Mixed Traffic Control and Coordination from Pixels

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Introduction

Our cities employ traffic lights, ramp meters, and tolls for traffic management but traffic congestion still persists, causing delays and increasing energy consumption.

The rise of autonomous Robot Vehicles (RVs) offers new opportunities to solve traffic issues.

Mixed Traffic Control

Mixed traffic: co-existence of RVs and human driven vehicles (HVs).

Mixed traffic control: RVs regulate upstream traffic, improving flow and reducing delays.

Existing studies use precise observations such as position, velocity or density which require redesigning the observation space for every mixed traffic control environment.

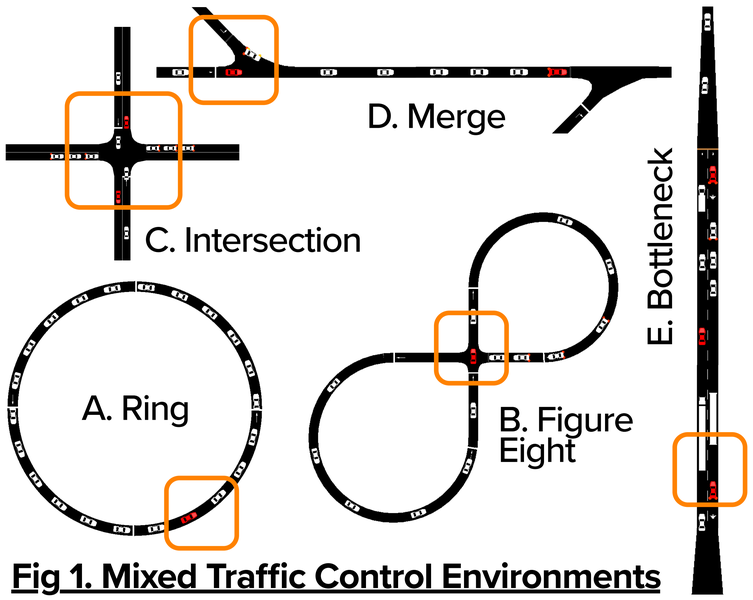

Fig 1. Mixed Traffic Control Environments

Fig 2. Bird's-eye view observations

In this work, we use bird's-eye view (BEV) images centered on the RV (marked with orange in Fig 1 with RVs colored red) which provide general purpose observations across environments. The observations after processing are shown in Fig 2 with RVs colored gray.

Results

RVs using BEV observations exhibit same traffic statilization properties to prevent stop and go waves as using precise observations (Fig 3).

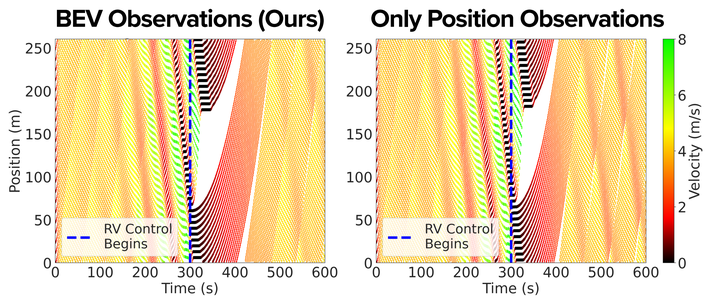

Fig 3. Space-time diagrams in the Ring

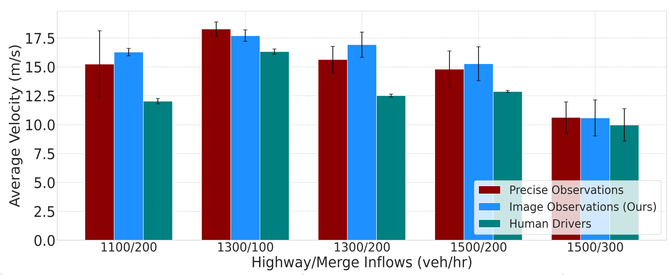

Fig 4. Average velocity performance in Merge

RVs with image observations are competitive and can also outperform RVs with precise observations (Fig 4) in environments such as Merge by upto 8%.

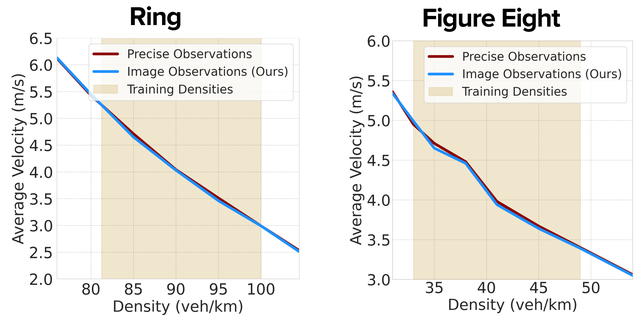

Fig 5. Performance at various densities

Our approach generalizes to various densities (including densities not present at training, shown in Fig 5) and to heterogeneous traffic in Bottleneck (Fig 1. E) which includes motorcycles, buses, delivery trucks, semi-trucks and cars.

Conclusion

- BEV images provide general purpose observations for various mixed traffic control environments.
- RVs trained on BEV image obervations are competitive and can even outperform RVs with precise observations.
- Finding a general purpose reward function that works across all environments still remains an open problem.

Paper & Code

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