Unified Frenet Frame Motion Planning Based Framework for Social Navigation

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RESEARCH QUESTION

In a fast paced and complex scenario such as self driving, what is a computational framework that enables autonomous vehicles(AVs) to interact safely and naturally with human-driven vehicles?

MOTIVATION

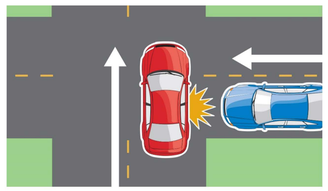

Figure 1: Example of incorrect behavior prediction

Figure 2: Real interaction scenario

- AVs are a high speed, safety critical application and existing behavior prediction algorithms are computationally expensive based on the planning horizon
- As the dimensionality of the space grows, the computation becomes higher
- Since safety is critical, a simplified planner is not sufficient for deployment in real interaction

APPROACH

Integrate a Stackelberg game-based Sarsa(λ) **tree search** with **predictive motion planning in Frenet frame**, activated based on time-to-collision(TTC) for AV-human interaction with **real data validation**.

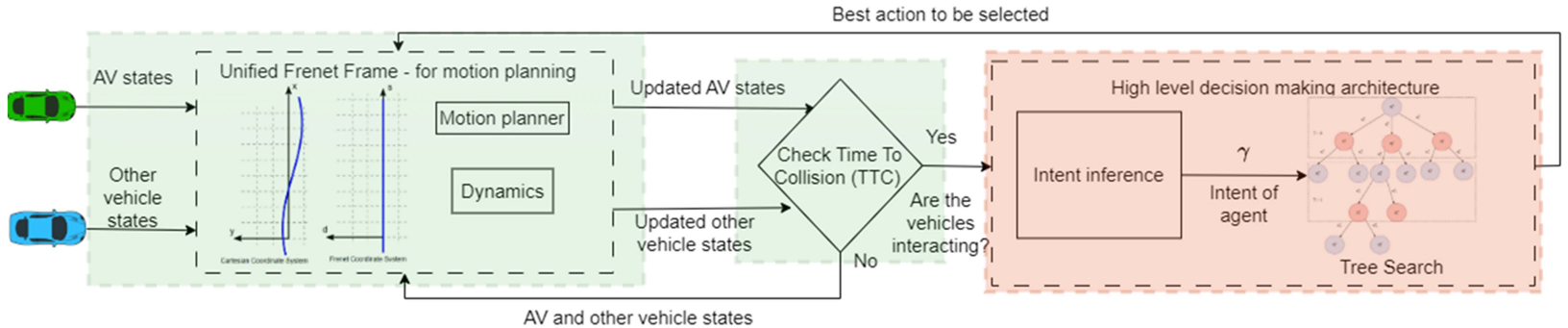

Figure 5: Architecture of Frenet frame based motion planning for platform agnostic social navigation

RESULTS

- Frenet frame based motion planning yields better results in terms of MAE and MSE for velocity compared to baseline.
- Without the decision making module, the interaction leads to a collision.

Metric (in m/s)	Exhaustive Search Motion Planner	Frenet Frame Motion Planner
MAE	1.0234	0.5857
MSE	1.7865	0.6656

Table 1: MAE and MSE of velocities from baseline[2] and Frenet Frame

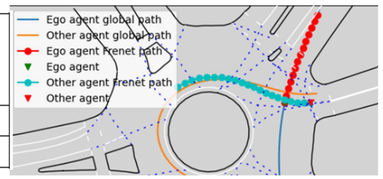

Figure 6: Ego and other agent colliding with only the motion planner

FUTURE WORK

- Integrate the intent inference and decision making block with the frenet frame motion planner, similar to [1]
- Validate the architecture with real data

ACKNOWLEDGEMENTS & REFERENCES

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[1] C. Li, T. Trinh, L. Wang, C. Liu, M. Tomizuka and W. Zhan, "Efficient Game-Theoretic Planning With Prediction Heuristic for Socially-Compliant Autonomous Driving," in IEEE Robotics and Automation Letters, vol. 7, no. 4, pp. 10248-10255, Oct. 2022, doi: 10.1109/LRA.2022.3191241

[2] Peng, B.; Yu, D.; Zhou, H.; Xiao, X.; Xie, C. A Motion Planning Method for Automated Vehicles in Dynamic Traffic Scenarios. Symmetry 2022, 14, 208.

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