Road slipperiness detection based on dynamic vehicle data

PIARC TC 2.4 Workshop, 11th March 2015, Helsinki
Mobile road surface condition measurements in winter
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Agenda

- Need for supporting road safety
- Detecting road slipperiness
- Prototype implementation
- Road ahead
Need for supporting road safety
Road safety

- EU: approximately 30,000 fatalities and 1.5 million injuries are reported yearly in road accidents, leading to annual costs in the scale of 130 billion €.

- WHO: road traffic injuries are the leading cause of death among people 5–29 years old (WHO European Region).

- In EU, a key development target is to significantly reduce traffic accidents caused by poor road conditions.

- Societal need to improve safety, reducing losses of lives and serious injuries.
Road slipperiness

- In Finland, poor weather conditions and slipperiness contribute to 20–25% of traffic fatalities and approximately 260 M€ costs per year (fatalities and injuries).

- **Accident risk in snowy or icy conditions** has been estimated to be over 4 times that of normal bare pavement road conditions.
  - In fatal accidents, the risk in road conditions of loose snow or slush estimated as nearly 5 times that of normal conditions.
Regulatory drivers

- **Strong regulatory drivers** in EU make it a priority to develop and more widely adopt new methods of detecting slipperiness on the roads.
  
  - EC regulation C(2013) 2550 calls for providing a real-time location-specific warning to drivers about temporary slippery road conditions.
  
  - The Commission also expects its member states to reduce road accidents by 50% between the years 2010 and 2020 (*COM*(2010) 389).
Detecting road slipperiness
Information sources

- Temperature measurements and weather modelling

- Stationary roadside sensors
  - Optical sensors (infrared)

- Mobile add-on sensors
  - Measuring wheels on friction trailers
  - Braking traction test devices
  - Optical sensors (infrared)
  - Carry-on sensors, e.g. mobile phones

- Analysis of in-vehicle data
Road slipperiness detection: GRIP

• Novel method for detecting road slipperiness, based on analysing several primary feeds of data available in the vehicle controller area network (CAN).

• **Real-time monitoring and analysis** in various driving situations:
  • Difference in the running speeds of pulling axle vs. freely rotating axle(s)
  • Operational engine data, primarily the engine running speed and torque

• Based on direct measurement of wheel slip.

• No additional sensors, regular maintenance or other driver activities required.
Properties

• Produces localized and real-time slipperiness data on a continuous scale
  • Also on constant speed road sections
  • No requirement for significant acceleration/deceleration

• Sensitive to small changes in traction during normal driving
  • Even when the driver is not yet aware of the change in conditions
  • Operates below the threshold levels of driver assistance systems such as ABS, ESC and TCS

• Unique combination of properties:
  • Low operational cost
  • Continuous monitoring
  • Precision and reliability
  • Information specificity
Scaling

- Low cost enables scalability to large vehicle fleets
- Large fleets make possible a road slipperiness information service with wide coverage
- Utilization in e.g. winter road maintenance, direct road slipperiness warnings and commercial value-added services
Exploitation and applications

Allows cost-effective and scalable provision of accurate and specific road slipperiness data with wide geographical coverage.

Potential information utilizers:
• Public authorities
• Maintenance operators
• Road weather service providers
• Navigation service providers
• Vehicle manufacturers
• Transport operators
• Insurance companies
Prototype implementation
Vehicle implementations

- **Implemented as software in various types of vehicle computers**
  - Real-time collection of CAN and GPS data
  - Data processing and analysis
  - Connectivity (GPRS, 3G etc.) with server-side system

- **Tested and proven in practice**
  - With up to 40 vehicle truck fleet
  - Correlation with driver opinions and official friction measurements

- Currently also being tested in Helsinki Region Transport (HSL) buses and a road maintenance vehicle

- **Heavy vehicles optimal**
  - High sensitivity to changes in slipperiness
  - Large quantity of existing vehicle computers with the needed properties
Prototype system and services

- **Server-side system** for data management and calibration of observations

- **Warning system** for drivers approaching dangerously slippery road sections
  - Simple LED signal based information system in the truck cockpit

- **Map visualization** for situation awareness

- Data interfaces planned
Visualization example

- An example: analysed slipperiness on the road network of Southern Finland on Dec 2, 2013.
- Slipperiness level is indicated by colour coding.
- Size of the dot indicates the number of observations in the area.
Development status

- Data from each vehicle is automatically calibrated.
- Data from various vehicle types is cross-calibrated to gain solid understanding of slipperiness levels.
- **Status:** a functioning road slipperiness detection system for heavy vehicles and accompanying prototype services.
- Recent development includes method optimization for commercial deployment.

Road slipperiness detection based on dynamic vehicle data
Road ahead
Industry interest

**Volvo, 19 March 2014:**
“Volvo Car Group (Volvo Cars), the Swedish Transport Administration (Trafikverket) and the Norwegian Public Roads Administration (Statens Vegvesen) are joining forces in a pilot project in which road friction information from individual cars is shared within a cloud-based system.”

**Nokia, 5 May 2014:**
“Nokia today announced the launch of a USD 100 million Connected Car fund to be managed by Nokia Growth Partners (NGP). The fund will identify and invest in companies whose innovations will be important for a world of connected and intelligent vehicles.”

Picture: Volvo press release
Kauppalehti, 9 March 2015:
Up-to-date information to road keepers from truck tyres
A method measuring tyre traction warns the truck driver about a slippery bottom of the hill and sends the information also to the road keeper.
Research and development items

- **Research and development items**
  - Passenger cars as data providers
  - Universal data provision; tackling the variety in data bus implementations
  - Driver notifications, communication channels and interaction
  - Operation model and value networks
  - Ensuring data quality and privacy protection

- **Pilot cooperation** prepared with
  - Helsinki Region Transport
  - City of Helsinki Public Works Department
  - The Finnish Road Weather Excellence project
  - COSMOS project / IoT programme of industry consortium Digile

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Data provision and value exchanges

- **Vehicle fleets** are employed to collect the data, in a closed environment of data producers and users, or as part of a larger ecosystem of information and services.

- **Fleet owners** are in a crucial role as data producers. To function, the operational model needs to generate value to the fleet owners. Options:
  - Free or low-cost information service that includes the produced road slipperiness information / warning service; reduced costs due to accidents.
  - Direct benefit from selling the generated data to a service provider.
Summary

• GRIP: Road slipperiness detection based on real-time analysis of primary data feeds in the vehicle data bus

• Slipperiness determined during normal driving, with no additional sensors
• Operates below the threshold levels of driver aid systems
• Developed and tested in up to 40 vehicle fleet of trucks and buses
• Research interests in wide-scale piloting and passenger car utilization
• Working to partner for commercialization – ongoing discussions

Thank you for your attention!
• See video at YouTube (2:33 min)
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