Using of Wavelet Transformation in Signal Processing of Acoustical Signals

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MUDr. Honěk is a violinmaker who has tried to determine objective characteristics of a violin's sound. In his research for the simplest method, he measured the duration and the intensity of a sound of plucked violins strings. An accelerometer and a sound level meter were used for measuring, and the data obtained were processed. Three coefficients were determined and are presented as characteristic of the sound quality of an instrument [4]. His idea found application in a construction of a professional experimental apparatus, but needs further elaboration for the more complex matter of signal processing .

The principal feature of the experimental method used is very similar to the manner of violin playing named "pizzicato". A violin is placed horizontally on two supports with its string down. A small mass hangs from its string in a standard playing position. After its release, the transient response is picked up by a Brüel&Kjær 4374 accelerometer, which is placed on the back plate. For the first set of measurement a measuring card ADSP2115 was used for recording signals with a sampling frequency 44,1 kHz for the second set of measurement a Brüel&Kjær 2825 PULSE was used with a sampling frequency 65,536 kHz. Data were processed in the system MATLAB.

One of the transformations which is obviously used for a signal processing is Fourier transformation. In transformation to the frequency domain, time information is lost. It could be used for stationary signals. Musical sounds generally are not stationary signals. There are some non stationary parts of signals (starting end ending transients, etc.), which are related with a quality of sound a lot. The information about these important characteristics is lost.

The correction of this deficiency has been made by Dennis Gabor (1946). The Fourier transform has been used to analyse only a small section at a time - a technique called windowing the signal. This method which is named Short Time Fourier Transform (STFT) maps a signal into two-dimensional function of time and frequency.

The STFT is a compromise between the time and frequency based views of a signals. It provides some information about both when and what frequencies a signal event occurs. The precision of obtained information is limited because it is determined by the size of the window.

Wavelet transformation represents the next logical step, a windowing technique with a variable-sized region. The major advantage of this method is the ability to perform local analysis – that is to analyse a localised area of a larger signal. Wavelet transformation is capable of revealing aspects of data that other signal analyses miss. This transformation use different functions (Morlet, Paul, DOG, Daubechies, etc.) for decomposition of a signal then Fourier transformation. These functions have different properties (orthogonal-nonorthogonal, complex-real, different with, different shape, etc.).

STFT and Wavelet transformation has been used for signal processing of signals of plucked violins and characteristics of different quality violins have been searched.

References:

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This research has been supported by MSM 210000018.