Smart Cities: Providing Mobility to All

A vehicle-pedestrian interaction environment

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What we can consider providing…

- **Need 1:**
  - Scheduled or on-demand access to mobility for the mobility impaired

- **Need 2:**
  - Safe, reliable transport of individuals in dense pedestrian areas
Background - Motivation

Intelligent Vehicles providing service in Shared Spaces

Safety and Efficiency
Background - Motivation

Vehicles in shared space

Normal size passenger car

Mobility Scooter

Golf cart
Background - Related Projects

Projects exploring intelligent vehicles in shared space

**Auro:** self-driving electric golf carts ferrying students on university campuses

**CityMobil2:** a pilot platform for automated road transportation systems

**LUTZ Pathfinder:** driverless pods providing service on public streets
The Smart Mobile Operation: OSU Transportation Hub (SMOOTH)

- Providing first-mile/last-mile transportation.
- Servicing primarily on campuses.
- Scheduling via multi-platform web-based applications.

SMOOTH architecture

Four-passenger golf cart

Electric wheelchair

Mobility scooter

Background - Related Projects
**Question:** Can we find a method to improve the **safety** and **efficiency** of intelligent vehicles surrounded by **pedestrians** in shared space?

**Answer:** Yes! By viewing pedestrians in a higher viewpoint. 

**By predicting pedestrians’ group behavior**

I would like to know all pedestrians’ next move

So that I can plan a best route to pass through
How does it work in automated vehicles?

- **Get information** of pedestrians and environment.  
  Information can be obtained from sensors, other vehicles, and infrastructure via communications.

- **Simulate** and predict the pedestrian behavior.  
  Different vehicle configurations can have different simulation results.

- **Send** simulated information to **local motion planning**.  
  Additional information can improve motion planning performance.
Modeling – Modified Social Force Model

Fundamental Interaction Mechanism:

**High-Level Control**
- Decision Making

**Motion Planner**
- Global Planning
- Local Planning

**Vehicle-Pedestrian Interaction Simulator**
- Modified Social Force Model
  - Between-Pedestrian Interaction
  - Vehicle-Pedestrian Interaction
  - Trajectory Prediction

Modified Social Force Model

  - Wide application in pedestrian behavior analysis of building design

Three Scenarios to evaluate this model

Inter-Pedestrian Interaction

Basic Vehicle-Pedestrian Interaction
- side
- back
- front

Advanced Vehicle-Pedestrian Interaction

Motion of pedestrians

Motion of vehicle
Simulation – Inter-Pedestrian Interaction

Inter-Pedestrian Interaction

Time = 5.94 s

Blue: slower pedestrian from right to left
Green: faster pedestrian from right to left
Gray: slower pedestrian from left to right
Scarlet: faster pedestrian from left to right

Download: https://drive.google.com/open?id=0B0L-zPpY7vhkc0pFbW5SSkJ5S0E
Recorded trajectories show lane formation
• The proposed simulation model can properly simulate vehicle-pedestrian interaction.
• Scenarios can be easily constructed and simulated.
• Various vehicle control and path planning algorithms can be tested.
• If necessary, characteristics of individual pedestrian can also be specified.

• Most importantly, this model has the potential of improving vehicle local motion planning algorithm in shared space, by providing societal pedestrian group behavior prediction.
Thank You! Questions are welcome!