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RSI – Road Status Information
A new method for detection of road conditions

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ABSTRACT

ITS – intelligent transport solutions are important in today's society with demand on safe and environmental friendly driving. With the new RSI technology (Road Status Information), it is possible to optimize road maintenance by offering accurate and comprehensive information to contractors and other user groups about road conditions along the entire road network. Using the information available within modern cars combined with models and data from RWIS – road weather information systems makes it possible to find solutions for detection of different kinds of road maintenance needs within areas such as:

- Winter Road Conditions
- Bearing Strength
- Pavement Quality
- Air Pollution

FCD (floating car data) from vehicles and road weather information from RWIS together with road weather prediction models makes it possible to determine the road conditions with regards to slipperiness and friction in between the field stations. Another use is to model and forecast the road status according to bearing strength during thaw freezing periods in a detailed and dynamic way. The availability of car data increases the spatial and temporal resolution of the road condition models and it also makes it possible to detect how the car behaves and react not only on weather related surface conditions. By having access to vehicle based data it is also possible to detect such features such as pavement quality along the roads as well as the ambient air quality.

Keywords: RSI – Road Status Information, RWIS, floating car data .

1 INTRODUCTION

In modern society it is crucial to ensure safe and efficient transports all year round. This means that there is a need for reliable and efficient tools which can be used as decision support for managers of the road system. Safe, efficient and comfortable driving requires regular monitoring and surveys by the road managers. Several factors may influence the driving conditions on roads. With the new RSI technology (Road Status Information), it is possible to optimize road maintenance by offering accurate and comprehensive information to contractors and other user groups about road conditions along the entire road network. Using RSI it is possible to monitor such factors as the pavement quality, and several seasonally and climatologically varying factors such as snow cover, icy conditions, and spring thaw as well as air pollution.

Today much the monitoring methods are based on fixed stations or comprehensive but expensive equipment that cannot be used extensively along the road network because of economic reasons. The RSI system addresses this by using the information available within modern cars and combines this with data from RWIS – road weather information systems and weather forecasts. Using this method it is possible to find solutions for detection of different kinds of maintenance needs. As pointed out by Pirkko Saarikivi et al [1] in the project MOBI-ROMA - Mobile Observation Methods for Road Maintenance Assessments – which was initiated by ERA-NET ROAD

there is huge potential for development of road maintenance services using floating car data in combination with other sources of data. Below examples are given from the MOBI-ROMA project as well as the newly initiated RSI project which focuses on winter road conditions,

2 ROAD STATUS INFORMATION

A modern car has a whole range of sensors and systems that can be utilized to analyze specific road characteristics. It is possible to measure and monitor using systems and sensors like the traction control systems, EPS, ABS, air temperature, air quality, air pressure, accelerometers etc. available via the CAN-bus system of a modern car. This type of data produced by cars during ordinary driving on the roads in the traffic systems creates a floating car network which is possible to utilize in applications suitable for road maintenance.

The basic idea with RSI is that data produced by different sources of monitoring systems can be combined and merged to products which give a more extensive and accurate information than each component by itself.

Four different areas which are of particular interest for maintenance:

- Winter Road Conditions
- Bearing Strength
- Pavement Quality
- Air Pollution

2.1 Winter Road Conditions

Focusing on a winter road conditions a new project is launched in SW-Sweden during the winter 2014 which aims at demonstrating the possibilities with combining floating car data with data from fixed stations and weather and climatic models. Initially a fleet of 20 Volvo cars will be used for gathering the road conditions along stretches of road during different weather conditions in this demonstrator project. The fleet will be expanded successively during the three year period of the demonstrator project aiming at 2000 vehicles in 2017.

Together with the basic data which is registered by the different sensors and safety systems in the cars – Volvo has developed a RFE value. This RFE value estimates a friction of the actual surface conditions. The recordings from the cars together with the RFE from the vehicle's internal sensors through the CAN-bus, will be sent to a cloud where the data is made anonymous. In the cloud the different car recordings will be available for further processing. The data from the cloud will then together with the data from the RWIS and the weather forecast serve as input to a climatological model. Inside the climatological model the data from the different sources are merged and interpreted according to topography and other geographical factors which will influence the temperature and conditions along the roads in the area, figure 1.

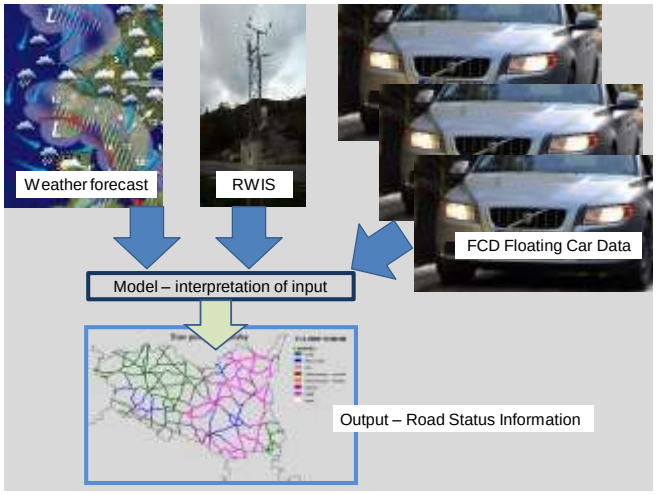

Figure 1. RSI – for winter road conditions, where input from different sources makes it possible to improve the information to maintenamce operators.

The output from the model is a detailed presentation of the present road surface conditions and temperatures together with a forecast of the situation along the roads in the area. This output provides the maintenance organization with up-to-date information on the need for action. The timing and result of decision on whether an action is needed or not is to a high degree dependent on the quality of the information about the present situation and forecast. It will also be possible to use the output information for evaluation of the actions taken.

2.2 Bearing Strength Conditions

Roads with a high load-bearing capacity are essential for harvesting natural forest resources in Sweden and to help keep the countryside open and prosperous. During periods in the spring when the ground frost thaws the load bearing capacity of the forest roads is greatly reduced, leading to road closure. Subsequently it is not possible to use the roads for transporting heavy goods such as lumber.

The on-going research project BiFi "Bearing information through vehicle intelligence" which has proven that the technology to map the load –bearing strength of roads by a vehicle-based method is possible. Combining the vehicle data with weather observations and forecasted weather data it is possible to model and forecast the road status according to bearing strength. The results are based on field tests in a rough and real environment for determining the load-bearing strength of the roads,[2] (FFI, 2011). The project aims at computing the load bearing capacity of gravel roads which often related to surface softness or spring thaw. Floating car data together with data from fixed measuring field stations generated geographically positioned information regarding the roads surface characteristics, figure 2. This data is then further integrated into a climatological model together with a weather forecast. The integration into the climatological model makes it possible to produce detailed nowcast and forecast maps of the road conditions on a scale possible to view single road segments.

The floating car data was retrieved from the CAN-bus outlet or by a purpose-built hardware, which was designed to imitate standard sensors equipped in modern vehicles. Due to the restricted CAN-bus communication protocol of the FIAT Fiorino that the Swedish Postal Service uses, an external sensor equipped with GPS, 3G/GPRS and accelerometers was installed in the postal vans. This external unit has the capability to register, process, store and send data. In the area where the postal vans are operating the connectivity to the mobile network is limited and therefore data is sent when the postal vans are back at the post office. This results in data transfer 1-2 times per day from the postal vans.

Figure 2.Display of frost thaw situation and example of how a typical gravel road can look like during these conditions..

2.3 Pavment Quality

The BiFi project for bearing strength conditions included a functionality to determine whether the vehicle is located on a gravel road. The algorithm has been re-developed to also determine the roads pavement quality. The system was partly broken out of its original project and aimed to use floating car data to provide, amongst others,

several road administrations with spatially distributed pavement quality information. Collection of data, used to further develop the pavement analysis algorithms, was performed parallel with MOBI-ROMA and fed into the maintenance tool. Data has been gathered using a Volvo V70 from which the CAN-bus could be read and the information processed. The data was manually ingested from the test car into the MOBI-ROMA maintenance tool, and was not for the majority of the project seen as real-time data, figure 3. However there were tests done with specialized versions of the BiFi hardware [3]. Due to the climate in the Nordic countries potholes and cracks in the road surface are a big issue which is of great interest to monitor and map.

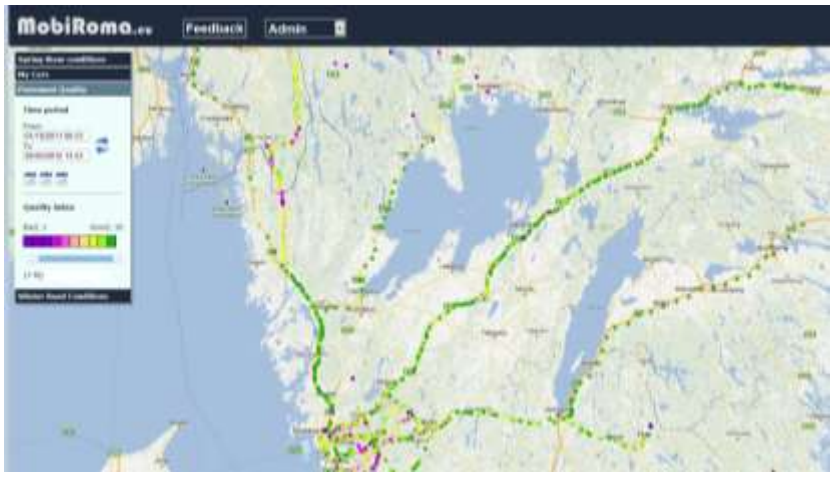

Figure 3. Variation in pavment conditons.

This technique makes it possible to have a system which covers large areas in a relatively short time compared with traditional systems. The outcome is a cost effective way of mapping the maintenance need regarding surface coating.

2.4 Air Pollution

Monitoring of air quality is of great interest especially in urban areas since it is has great impact on people's health. Many cities lack proper surveillance of the air quality. A few fixed stations with sensors for detection of air pollutants is seldom enough for spatial coverage of the situation. A solution which has shown very interesting is to use the standard sensors for NO2, CO and VOC which are available in modern cars. Field tests in the Gothenburg area has shown that this approach gives a high spatial and temporal resolution.

Figure 4. Example of air quality monitoring in Göteborg.

The data monitored by the cars are a good input to forecast models about episodes of heavy pollution episodes. By combining the data from the car fleet with data from fixed stations a huge possibility appears when it comes to different applications.

3 DISCUSSION

The project report MOBI-ROMA [4] which was initiated by ERA-NET states that there is a great potential of benefits of improved safety services for road transport where floating car data can play a substantial role. This potential can be understood by looking at road accident costs which differ regionally depending on the climate, national driving culture and other demographic effects. For the Northern Europe severe driving conditions during wintertime form an increased risk almost half of the year. For Europe as a whole the costs caused by winter weather are not quite as high as in the cold North however but according to Eurostat there were 49 000 killed and 1.9 million injured in traffic accidents during 2007. The economic and social losses are so large that any new means to reduce these figures result in considerable benefits. A small reduction of accidents in the range of 1% due to improved road condition data can result in substantial benefits on both national and European scales.

Using methods where different sources of data are combined and merged into models and products looks very promising. Having access to floating car data the accuracy and resolution in time and space will increase the possibilities for reliable information about road conditions for maintenance as well as for drivers and authorities, figure 5.

Figure 5. Information in the car about road status will increase the avarness of the driver.

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