Quick and Autonomous Platoon Maintenance in Vehicle Dynamics For Distributed Vehicle Platoon Networks

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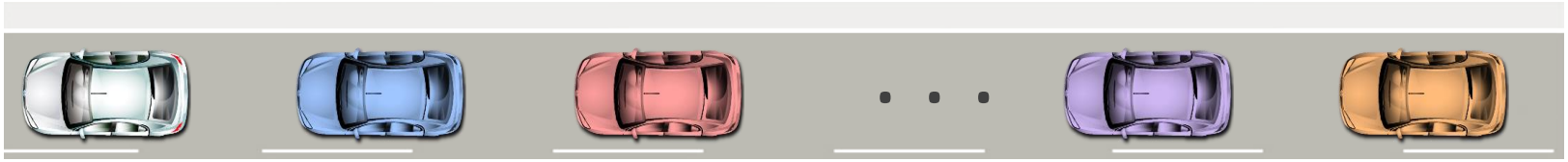
Outline

- Introduction
- System Design
- Performance Evaluation
- Conclusion

Introduction
Platoon system

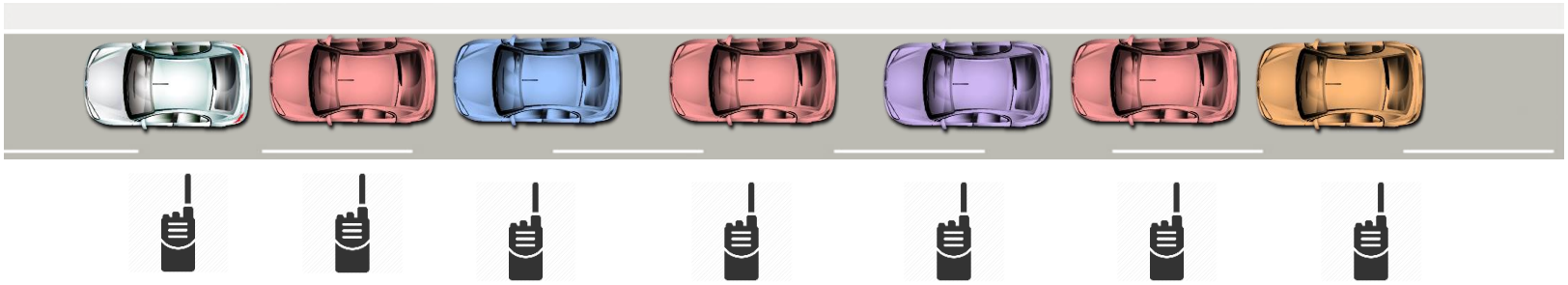
In a platoon, one leader vehicle and several follower vehicles drive in a single lane, maintaining a safety inter-vehicle distance



Introduction

Solution: Distributed CACC system

1. Vehicles have short range communication devices
2. Guarantee vehicles' safety
3. Increase the number of vehicles
4. Dynamic formation of platoon



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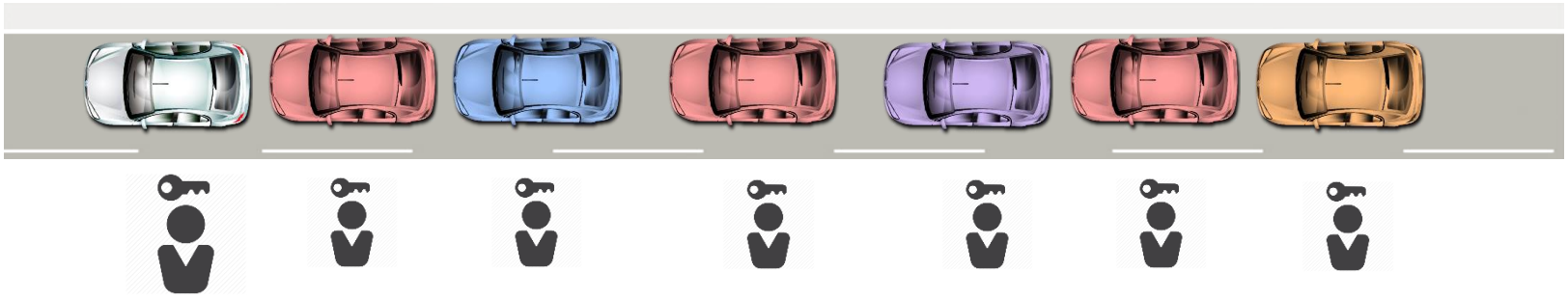

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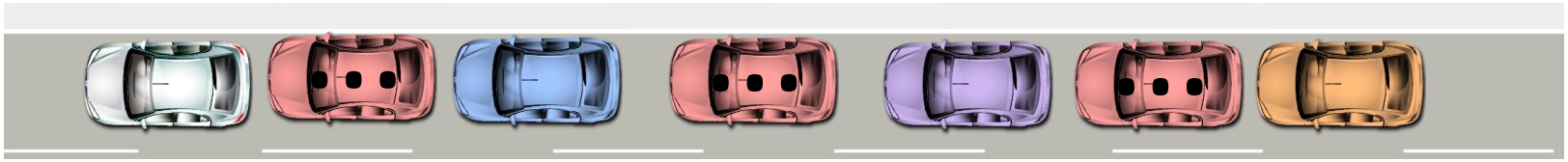

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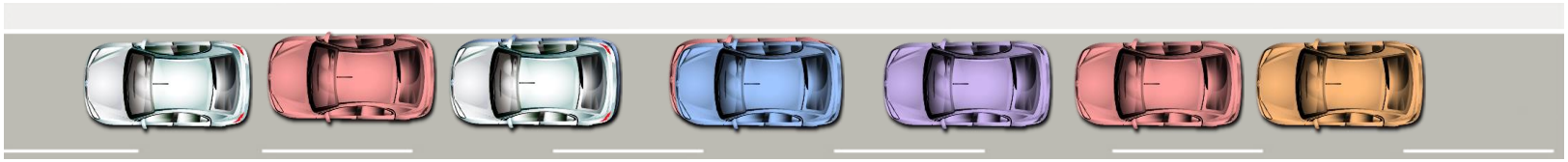
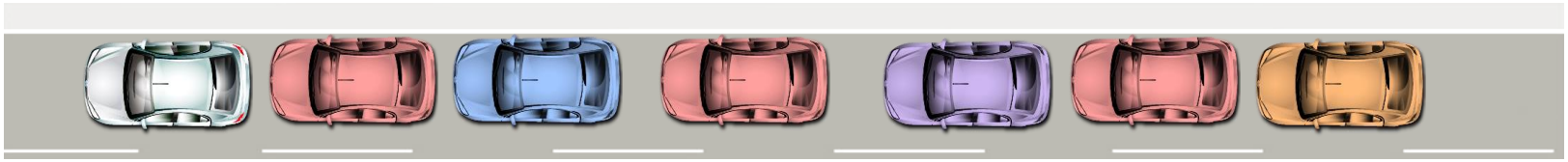


Introduction

Challenge of distributed platoon system

- ❑ Platoon maintenance in dynamic environment
- ❑ Without any communication
- ❑ without any accurate distance information



Introduction

Challenge of distributed platoon system

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- ❑ Without any communication
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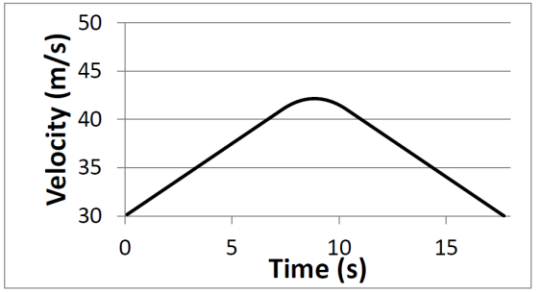
Our method: Autonomous platoon maintenance

1. Study velocity profiles
   - ☐ Analyze velocity profiles for different scenarios
2. Stored velocity profiles
   - ☐ Based on different inter-mediate distances and velocities, stored different profiles
3. Adaptive platoon maintence
   - ☐ Use mainly two set of profiles for creating or recovering holes inside platoon

System Design
Velocity profiling

Study velocity profiles for two cases:

- Vehicle leaving: Following vehicles must accelerate gradually maintaining safety and comfort.



Vehicle leaving

System Design
Velocity profiling

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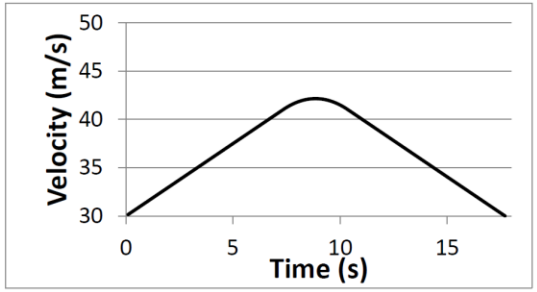
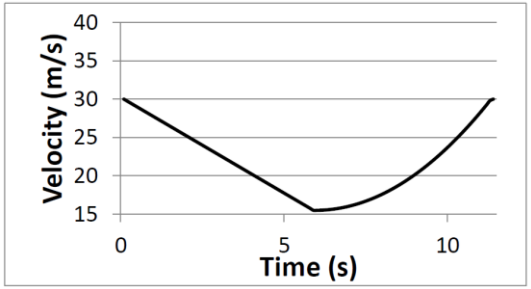


Vehicle leaving

- Vehicle entering: Following vehicles must deaccelerate gradually maintaining safety and comfort.

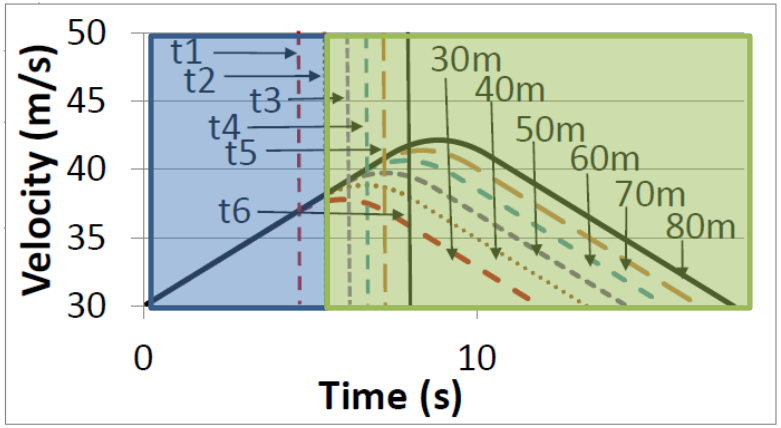


Vehicle entering

System Design
Velocity profiling

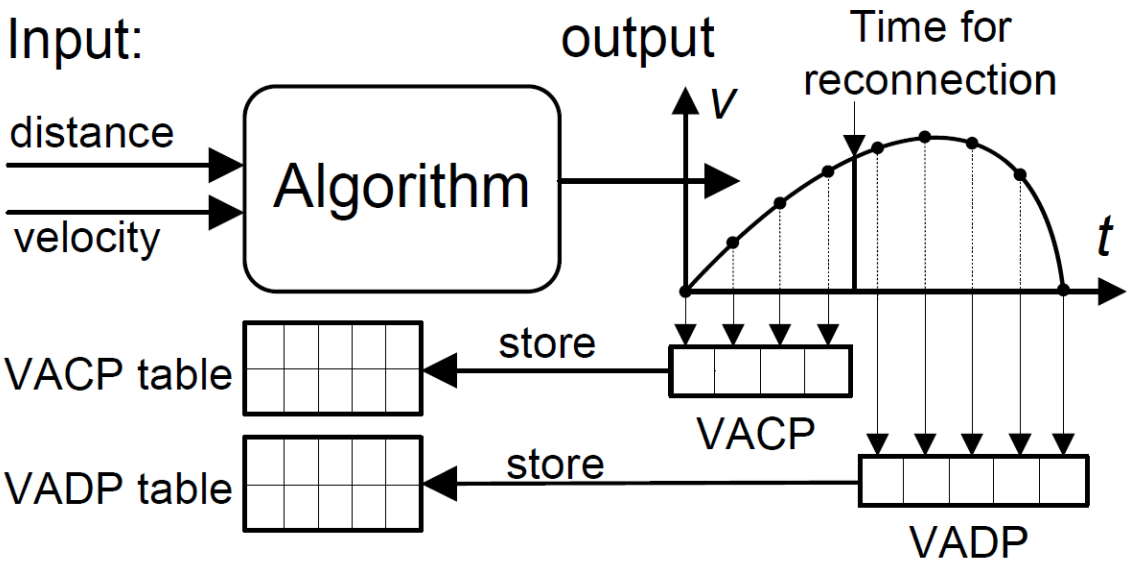
Then, study velocity profiles wrt distances and velocities:

- Initial velocity changes are similar due to deceleration/acceleration limits.
- Thus, store mainly two different velocity profiles considering different scenarios.



Changes of velocity wrt different distances

System Design
Overview



VACP: Vehicle ACcelerating Profile
VADP: Vehicle ADjusting Profile
v: velocity
t: time

Experiment

Simulation settings

1. One leader vehicle and thirty follower vehicles
   - ❑ Velocities are changed from 8m/s to 30m/s
   - ❑ The vehicular inter-mediate distance varies from 47.5m to 80m
   - ❑ Velocities are changed at every 0.1 second (if necessary)

2. 3 scenarios-
   - ❑ Platoon maintenance
   - ❑ Vehicle joining
   - ❑ Vehicle leaving

Compared methods

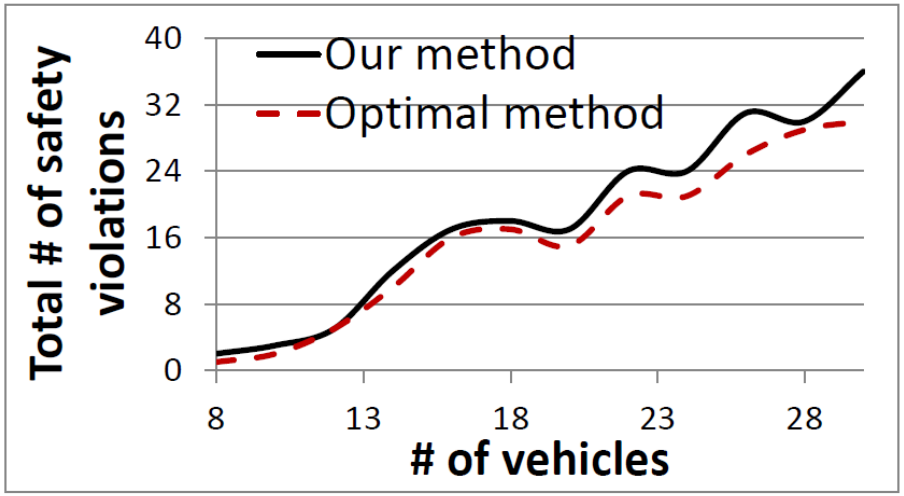
1. Kyongsu Yi and Young Do Kwon. 2001. Vehicle-to-vehicle distance and speed control using an electronic-vacuum booster. JSAE review 22, 4 (2001), 403–412

Experiment
Platoon maintenance

Metric: Safety violation (inter-vehicular distance< safety distance)

Observation: Safety violations of two methods are almost similar

Reason: The stored velocity profiles are very similar to the optimal velocity profile



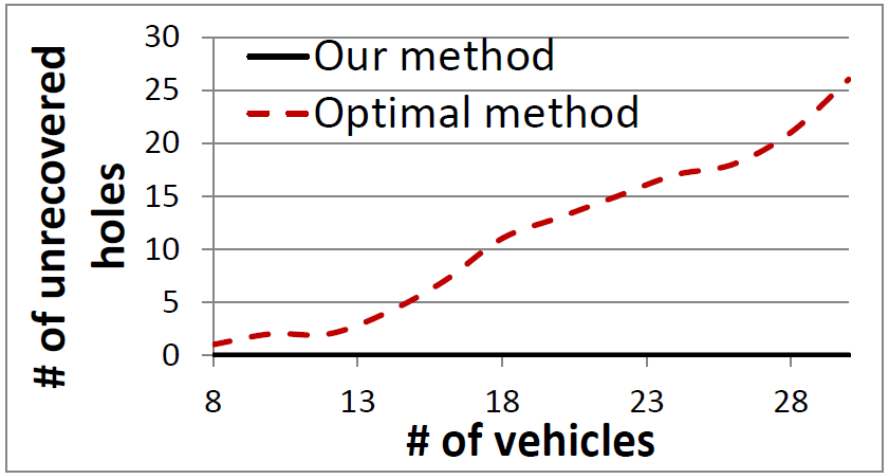
Safety violations

Experiment
Platoon maintenance

Metric: Recovering hole (distance information is unavailable)

Observation: Optimal method causes more unrecovered holes

Reason: Optimal method needs neighbor vehicles' information



Recovering hole

Conclusions

1. We proposed a decentralized platoon maintenance mechanism
2. We conducted velocity profiling study
3. We devised autonomous vehicular control strategy

Future work

1. Consider complex road structures
2. More practical experiments in different traffic conditions

Thank you!
Questions & Comments?

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