Hybrid Validation of V2X Collective Perception in Complex Scenarios

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EVENTS

Presentation Overview

- Motivation
- Our Contribution
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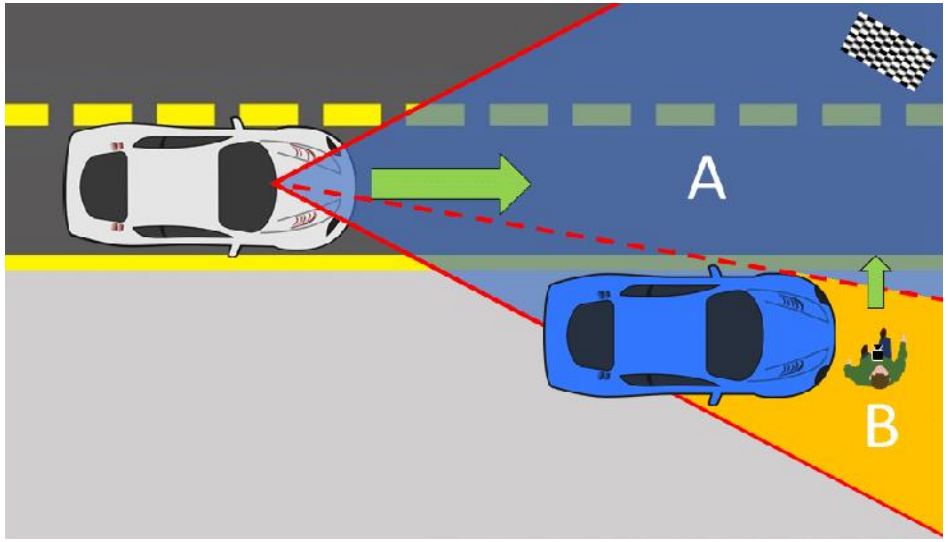
Why Collective Perception?

- AVs are limited by sensor range and occlusions
- V2X sharing enables Collective Perception (CP)
- Validating CP in complex, realistic conditions is challenging



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Why a Hybrid Setup?

- **Safety in High-Risk Scenarios:** Edge-Case Testing, Fail-Safe Mechanisms
- **High Fidelity and Realism:** Closing the Sim-to-Real Gap
- **Efficiency and Scalability:** Faster Development Cycle, Concurrent Testing
- **Repeatability and Determinism**
- **Validation of V2X Systems:** Virtual Traffic Interaction, Communication Latency

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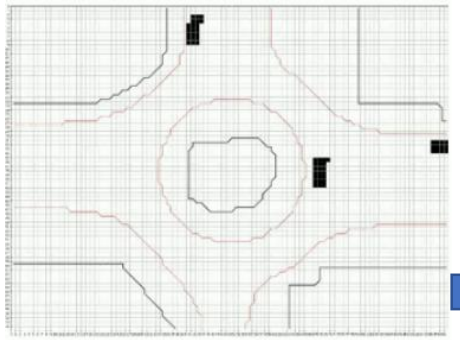
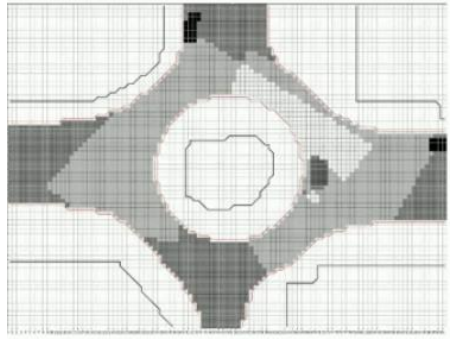
Our Contributions





- Bayesian probabilistic fusion algorithm for multi-agent CP.
- Hybrid validation combining simulation and real-world testing.

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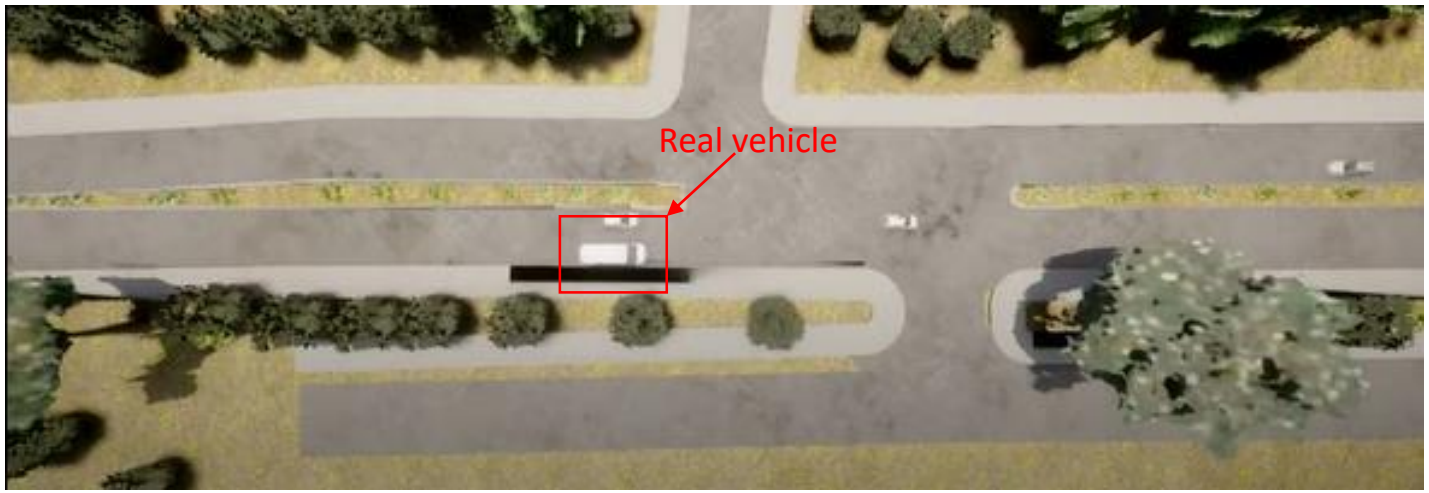
ICCS's Digital Twin



- Digital Twin of the NTUA Campus
- Hybrid setup: The real vehicle drives on the actual road and sends information (GPS coordinates, image from camera, LiDAR point cloud etc.) in real time in the simulator, which shows it along with any digital agent.
- This allows for multiple experiments and multiple variations of the same experiment to be performed in minutes

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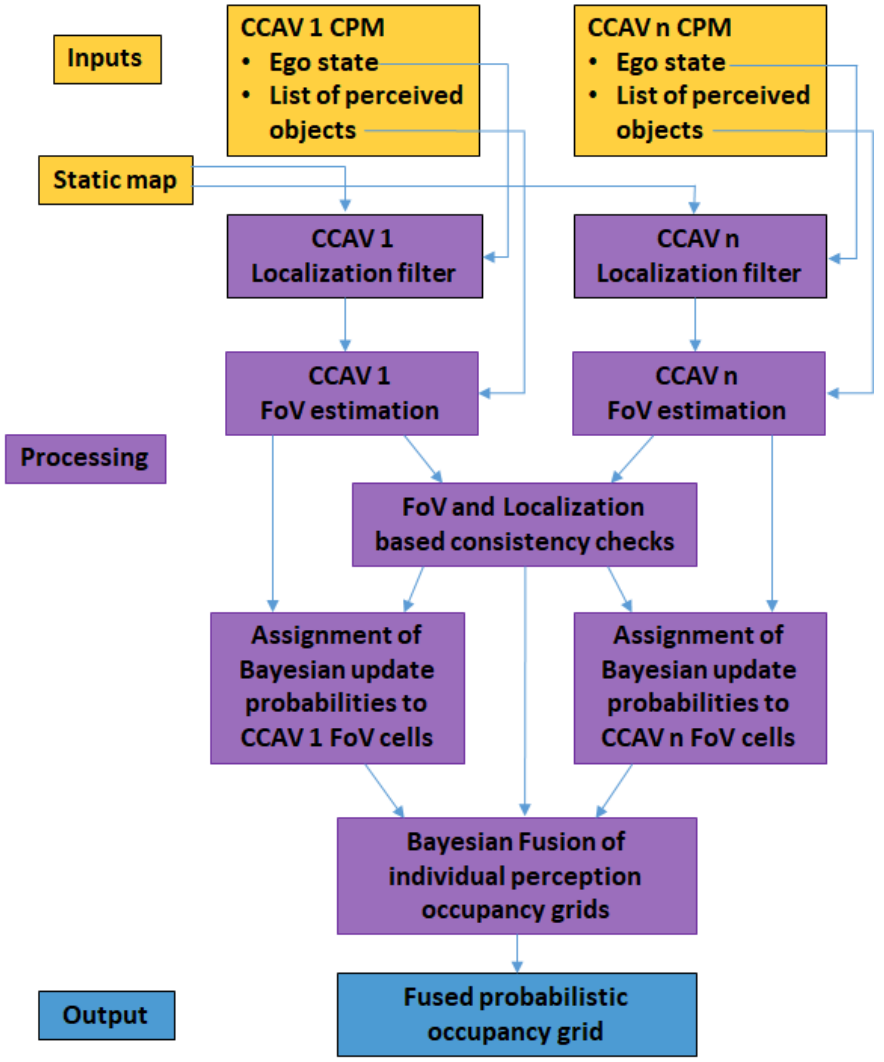
Collective Perception Framework Overview

- Inputs: ego vehicle data, object lists, localization.
- Processing: probabilistic fusion + consistency checks.
- Output: probabilistic occupancy grid (shared world model).



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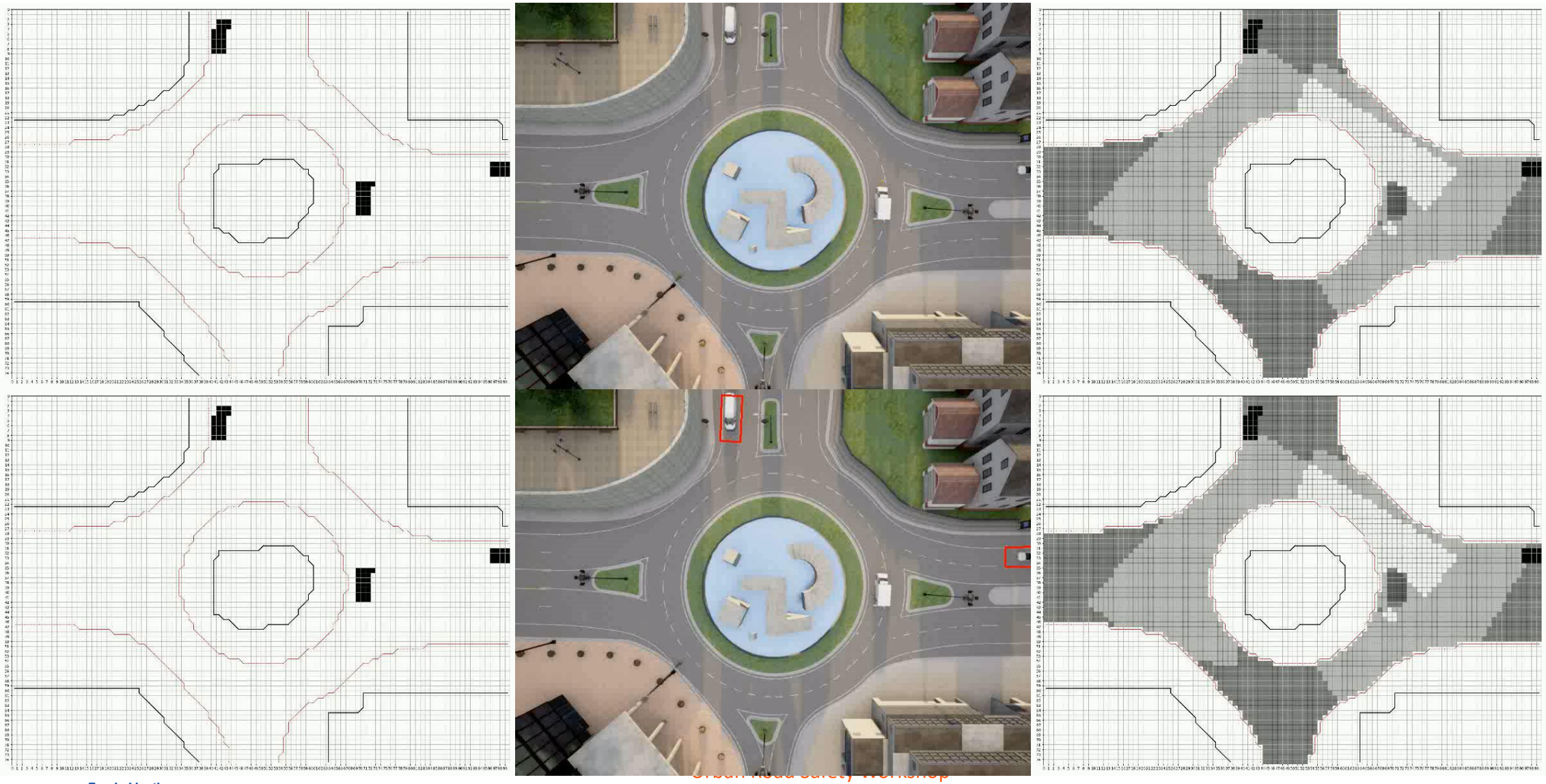
Evaluation Results (6 agents VS only ego)



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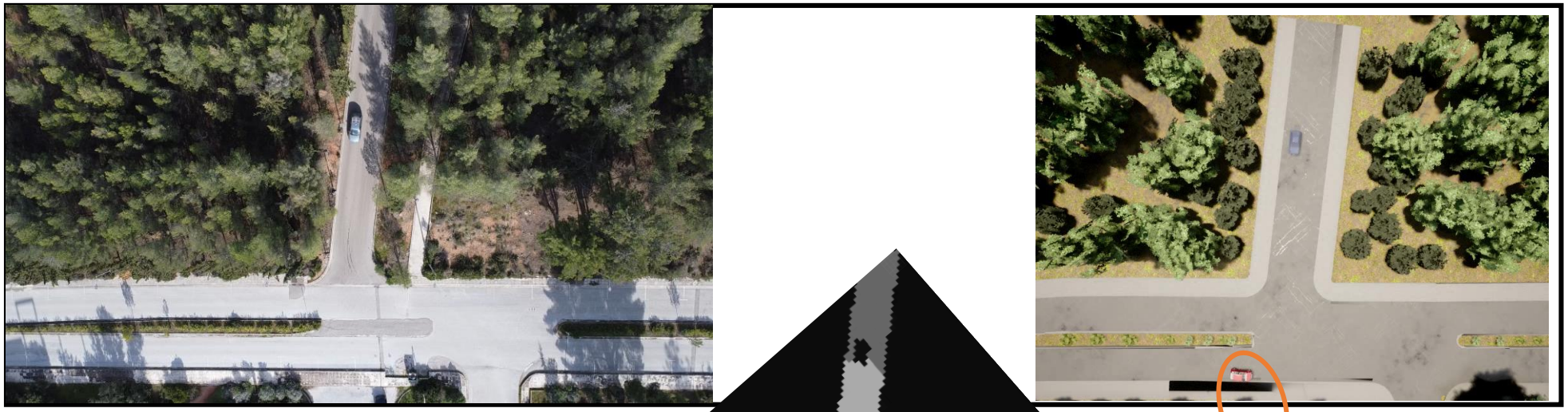
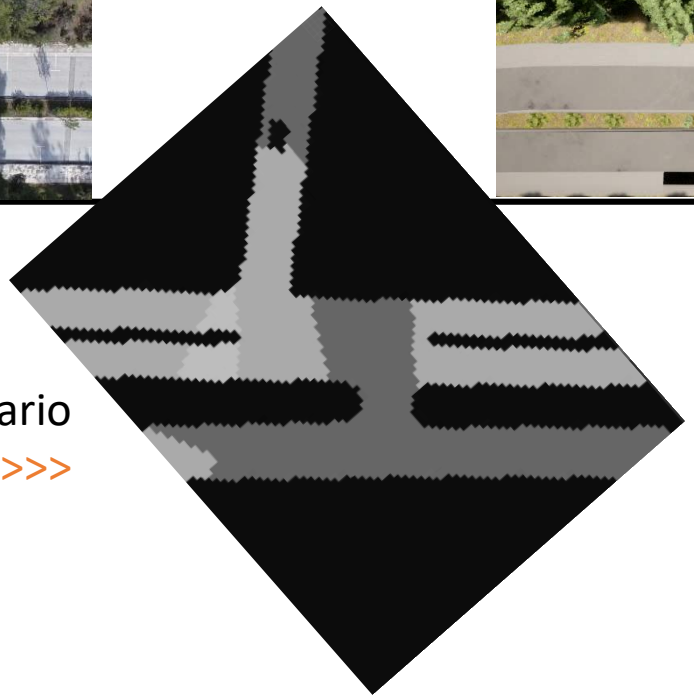
Hybrid Demonstration



POG generation during scenario variation runtime >>>



Virtual agent: parked vehicle

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Conclusion

- Hybrid framework bridges simulation and real testing.
- Probabilistic fusion enhances explainability and robustness.

Our approach supports safe and explainable deployment of collective perception systems, moving toward trustworthy cooperative autonomy

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Thank you for your attention!

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