TrafficSense – Energy efficient traffic with crowdsensing

Aalto University

- SCI: Heikki Saikkonen, Seppo Törmä, Esko Nuutila, Mikko Rinne, Jani-Pekka Jokinen, Kimmo Karhu, Mikko Heiskala
- ENG: Tapio Luttinen, Iisakki Kosonen
- HIIT: Jaakko Hollmén, Indre Žliobaite
- BIZ: Markku Tinnilä
Transportation Environment

Old structures
- Timetabled traffic
- Separate payment systems
- Few real time information services

New structures and models
- Demand responsive public transportation
- Mobile ordering
- Smart traffic control
- Real-time traffic information
- Route planners
- Payment systems
- Shared taxis
- Public transportation

Profiling - segmentation
- Consumer behaviour & motivations
Mobile devices

- Sense travel related information
  - location
  - acceleration
  - activity type (still, on foot, in vehicle, ...)
  - entry and exit to specific areas (geofences)
- Covers whole door-to-door travel chains
- Communicate with the services in the Internet
- Sensing is becoming practical due to its improving energy efficiency

Information sources

- Maps and road network models
- Route planners
- Road segment velocities
- Traffic incident reporting
- Schedule deviations of busses
- Parking lot availability
- Ridesharing systems
- Weather reports
TrafficSense project

Opportunities

- Mobile devices
- Information sources
- Transportation environment

Research topics

- Gather real-time traffic information
- Data fusion to understand traffic situation
- Enable more energy efficient travel services
- Learn regular routes of users
- Make short term traffic predictions
- Advice users of more energy efficient travel options

Goal

Improve the energy efficiency of traffic
TrafficSense service functionalities

1. Learn regular routes from trip observations
2. Predict current routes
3. Data fusion to predict the traffic situation
4. Generate alternative travel chains
5. Advice users about problems and options down the road

- Better route
- Better travel time
- Better bus connection
- Ridesharing
- Park & ride
- DRT (Kutsuplus)
- Congestion
- Accident
- Full parking lot
- Delayed bus

- Background application in a mobile device (sensing, guidance and notifications)
- Benefits the user with advices based on real-time traffic data
- Completely voluntary to use – must provide value to users
- Privacy issues addressed by a combination of local processing and anonymous sharing
Energy saving potential

Total energy consumption

195 kWh/person/day
- MacKay, 2008

1. Sharing: Switching from private to public transportation
   - About 50% of car traffic is private cars
   - Public transportation consumes ≤ 20% energy/passenger-km
   - For each weekday when public transportation is used instead of a private car, the saving in traffic energy is (50%/7)*80% ≅ 5%

2. Shortening: Achieving shorter travel times
   - More accurate information leads to shorter travel times through better routes, less congestion, and traffic system optimization
   - Travel time correlates with energy consumption
   - So, per each 5% reduction in time the saving in traffic energy ≅ 5%
Energy saving potential at Helsinki Region

• A realistic estimate should not require
  – a radical behavioral change from people
  – a dramatic penetration of the service

• A proposal
  – Change 2/7 weekdays from private cars to public transportation
  – Achieve 5% reduction in total travel times
  – Achieve 2% penetration of the service

• Figures at Helsinki Region (population 1 million):

<table>
<thead>
<tr>
<th></th>
<th>Reduction of traffic energy</th>
<th>Reduction of total energy</th>
<th>Yearly savings/2% (20000 persons)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>per user</td>
<td>per user</td>
<td>GWh</td>
</tr>
<tr>
<td>1. Sharing (2/7)</td>
<td>10%</td>
<td>2%</td>
<td>28</td>
</tr>
<tr>
<td>2. Shortening (5%)</td>
<td>5%</td>
<td>1%</td>
<td>14</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15%</strong></td>
<td><strong>3%</strong></td>
<td><strong>42</strong></td>
</tr>
</tbody>
</table>

\[\text{Reduction of traffic energy per user} = 10\%\]

\[\text{Reduction of total energy per user} = 2\%\]

\[\text{Yearly savings/2% (20000 persons)} = \text{M}\]$
Summary

• There has recently been impressive developments in
  – Mobile sensing technology
  – Traffic-related information services
  – Transportation solutions

• TrafficSense studies how the energy efficiency of traffic can be improved by utilizing these new opportunities:
  – Sense, learn and predict multimodal routes of users
  – Advice users on better routes, travel modes, and travel times

• Such solutions can have a significant impact on the energy efficiency of traffic through
  – Increased use of shared vehicles
  – Reduced travel times