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Envisaging a world with greener cities

Vehicle emissions modelling MAGIC

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March 2019

UNIVERSITY OF CAMBRIDGE

Imperial College London

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Air pollution in Europe (EU-28)

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- 391 000 premature yearly death due to $PM_{2.5}$
- 76 000 premature yearly death due to NO_2
- 16% of lung cancer deaths caused by air pollution
- total health related external costs of air pollution between €330 and €940 billion per year

Sources: EEA (2018), WHO (2019), European Commission (2013)

Pollution sources

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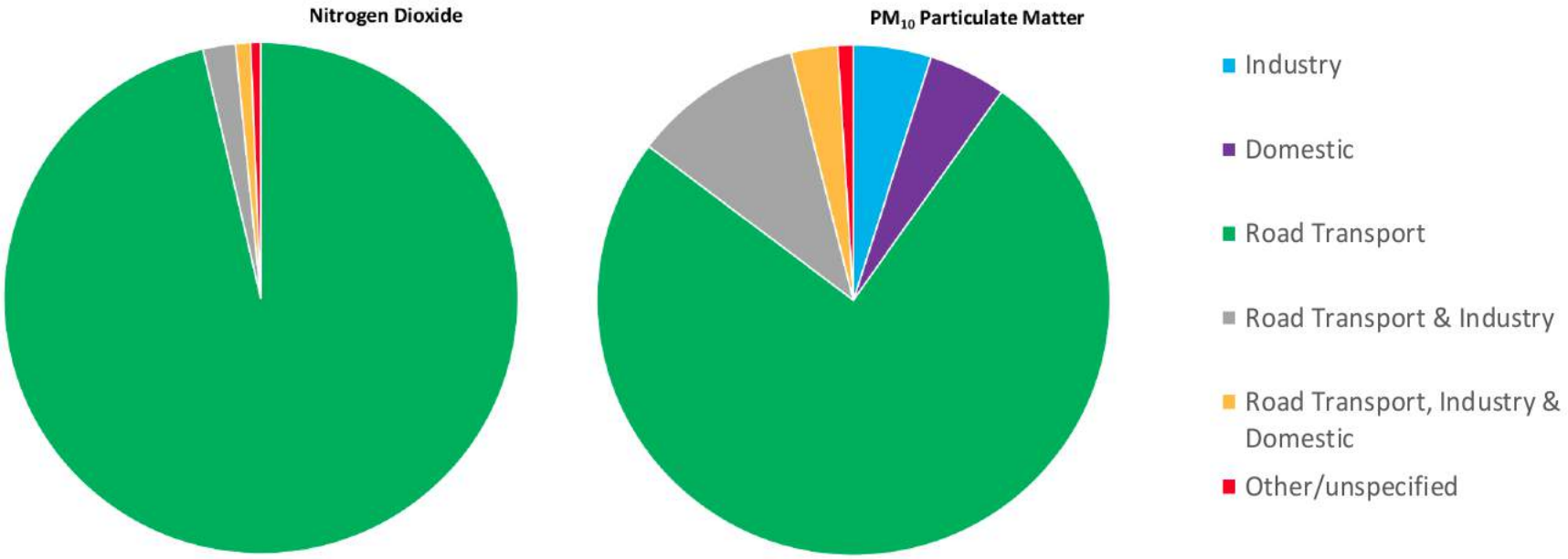
Pollution sources at Air Quality Management Areas, UK



Source: Defra 2018

Vehicle emissions modelling

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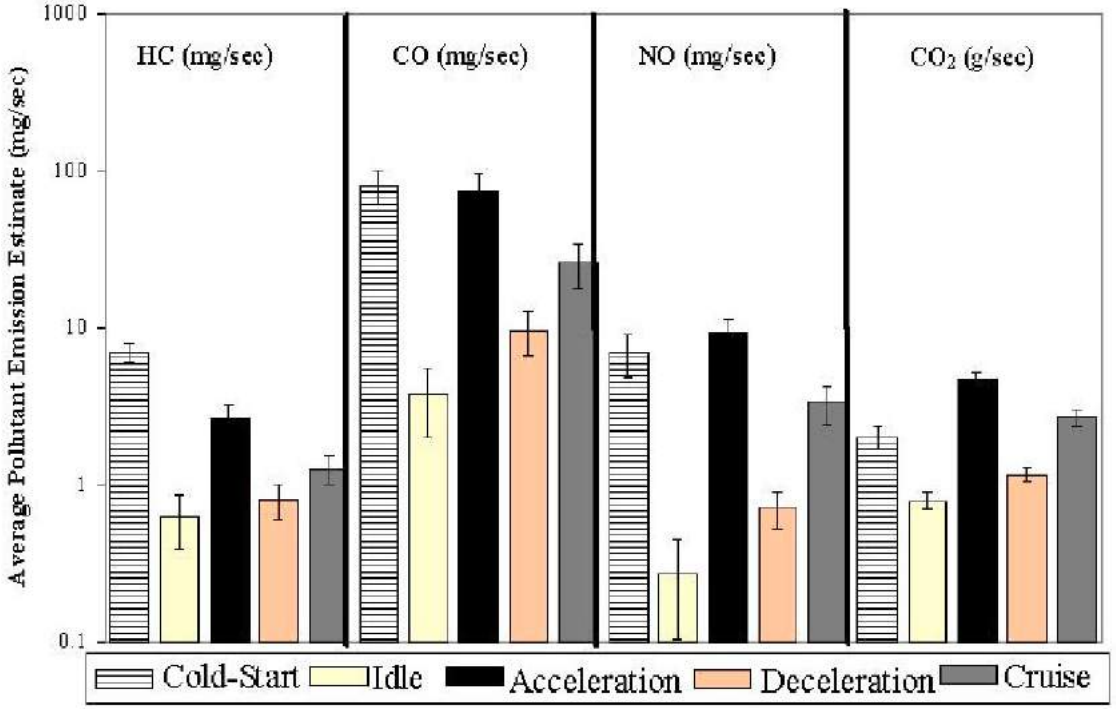
- Average speed versus acceleration
- Usage of transport models (e.g. SATURN, PTV Vissim)
- Computer vision



Frey, H Christopher and Alper Unal. "Use of On-Board Tailpipe Emissions Measurements for Development of Mobile Source Emission Factors." (2002)

Main links within MAGIC

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Envisaging a world with greener cities

Vehicle footage

speed / acceleration, vehicle information

Vehicle emissions model

Fluidity

Indoor – Outdoor exchange

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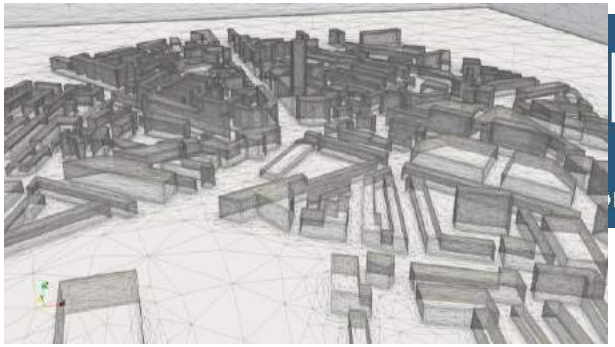

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rld with greener cities

Vehicle footage

speed / acceleration, vehicle information

Vehicle emissions model

vehicle information, vehicle emissions

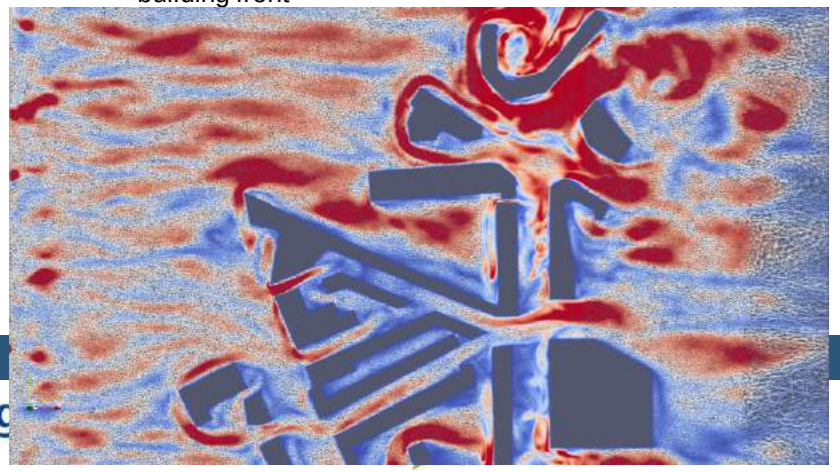
Meteorology, mesh of urban environment, etc.

Fluidity

Pollution levels at building front

Indoor – Outdoor exchange

Indoor air pollution



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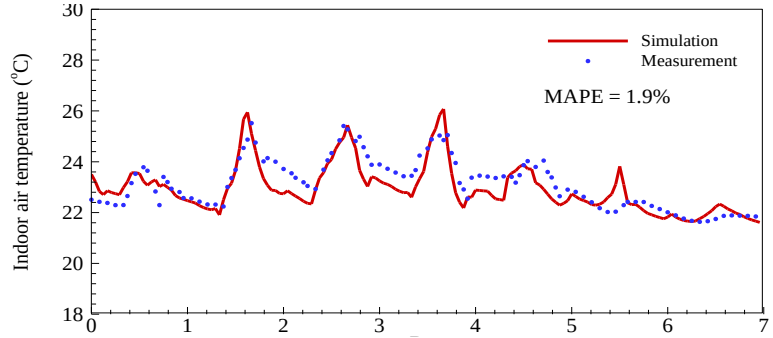

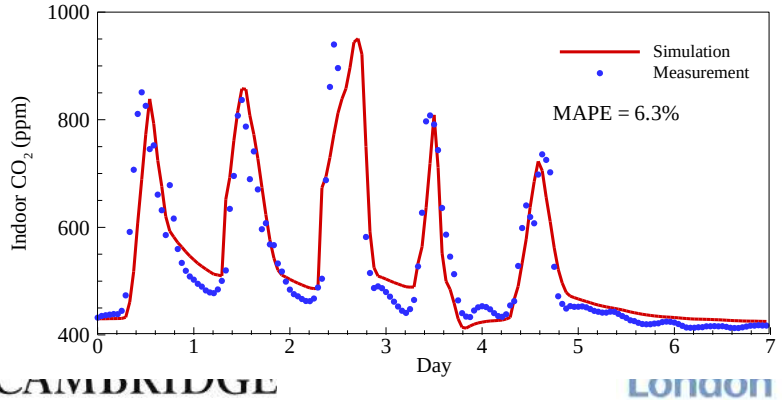

Cambridge Study (Dec 18)

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- Comparison of particulate matter sensors and traffic footage

Analysis of video footage

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Needed:

- detection of vehicles
- tracking of vehicles
- vehicle counts
- positional data (for speed and acceleration)

Vehicle Detection

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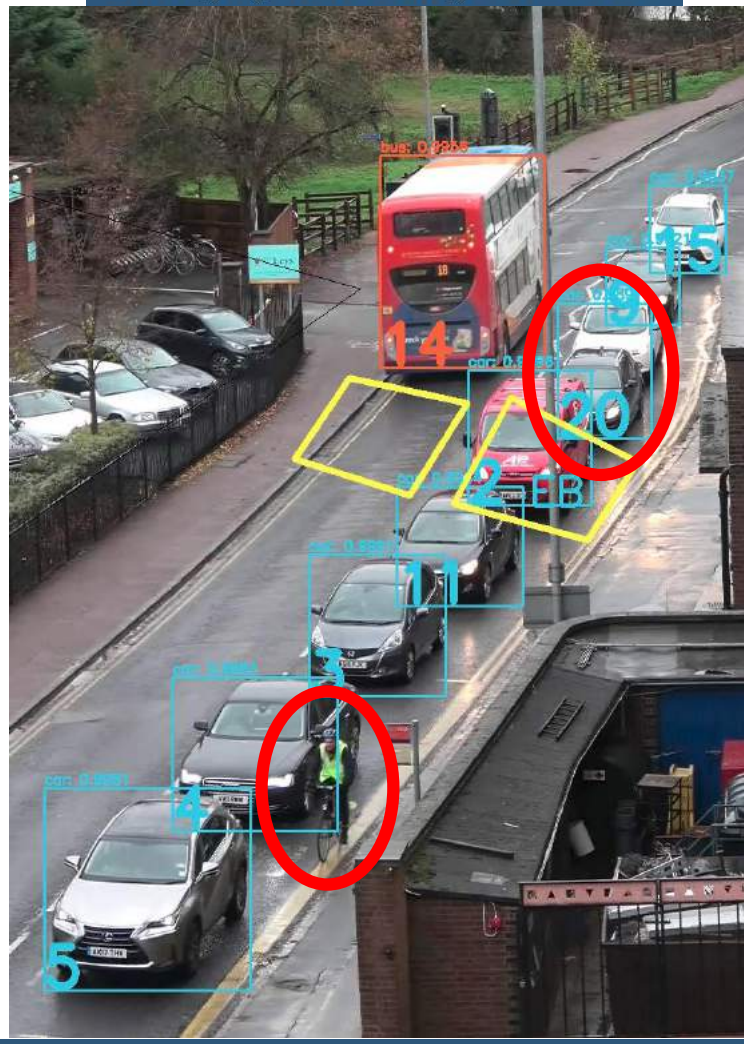
- YOLO v3* detection algorithm:
  - Fast (up to 45 fps in theory)
  - Can detect cars / LGVs, HGVs, buses, bicycles and motorbikes
  - Main challenges:
    - Congestion
    - Lighting
    - Uncertainty regarding HGV & bus
    - Size of objects (problems detecting bikes / motorbikes)



*https://pjreddie.com/darknet/yolo/

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WB counter 1: 2

WB cars 1: 25

WB motorbikes 1: 0

WB buses 1: 0

WB trucks 1: 0

WB counter 2: 2

WB cars 2: 25

WB motorbikes 2: 0

WB buses 2: 0

WB trucks 2: 0

Performance of script - counts

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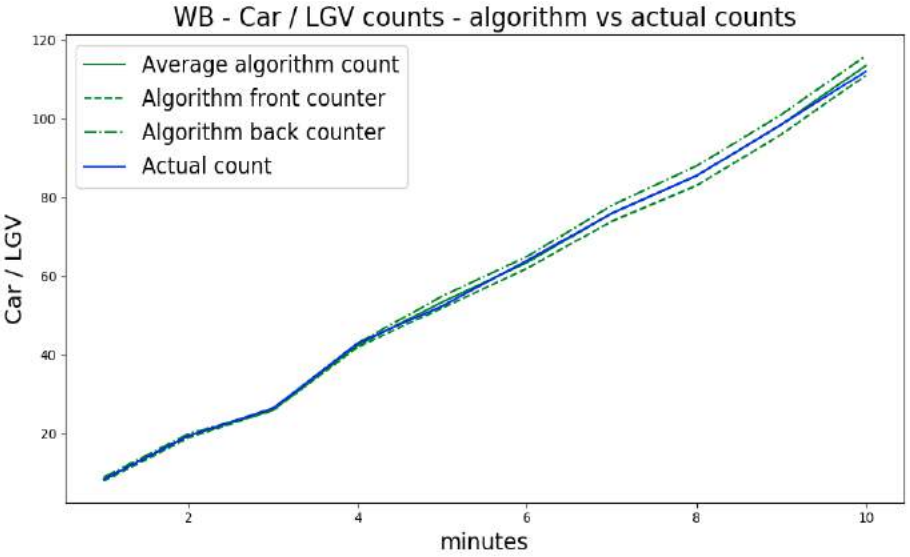
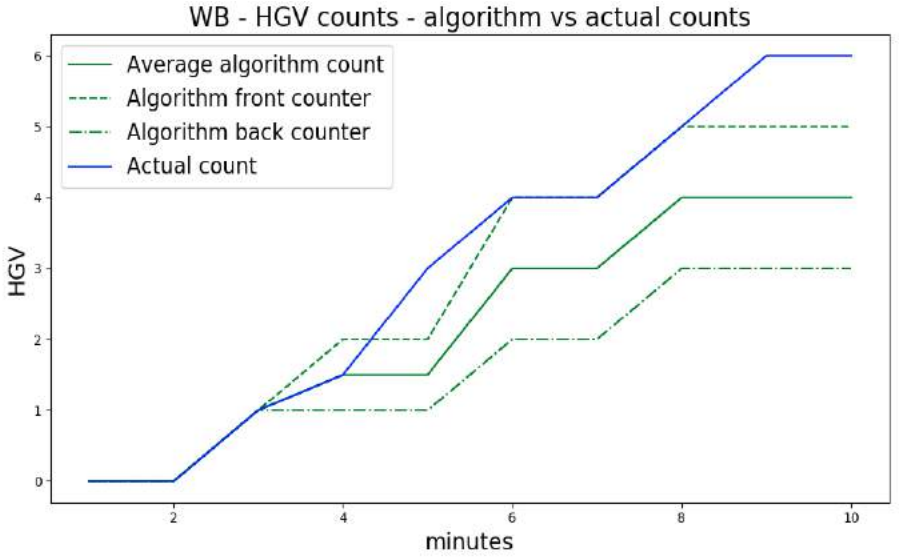
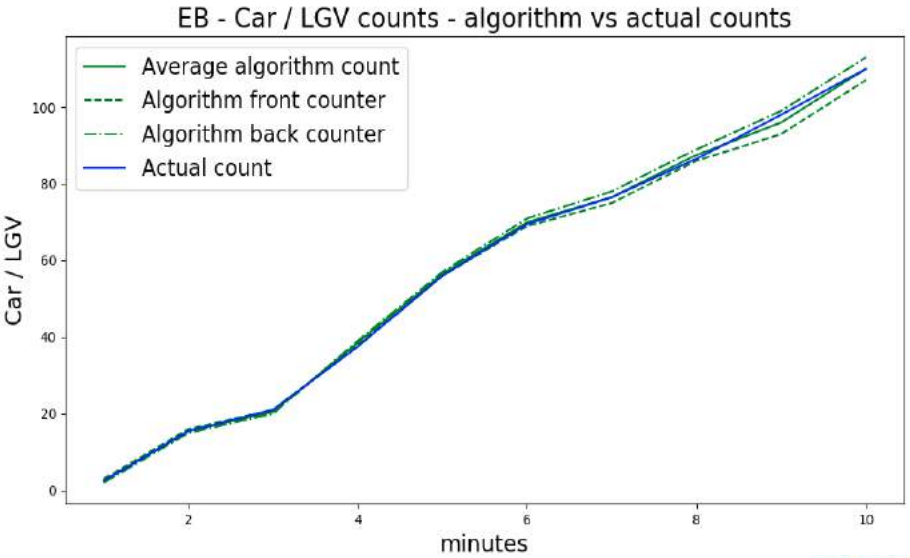
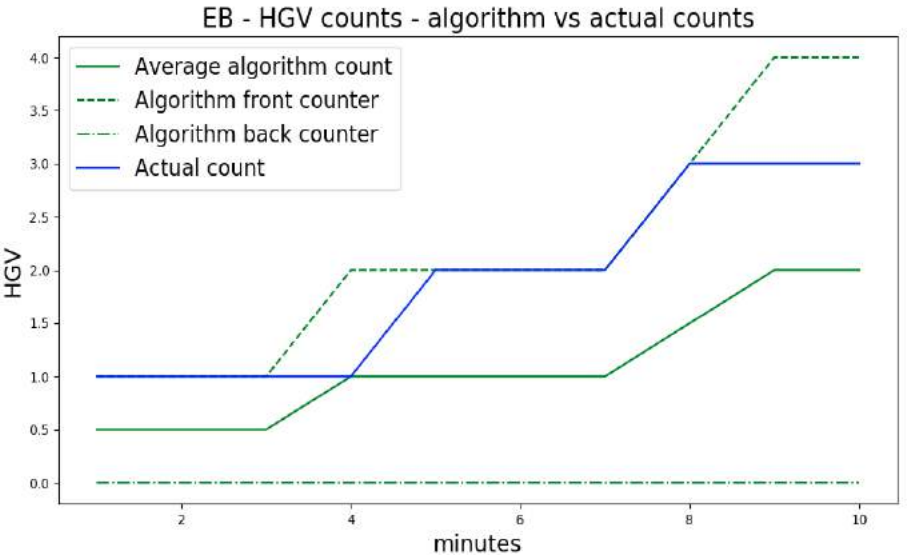
10min – good light, free-flowing traffic









Speed and acceleration

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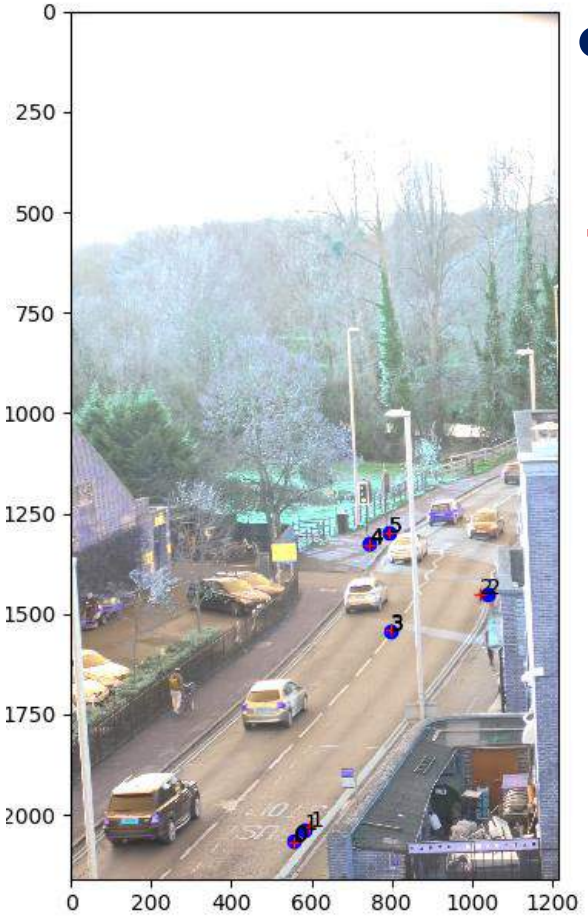
- Map video coordinates to world coordinates
- Camera Transform module *

Video



● Point on video

\+ Point on satellite image

Satellite image

* https://cameratransform.readthedocs.io/en/latest/

Speed comparison – x and y values

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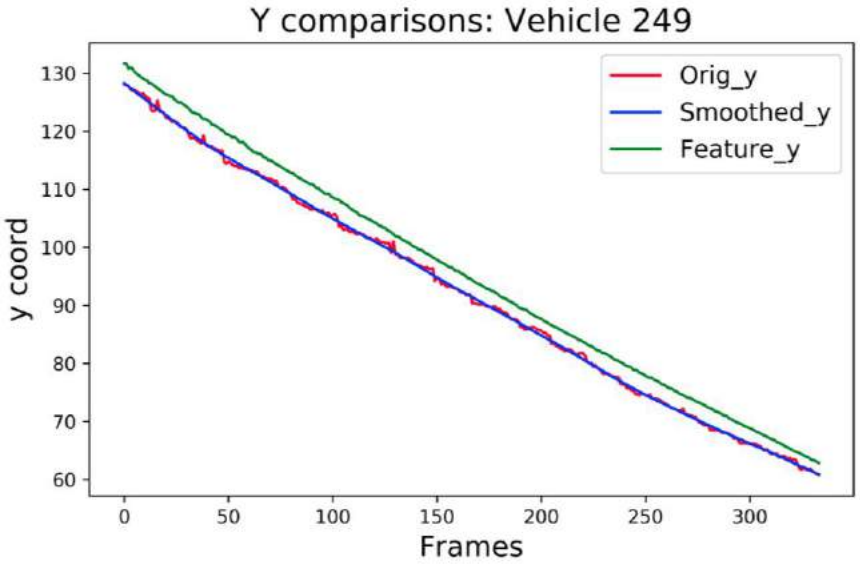

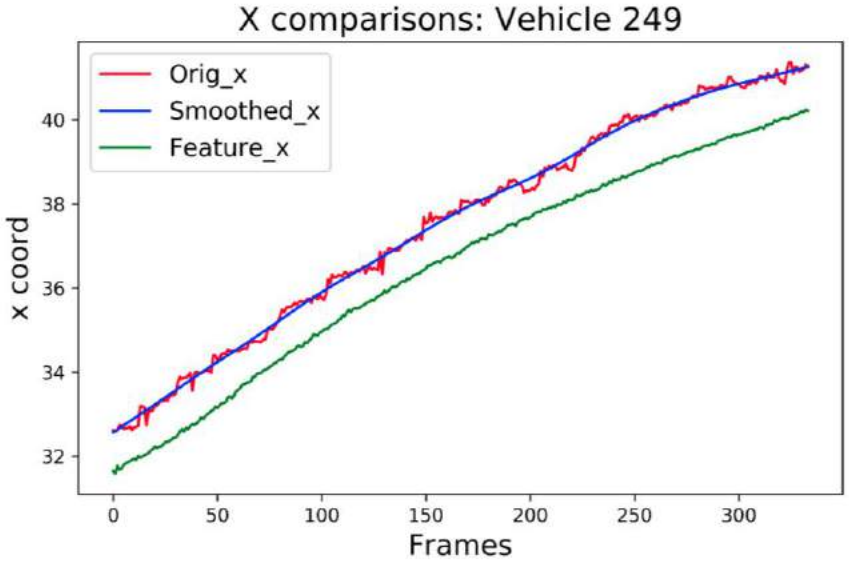

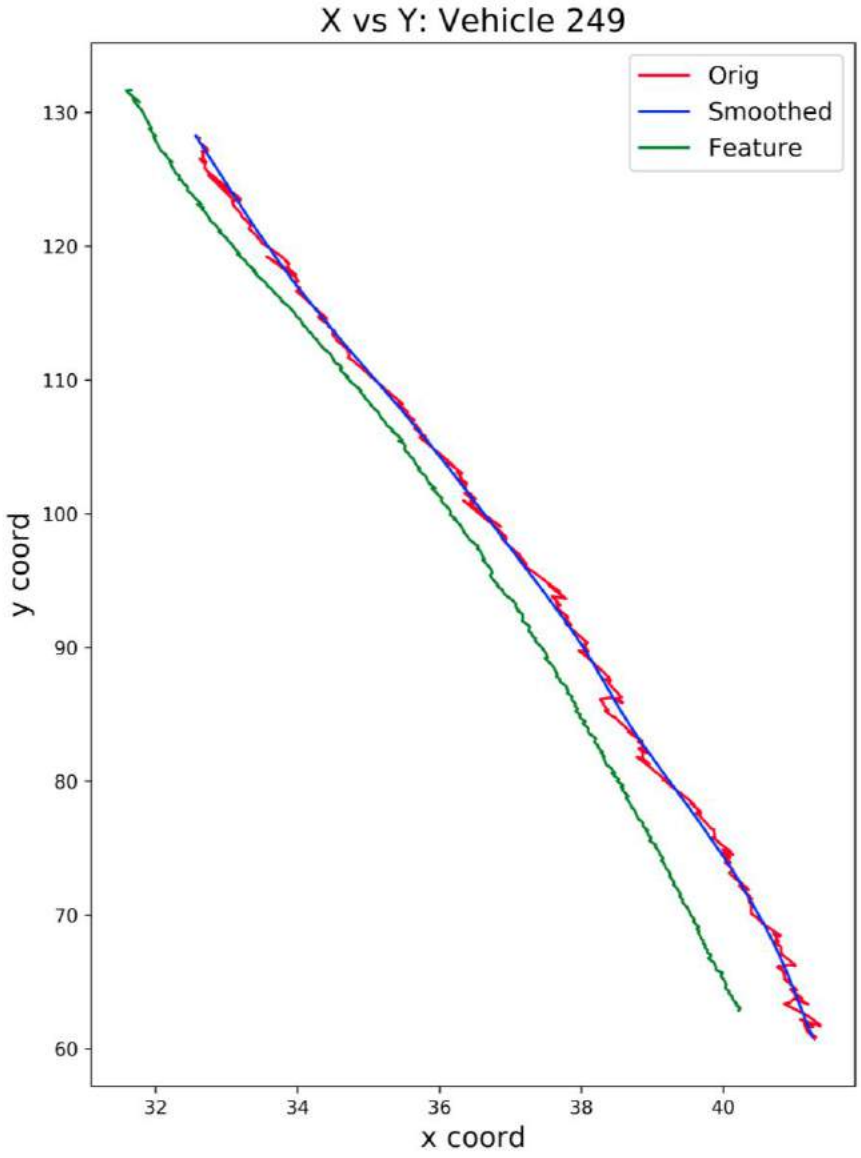

Speed comparison – frame vs aggregated speed

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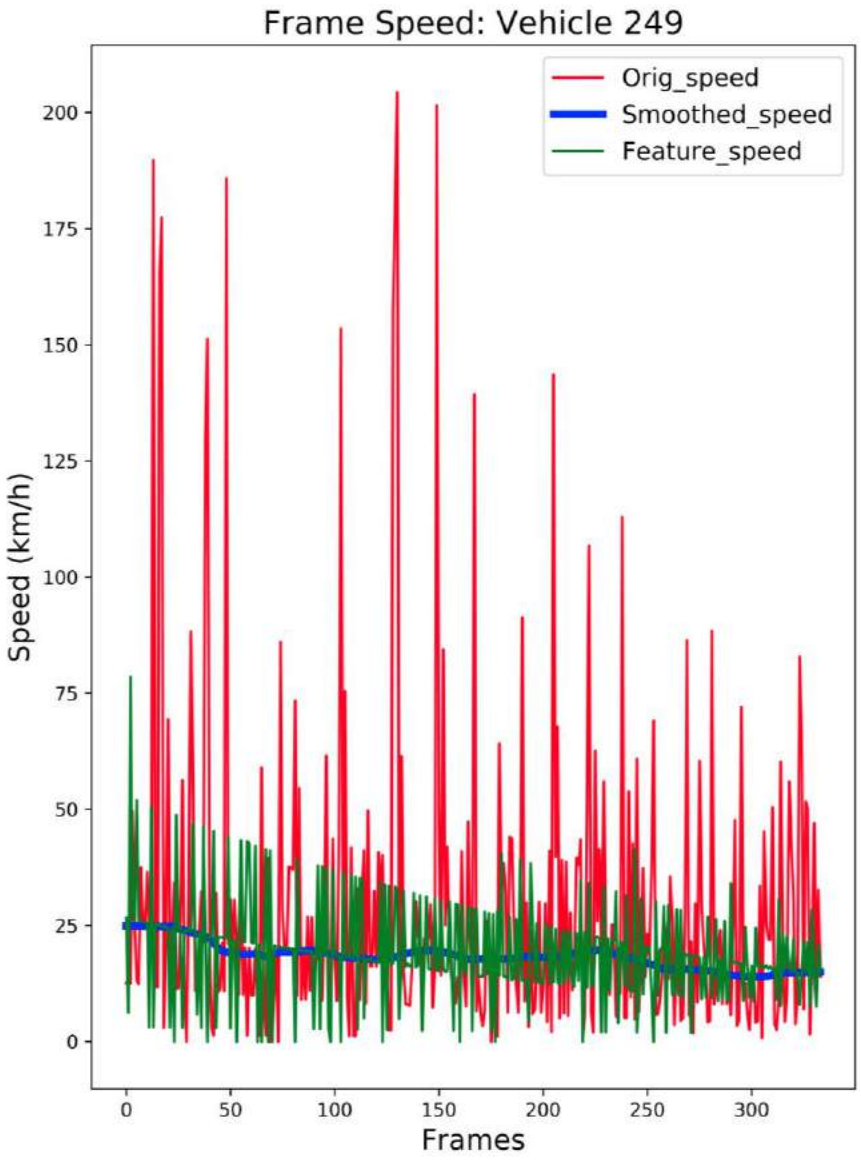

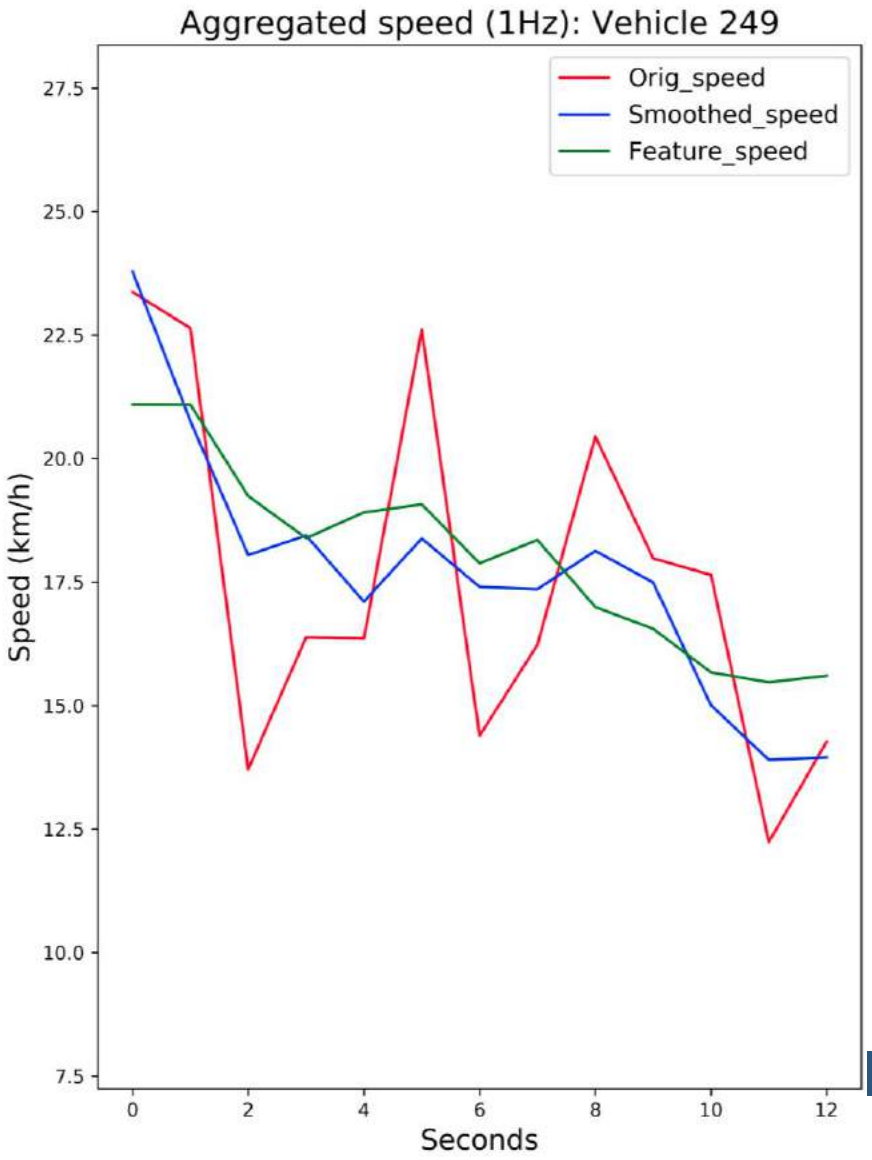

Speed comparison

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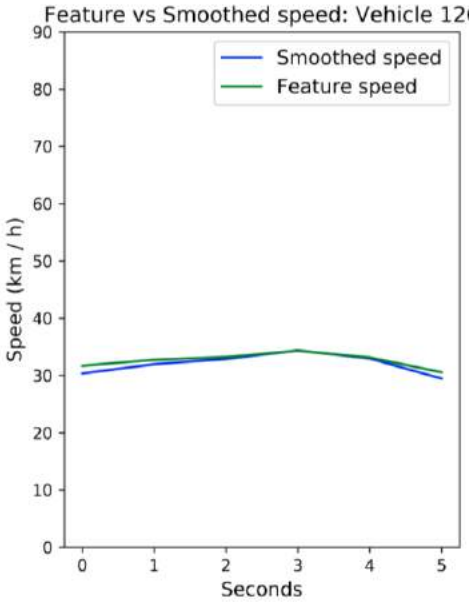

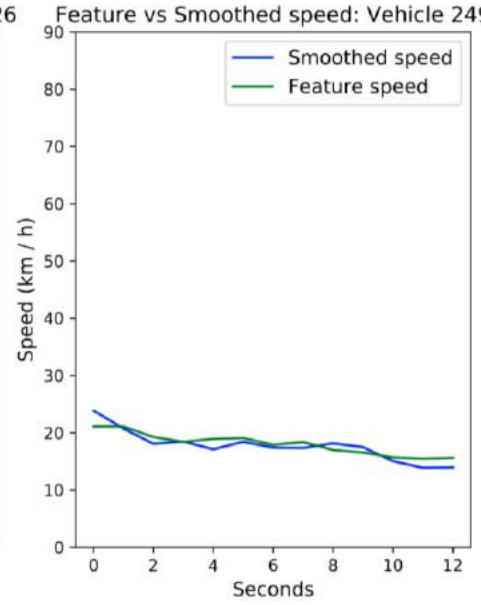

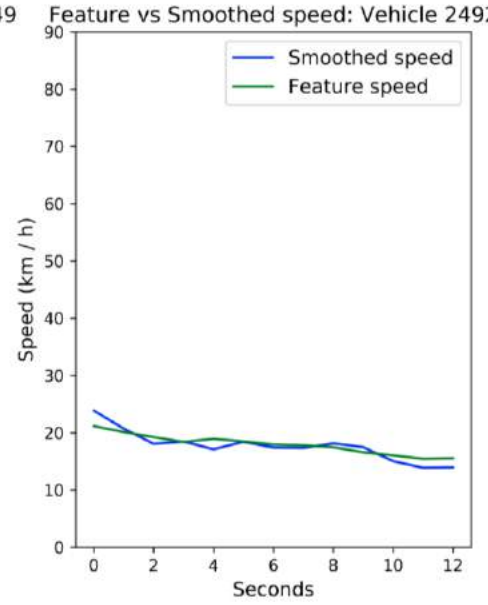

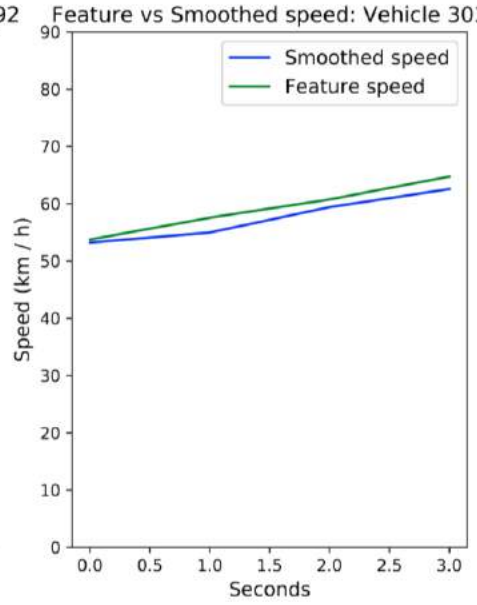

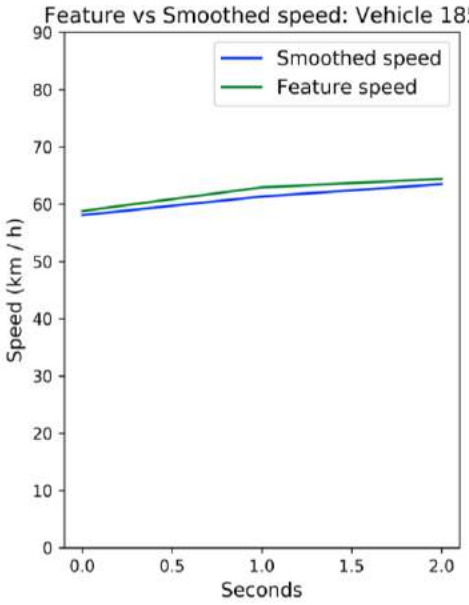

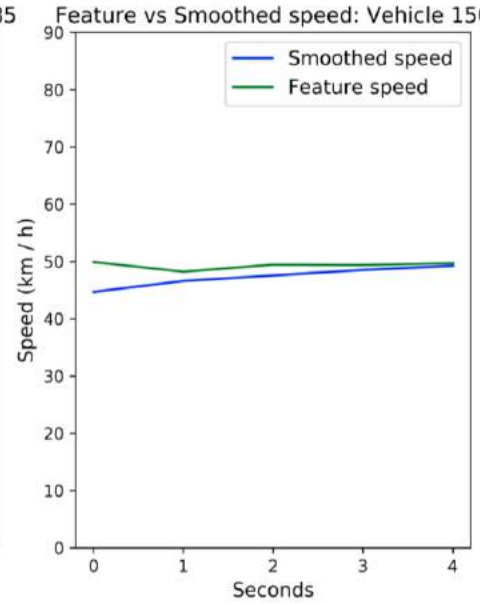

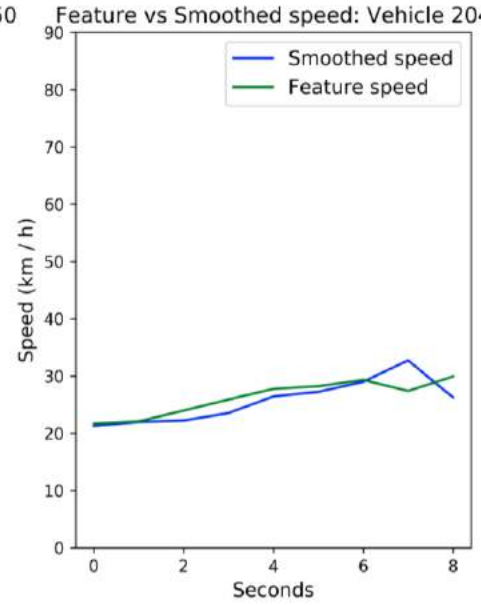

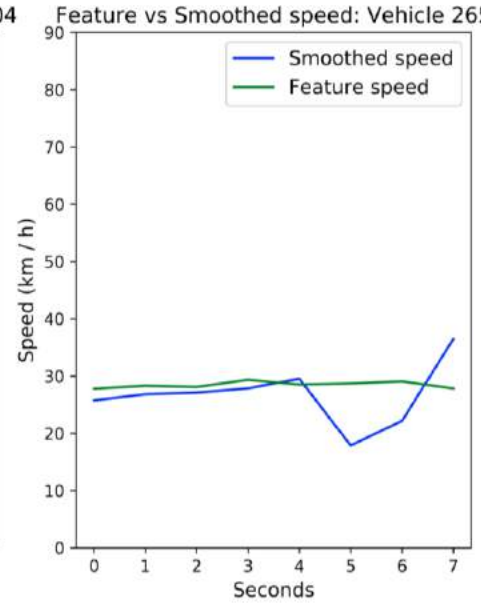

Field study this summer

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- Apply to larger area (network of cameras)
- Add number plate recognition
- Emissions model
- Validate vehicle emissions results of emissions model and Fluidity