02-03 November 2023, Patras, Greece

INTERNATIONAL CONFERENCE ITS2023: INTELLIGENT SYSTEMS AND CONSCIOUSNESS SOCIETY



Correlations of automated mobility conditions with traffic conflict types

Maria G. Oikonomou¹, Apostolos Ziakopoulos^{1*}, Marios Sekadakis¹ and George Yannis¹

¹National Technical University of Athens



o The SHOW project

SHOW aims to support the deployment of shared, connected and electrified automation in urban transport, advancing sustainable urban mobility.

Naturalistic demonstrations and simulated environments are both deployed within the project.

- SHOW Partners: (more than) 70 partners from 13 EU-countries
- Duration of the project:
 48 months (January 2020 January 2024)
- Framework Program: Horizon 2020 | <u>www.show-project.eu</u>





Introduction

Connected & Automated Vehicles (CAVs) are expected to change transportation systems fundamentally:

- Increases are expected in road capacity, transport accessibility and fuel efficiency
- Decreases are expected in environmental emissions, delays and overall crash rates

Connected-Automated Transport Systems (CATS) are expected to be the first large-scale business cases.

However their safety impacts in terms of interactions are unclear, especially within variable traffic mixes.







Study aims and approach

The present study aims to assess road safety by predicting and correlating traffic conflicts under various automated public transport configurations.

- The operation of an automated shuttle service is simulated with various operating speeds.
- Additionally, increasing Market Penetration Rates of general automated traffic are considered.
- Traffic conflicts are then statistically analysed as Surrogate Safety Measures (SSMs).







Methodological aspects

- Within this study:
- Microscopic simulation is employed (using AIMSUN Next), providing data for otherwise unattainable configurations (high CAV MPRs).
- The study network was the Villaverde district of the city of Madrid, Spain, in which an Automated Shuttle Bus Service was introduced.
- Surrogate Safety Assessment Model (SSAM) software used to obtain simulated conflicts.
- A conflict is identified when the Time-To-Collision (TTC) and Post-Encroachment Time (PET) are lower from preset thresholds.







In total, 33 simulation scenarios were formulated, considering:

- 11 CAV market penetration rates (from 0% to 100% by 10% increments) within the current traffic demand (of the morning peak hour) applied to passenger cars and trucks.
- 3 different operational speeds for the automated shuttle bus service: 15, 30, and 45 km/h.
- Trajectory data were extracted and further analyzed to obtain traffic conflicts through the SSAM software.



International Conference TS2023: Intelligent Systems and Consciousness Society"

Patras, Greece



Naïve Bayes Classification Algorithm

The algorithmic foundation is Bayes' theorem: P(A|B) = [P(B|A)*P(A)] / P(B)

- A probabilistic approach to classification.
- The algorithm is simple and rapid.
- Good efficiency and scalability capabilities.
- Conditional independence of categories is assumed:
 - \circ $\,$ This helps in ignoring noise and irrelevant information.
 - However, it might not hold entirely in real data
 (in our case, conflict types, which might not hold for secondary conflicts).

Performance is checked on an unseen test subset (20% of the total)





02-03 November 2023

Patras, Greece

Results (1/2)

- Conflicts will be observably lower as MPR increases.
- The most substantial reduction is observed in rear-end traffic conflicts.
- Lane-change conflicts are reduced at a lower pace, while crossing conflicts display fluctuations.



Results (2/2)

- Crossing conflicts are more likely encountered on one-lane and three-lane segments.
- Rear-end conflicts are more likely encountered on two-lane segments.
- Give way and Traffic light traffic control lead to increase conflict likelihood.
- Prediction Accuracy is 79.3% on unseen data.



Discussion

- At higher CAV MPRs, conflict counts will be significantly lower, demonstrating the potential of CAVs in enhancing safety levels in traffic interactions.
- The most substantial reduction is observed in rear-end traffic conflicts, which predominate in non-automated mobility conditions, and are closely linked with speeding and distraction.
- Lower overall conflict frequency in the fully-automated conditions compared to the constant occurrence of crossing conflicts across lower MPR levels.
- It is possible that segments without infrastructure-based control lead to increased safety levels, supporting increased
- vehicle autonomy.



International Conference ITS2023: Intelligent Systems and Consciousness Society"

02-03 November 2023 Patras, Greece



Conclusions

- Automated Shuttle operation is likely to be one of the first applied large-scale naturalistic road automation operations.
- The present study sheds light on future safety conditions by classifying conflicts as Surrogate Safety Measures.
- Market Penetration Rates of CAVs are a highly influential parameter governing the traffic mix.
- Conflicts are immensely promising as SSMs, especially given that they can probabilistically approach crashes.
- Research gaps per conflict/crash type are formulated.





02-03 November 2023, Patras, Greece

INTERNATIONAL CONFERENCE ITS2023: INTELLIGENT SYSTEMS AND CONSCIOUSNESS SOCIETY



Correlations of automated mobility conditions with traffic conflict types

Maria G. Oikonomou¹, Apostolos Ziakopoulos^{1*}, Marios Sekadakis¹ and George Yannis¹

¹National Technical University of Athens

