Application of intelligent speed adaptation for connected vehicles

Martin Gregurić, Sadko Mandžuka, Edouard Ivanjko
University of Zagreb, Faculty of Transport and Traffic Sciences, Intelligent Transport Systems Department
www.fpz.unizg.hr, http://its.fpz.hr
martin.greguric@fpz.hr; sadko.mandzuka@fpz.hr; edouard.ivanjko@fpz.hr

Introduction to Variable Speed Limit Control

• Variable speed limit control (VSLC) presents an efficient way to increase the Level of Service (LoS) and safety of urban motorways

• Main impact of VSLC on traffic flow
  • Reduction of the mean speed under critical densities ("shock-wave suppression")
  • Homogenization of vehicle speeds, i.e. reduction of speed differences among vehicles and mean speed on motorway
  • Increased safety on motorway

Intelligent Speed Adaptation (ISA)

ISA system monitors the location and speed of the vehicle, compares it to a defined set speed, and takes corrective action such as advising the driver and/or governing the top speed of the vehicle.

VSLC infrastructure-to-vehicle communication

Future work on this topic
– ISA penetration rate in the future will be tested on the microscopic level, also
– Development of a cooperative VSLC algorithm which will incorporate other supportive motorway control methods
– Development of a VSLC algorithm with learning capabilities
– Real connected vehicle approach testing

Modeling of ISA in macro-simulation ACTM model
• VSLC is implemented through modification of the cell mean speed equation

\[ v_i^f = \min(\mu v_{iSLC}^f, v_{iSLC}^f + \Delta v_i^f), v_{iSLC}^f, v_{iSLC}^f + \Delta v_i^f) \]

• Penetration coefficient

\[ \mu = \frac{1}{n} \sum_{i=0}^{n} v_{SLC}^f \]

• Coefficient is added to the parameter \( v_{iSLC}^f \)

\[ v_i^f = \min(v_{iSLC}^f + \mu v_{iSLC}^f, v_{iSLC}^f, v_{iSLC}^f) \]

Estimation of ISA penetration rate impact on actual speed

Zagreb bypass use case model
Simulation model is based on Zagreb bypass (section Lučko-Jankomir)
– Realistic traffic demand based on a working day traffic demand change characteristic

ACTM model of Zagreb bypass

Simulation results (neutral prognosis)
• Different ISA penetration rates (PR) applied on three different traffic scenarios

<table>
<thead>
<tr>
<th>Traffic</th>
<th>0</th>
<th>25</th>
<th>50</th>
<th>75</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>4.53</td>
<td>5.26</td>
<td>5.56</td>
<td>5.64</td>
<td>5.68</td>
</tr>
<tr>
<td>Medium</td>
<td>5.87</td>
<td>6.31</td>
<td>6.42</td>
<td>6.45</td>
<td>6.49</td>
</tr>
<tr>
<td>High</td>
<td>14.14</td>
<td>14.51</td>
<td>14.89</td>
<td>15.03</td>
<td>15.06</td>
</tr>
</tbody>
</table>

Table 1 Average speeds in case of various ISA penetration rates

Conclusion
• In macro-simulation environment greatest difference between 0 % and 25 % of ISA PR
• Increase of ISA PR improves overall results
• Simulated ISA prevented complete traffic standstill during congestion

Literature
