Identification of Road Pavement Types Using Bayesian Analysis and Neural Networks

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A new method to classify and identify different types of road pavements by analysing the near field sound profile and texture using statistical learning methods is proposed. A set of characteristics were extracted from the noise profile and from the road surface texture. Sound measurements were carried out following the close-proximity method with the texture descriptors being provided by a high speed profilometer system. As a first approach, it is assumed that the features extracted from the noise and texture characteristics follow normal distributions. However, this assumption is not completely verified for all types of road surfaces. The method presented herein exploits the use of Bayesian analysis complemented by a neural network in order to improve the classification results.

1. INTRODUCTION

Urban road traffic noise is one of the most serious environmental problems that modern societies face nowadays. Efforts have been taken for the development and implementation of noise abatement strategies that can be adopted in urban settings and that do not pose problems of visual impact as noise barriers generally do. Therefore, a considerable variety of different low noise surfaces is now available. 1,2 A good knowledge of the characteristics of the road pavement surfaces regarding noise and texture is important in terms of assessment for road conformity purposes. Statistical classification and identification of road pavements approaches by using non-destructive methods has been addressed recently. 3,4 However, these studies focused only on the statistical Bayesian classifier, assuming features such as normal probability density functions and a vehicle speed of 80 km/h. The possibility of features with different distribution functions and the evolution of each feature set for a range of vehicle speed were left for future study.

The present study aims to outline guidelines regarding an accurate and automatic method for the classification/identification of road pavements using both Bayesian and neural networks classifiers for comparison purposes. 5,6 We believe the use of noise and texture characteristics applied to a pattern recognition approach could be a valuation tool for pavement management systems.

2. METHODOLOGY

Macrotexture and sound pressure levels were measured together along the extension of five selected road surfaces in order to extract relevant characteristics to be used on the pavement classification.

The pavement surface macrotexture was estimated by the mean profile depth (MPD) method. The pavement surface data was acquired with a high speed Profilometer (HSP) following the ISO 13473-1 standard. 7 The sound signal was acquired, in near field conditions, along the road segments for vehicle speeds in the range of 30 to 100 km/h (in most tracks), in steps of 10 km/h, following the close proximity procedure (CPX) as described in the ISO/DIS 11819-2 standard. 8

For final model validation purposes, only the speed of 80 km/h was used, which was chosen among the reference speeds mentioned in the ISO/DIS 11819-2 standard. The tyre used was Michel-in Energy 205/65-R15, designated as standard reference test tyre (SRTT). It is one of the two tyres recommended in the proposed ISO/DIS 11819-2 standard.

From the macrotexture and the corresponding audio signal of each road surface, a set of features that best described the type of data acquired were selected and analysed. The relation macrotexture/noise was determined through this set of features which in turn was used for evaluation and assessment of each road surface.

After applying the feature selection procedure to the whole set of the features considered relevant on characterizing the road surface, a sub-set was applied to the Bayes classifier and a neural network. Figure 1 shows the scheme of the setup used in this research.

The road surface set chosen for this study included the ones most commonly used in Portugal: one of dense asphalt (DA), one of slurry surfacing (SS) and three surfaces of open-graded asphalt rubber (OGAR), which are used extensively now. 9 Table 1 presents the maximum aggregate size and the age of each surface. The maximum aggregate size used together with the texture and the porosity as well as the age of the surface are reported in literature as being the main parameters affecting tyre/surface noise. 10–14 Although this set does not cover the...