Investigating the potential impact of Connected and Automated Vehicles in the Irish context

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Context

• Growing interest of citizens towards the adoption of autonomous cars [1]
• Connected and Automated Vehicles (CAV) technologies are expected to have positive impact on traffic [2]
• This research investigates the potential effects of CAV on:
  • road safety,
  • traffic (efficiency, management),
  • and governance,
• in the Irish context, using real data.

Project team

Principal investigator
Dr. Maxime Guériau
Research fellow

Supervisor
Dr. Ivana Dusparic
Ussher Assistant Professor

Expertise
AI techniques for Cooperative ITS and smart mobility

Supervisor
AI algorithms for traffic optimisation, smart mobility

Funding & partners

Previous projects
Projet SCOOP French pilot project for the deployment of C-ITS

Wider Impacts of Autonomous Vehicles WISE-ACT

Surpass: how shared autonomous cars will change cities

Current project
ITS Ireland Research Bursary:
CAV impact assessment on Irish roads through Multi-Agent traffic Simulation
Methodology

Network modelling
- Network extraction from OSM
- Network processing
- Network model

Demand modelling
- Mapping sensors
- Extracting demand
- Generated trips

Simulation (SUMO [3])
- CAV adoption scenarios definition
- Generated HDV and CAV trips
- HDV and CAV modelling

Validation
- Comparison of simulated flows with real data
- Comparison of detected conflicts with real data
- Calibration of HDV and CAV models

Outputs
- Simulation results
- Surrogate safety and traffic indicators definition
- Graphs, conflicts
- Recommendations (policies, strategies)

Real Data
- Open Street Map
- Traffic data (TII, Smart Dublin, SCATS)
- Safety data (RSA, Smart Dublin)

Case studies

CS1: Urban network
- Dublin city centre
- Traffic lights
- Reduced speeds

CS2: National road network
- N7 Johnstown – Rathcoole
- Higher speeds
- Multiple lanes
- Different safety concerns

CS3: Motorway
- M50 J7 – J9
- High speeds
- Complex junctions
- High traffic volumes
- High speed variability
Simulation set-up: M50 network

~7 km
Simulation set-up: baseline scenario

- Flows are generated from TII loop sensor data (includes % of HGV, and flows per lane, every 5 min)

TII traffic data: https://www.nratrafficdata.ie/

Average workday traffic volumes January to June 2019 (excl. holidays)

Sensor: TMU M50 020.0 N
(M50 Between J7 N4/M50 and J9 N7/M50)
Simulation set-up: models for HDV and CAV

<table>
<thead>
<tr>
<th>Example</th>
<th>Human Driven Car/Truck</th>
<th>CAV (level 2)</th>
<th>CAV (level 4/5)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Car-following model</strong></td>
<td>Human-driven cars and trucks</td>
<td>ACC or C-ACC enabled vehicles</td>
<td>Fully automated driving</td>
</tr>
<tr>
<td>1.5s headway [5]</td>
<td>0.8s headway [5]</td>
<td>0.6s headway [5]</td>
<td></td>
</tr>
<tr>
<td>50% variability</td>
<td>5% sensor failure rate</td>
<td>5% sensor failure rate</td>
<td></td>
</tr>
<tr>
<td>moderate cooperation and anticipation</td>
<td>moderate cooperation and anticipation</td>
<td>high cooperation and anticipation</td>
<td></td>
</tr>
</tbody>
</table>
Simulation set-up: CAV adoption scenarios

- A main challenge will be the short- and mid-term highly mixed traffic situation [2]
- Adoption scenarios are based on existing surveys [1] and literature [8]

Preliminary results:

- morning peak hour (7-8am)
Preliminary results: impact on traffic

- morning peak hour (7-8am)

Preliminary results: impact on safety

- Surrogate safety indicators allow to detect conflicts [10] in simulation:
  - for the motorway, Time to collision (TTC) is used, with specific thresholds: 1.5s for HDV 0.5s for CAV [11];
  - the approach is validated by comparing detected conflicts with real collision data.

Preliminary results: impact on safety

- morning peak hour (6-8am)

\[ \begin{align*}
\text{Conflicts (38)} & \quad \begin{cases} 
\star \text{ CAV-CAV (0)} \\
\text{CAV-HDV (0)} \\
\text{HDV-CAV (0)} \\
\text{HDV-HDV (38)} 
\end{cases} \\
\text{Conflicts (52)} & \quad \begin{cases} 
\star \text{ CAV-CAV (0)} \\
\text{CAV-HDV (0)} \\
\text{HDV-CAV (3)} \\
\text{HDV-HDV (49)} 
\end{cases} \\
\text{Conflicts (29)} & \quad \begin{cases} 
\star \text{ CAV-CAV (0)} \\
\text{CAV-HDV (2)} \\
\text{HDV-CAV (2)} \\
\text{HDV-HDV (25)} 
\end{cases} \\
\text{Conflicts (31)} & \quad \begin{cases} 
\star \text{ CAV-CAV (0)} \\
\text{CAV-HDV (0)} \\
\text{HDV-CAV (9)} \\
\text{HDV-HDV (22)} 
\end{cases} \\
\text{Conflicts (18)} & \quad \begin{cases} 
\star \text{ CAV-CAV (0)} \\
\text{CAV-HDV (1)} \\
\text{HDV-CAV (9)} \\
\text{HDV-HDV (8)} 
\end{cases} \\
\text{Conflicts (17)} & \quad \begin{cases} 
\star \text{ CAV-CAV (5)} \\
\text{CAV-HDV (0)} \\
\text{HDV-CAV (10)} \\
\text{HDV-HDV (2)} 
\end{cases}
\end{align*} \]
Conclusions and future work

• **Availability of real data allows to build and validate realistic baseline scenarios**, capturing specificities of the Irish network.

• **State-of-the-art research models** for CAV and HDV ensure realistic behaviours and variability.

• Preliminary results are consistent with literature [12,13], and show that while improvement is expected at long term, the short-term mixed traffic context would require more attention.

• **New forms of mobility enabled by CAV** like shared AV and dynamic ride-sharing [14] would affect the impact of CAV [15]

Thank you!

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References I


References II


