Vehicle Positioning on the Roads

Relevant Traffic Tracking

- **Problem:** How to track the relative positions and directions of other vehicles?
- **Solution:** Navigation module is responsible to:
  - Processing the output from a Garmin GPS device using the Garmin Simple Text Output Protocol (GSTOP).
  - Smoothing the GPS readings by filling the missing readings and removing the outliers.
  - Match the GPS values to a reference point on a road.

GSTOP Line Example

Example of a GSTOP character line: start of GPS reading line: 0, date(YY/MM/DD): 03/12/22, time(hh:mm:ss): 18:12:26, location: 40 degrees and 31.717 minutes North and 74 degrees and 28.034 minutes West; reading obtained using 3D GPS position method, horizontal position error: 14m, altitude above the sea level: 43m, velocities: 12.3 m/s Eastward; 3.1 m/s Northward; and 0.01 m/s Upward.

Road Representation & Identification

- **Problem:** How to represent roads information and identify them efficiently?
- **Solution:** Using a digital road map from publicly available database (e.g.: TIGER/Line® from U.S. Census Bureau).
  - The map is constructed by RT1 files (road end points) and RT2 files (road inner points), see figure.
  - To increase location precision, each Tiger Line road segment is divided in sub-segments creating equally distant reference points on it such that any of the segments that form a road have length less than a predetermined value $d$.
  - The Peano keys corresponding to roads reference points are sorted in lexicographic order.
  - To identify road:
    - Identify closest reference points to GPS location by searching Peano keys.
    - Maintain short history of identified roads
    - Either match GPS movement segment with closest road (angle less than 15 degrees) or use a smoothing video technique to identify the road.

Prototype Evaluation

**Evaluation Experiment**

- We used eight vehicles to move in a row with an average distance between each consecutive cars of 200m.
- The GPS traces are collected by driving vehicles on highway road of 10939m length with an average speed of about 15m/s by recording time, latitude, longitude, and speed.
- We fed these traces, as movement patterns for eight vehicles, to the TrafficView prototype.

Simulation Results

**Simulation Environment**

- Ns-2 simulations (15,000 meter long road with 4 lanes, 802.11b with 11Mb transmission rate, 250m wireless transmission range)
- Scenario Generator:
  - Parameters: simulation time, road length, average speed, # of lanes, average gap.
  - Traffic model: entries/exits evenly distributed, speed changes, changes lanes, vehicle density

**Metrics**

- **Visibility**
  - Average distance ahead about which a vehicle has information
- **Accuracy**
  - Average position error introduced due to aggregation
- **Knowledge Percentage**
  - Average percentage of vehicles in each region ahead about which a vehicle has information

**Effect of Road Parameters**

- **On Visibility (1)**
  - Ratio-Based Aggregation
  - Cost-Based Aggregation
- **On Visibility (2)**
  - Non-aggregation
  - Brute-force Cost-based

**Knowledge Percentage**

- High-density Highway
- Non-aggregation
- Brute-force Cost-based

**Metrics**

- **Visibility**
  - Average distance ahead about which a vehicle has information
- **Accuracy**
  - High-density Highway
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**Scenario**

- Traffic View Prototype Evaluation

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