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Comparison of classical statistical methods and artificial neural network in traffic noise prediction

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ABSTRACT

Traffic is the main source of noise in urban environments and significantly affects human mental and physical health and labor productivity. Therefore it is very important to model the noise produced by various vehicles. Techniques for traffic noise prediction are mainly based on regression analysis, which generally is not good enough to describe the trends of noise. In this paper the application of artificial neural networks (ANNs) for the prediction of traffic noise is presented. As input variables of the neural network, the proposed structure of the traffic flow and the average speed of the traffic flow are chosen. The output variable of the network is the equivalent noise level in the given time period L_{eq}. Based on these parameters, the network is modeled, trained and tested through a comparative analysis of the calculated values and measured levels of traffic noise using the originally developed user friendly software package. It is shown that the artificial neural networks can be a useful tool for the prediction of noise with sufficient accuracy. In addition, the measured values were also used to calculate equivalent noise level by means of classical methods, and comparative analysis is given. The results clearly show that ANN approach is superior in traffic noise level prediction to any other statistical method.

Introduction

In recent years, due to the constant increase of population and the number of circulating vehicles in urban areas, pollution reached an alarming level. Apart from air pollution, a very important factor regarding environmental pollution in urban areas is noise. Among different sources of noise that are present in an urban area, traffic noise is by far the most annoying noise source (Calixto et al., 2003). The influence of traffic noise on human health has been studied numerously in recent years (Babisch et al., 2013; Brink, 2011; Caciari et al., 2013; Fyhri and Klboe, 2009; Pirrera et al., 2010), the results of which confirmed that this kind of annoyance significantly affects both mental and physical health. Therefore, traffic noise is to be considered not only as a cause of nuisance, but also as a concern for public health and environmental quality (Kassomenos et al., 2014). To successfully implement the most efficient noise action plans for preventing and reducing exposure to harmful levels of noise in a sustainable and resource efficient way, it is first necessary to obtain information about the noise levels to which people are exposed (Suarez and Barros, 2014; Kassomenos et al., 2014). Thus, in order to control noise sound level in urban areas, it is very important to develop methods for prediction of the traffic noise. The first traffic noise prediction (TNP) models date back to early 1950s. Since then a large number of methods and models for traffic noise prediction have been developed. The critical reviews of the most used ones are given in Steele (2001) and Quartieri et al. (2009) as well as in Garg and Maji (2014). Most of the TNP models that are presented in literature are based on linear regression analysis. The main limit of those models, as concluded in Quartieri et al. (2009) and Claudio Guarnaccia et al. (2011), is "that they don't take into account the intrinsic random nature of traffic flow, in the sense that they don't take care of how vehicles really run, considering only how many they are". More advanced models involve artificial neural networks (ANN) (Cammarata et al., 1995; Givargis and Karimi, 2010) and genetic algorithms (Güdogdu et al., 2005; Rahmani et al., 2011). ANN model that was used in Cammarata et al. (1995) has 3 inputs: equivalent number of vehicles, which was obtained by adding to the number of cars the number of motorcycles multiplied by 3 and the number of trucks multiplied by 6, the average height of the buildings on the sides of the road, and the width of the road. In order to increase the number of inputs the authors decomposed equivalent number of vehicles into the number of cars, the number of motorcycles, and the number of

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