Monitoring of the longitudinal profile on road networks with the use of probe vehicles

Speaker : Philippe Lepert
Author : Fabien Menant

• IFSTTAR (France)
• Researchers - Laboratory for Modelling, Experimentation and Survey of Transport Infrastructures
• fabien.menant@ifsttar.fr
Context

- In France, one of the main challenge is to maintain the road network more than to expand it.

Distribution New works / Maintenance works

- Motorways: 12,500 km
- Main roads: 10,000 km
- Rural roads: 380,000 km

Source FNTP 2013

- An appropriate maintenance program requires a carefully monitoring of the network.
- In France, the pavement monitoring is provided by specialized vehicles equipped with high-level instruments...
• …. but this method is less and less compatible with the needs of road managers (especially for rural roads) who are facing to budget cuts
Technological proposition

• Using probe vehicles as:
  - a first level of intervention for the monitoring of main roads

1. Pavement monitoring with probe vehicles

<table>
<thead>
<tr>
<th>Location marker</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
</tr>
<tr>
<td>20</td>
</tr>
</tbody>
</table>

First quarter of 2014

Second quarter of 2014

Third quarter of 2014

Fourth quarter of 2014

Detection of road significant irregularities

Temporal and spatial optimization

2. Intervention of a specialized vehicle

12
14
Technological proposition

- Using probe vehicles as:
  - a first level of intervention for the monitoring of main roads
  - a solution in itself for the monitoring of rural roads

![Diagram showing cost and accuracy vs. geographic coverage and frequency of surveys]
Research approach

• Target application: monitoring the road longitudinal profile

• Main goal: studying the feasibility of such a method:
  - What kind of defects can we detect and measure?
  - What are the kind of sensors we need?
  - What is the level of accuracy?
  - What is the level of reliability / robustness?
Using embedded low-cost sensors is an imperative.

Instrumentation and sensors assessment

Solution n°1
- Sensor = Smartphone
- Level of defect detection
- Band 1: λ = 50m
- Band 2: 11m
- Band 3: 3m
- λ = 0.7m

Assessment in laboratory + on road

Solution n°2
- Sensor = External accelerometer + GPS
- Level of defect detection
- Band 1: λ = 50m
- Band 2: 11m
- Band 3: 3m
- λ = 0.7m
Data processing

• Final goal: computing a road profile indicator since the data provided by all probe vehicles

• Data fusion is required in order to calculate the final score while taking account of the measurement uncertainties

---

**Accelrometer response**

- **Measure**
- **Real response**
- **Exact response**

---

**GPS error**

- **x**
- **y**

---

**Mechanical response of each probe vehicle**

- Veh. A
- Veh. B
- Veh. C

+ speed deviation effect
+ wheel path error
Evaluation of the level of accuracy

- Probe vehicles vs. referency on an itinerary-test (8 km)

<table>
<thead>
<tr>
<th>Band 1</th>
<th>Band 2</th>
<th>Band 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of road sections:</td>
<td>% of road sections:</td>
<td>% of road sections:</td>
</tr>
<tr>
<td>score difference ≤ 1 pt</td>
<td>score difference ≤ 1 pt</td>
<td>score difference ≤ 1 pt</td>
</tr>
<tr>
<td>95 %</td>
<td>85 %</td>
<td>76 %</td>
</tr>
<tr>
<td>1 pt &lt; score diff. ≤ 2 pt</td>
<td>1 pt &lt; score diff. ≤ 2 pt</td>
<td>1 pt &lt; score diff. ≤ 2 pt</td>
</tr>
<tr>
<td>5 %</td>
<td>11 %</td>
<td>18 %</td>
</tr>
<tr>
<td>score diff. &gt; 2 pt</td>
<td>score diff. &gt; 2 pt</td>
<td>score diff. &gt; 2 pt</td>
</tr>
<tr>
<td>0 %</td>
<td>4 %</td>
<td>6 %</td>
</tr>
</tbody>
</table>
Deployment on a test road network

- Development of a demonstrator named MIRANDA
Deployment on a test road network

• Application of MIRANDA in real condition

*Monitoring of a 1000 km long road network*

*Data collected during 2 months*

*10 probe vehicles*
Conclusion

• Probe vehicles advantages for pavement monitoring:
  ✓ Frequent surveys
  ✓ Data collected on the entire road network (including rural roads)
  ✓ Economical method

• Development:
  ✓ Development of an instrumentation for data acquisition and transmission
  ✓ Development of several algorithms (map-matching, data fusion, etc.)
  ✓ Database (automatic updating, multiple criteria queries, ….)

• Tests:
  ✓ Feasibility, level of accuracy (road experiments)

• Outlooks:
  ✓ Making operational tests on a larger network + during a longer period
Thank you for your attention

Laboratory website: http://www.lames.ifsttar.fr