Optimizing Hybrid Vehicles via Route Prediction

jon froehlich & john krumm
HCI Intern Talk
July 26th, 2007
U.S. gas prices

USD/Gallon (including tax)

Date


$3.40

http://www.eia.doe.gov/emeu/international/gas1.html
global gas prices

http://www.eia.doe.gov/emeu/international/gas1.html
CO₂ emissions (2003)

<table>
<thead>
<tr>
<th>Country</th>
<th>Emissions (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>21.20%</td>
</tr>
<tr>
<td>China</td>
<td>15.20%</td>
</tr>
<tr>
<td>European Union</td>
<td>13.70%</td>
</tr>
<tr>
<td>Russia</td>
<td>5.40%</td>
</tr>
<tr>
<td>India</td>
<td>4.60%</td>
</tr>
<tr>
<td>Japan</td>
<td>4.50%</td>
</tr>
<tr>
<td>Germany</td>
<td>2.90%</td>
</tr>
<tr>
<td>Canada</td>
<td>2.10%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>2.00%</td>
</tr>
<tr>
<td>South Korea</td>
<td>1.70%</td>
</tr>
<tr>
<td>Italy</td>
<td>1.60%</td>
</tr>
</tbody>
</table>

2003 United Nations Statistics Division
http://www.un.org/
U.S. oil demand by sector

- Transportation
- Industrial
- Residential and commercial
- Electric utilities

U.S. Department of Transportation, 2005
why hybrids?

![Fuel Economy](image1)

![Emissions Comparison](image2)

![Acceleration (0–60 mph)](image3)

![Handling (Slalom)](image4)

http://www.fueleconomy.gov/feg/tech/TechSnapPrius1_5_01b.pdf
how hybrids work

**Series**
- Combustion Engine
- Generator
- Reduction Gear
- Drive Wheels

**Parallel**
- Combustion Engine
- Motor/Generator
- Transmission
- Reduction Gear
- Drive Wheels
at low speeds

highway cruising

heavy acceleration

engine idling

regenerative braking

what if we could predict a driver’s route?

- road grade
- road curvature
- traffic conditions
HEV Charge/Discharge Control System Based on Navigation Information

Convergence Transportation Electronics Association 2004
Nissan Motor Company

road grade

traffic conditions
Predestination: Inferring Destinations from Partial Trajectories

Ubiquitous Computing 2006
John Krumm and Eric Horvitz

Trip starts, uniform destination probability

4 squares south, half of region eliminated

More squares in trip, ¾ of region eliminated
msmls dataset

UbiComp 2006
- 189 subjects
- 1,351,669 points
- 73,903 miles
- 9414 trips

As of today
- 251 subjects
- 2,131,440 data points
predestination for routes?
gps massaging
route segmentation
route comparison
route periodicity (recurrence)
route prediction
GPS can be noisy

Breaking the sound barrier (and all other sorts of physical feats) on the way to work
Yes, people *do* drive the exact same routes over and over again. And they often have a temporal pattern: 8 of the 9 trips along this route occurred between 8:00 & 9:30AM.
route profiles
evaluation

stage 1

Mine the MSMLS dataset
Check our route prediction algorithm
Check our deceleration prediction algorithms

stage 2

Create (or purchase) hybrid simulator
Dynamically shift power train policies
Compare with baseline
Evaluate based on better electrical motor utilization, state of charge, and fuel economy
contributions

Automatic route prediction

Predicting speed, acceleration (and deceleration), and elevation along route

Studying effect of route prediction and dynamic power train policies through simulation
questions?
comments?
other ideas?