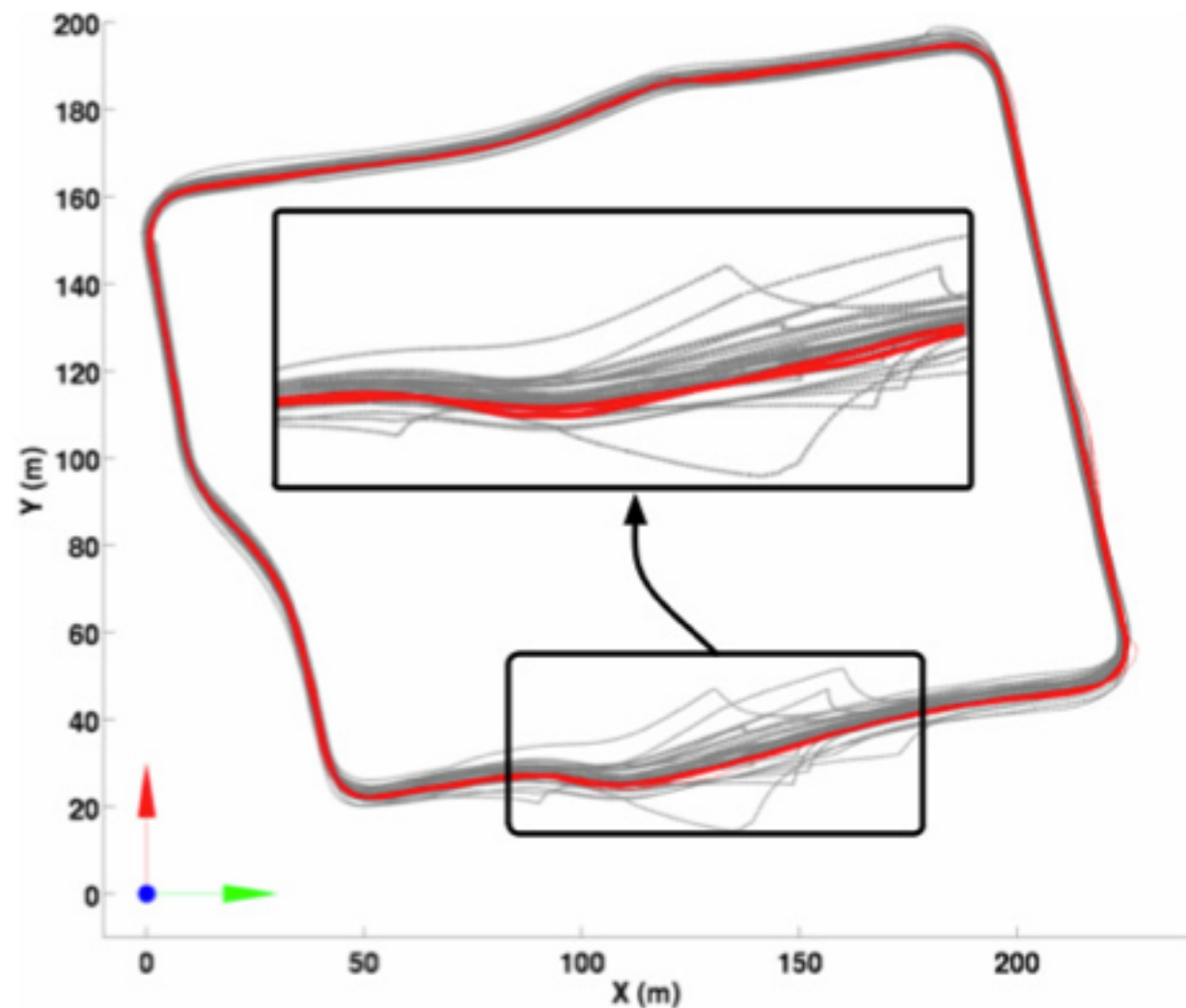
Why is this interesting?

- Usually, ground strike makes 2D motion estimation break badly.
- We embrace it ! Aim at the ground, synthesise a 3D swathe over a period of time and match to a prior map...
- That's it...
 - No GPS.
 - No Inertial.



It's cheap.

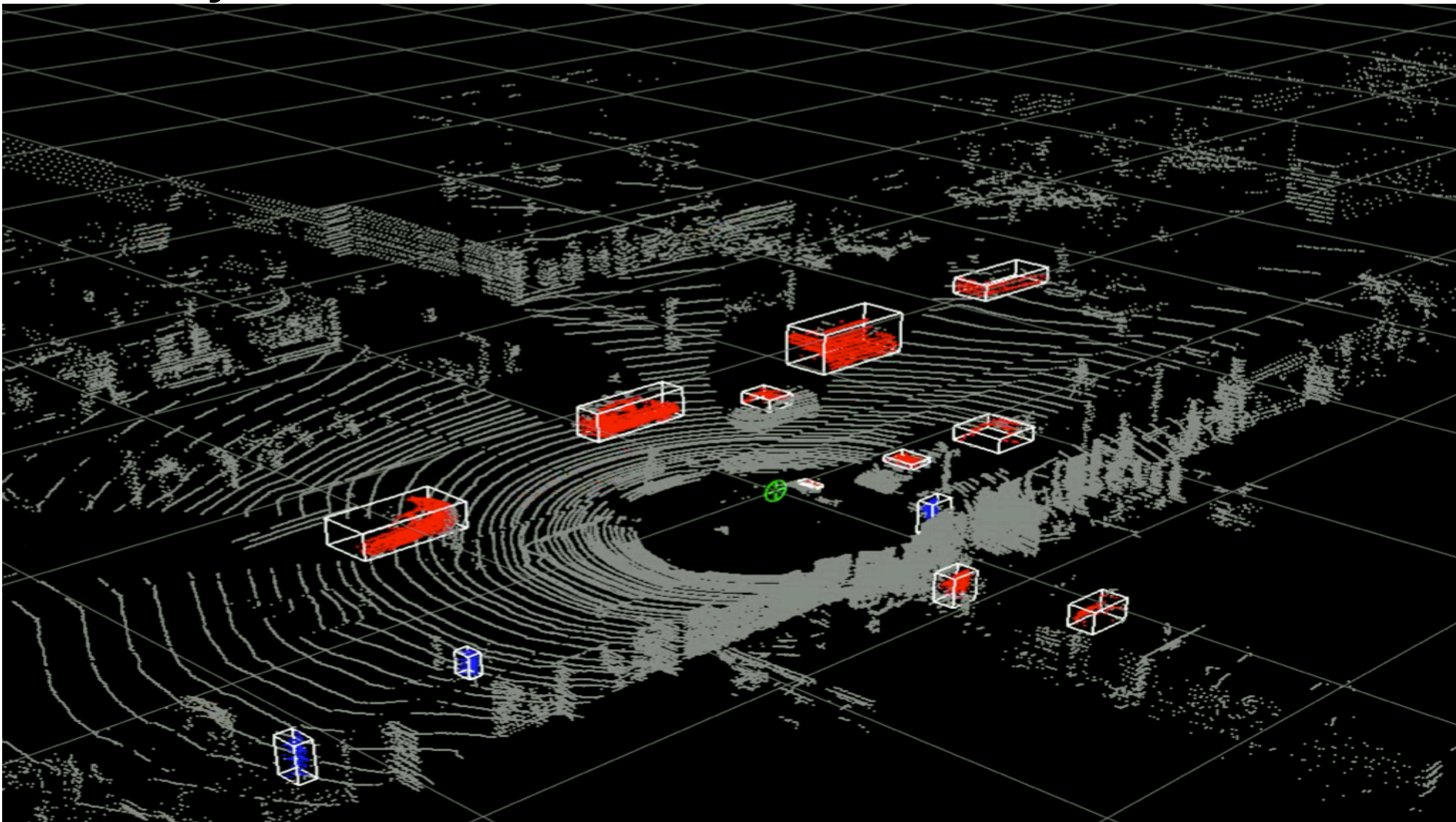
How well does it work?



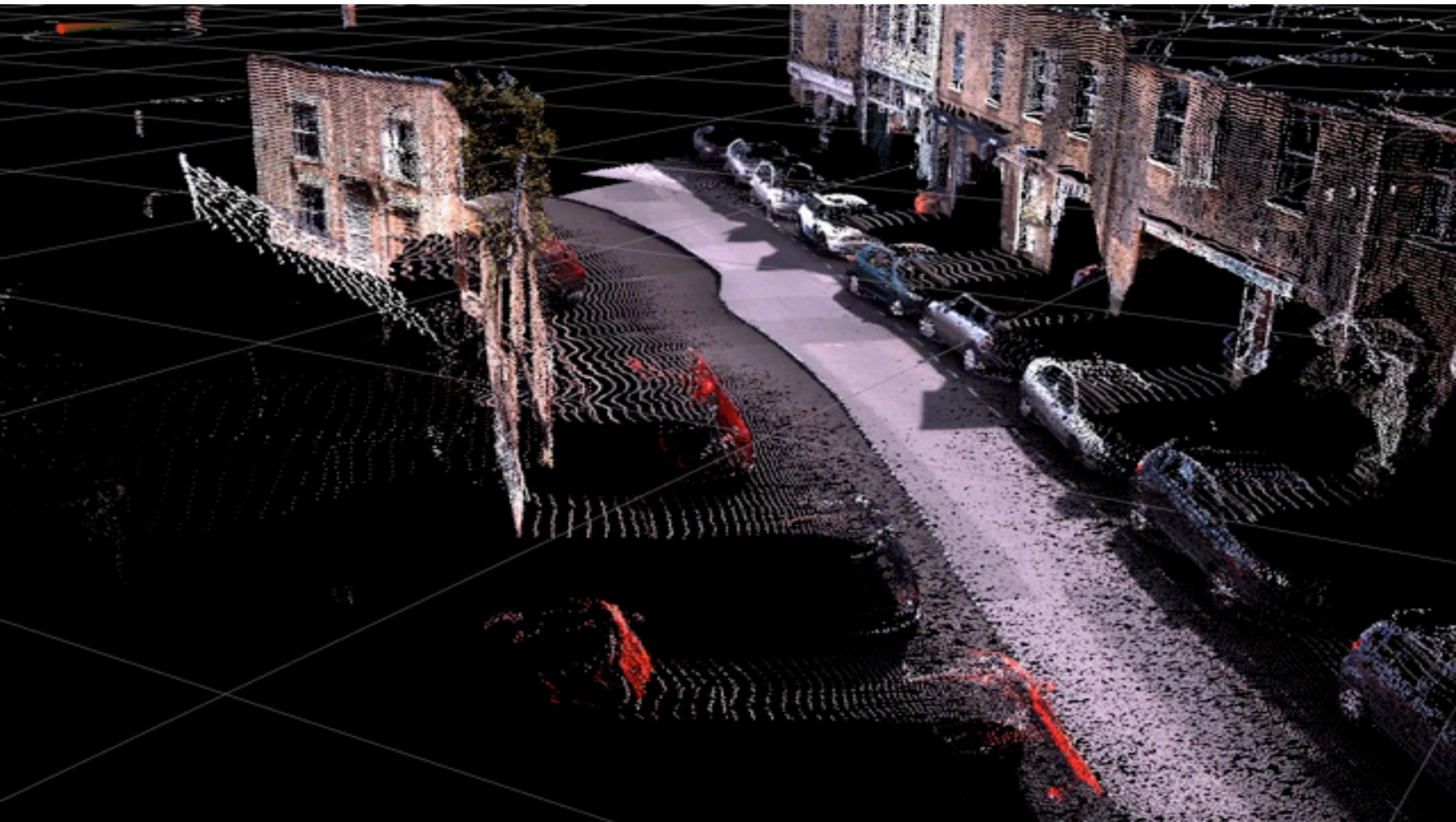
- 50 km of trials. Better than a £100K INS.

It's accurate.

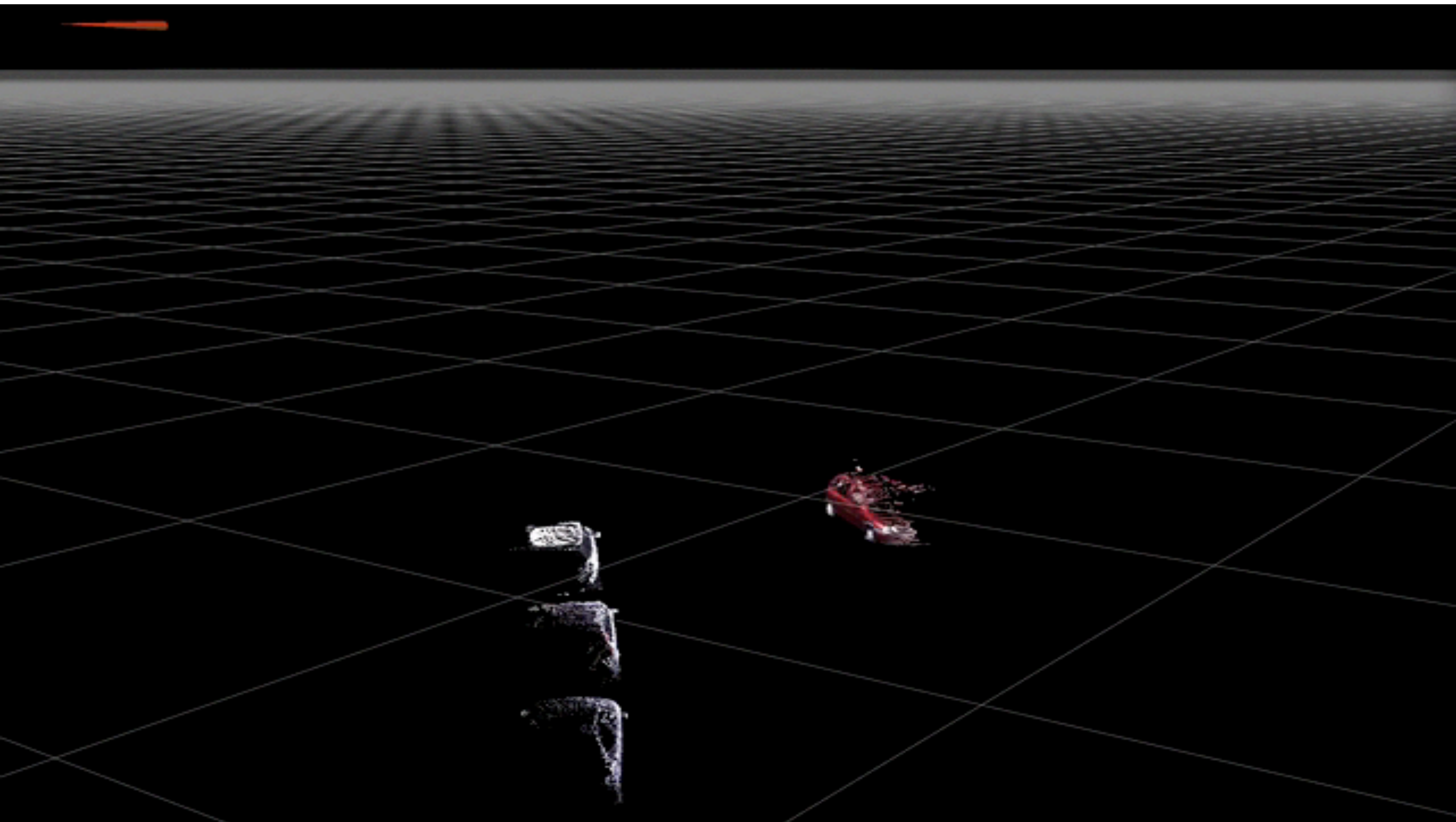
If Only The World Were a Static Prior



Wang, Posner, Newman



Asset Removal



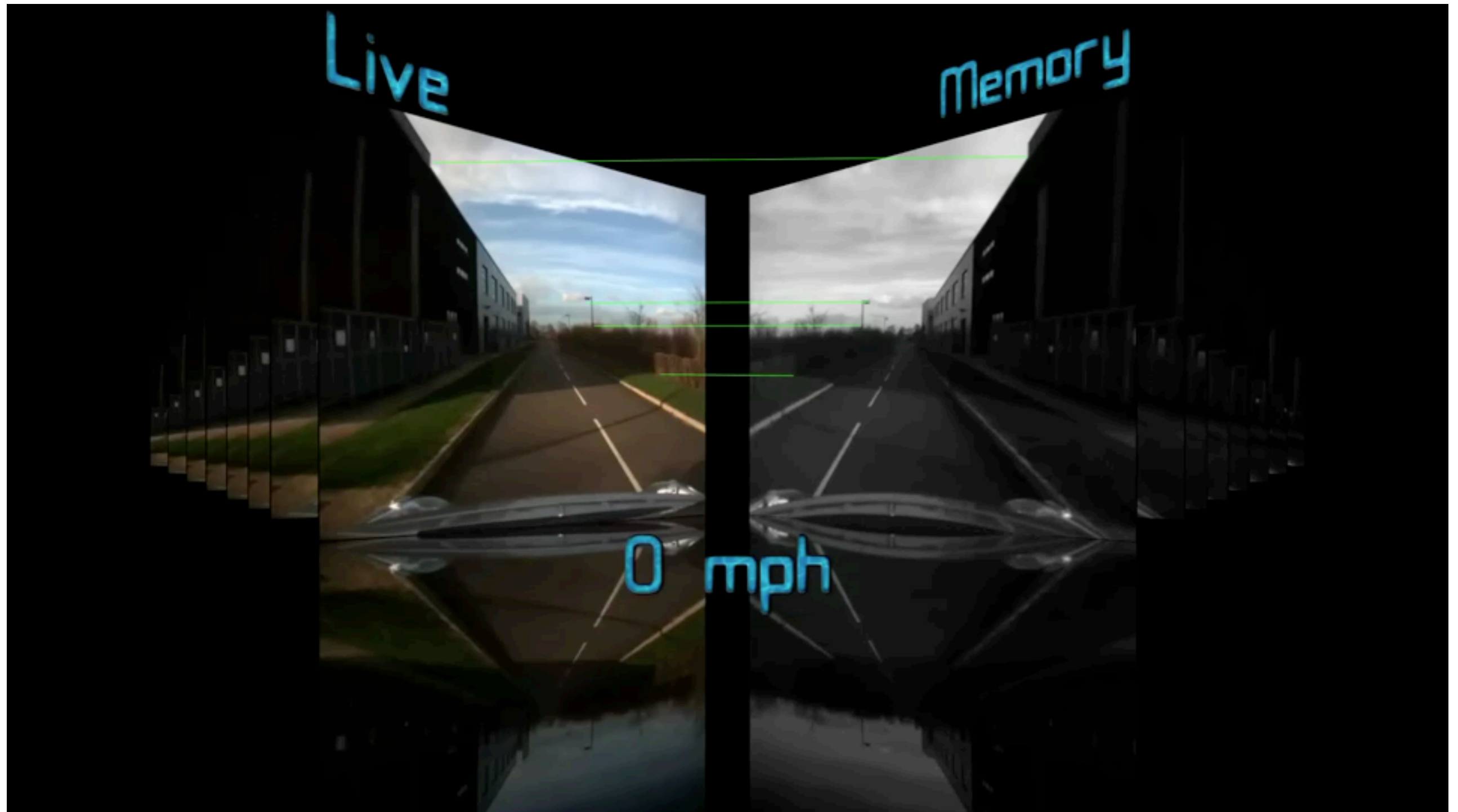
Asset Detection

Vision Mainly: EBN



Let's experience the changing faces of the world. All of them.

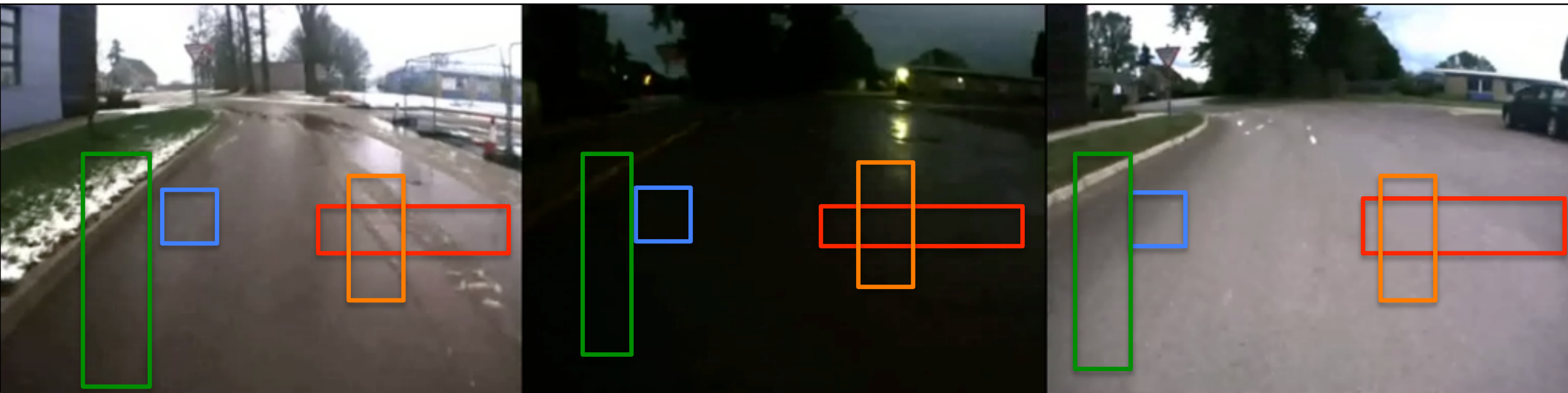
An example (visual) experience



Vision Mainly: Learning Scene Signatures



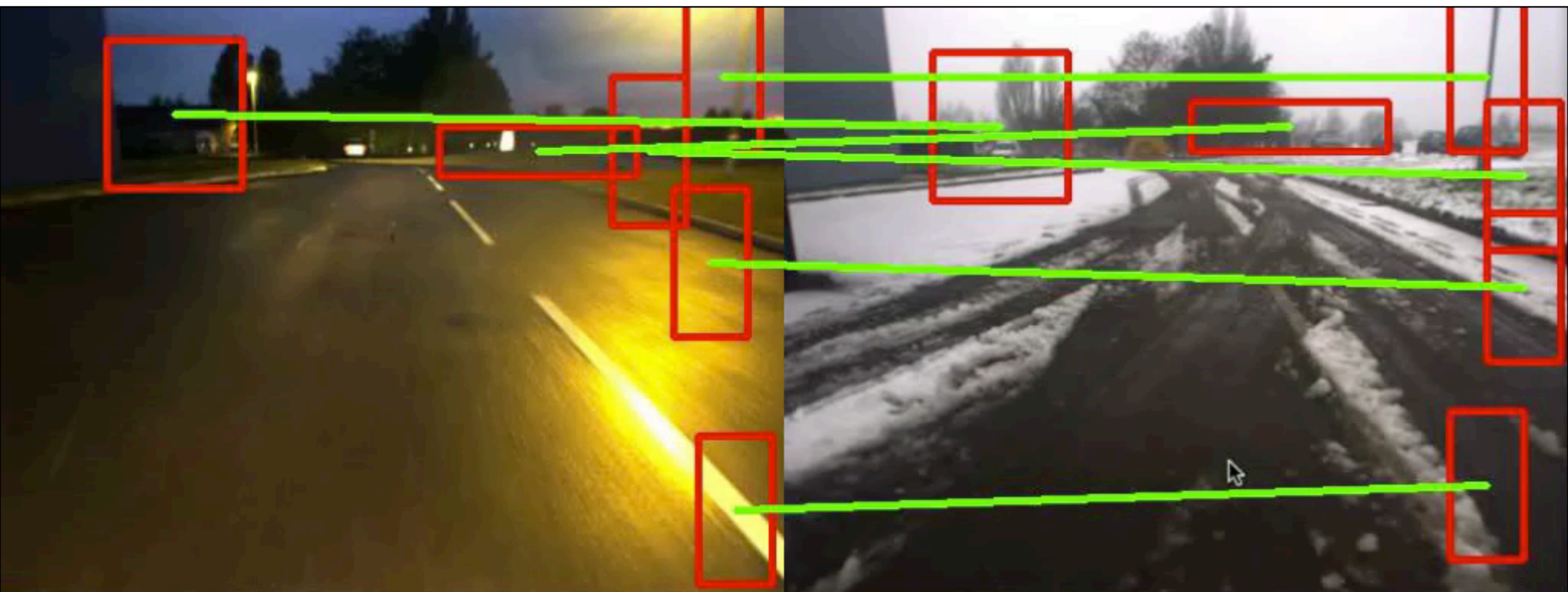
Matching point features across images with large appearance changes is a futile endeavour.



Instead, we search for larger, distinctive elements specific to a particular place. We call these elements, scene signatures.

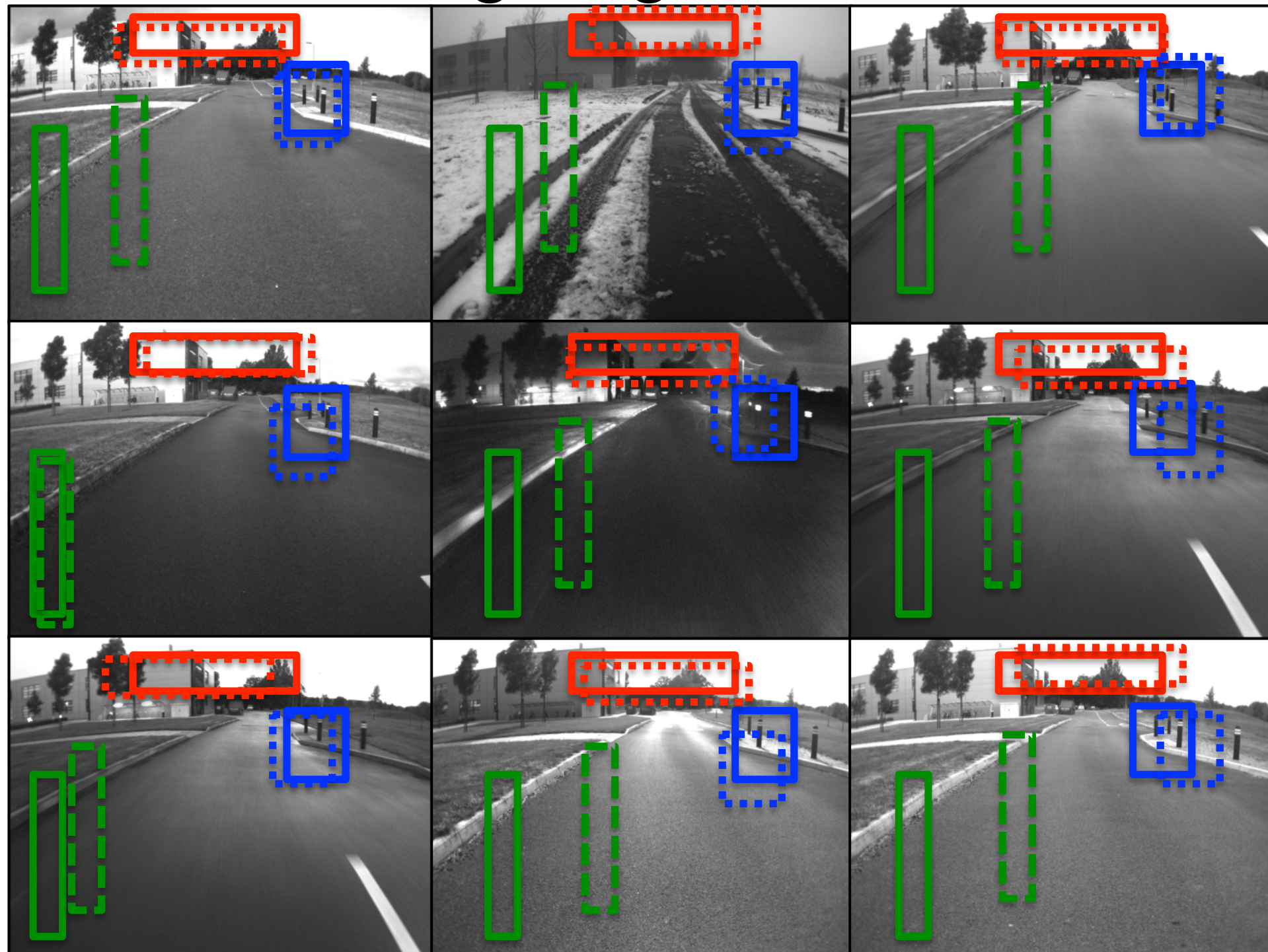
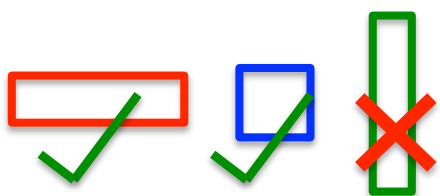
Visual Memory

Live Stream



Training Images for Place

1. Collect images under varying appearances at the same location.
2. Deterministically sample patches of various shapes.
3. For each candidate shape, compute HOG features and train an SVM classifier, using adjacent patches as negatives.
4. Test the stability of each classifier.



If Only The World Were a Static Prior



Prior Map Building



- Minimise dynamic objects in prior map (or remove them with batch processing)

Initialisation

- Localise using EBN
- Generate synthesised LASER image

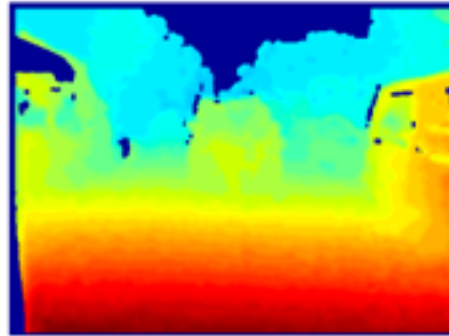


Detect Depth Inconsistencies

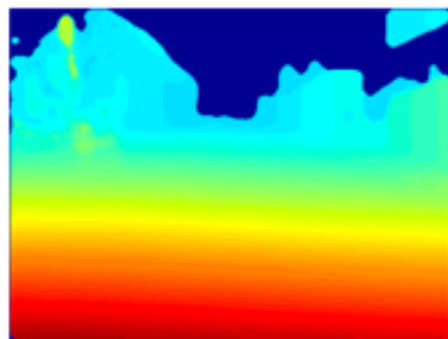
Stereo (Disparity)



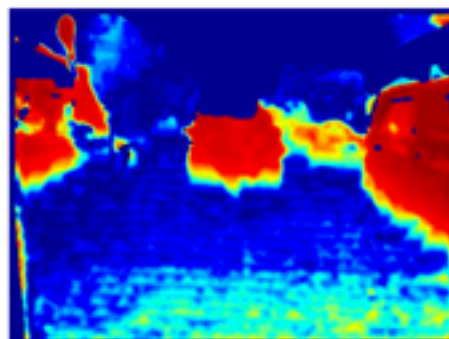
(a) Camera image for reference.



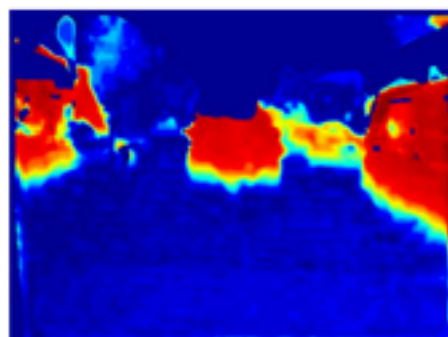
(b) Stereo disparity image using the method of Geiger et al. [21].



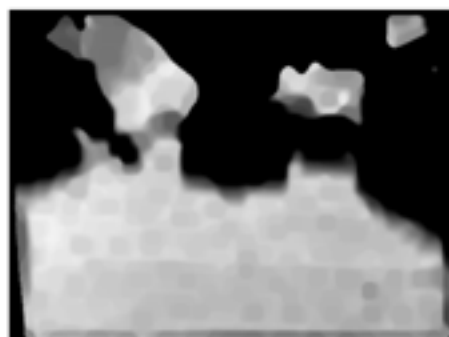
(c) Synthetic disparity image generated from the 3D scene prior.



(d) Disparity difference image (i.e., the absolute value of the difference between 4(b) and 4(c)).



(e) Depth-weighted stereo disparity difference.

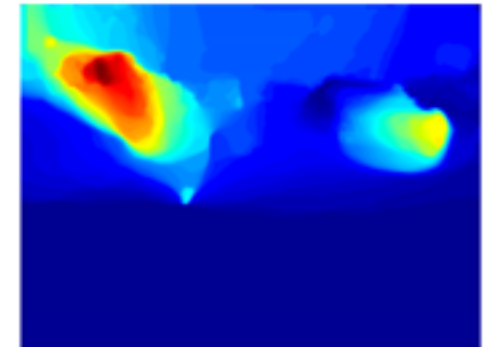


(f) Background-likelihood image.

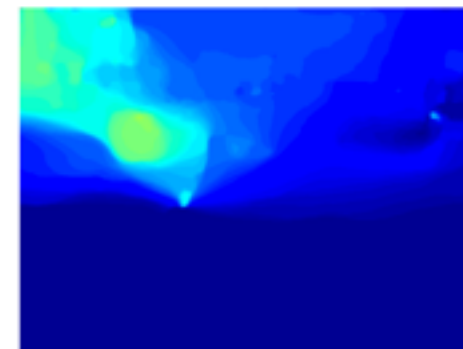
Monocular (Optical Flow)



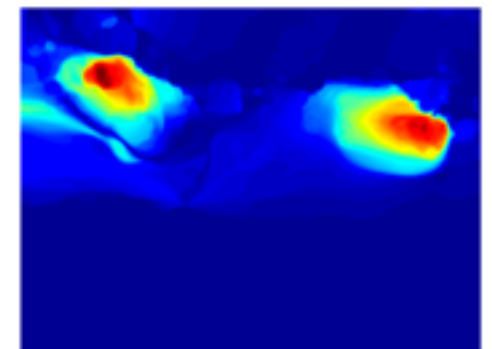
(a) Camera image for reference.



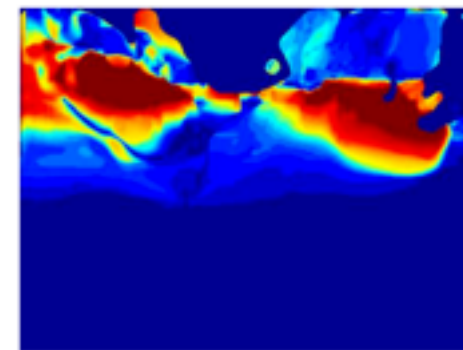
(b) True optical flow.



(c) Synthetic optical flow using the 3D prior.



(d) Optical flow difference.



(e) Depth-weighted optical flow difference.



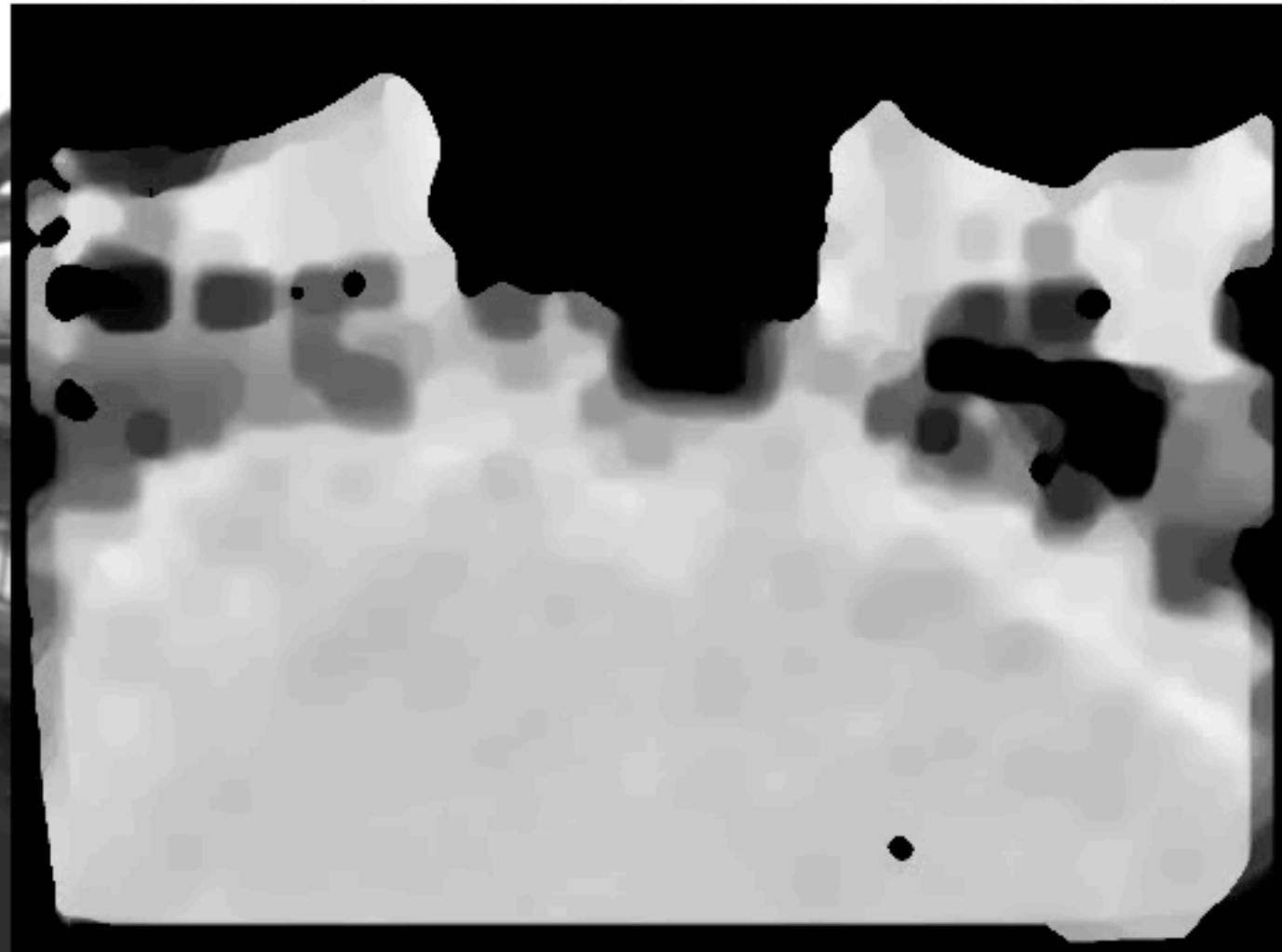
(f) Background-likelihood image.

Apply Distraction Mask

Live Image



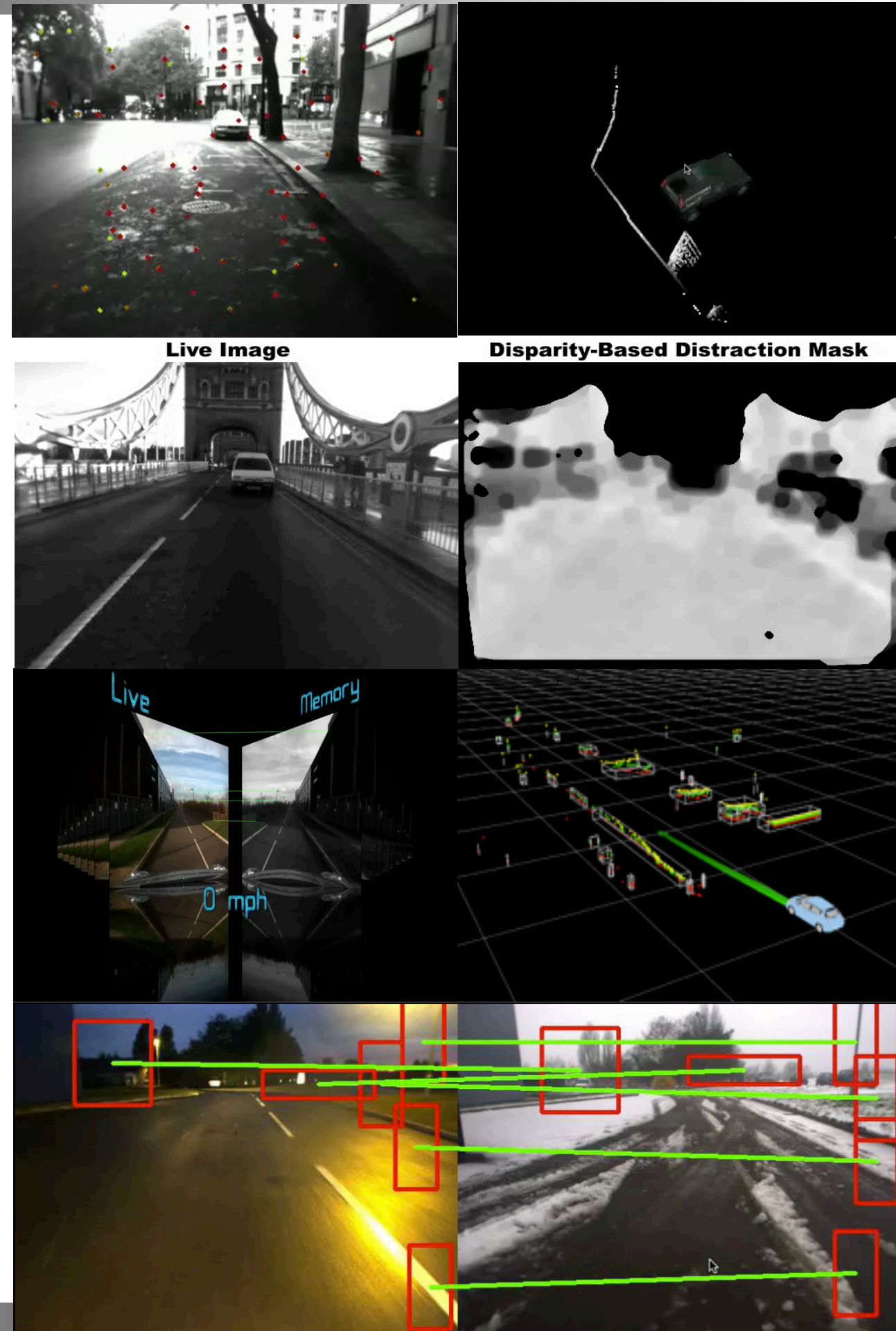
Disparity-Based Distraction Mask



The Oxford Robot-Car

An Overview of techniques for Persistent and robust long-term autonomous driving:

- VO, EBN, LAPS, L3
- Distraction Suppression
- Scenes Signatures



Driving Autonomy...

- Modern robotics will provide the solutions to the transport's future.
- Autonomy is the future.
 - safety.
 - efficiency.
 - access.
- Infrastructure-free.
- Oxford's vision: autonomy on offer rather than on demand.
 - driving is a passion.
 - realistic substrate for full autonomy.
- The technology is coming.
 - and the opportunities are (almost) endless.



RobotCar UK

Department of Engineering Science

Home

The Cars

How It Works

The Team

Sponsors

Robotics Science For Smarter Cars

We are not condemned to a future of congestion, accidents and time wasting.

[Learn More...](#)



The Cars

Our base vehicle is a **Nissan LEAF** - an all-electric car. The car has an off-the-shelf computer in the boot connected to various cameras and lasers hidden around the car's body. We started working on the LEAF in September 2012 as part of a collaboration with Nissan. [Read more...](#)



How It Works

You'll always see someone sitting in the driver's seat but they won't always be doing the driving. Our software uses data from the on-board sensors to figure out where the vehicle is on the road. We don't rely on GPS or expensive 3D sensors. The navigation system we have built costs less than €5000. [Read more...](#)



The Team

We are the Oxford Mobile Robotics Group - a team of 22 researchers within the Department of Engineering Science at the University of Oxford. We are led by Prof. Paul Newman and Dr. Ingmar Posner and specialise in large-scale robust robot autonomy. [Read more...](#)

