GUI: GPS-Less Traffic Congestion Avoidance in Urban Area with Inter-Vehicular Communication

Zhen Jiang, Jie Wu, Paul Sabatino
CIS Dept., Temple University
CS Dept., West Chester University
Information Security Center, West Chester University

Presenter: Zhen Jiang
E-mail: zhen.jiang@temple.edu or zjiang@wcupa.edu
Outline

- Target Problem
- Challenges
- Our Approach
- Experimental Results
- Conclusion
Target Problem

- Turn problem
Challenges

- Mass congestion in urban area
GPS?

- A short range focus
  - in order to clearly see the lane and the turn
- Cannot have a seamless shift in navigation service
  - Signal is interfered by buildings and other factors
- Inaccurate turn will lead to more severe results

? Left or Right

Blind point of GPS
Accurate turn navigation with the prediction using the information at the global view level becomes very critical!
Our approach

- Form and distribute the information with V2V communication (to enhance the efficiency of prediction)
  - Free of traffic
  - Collaboration to identify blocked street
  - Distribute information in opposite direction to alert incoming vehicles
Our contribution

- The information is not simply the location of the congestion.
- It is a snapshot at the global view level
  - Mutual impact of all congestions, i.e., delay chain problem.
  - Subject to any dynamic change in traffic
    - Both target congestion and information delivery
  - Normalized as an index, for vehicle easy to carry and calculate in the presence of dynamics
  - Such normalization is difficult because the block impact can be different when the relative positions of the source and the destination change!
Information Collection

- The congestion identified among neighboring vehicles [7]
- Identification of the block of congested segment
- Calculation of mutual impact of blocks
• Mutual impact of blocks
• Mutual impact of blocks
  ◦ Delay chain and relative effect
  ◦ Blocked in the direction to the destination whenever no congestion-free path exists.
  ◦ *MCC block region – Type I – an intersection is inside block region if and only if both east and north direction are blocked (by adjacent congested segment or blocked intersection)
    ◦ Heuristic search of congestion-free path in the reversed direction, by our block information constitution
    ◦ In the proactive manner
    ◦ Total four types, sufficient enough for guiding the vehicle in any possible direction
Solution for information collection

- The congestion can be identified among neighboring vehicles, by the collaboration with V2V communication in [7].
- Identification of the block of congested segment at the “end node” [16] when the information can be propagated via V2V communication (or carried by vehicle) in the opposite direction.
- “End node” will receive information from both directions at the intersection, and then determine whether this intersection is inside the (MCC) block region.
· Navigation solution
  ◦ Follow the GPS guidance when the vehicle is out of any block region.
  ◦ To avoid entering the block region along the boundary, perimeter routing until it is safe to approach the destination in the congestion-free path.
  ◦ Escape from a congestion region.
• Solution (of type 1)
• Extension
  ◦ 2 directions => multiple directions
    ◦ Sufficiency of our approach
  ◦ Size of block
  ◦ Mobility and disconnections

![Diagram](image-url)

- **Location (lagged information)** (a)
- **Succeeding end node** (b)
- **Previous location of end node** (c)
- **Succeeding end node** (d)

- **Direct Comm.**
- **Incorrect Info.**
- **Driving Direction**
- **Direct Transfer of Role**
- **Lagged Location Info.**
- **Indirect Role Transfer**
Experimental Results

- Map of New York City, Manhattan, OpenStreetMap [17]
- Central Park to Madison Square Park
- Daily traffic with different volume (10 to 120% of the average)
- Trace Data generated by SUMO [8]
- Average speed (~10 min to pass through, with +/- 25%)
- Random congested segment (1 to 40%)
- V2V communication
Probability of encountering congestion

GPS

GUI
Existing proactive solution with the consideration of dwell time (under ideal mode)
Summary (of experimental results)

- Block region is an accurate estimation of mutual impact of congestions.
- Up to 35% reduction is achieved with our block information, compared with the best proactive solution in existing work.
- GPS navigation in urban area may frequently encounter the live-lock and delay chain problem. The vehicle requires to take double time to reach the destination, compared with the performance of GUI.
Conclusion

- Precise information collection/distribution with a fully distributed manner
- Dynamic adjustment
- Retrieving a global view of possible congestion-free path with a simple index
- Optimistic manner adopted, reducing the overhead cost
- Study of the mutual impact of congestions
- Quick way for the vehicle to pass urban canyons.
Thank you!

- Questions and Comments