

INNOVATIVE DETECTION OF ROAD SURFACE CONDITIONS IN TWO DIMENSIONS BY 2DROAD

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In this paper, an introduction to a new and ground-breaking road surface sensor, the first-of-its-kind in sensing the road surface for winter road maintenance in two dimensions will be presented. Traditional road sensors, either embedded or non-intrusive, detect the surface by a single spot or a small area. What separates 2DRoad (**Fig. 1**) from these traditional road sensors is a stationary meteorological camera carefully designed to increase the amount of information from a much wider area by sensing 4096 points simultaneously instead of a single spot or a small area.



Fig. 1. 2DRoad – a sensor and a spotlight.

The problem with weather and road condition is that it varies along the road (with both terrain and geographical factors) and it varies even in one location across the road profile. The first aspect is traditionally solved by locating road weather stations in representative as well as risk locations, e. g. cold spots. But still, there is one weather station per tens of kilometers. The second aspect is also hard to deal with. One can install the sensor (or focus a non-invasive sensor) to a wheel track or between wheel tracks, but the uncertainty about the road condition in different parts of the road remains.

The 2DRoad fights against the second aspect very well by scanning the whole profile of the road or a traffic lane. Based on the measuring distance, the sensor can observe an area up to 6 x 6 meters. The main purpose is to detect different road conditions. The detection principle is near-infrared spectroscopy. The 2DRoad distinguishes 7 statuses: dry, moist, wet, slush, snow, bright ice and dark ice. Another status to be fairly separated is frost and light snow. Two-dimensional overview of the road conditions provides the winter maintenance operator with completely new road surveillance capabilities, including more complex situations with various road conditions in different parts of the road such as icy wheels tracks, snow between wheels tracks or snow in the shoulder.

Based on the detected road condition combined with raw spectral data, 2DRoad calculates the friction which is more and more popular value in recent years when it comes to evaluation of the level of danger for travelers. The friction is basically calculated for each detection point but visualized in a longitudinal direction of passing traffic. One general value of friction is also available per image to represent the overall road condition.

The most important component to perfectly observe the state of the pavement is raw spectral data. The latest development focuses on the improvement of measuring the amount of water, ice, and snow on the road surface.

Further on, the sensor is equipped with a remote temperature sensor. 2DRoad measures the road surface temperature in one spot, located approximately in the center of the scanned area.

Last but not least, the sensor provides a conventional visual image which is the foundation of the user output from the meteorological camera. The classified spectral data is presented as a colored overlay over the gray-scaled visual image (Fig. 2) which enables clear graphic perception of a spatial distribution of different road conditions.

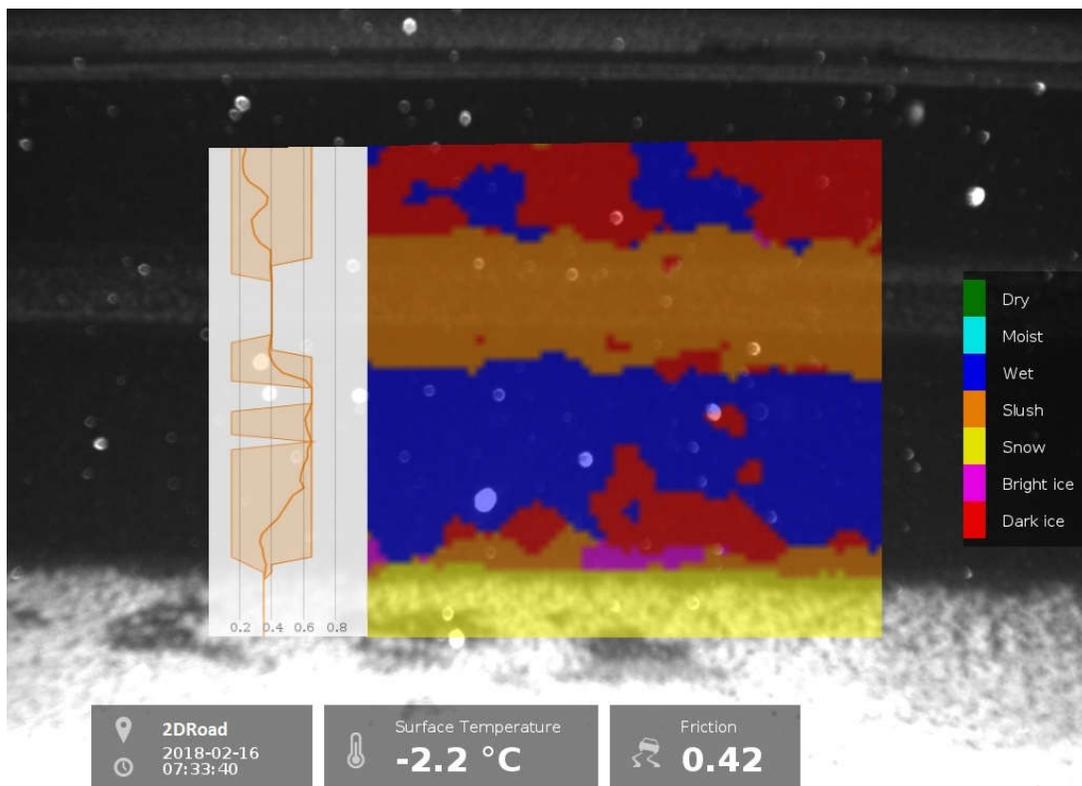


Fig. 2. 2DRoad user output.

Conclusion

The role of the winter maintenance dispatcher is to continuously judge all meteorological data and make decisions regarding maintenance management. The decision-making is not an easy field and the dispatcher has a huge responsibility. The contribution of the new meteorological camera 2DRoad is the increase of the amount and usability of information from a weather station site.

During the last five years of development and testing a ground-breaking product has been completed as a 2-dimensional sensing of the road condition, as the first on the market. Moreover, the experience from multiple testing sites confirms that the same classification algorithms are universally applicable on different sites; only a minor setup procedure during dry conditions is required to determine the local properties of the surface (1).

References

1. Bogren et al., **2018**, Road surface conditions – detection in two dimensions by 2DRoad, *XVth International Winter Road Congress in Gdansk*, topic 3-1, IP 124.