Wheel-Based Ice Sensors for Road Vehicles

Ice would be sensed via its electric permittivity.

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Wheel-based sensors for detection of ice on roads and approximate measurement of the thickness of the ice are under development. These sensors could be used to alert drivers to hazardous local icing conditions in real time. In addition, local ice-thickness measurements by these sensors could serve as guidance for the minimum amount of sand and salt required to be dispensed locally onto road surfaces to ensure safety, thereby helping road crews to utilize their total supplies of sand and salt more efficiently.

Like some aircraft wing-surface ice sensors described in a number of previous NASA Tech Briefs articles, the wheel-based ice sensors are based, variously, on measurements of changes in capacitance and/or in radio-frequency impedance as affected by ice on surfaces. In the case of ice on road surfaces, the measurable changes in capacitance and/or impedance are attributable to differences among the electric permittivities of air, ice, water, concrete, and soil. In addition, a related phenomenon that can be useful for distinguishing between ice and water is a specific transition in the permittivity of ice at a temperature-dependent frequency. This feature also provides a continuous calibration of the sensor to allow for changing road conditions.

Several configurations of wheel-based ice sensors are under consideration. For example, in a simple two-electrode capacitor configuration, one of the electrodes would be a circumferential electrode within a tire, and the ground would be used as the second electrode. Optionally, the steel belts that are already standard parts of many tires could be used as the circumferential electrodes. In another example (see figure), multiple electrodes would be embedded in rubber between the steel belt and the outer tire surface. These electrodes would be excited in alternating polarities at one or more suitable audio or radio frequencies to provide nearly continuous monitoring of the road surface under the tire. In still another example, one or more microwave stripline(s) or coplanar waveguide(s) would be embedded in a tire near its outer surface; in comparison with lower-frequency capacitive devices, a device of this type could be more sensitive.

This work was done by G. Dickey Arndt, Patrick W. Fink, and Phong H. Ngo of Johnson Space Center and James R. Carl (independent consultant). Further information is contained in a TSP (see page 1). GSC-15705-1