Impacts of Shared Autonomous Vehicles: Tradeoff between Parking Demand Reduction and Congestion Increase

シェアリング自動運転導入のインパクト：駐車需要削減と混雑増加のトレード・オフ

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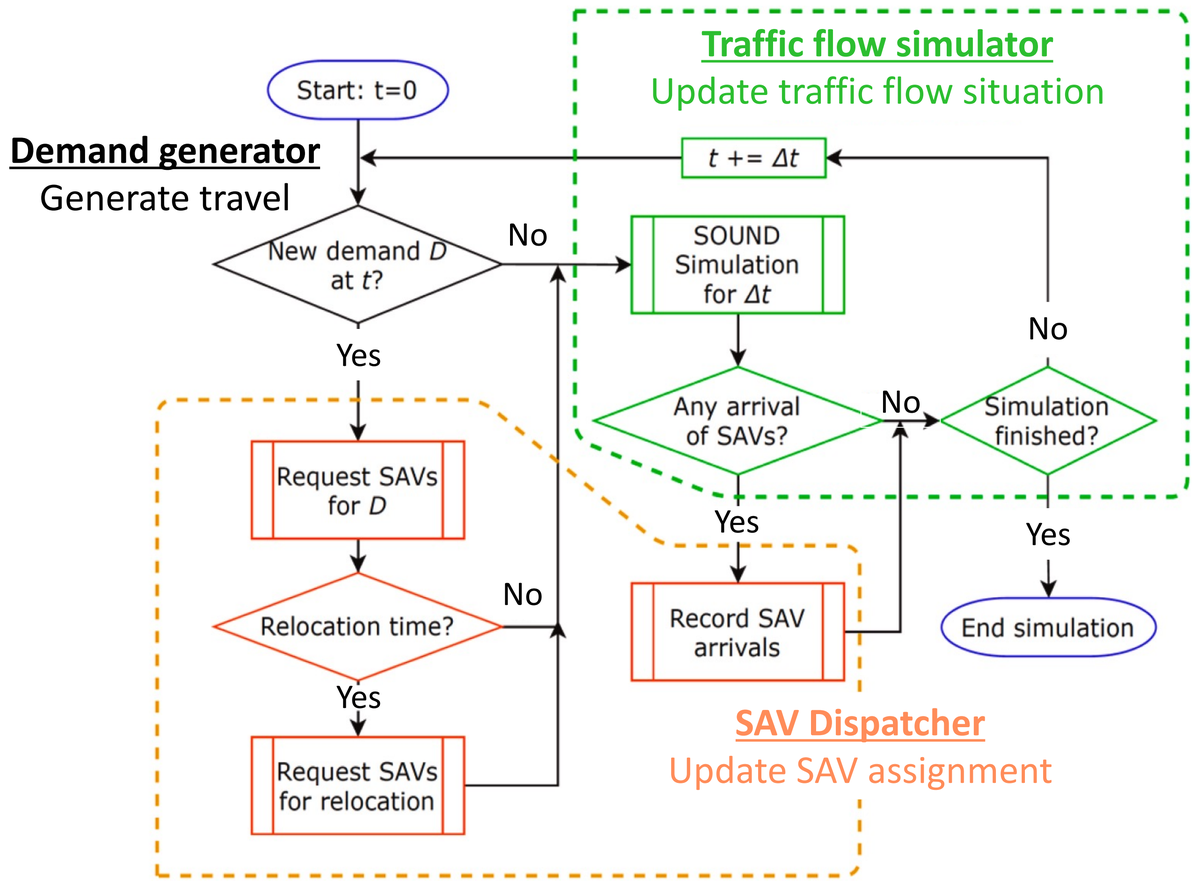
1. Background and Objective

- Shared autonomous vehicles (SAVs) have:
  - Pros: Reduce parking demand by replacing private vehicles;
  - Cons: Increase congestion by empty fleets.
- If all private vehicles are replaced by SAVs:
  - Which type of land use will reduce the parking demand the most?
  - In which part of the road network will the congestion increase the most?
- **Objective:** Estimate the impacts of SAVs at the local scale by simulating their operation.

2. Simulation Framework

- **Scenarios:** 1. SAV scenario with 100% SAVs & 2. Current situation with 100% private vehicles.
- **Simulation structure:**
  - Three main modules: Demand generator, SAV dispatcher & Traffic flow simulator.



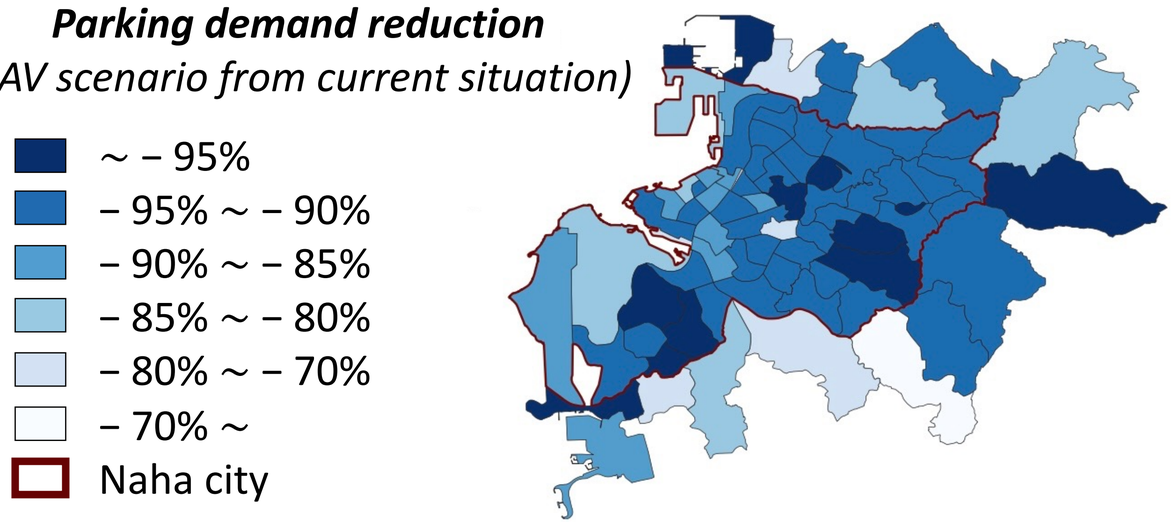
- **Note:**
  - Area is divided into zones according to land use;
  - Demand is generated based on real traffic data;
  - Parking demand is estimated using different methods for two scenarios.

Kumakoshi, Y., Hanabusa, H., & Oguchi, T. (2021). Impacts of shared autonomous vehicles: Tradeoff between parking demand reduction and congestion increase. Transportation Research Interdisciplinary Perspectives,12, 100482.

3. Case Study of Okinawa Mainland

- **Study area:** Naha City with surrounding zones
- **Reduction in parking demand:**
  - 94% reduction in total, periphery zones > core zones;
  - Office zones (−39%) > residence zones (−15%) > others.

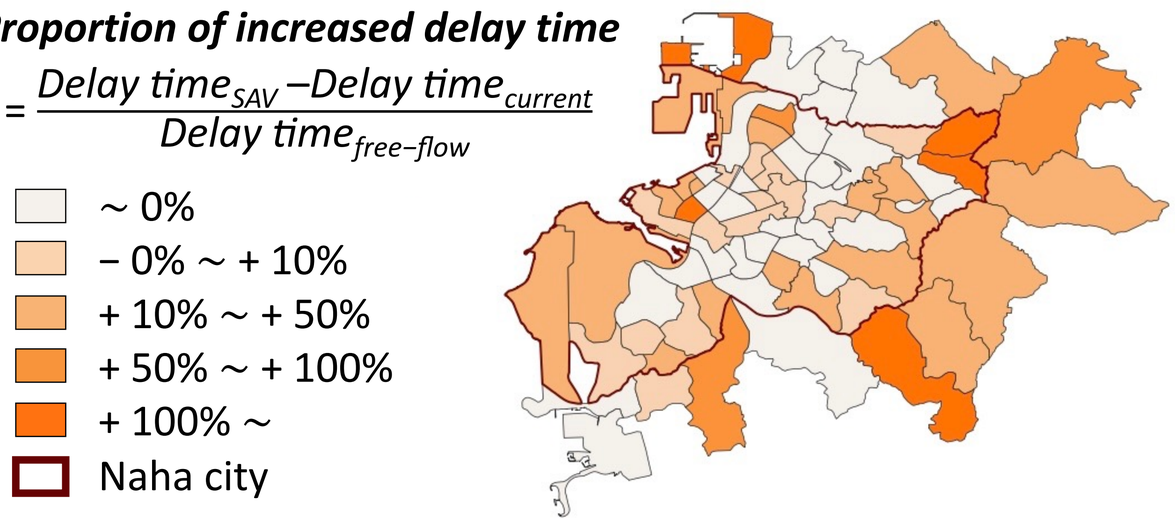
Parking demand reduction
(SAV scenario from current situation)



- **Congestion increase:**
  - Vehicle Kilometer Traveled (VKT) & delay time increased (+16% & +33%), average travel speed reduced(−9%);
  - For proportion of increased delay time: periphery zones > core zones.

Proportion of increased delay time

$$= \frac{Delay\ time_{SAV} - Delay\ time_{current}}{Delay\ time_{free-flow}}$$



4. Discussion & Conclusion

- Reasons for the parking demand reduction:
  - Smaller SAV fleet size;
  - Efficient movement of SAVs.
- Reasons for increased congestion:
  - The empty fleets and detour behavior of SAVs;
  - Differences in the traffic capacity of road network and the spatial density of SAV stations → heterogeneity between core and periphery areas.
- **Conclusion:**
  - SAVs reduce parking demand greatly in office & residence zones and increase traffic flow mostly in periphery areas;
  - Urban planners should **balance the pros & cons** from the two factors, otherwise **reorganize the traffic system** to totally remove detriments.