ARTRAC workshop held in Hamburg

Volkswagen test car on display


Audience of the ARTRAC Workshop

On 3 December 2013 a public workshop was held at TuTech Innovation, which gave an overview of the ARTRAC development for 38 participants. The invitation to the workshop and the list of participants may be found at the end of this document.

After the presentations the project results and approach were discussed during a lively debate. The general opinion was that the ARTRAC sensor can be very useful. Some of the external participants even expressed their regret that not more people from outside the project attended the workshop as the project is very relevant to those interested in the protection of vulnerable road users.

During the lunchbreak many participants were keen to look at the demonstration car from Volkswagen which was stationed outside the TuTech building.


Professor Hermann Rohling showing the ARTRAC sensor

Road Surface Condition Detection

The ARTRAC project aims to develop a radar sensor system which improves the protection of vulnerable road users by detecting and classifying pedestrians. In addition to this, road surface condition detection and road surface friction estimation are investigated. The road surface condition is recognised using 24 GHz automotive radar by measuring the polarisation of the backscattering from the road surface – different road surfaces, e.g. icy, wet or dry asphalt, have different backscattering characteristics. The final objective is that the road surface friction coefficient can be estimated from the road surface clutter polarisation properties so that the road friction information can be used as input in the safety applications to protect vulnerable road users. The road surface condition detection is investigated by ARTRAC partners VTT Technical Research Centre of Finland co-operating with “Politehnica” University of

Timisoara (UPT).

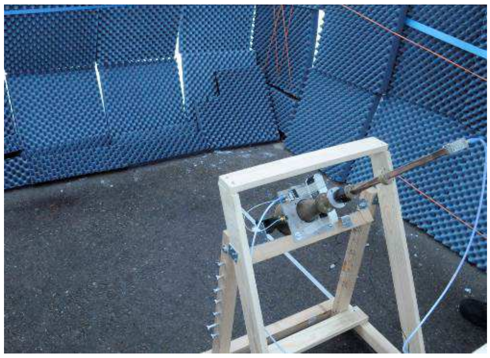
The road surface friction is mostly determined by the surface (ice, snow, water or clear asphalt) and if the surface can be identified the typical friction coefficient for that type of a road surface can be estimated. In the Figure below, the road weather conditions used by the Finnish Meteorological Institute and Finnish Road Administration are shown. Dry clear asphalt has typically a friction coefficient around 0.8 but above 0.45 is considered normal, wet asphalt has lower friction coefficient in the range 0.3-0.45 and icy roads have friction coefficients below 0.3. The 24 GHz radar is used to identify dry, wet and snowy & icy asphalt surfaces.

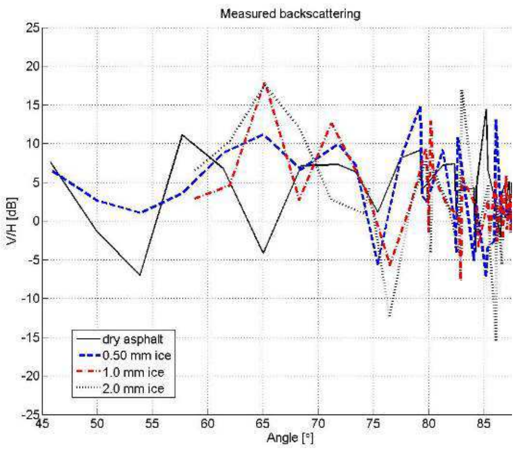
Friction	0.00 – 0.14	0.15 – 0.19	0.20 – 0.24	0.25 – 0.29	0.30 – 0.44	0.45 – 1.00
Description of the road surface	Wet ice	Icy	Packed snow	Rough ice/ packed snow	Clear and wet	Clear and dry
Slipperiness classification	Very slippery	Slippery	Fair winter condition	Good winter condition	Good road condition	Good road condition
Road weather index	Very bad road weather	Bad road weather			Normal road weather	

Driving and road surface conditions used by Finnish Road Administration (Hippi et al, D3.4b Report for ROADIDEA project 215455, 2010).

The road surface is identified based on the backscattering polarisation properties, i.e. by measuring the ratio of the backscattering coefficients at different polarisations by transmitting a circularly polarised wave and receiving the both linear polarisations (vertical and horizontal). The key feature to extract from the data is the ratio of the backscattered power at the two linear polarisations, σ_{VV}/σ_{HH}. Based on the differences in this ratio obtained at different incidence angles, the road surfaces can be classified and the corresponding friction coefficient estimated.

In order to be able to classify the road surfaces for friction estimation, the backscattering properties of different road surfaces have to be investigated in detail. For this purpose a radar test-set up was designed and assembled onto a movable cart. This set-up allows measurements of the asphalt surface at different locations and with different incidence angles by changing the antenna pointing angle manually. Measurements were done on different asphalt surfaces – coarse and smooth asphalt, wet, icy and asphalt covered with tree leaves. The measurement site is shown in Figures below together with the measured polarisation ratio for icy asphalt with different ice layer thicknesses.

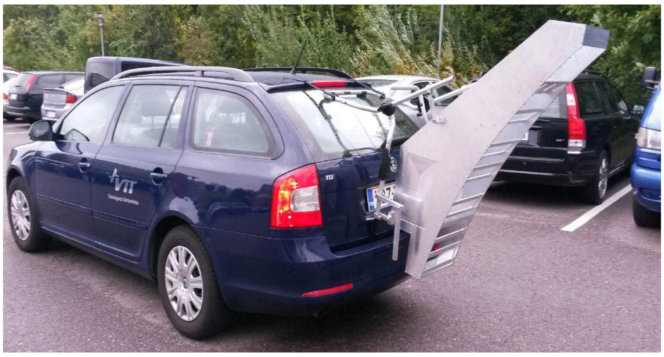




Measured backscattering from icy asphalt.

The backscattering from the road surface depends greatly on the surface roughness of the asphalt and the road surface clutter is thus highly random. Therefore, individual measurements vary considerably and in order to characterise different road surfaces sufficient statistics of the backscattering properties have to be collected. By collecting a large amount of data on different road surfaces a reference library can be built. The road surface condition classification is based on comparing the observed polarisation ratio σ_{VV}/σ_{HH} to a set of reference surface classes representing a selection of dry, wet and icy surfaces and finding the best match to estimate the friction coefficient.

To measure and characterise a large number of different asphalt surface an automatic measurement system based on 8 radars is being implemented. Each radar module has a circularly polarised TX-antenna array and two linearly polarised RX-antennas for measuring σ_{VV}/σ_{HH}. The antennas in the radar modules point to different incidence angles on the asphalt and the backscattering measurements can be performed in a sequence up to 20 times per second. The measurement radar set-up is mounted behind a test vehicle together with other equipment to determine the road surface condition under measurement. These reference devices include an infra-red road condition monitor RCM411 by Teconer, a smart-phone accelerometer based friction meter and a video camera. The road surface measurement system is mounted behind a vehicle as shown in Figure below.



The radar set-up is nearing completion and an intensive measurement campaign is planned for next winter and spring. The collected data will be used in the development of a road surface condition classifier to investigate the capabilities of 24 GHz radar in estimating road surface friction.

Next ARTRAC Events

ARTRAC Workshop for Radar Specialists
13 March 2014
TuTech Innovation, Hamburg

ARTRAC Final Conference with demonstrations

24 – 25 September
Volkswagen proving ground, Ehra

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