Using Mobile Phones to Track Multimodal Travel Behavior: Lessons Learned

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Problem

- Past vehicle-based GPS tracking give low-resolution view of daily travel behavior
- Are these GPS fixes:
  - Points-of-interest?
  - Stops in traffic?
- Difficult to extract info:
  - Distance traveled
  - Origin-Destination pairs
- Misses non-vehicle trips
Innovation

• USF's TRAC - IT can capture "high-definition" view of travel behavior

• Much easier to determine:
  – Path, distance traveled
  – Origin-Destination pairs
  – Avg. speeds

• Can capture transit/bike/walk trips
New Problem

• We can record GPS fixes as frequently as once per second and send to our server
• However, frequent GPS fixes come at great cost to:
  – battery energy
  – data transfer over network
• Both battery life and cell network data transfer are very limited resources
Impact of GPS on Battery Life

One-day Requirement

Battery Life (hours)

Sanyo Pro 200

HTC Hero
(Android 2.1)

4 sec. sampling interval
Let’s decrease the GPS recalculation rate when stationary!
What is “Stationary”? Detecting User Movement

4 second GPS sampling

Moving

Stopped

5 minute GPS sampling

• GPS noise causes uncertainty in states
• Many false transitions waste battery energy
Auto-Sleep to Reduce Energy Consumption

Dynamically change the GPS sampling interval on the phone
**Evaluation – Summary of 30 tests**

<table>
<thead>
<tr>
<th></th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>50th</th>
<th>68th</th>
<th>95th</th>
<th>STD DEV</th>
</tr>
</thead>
<tbody>
<tr>
<td>State Error Percentage</td>
<td>0.51%</td>
<td>29.10%</td>
<td>11.60%</td>
<td>10.54%</td>
<td>15.67%</td>
<td>23.97%</td>
<td>7.37%</td>
</tr>
</tbody>
</table>

- Approx. 88% mean accuracy in state tracking
- Avg. doubling of battery life (based on TRAC-IT tests)
Using TRAC-IT to Assess Variable Pricing Impacts on Carshare User Behavior
Case Study - Carsharing

Summary

• Provided flip-phones for test and control subjects
• Carried phone for all trips (passive data collection)
• Varied hourly price in peak to shift time of rentals
• Provided daily summary and map of trips via email
• Collected data for two 3-week data collection periods; data instantly transmitted to us

Results

<table>
<thead>
<tr>
<th>User Type</th>
<th>Trip Length (miles)</th>
<th>SDE (square miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Carsharing Trip</td>
</tr>
<tr>
<td>Carsharing</td>
<td>2.6</td>
<td>8.0</td>
</tr>
<tr>
<td>Non-Carsharing</td>
<td>4.2</td>
<td>---</td>
</tr>
</tbody>
</table>
Lessons Learned

Pluses

• Providing phone with data only capabilities rather than software reduced need to test on multiple platforms and provided additional privacy protection
• Continuous tracking while moving without running out of battery energy
• Passive collection with free-text self-validation worked well with extended period of data collection
• Phone instantly provides data to identify problems quickly
• Virtually limitless length of field deployment

Minuses

• Need to carry a second phone/charger
• Providing cell phones and data plans
• More work needed to differentiate “points of interest” from stuck in traffic when passively collecting data
  – A current research focus
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