24 GHz AUTOMOTIVE RADAR FOR DETECTING LOW-FRICTION SPOTS DUE TO WATER, ICE OR SNOW ON ASPHALT

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INTRODUCTION

After extensive research work of several decades, automotive radars are finally pushing into consumer market. Commercially available radars are either for automatic cruise control or blind spot detection. Automatic cruise control systems adjust the vehicle speed according to the preceding vehicle whereas blind spot detection systems ease certain maneuvering, such as lane changing.

Automotive radars are also proposed for road condition recognition [1,2]. In this paper, we study the possibility to use forward-looking dual-polarized 24 GHz automotive radar for detecting low-friction spots due to water, ice or snow on asphalt.

EXPERIMENTS

The backscattering properties of dry, snowy and icy asphalt were studied in one measurement campaign during winter and backscattering properties of dry and wet asphalt were studied in another measurement campaign during summer. Different road conditions were arranged on test tracks that are normally used for car tire testing and test driving.

The measurements were performed at the lower European automotive radar band of 22-24 GHz [3]. A network analyzer was used to measure the backscattering from asphalt in different conditions. The test equipment was installed in a boot space of a van and the test antennas were aligned to point to the test track from the opened back door of the van. The antenna pointing angle with respect to the normal of the road surface was 65°.

The backscattering was measured at different polarizations and it is denoted as σ_{xx}, where the first sub index refers to the transmitted polarization (vertical or horizontal) and the second to the received polarization.

The measured backscattering from dry, icy, snowy and wet asphalt are shown in Figure 1. Markers represent single measurements and solid lines are averaged over certain polarization and road condition.

As shown in Figure 1, ice increases the backscattering at all polarizations from 2 to 3.5 dB as compared to dry asphalt. Snow further increases the backscattering as compared to ice. Contrary to snow and ice, water increases the backscattering at vertical polarization and decreases it at horizontal polarization.

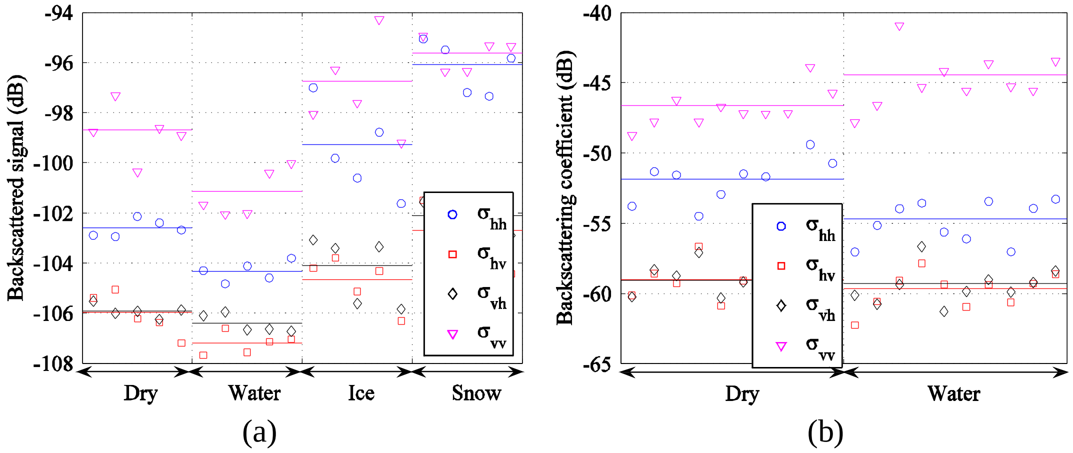

Figure 1. Measured backscattering at different polarizations from: (a) dry, icy and snowy asphalt, (b) dry and wet asphalt. Single measurements are represented with markers and solid lines are averaged values over respective road condition and polarization.

Several unknown parameters, such as weather, the slope of the road and the target distance affect the absolute backscattering. Therefore, instead of absolute backscattering, it is more favorable to use relative quantities for identifying road conditions. According to Figure 1, the ratio between backscattering at vertical and horizontal polarizations could be used to recognize the road condition. The average ratios σ_{vv}/σ_{hh} are 10 dB for wet asphalt, 5 dB for dry asphalt, 3 dB for icy asphalt and 0.5 dB for snowy asphalt.

CONCLUSIONS

In this paper, we have studied the use of 24 GHz dual-polarized automotive radar for recognizing low-friction spots due to water, ice or snow on asphalt. Our experimental results suggest that road conditions could be detected by comparing the backscattering at vertical and horizontal polarization.

REFERENCES

[1] V. Viikari, T. Varpula, and M. Kantanen, "Road condition recognition using 24 GHz automotive radar," submitted to *IEEE Transactions on Intelligent Transportations Systems*, 2008.

[2] V. Viikari, T. Varpula, and M. Kantanen, "Automotive radar technology for detecting road conditions. Backscattering properties of dry, wet and icy asphalt," to be published in *Proceedings of the 5th European Radar Conference (EuRAD)*, Oct. 2008.

[3] "Electromagnetic compatibility and Radio spectrum Matters (ERM); Radio equipment to be used in 24 GHz band; System Reference Document for automotive collision warning Short Range Radar," ETSI TR 101 982 V1.2.1, July 2002.