AUTOMATED RAVELING INSPECTION AND MAINTENANCE PLANNING ON POROUS ASPHALT IN THE NETHERLANDS

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ABSTRACT

A new automated road pavement inspection system was developed and deployed to determine raveling on porous asphalt. The system acquires high-resolution 3D measurements of road surfaces by means of high-speed laser triangulation. The developed system is capable of determining the pavement type, measuring the amount of raveling and remaining service life on porous asphalt in the Netherlands. The system has been in use for multiple years and is capable of adequately providing raveling data and remaining service life predictions for the Dutch principal motorway network.

KEYWORDS

Ravelling, Cracking, Pavement, Porous Asphalt, Inspection, Maintenance Planning

INTRODUCTION

The surface layer of the majority of the Dutch principal motorway network (HWN) consists of a course porous asphalt (>90%). The most dominant failure mechanism of this type of asphalt is raveling (Figure 1). Previously, the amount of raveling and the remaining service life of each 100 meter section of porous asphalt was estimated by means of visual inspections. These visual inspections are time consuming, partially ambiguous and sometimes it is even not possible, or too dangerous, to inspect a road section. Existing measurement systems using multiple point lasers (Van Ooijen et al. 2005; McRobbie et al. 2010; Wright et al. 2012) were found inadequate for the specific conditions and requirements in the Netherlands.

Under the authority of the Dutch Highway Agency a new automated road pavement inspection system was developed and deployed. The developed system is integrated in a vehicle which can operate at speeds up to 120 km/h and can be used in normal traffic (as shown in Figure 1). The measurement system is based on the high-speed measuring of height profiles by means of laser triangulation. The sensors used for this purpose are a part of the Laser Crack Measuring System (LCMS) of Pavemetrics. The developed system makes it possible to generate a detailed 3D road surface with a (in plane) resolution of 1.0 by 4.7 mm.

From the 3D surface (as shown in Figure 2) first the type of asphalt is classified by means of texture analysis. Based on 11 texture measures and a (trained) quadratic classifier the pavement type is determined. Next to the pavement type, the amount of raveling (stone loss) is computed from the 3D data, after several pre-processing steps, by means of a specifically develop algorithm (Figure 3). The pre-processing consists of the detection of roadmarkings, ‘flattening’ of the data to compensate for the road unevenness and vehicle motion, removal of...
non-ravelling damage (rim marks) and determining both the wheel paths (lateral location of maximum damage). The ravelling is determined per square meter for each wheel path by determining the surface area where a cylinder of a certain diameter and height ('coin') can fit in the 3D surface. This algorithm is a sort of 3D analogy of the so-called 2D ‘Stone(a)way’ algorithm as described by Van Ooijen et al. (2005).

The ravelling per square meter is then used to compute the expected remaining service life for each individual 100 meter section. The model used is based on a training set of more than 5000 sections (each a 100 m), each visually inspected by (multiple) experts.

RESULTS AND DISCUSSIONS

At the moment there is a four year experience with the developed system, which measured the complete Dutch Highway infrastructure in 2013 and 2014 (>14.000 km and 15 Tbyte of raw data per year).

Figure 4 shows the two strongest texture measures on which the pavement type is determined. A set of 27,128 (100 meter) sections is used to train a (quadratic) classifier based on the eleven texture features. Overall this classifier predicts a 98.8% correct pavement type, for porous asphalt the algorithm is even more correct 99.7 %.
Figure 4: Two of the most dominant texture measures plotted for four pavement types of the 27,128 sections used for the automatic pavement type classification. Each dot represents a 100 meter section; each color represents a different pavement type.

The remaining service life for all porous asphalt sections was computed and successfully used by the Dutch highway Agency for their maintenance planning (see Figure 5). The system is capable of correctly predicting the remaining life of each section in more than 94% of the 100 meter sections.

Figure 5: Example representation of the predicted remaining service life of all 100 meter sections.

The repeatability (multiple measurements with the same system) and reproducibility (measurements compared with another similar system) were evaluated and observed to be very good.

CONCLUSIONS

The developed system is capable of determining the pavement type, measuring the amount of ravelling and remaining service life on porous asphalt in the Netherlands. The system has been in use for multiple years and is capable of adequately providing ravelling data and remaining service life predictions for the Dutch principal motorway network.

REFERENCES

