Optimization of crosswalk locations in urban street network

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What is a crosswalk?
• Crosswalk: a pedestrian facility for crossing the vehicular lane.
• Position: could be either within or out of the intersection.
• Signal: Signalizing the crosswalk is for both safety and efficiency.

Motivations
• Current Situation:
  • Related design manuals suggest the crosswalk position considering only safety while ignoring the impact to the network efficiency.
  • Previous studies commonly ignore crosswalk alternatives. Even with consideration, the network-level evaluation have not been done.
• Objectives:
  • To formulate a model to optimize crossing facilities design in networks from the operational efficiency.
  • To propose an integrated approach of crosswalk design considering stochastic choice of pedestrians.

Basic problem modeling
• From the point of efficiency, the target is to minimize the delay of both vehicle users and pedestrians.

\[
\min \left( \alpha \times \beta \times (D_v + T_v) + y \times (D_p + T_p) \right)
\]

• Using both deterministic and heuristic algorithm, we obtained system optimum of routes, crosswalk positions, signals and pedestrian volumes of crosswalks.

Combine with pedestrians’ behaviors
• Pedestrians choose the path with perspective cost but not the full information. The choice behaviors are considered following 3-step integrate approach.

Ⅰ: Network Configuration
Ⅱ: Path Set Generation
Ⅲ: Network Optimization

• Due to a better performance, here use genetic algorithm only.
• Pedestrian volumes can influence the network performance much more significantly than the case of basic problem modeling (social optimum) before.

Result: Cost function (Total monetary delay)

Conclusions
• The study answer the core question that how to set crosswalk considering efficiency.

• Contributions:
  • The formula optimize the crosswalk existence, quantity, location and signal settings in urban street network.
  • On the top of system optimum condition, the cases of pedestrian routing behaviors are discussed.
  • Both deterministic and heuristic methods are utilized in optimization. It promise to achieve optimum with reasonable computational time.

• Future Directions:
  • Considering pedestrian space restriction and congestion effect.
  • Consideration of two-stage pedestrian crosswalks
  • Incorporation of signal coordination
  • A comprehensive study on how to locate pedestrian origins and destinations in networks

Basic problem modeling

Pedestrian network are present by graph

Find loop-less and reasonable path.