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A FIELD TRIAL OF ACOUSTIC SIGNATURE ANALYSIS FOR VEHICLE CLASSIFICATION

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Abstract—The aim of this research is to investigate the feasibility of developing a traffic monitoring detector for the purpose of reliable on-line *vehicle classification* to aid traffic management systems. The detector used was a directional microphone connected to a DAT (Digital Audio Tape) recorder. The digital signal was pre-processed by LPC (Linear Predictive Coding) parameter conversion based on autocorrelation analysis. A Time Delay Neural Network (TDNN) was chosen to classify individual travelling vehicles based on their speed-independent acoustic signature. Locations for data acquisition included roadside recordings at a number of two-way urban road sites in the city of Leeds with no control over the environmental parameters such as background noise, interference from other travelling vehicles or the speed of the recorded vehicles. The results and performance analysis of TDNN vehicle classification, the convergence for training patterns and accuracy of test patterns are fully illustrated. The paper also provides a description of the TDNN architecture and training algorithm, and an overview of the LPC pre-processing and feature extraction technique as applied to audio monitoring of road traffic. In the final phase of the experiment, the four broad categorisations of vehicles for training the network consisted of: buses or lorries; small or large saloons; various types of motorcycles; and light goods vehicles or vans. A TDNN network was successfully trained with 94% accuracy for the training patterns and 82.4% accuracy for the test patterns. © 1997 Elsevier Science Ltd. All rights reserved.

Keywords: vehicle classification, traffic sensor, acoustic signature, TDNN, LPC.

1. INTRODUCTION

This project has investigated the feasibility of developing a novel traffic sensor based on audio monitoring of road traffic for the purpose of reliable vehicle classification. The approach is centred on neurocomputing classification based on feature extraction by digital signal processing of the acoustic signature of travelling vehicles (Fig. 1). The motivation for this research is exemplified by the apparent capability of human listeners to distinguish between different road traffic sounds based on the profile of their short-term auditory spectra. Automatic speech recognition research has also encouraged us to believe that such short term and relatively low frequency spectral information may form a good basis for neurocomputing classification of target vehicles. The final choice of signal processing technique and the neurocomputing architecture was determined experimentally with guidelines from the application of neural networks in time-variant speech recognition systems.