HyGenPed: A Hybrid Procedural Generation Approach in Pedestrian Trajectory Modeling in Arbitrary Crosswalk Area

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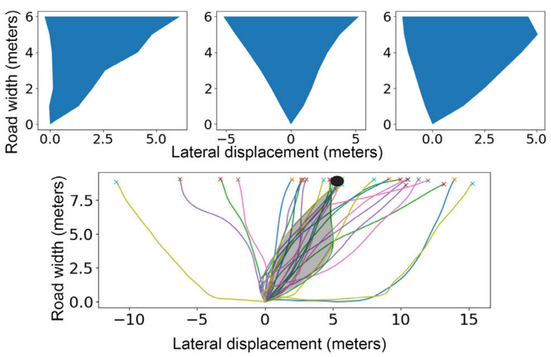
Abstract

A new method to create plausible pedestrian crossing trajectories that cover a given arbitrarily shaped crosswalk area for simulation-based testing of autonomous vehicles. This method addresses the crossing area coverage problem where the trajectories produced by the generative methods do not cover the entire area that pedestrians may possibly walk on. The actual area covered by pedestrians often differs from marked crosswalks on the road. Furthermore, in the case of jaywalking, the area can take a variety of shapes based on the road structure and surrounding places of interest. We demonstrate that the method can generate trajectories that cover a wide range of crossing areas, including ones from the InD dataset.



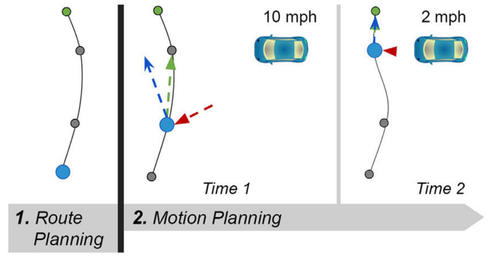
Main Contributions

- A hybrid pedestrian trajectory modeling approach that facilitates route planning and motion planning in isolation.
- A route planner that solves spatial coverage problems of the pedestrian.
- A set of control parameters to guide the generation of pedestrian trajectories.

Methodology

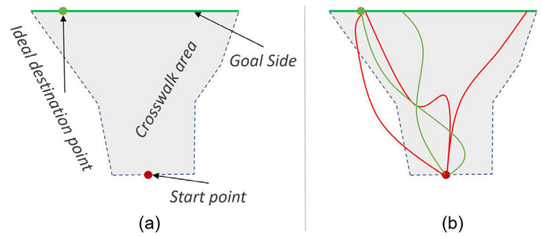
Two phase simulation

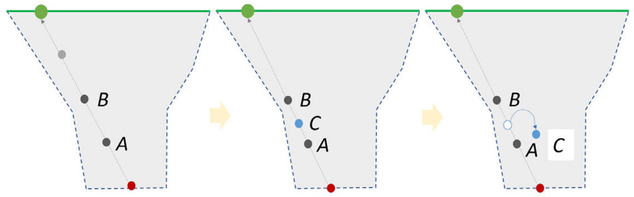
First, the route planner creates a set of waypoints for high-level navigation. Second, force-based maneuver models define the trajectory in the motion planning phase.



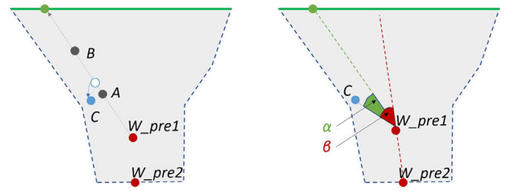
Route Planning

The route planner takes a crosswalk or trajectory envelope as a polygon, a start point, a goal side, the number of waypoints between the start and goal side, and, optionally, the destination point on the goal side as the inputs.





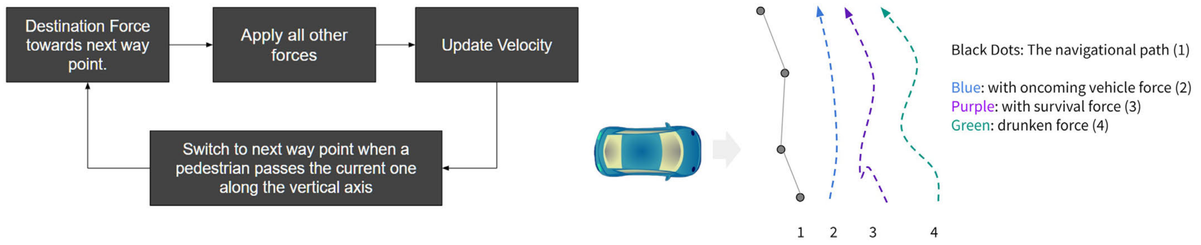
First intermediate point generation



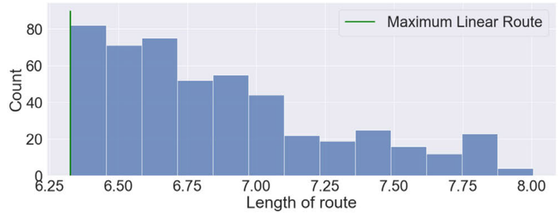
Angular shift constraints

Motion Planning

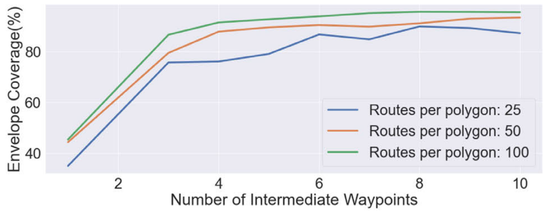
During the simulation, we drive the pedestrian towards the next waypoint with Helbing's destination force. In addition, we use three maneuver models from our motion planning research to interact with the on-coming vehicle: (a) the on-coming vehicle force model, (b) the survival model, (c) the drunken model



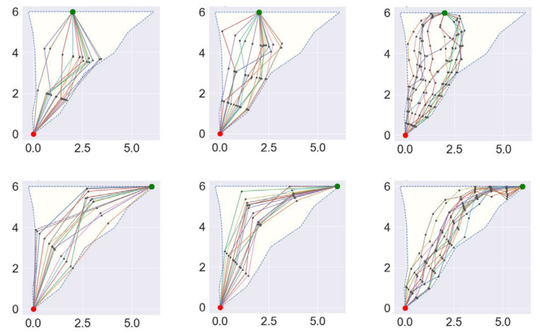
Results



Fixed start and destination points on a 6-meter wide road.



Spatial Coverage of the Crossing Area



Shape of the Routes

Future Work and Conclusions

Statistical modeling can learn the design parameters of the route planner.

With route planning and motion planning isolated from each other, it is possible to improve the expressiveness of the generative models as one can incorporate different models for each part.

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