Faculty of Electrical Engineering & Computer Science
Master Degree Course Electronics Engineering, MSc EE

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Model-Based Simulation and Development of a Structure-Borne Sound Sensor for Real-Time Scratch and Deformation Detection in Vehicle Bodies.

ABSTRACT - Masterthesis

Due to economic and environmental benefits more and more people decide to participate on car sharing communities. Over the past decade there has been a constant increase in car sharing users. The research of this master thesis should help car sharing companies to detect vehicle body damages like scratches and small deformations in real-time. As a result, those companies would be able to find the cause and causer of the damage more easily.

Every physical change or interaction of solid material produces some specific kind of structure-borne sound. In this thesis, the structure-borne sound in steel vehicle bodies has been investigated in order to find solutions to distinguish between relevant damages and noisy events (closing of doors or other elastic deformations). It has been demonstrated that plastic deformations excite a characteristic frequency band in the range of 600 Hz up to 20 kHz while most noise sources in cars generate lower frequencies.

A digital signal processing algorithm was designed to decide automatically if the measured structure-borne sound was a plastic deformation, an elastic deformation or just background noise of other vibrations. This algorithm has been implemented on a fast DSP microcontroller system to run in real-time. For the development and parameterization of the algorithm, a digital simulation environment was created. In this simulation environment, different structure-borne sound events could be synthesized with a lot of vibrational states to simulate sound events of damages while the car was driving in various situations. At the end, a fully functional prototype of a real-time DSP microcontroller based sensor system has been realized.