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Infrared thermography applied to road networks winter risk evaluation

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Thermal mapping has been implemented since the late eighties to measure road pavement temperature along with some other atmospheric parameters to establish a winter risk describing the susceptibility of road network to ice occurrence. Measurements are done using a vehicle circulating on the road network in given road weather conditions (clear weather, cloudy, wet pavement, . . .). If the dew point temperature is below road surface temperature there is a risk of occurrence of water in a solid phase and therefore a loss of grip for circulating vehicle.

Road surface temperature is obtained with an infrared radiometer on board of a dedicated vehicle. To avoid too much influence of the sun, and to see the thermal behavior of the pavement enhanced, thermal mapping is usually done before dawn during winter time. That is when the energy accumulated by the road during daytime is mainly dissipated (by radiation, by conduction and by convection) and before the road structure starts a new cycle. This analysis is mainly done when a new road network is built, or when some major pavement changes are made, or when modifications in the road surroundings took place that might affect the thermal heat balance. This helps road managers to install sensors to monitor road status on specific locations identified as dangerous, or simply to install specific road signs. Measurements are anyhow time-consuming. Indeed, a whole road network can hardly be analysed at once, and has to be partitioned in stretches that could be done in the open time window to avoid temperature artefacts due to a rising sun.

The LRPC Nancy has been using a thermal mapping vehicle with an infrared radiometer in a temperature-regulated compartment. Data acquisition is performed every 3 m using a LabVIEW® interface. Road events were collected by the operator to help the analysis of the network thermal response. Although a conventional radiometer has great performances, it could only analyse one lane at a time.

The objective of the work was to use an infrared camera on the thermal mapping vehicle to improve the winter risk determination of road network. The FOV of such camera is larger than the one of a radiometer and its FPA detector would capture a whole infrared scene including several lanes and the surroundings at once. A comparison was made installing a radiometer along with a FLIR® S65 camera. The camera is installed in a compartment attached to a window on the right side of the vehicle. To cope with the camera time integration and limits with data transfer, thermal images were only acquired every 24 m, at speeds staying below 70 km/h. All the atmospheric parameters measured by the different sensors such as air temperature and relative humidity were used as input parameters for the infrared camera when recording thermal images.

Road thermal heterogeneities were clearly identified, while usually missed by a conventional radiometer. In the case presented here, the two lanes of the road could be properly observed. Promising perspectives appeared to increase the measurement rate. The analysis of road surface temperature obtained from the radiometer and the infrared camera are showing great similarities. A comparison was made between winter risks obtained from data of the two instruments. Furthermore, a new winter risk calculation was implemented to improve its consistency with seasons and road infrastructure. Some investigations were also conducted to analyze the meteorological measurements conditions with the introduction of a cloud cover and its effect on the network thermal balance.