Interaction in Urban Traffic – Insights into an Observation of Pedestrian-Vehicle Encounters

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Observation of Pedestrian-Vehicle Encounters

The challenge

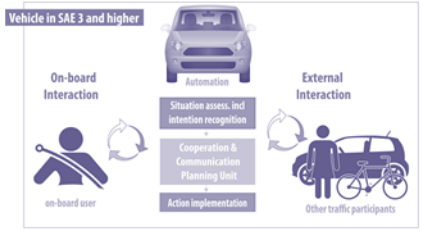
5th Enabler
Methodology for assessing the quality of interaction

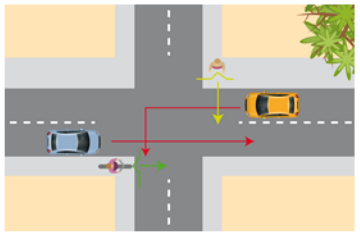
1st Enabler
Psychological models

Achieve a safe, highly accepted and efficient integration of Automated Vehicles in mixed traffic environment

4th Enabler
Novel HMI elements

3rd Enabler
CCPU & safety layer





2nd Enabler
Intention recognition & behavioural predictions

Key Objectives

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- **Model interaction** using different approaches
  - Interaction vocabulary: *How do TPs communicate and anticipate intent*
  - Interaction sequences: *What is the general interaction process in specific use cases, scenarios and scenes?*
  - Quantitative models: *How can interactions be mathematically formulated to allow model-in-the-loop simulations?*

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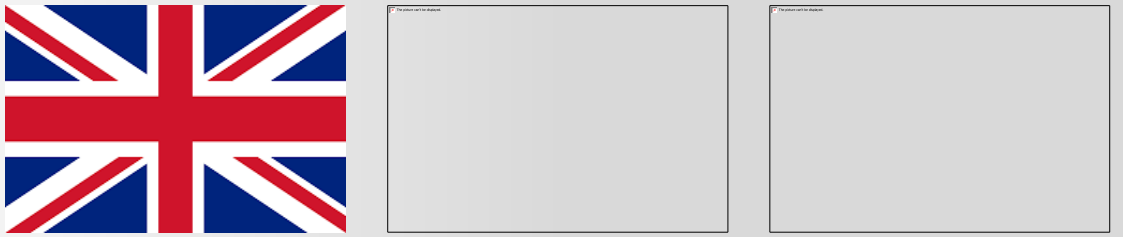
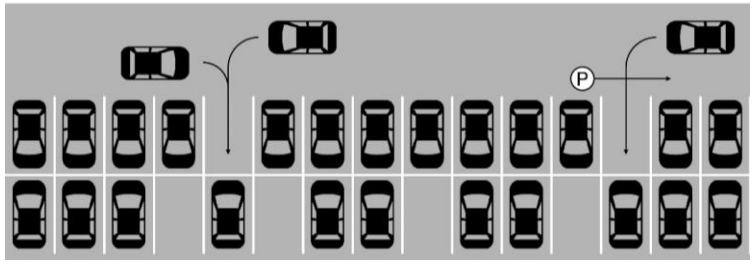
Observe, Model, Predict

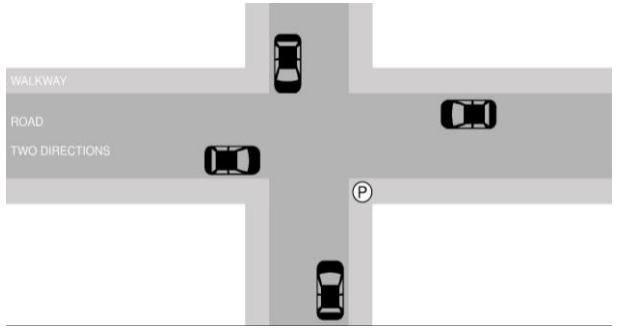
Methodology

- 3 Countries



- 4 Use Cases

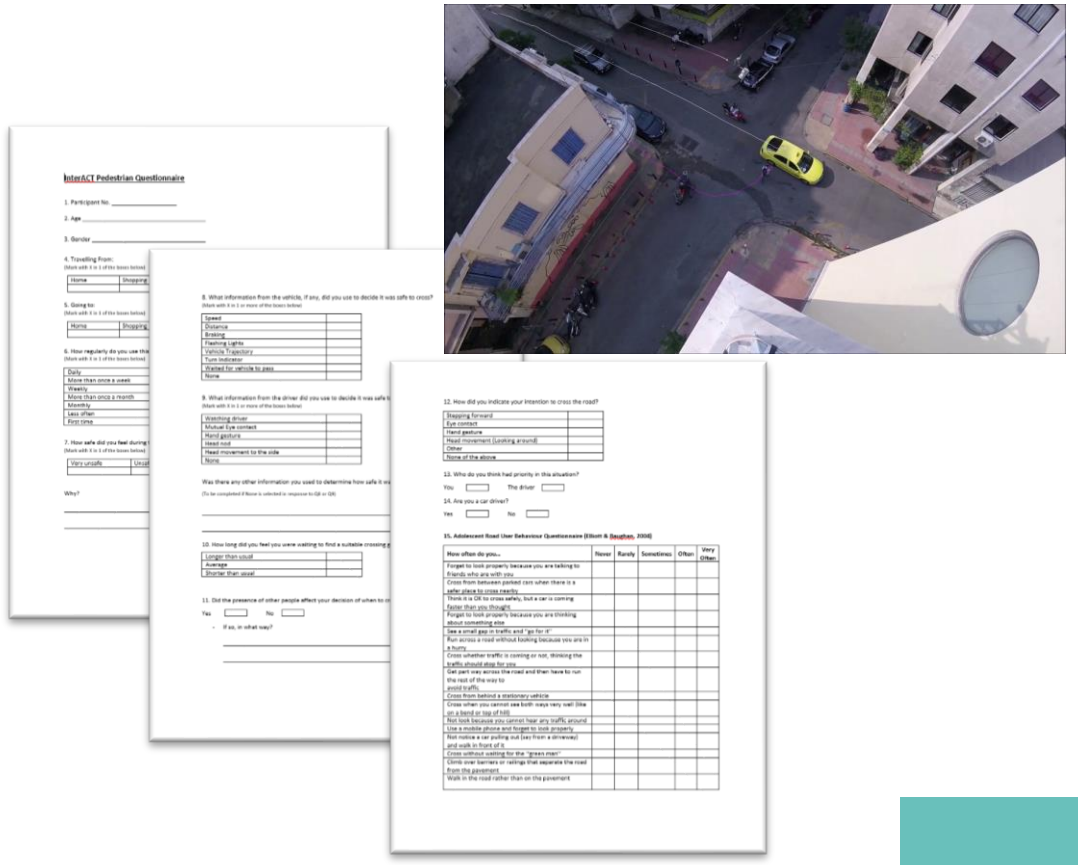




Methodology

Naturalistic observation of urban traffic

- Video
- Observation Protocols
- Questionnaires
- LiDAR



Methodology

Video:

- Birds eye view perspective of locations chosen to represent the use-cases

- Algorithmic analysis of the videos to derive positions and velocities of various traffic participants

Methodology

LiDAR:

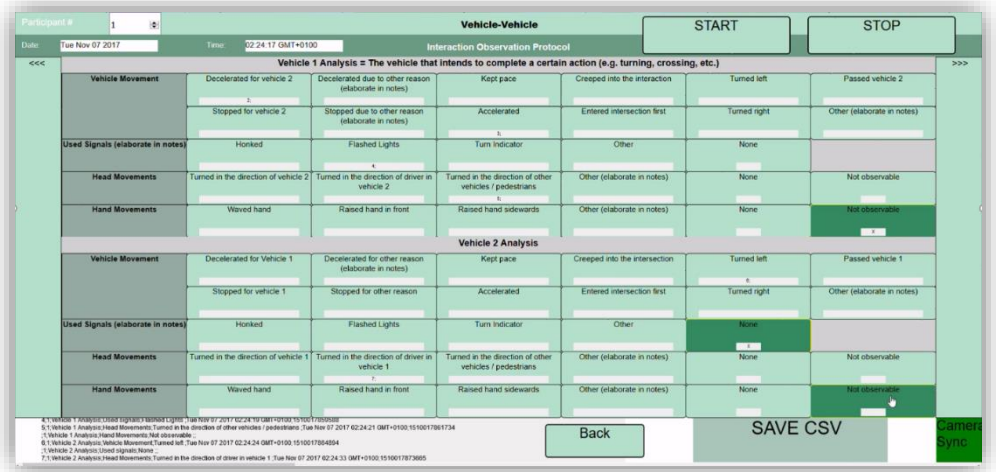
- Stationary LiDAR giving additional information on traffic participants and increasing tracking range

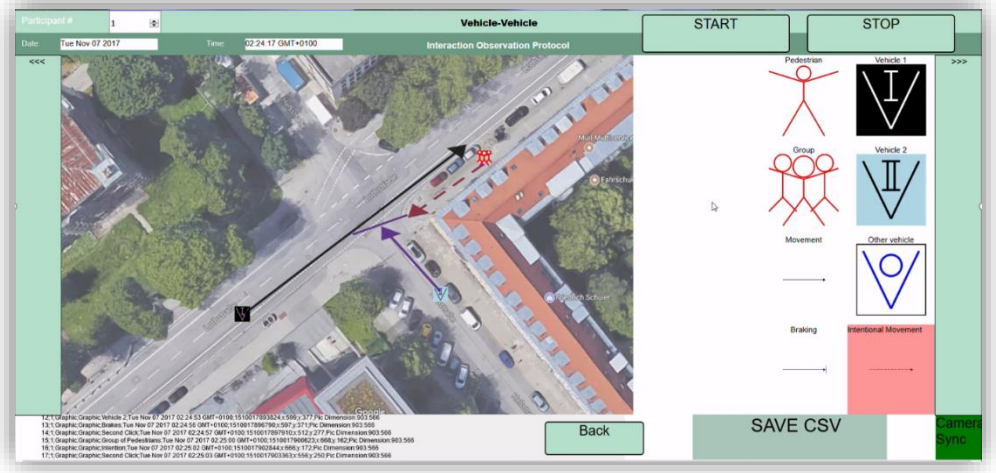
- Collected data is synchronized in time enabling a holistic overview of observed interactions

Methodology

Manual Observation:

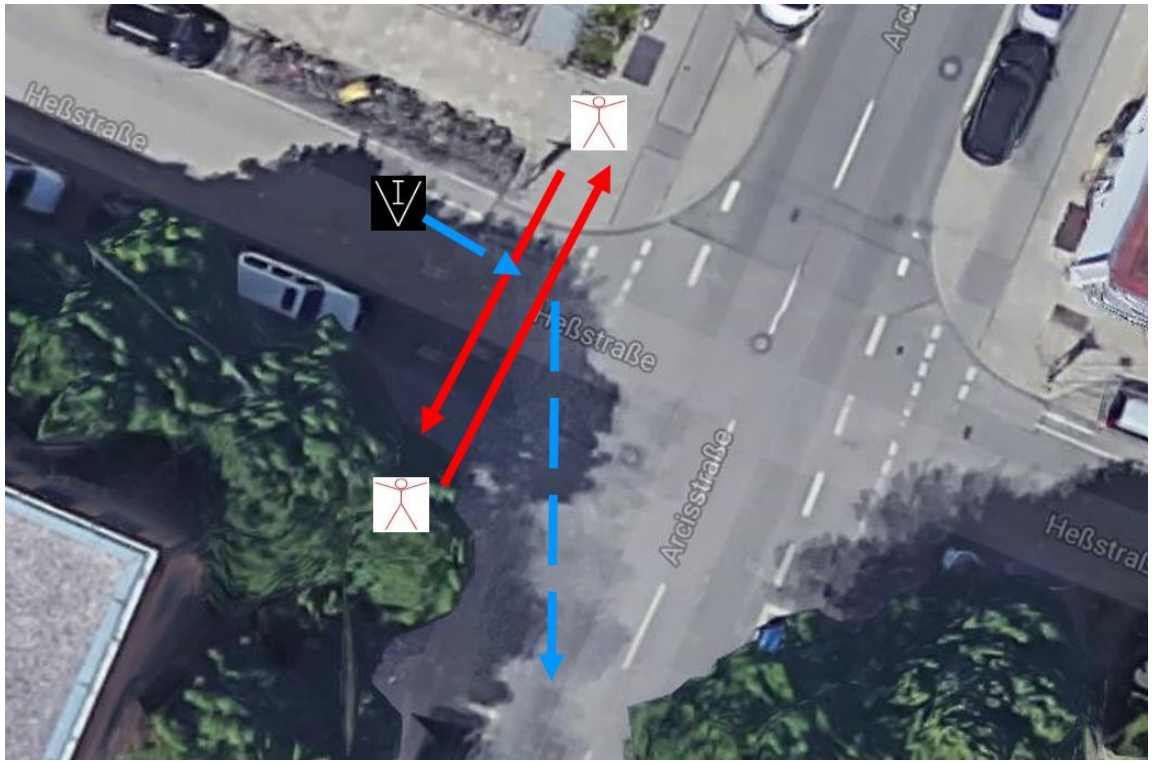
- Observers protocolling individual observed interactions from the ground
- HTML based app for tablets observing pedestrian and driver behaviour, including head rotation, eye contact, etc.
- Questionnaires





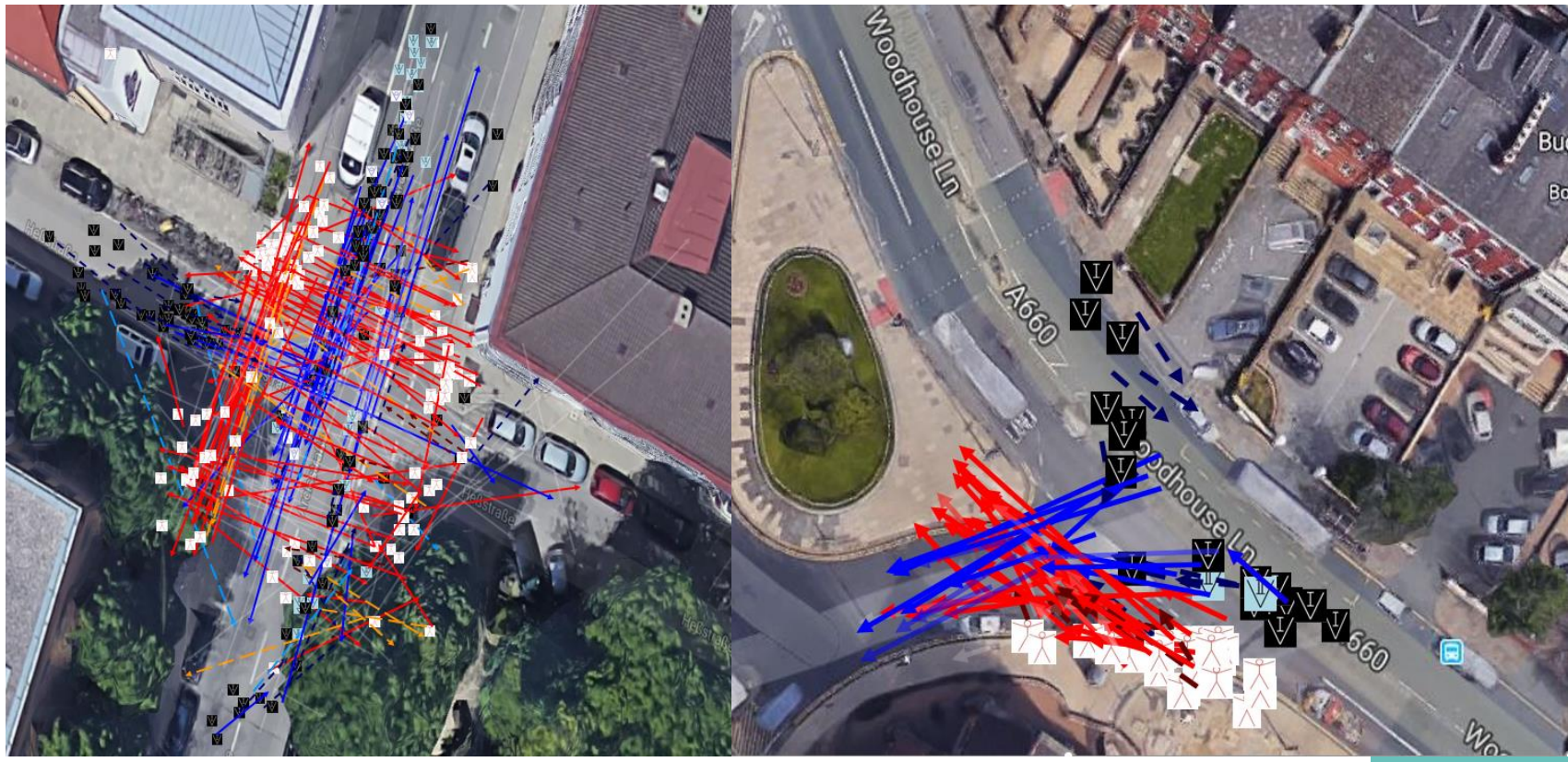
Preliminary Results – Manual Observation

- Observers were advised only to record interaction-demanding situations
- In these situations both traffic participants would have a conflict, if neither of them changed their behaviour
- If there was some sort of interaction between pedestrian and driver, observed pedestrians were asked to fill out a questionnaire.



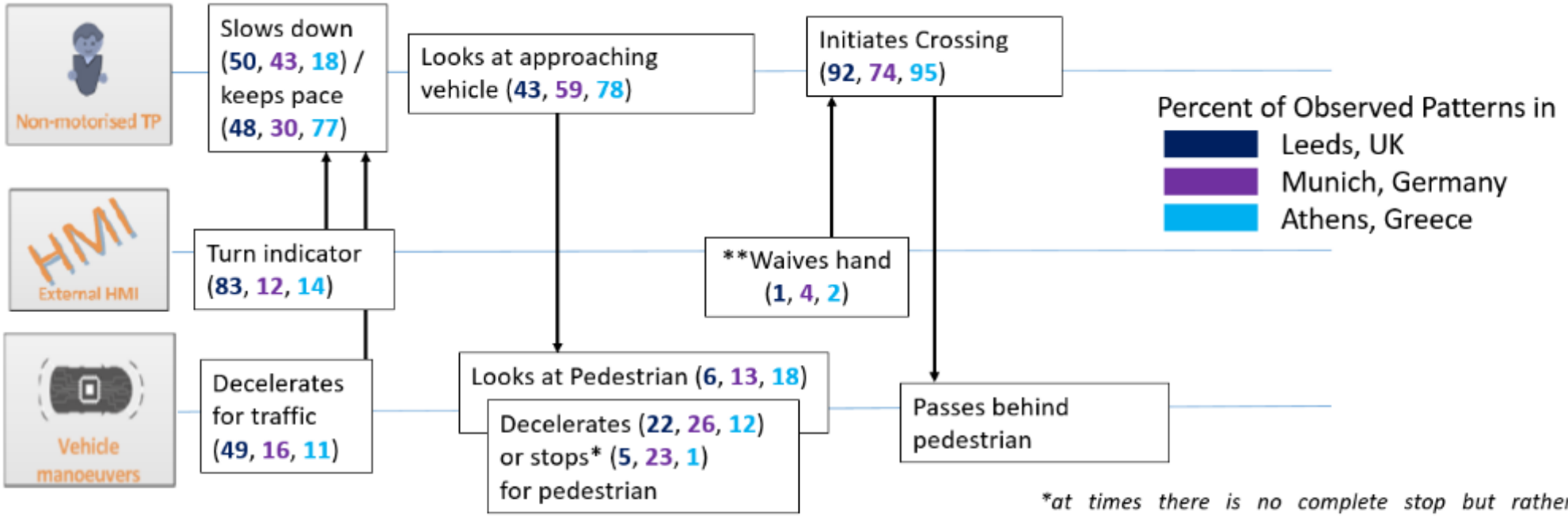
Preliminary Results – Manual Observation

- Over 100 Protocols per use case and country
- Also: combined 100+ hours of videos, 20+ hours of LiDAR Data and 150+ people interviewed



Preliminary Results – Manual Observation

Intersection – pedestrian goes first:

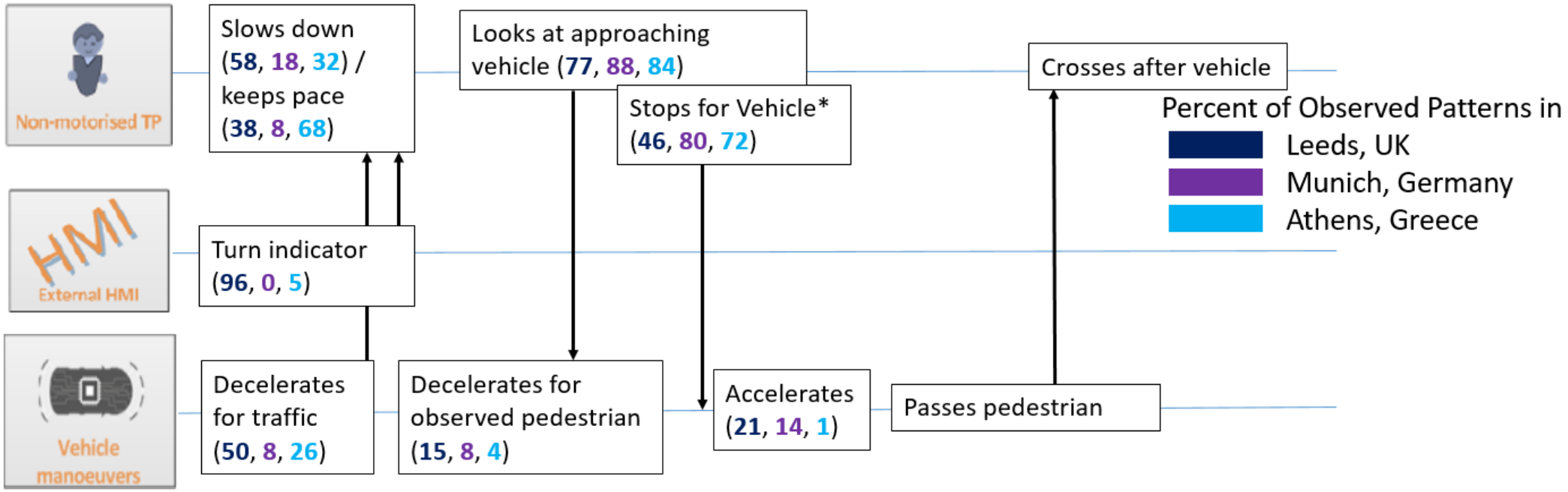


*at times there is no complete stop but rather a continuation of the movement at a very slow pace

**in some cases there was no hand waiving and the scenario played out comparably

Preliminary Results – Manual Observation

Intersection – vehicle goes first:



**at times there is no complete stop but rather a continuation of the movement at a very slow pace*

Overall Findings

- Occurrence and **necessity of interactions** highly depends on the situation and a variety of **other influences**, such as traffic density, time of day and specific traffic conditions
- **Explicit communication (e.g. gesturing, flashing lights etc.) happens rarely** - most potential interaction-demanding situations are resolved before they actually arise, mostly by adjusting kinematic motion
- **Cooperation, communication and thus interaction** between human road users takes place at **low speeds**, usually below 20 km/h
- At **higher speeds conflict avoidance** is predominant – pedestrians use large enough inter-vehicle gaps to cross without expecting the second vehicle to adapt
- **Self reports ≠ reality**: About 50% of pedestrians reported to use some sort of visual information from the driver – even when the driver could not have been physically perceived

Overall Findings

- Human road users seem to **avoid active communication with others** by adapting their movement behavior early
- Only in **ambiguous situations** (e.g. deadlocks) **communication** is used to let the other traffic participant go first, mostly **using gestures**
- In the rare case that pedestrians waved a driver through, the **“Thank You” hand gesture** always followed by the driver.

(First) Conclusions

- Automated Vehicles do not need to communicate much using external Human Machine Interfaces if the **idea is to replace a human driver** – only in ambiguous situations explicit communication is really necessary
- **BUT** – Automated Vehicles could **enhance the vehicle by communicating early** in addition to adapting their movement possibly increasing **Acceptance, Safety and Traffic Flow**

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Thank you!

interACT

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