Research Report Summary

SAFER-SIM University Transportation Center, 69A3551747131

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Shared Connectivity for Safer Shared Space Facilities

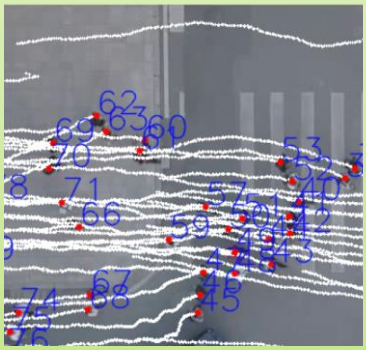
Improving mobility for non-motorized and vulnerable Road-Users

The proposal investigates the challenges of urbanization and studies the concept of "shared space [1]," a holistic redesign of the existing micro-mobility infrastructure. To understand non-motorized agents' mobility and safety, we focus our research on developing a framework that simulates shared space active mobility scenarios. This framework will aid in studying the performance of established MANETs in active traffic agents and engineer the formation of a stable and connected ad-hoc network for active urban mobility in shared space.

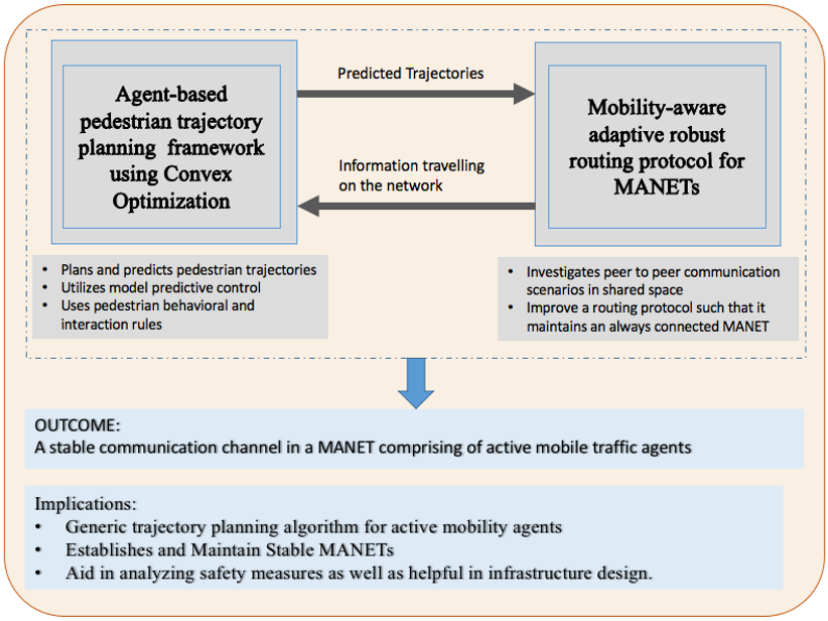
We have developed a trajectory planning algorithm based on convex optimization and utilizes pedestrian behavioral rules to imitate the realistic pedestrian movement in each scenario. The generated trajectories will aid in the development of a routing protocol that establishes and maintains a stable MANET for a dynamic network. Once stable network connectivity is achieved, the network will be capable enough for information dissemination between any nodes and at any time. Such a stable active agents' traffic network can be used in shared space traffic scenarios and emergencies such as evacuation and disaster and assisting the researchers and engineers from transportation agencies in conditions in urban transportation and assessing pedestrians' safety shared space.

Pedestrian dataset

Location for Data collection



Sample Extracted Trajectories

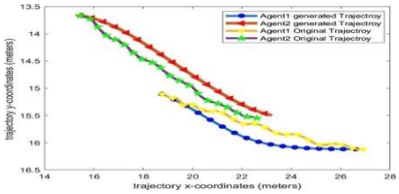


Our research focuses on developing a pedestrian trajectory planning algorithm for shared spaces scenarios based on pedestrian behavior during group, unidirectional, and fixed obstacle interactions. We developed the convex optimization-based trajectory planning model to simulate shared space scenarios and produce realistic trajectories for agents. Also, gait parameters [2] (step length and step frequency) were extracted from the Agent's speed profile, further validating the model's capability to generate high accuracy trajectories. The generated trajectories, which imitates agents' natural walking behavior, then aids in achieving the goal of establishing a stable MANET in shared space to enhance the connectivity among them.

We considered data from the paper [3], which was collected at the Dalian University of Technology (DUT) campus in China. The location includes an area of pedestrian crosswalks at an intersection without traffic signals. Pedestrians in the data are mainly college students. We have performed three case studies for the calibration and validation of the developed trajectory planning algorithm. The model generated trajectory gives very small values of root mean square error, mean Euclidian distance when compared with the ground truth. The values validate the efficiency of trajectory planning model.

We have performed a preliminary simulation study analyzing the shortlisted state-of-the-art MANET routing protocols [4] while inputting real pedestrian trajectories. Next, we will focus on improving an existing MANET routing protocol that enhances the communication between moving nodes.

This research addresses a mobility challenge that we are going to see in the coming future. Therefore, if there already exists a framework that can allow testing the scenarios of urban mobility, this gives traffic enforcement agencies an upper hand in handling the challenges and allows the government to have a holistic redesign of existing mobility infrastructure, which provides a better traffic safety.



Case study1: Two agents walking together

Case Study 1 Performance metrics average values

Performance metrics	Average values
MED_1	0.32
MED_2	0.24
FDE_1	0.54
FDE_2	0.45
rmse_xsep	0.36
rmse_ysep	0.007

The MED(Mean Euclidean Distance), FED(Final Displacement error), and rmse (root mean square error) are the performance metrics. The table shows the result for case study 1.

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Outcomes:

- A simulation platform for pedestrian behavior and interaction in shared spaces.
- The simulation considers the microscopic behavior through the modeling of the gait parameters, group behavior and obstacle avoidance.
- A stable connectivity network in MANET comprising of active mobile traffic agents and their walking behavior. The network will be used for data dissemination for safety events

Impacts

- The developed simulation will provide a means to understand the behavior of pedestrians under mixed traffic conditions.
- The developed framework aids in investigating urban mobility and peer to peer communication scenarios which will foster next generations shared transportation systems.
- A robust communication network will share information reliably to all the participating nodes in a network and therefore can be used to address challenging times of disaster evacuation, emergency evacuation.
- Better communication will help to maintain the safety of non-motorized traffic agents and micro-mobility agents against motorized traffic in shared space.

References

[1] B. Hamilton-Baillie, "Shared space: Reconciling people, places and traffic," Built environment, vol. 34, no. 2, pp. 161–181, 2008.

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[3] D. Yang, L. Li, K. Redmill, and U. Ozguner, "Top-view trajectories: A pedestrian dataset of vehicle-crowd interaction from controlled experiments and crowded cam- pus," in 2019 IEEE Intelligent Vehicles Symposium (IV). IEEE, 2019, pp. 899–904

[4] A. Moussaoui and A. Boukeream, "A survey of routing protocols based on link-stability in mobile ad hoc networks," Journal of Network and Computer Applications, vol. 47, pp. 1–10, 2015.

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