Digital Signal Processing
Seminar 1
Guitar tuner
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1. Introduction

It is very important that every guitar is properly tuned before playing. This is done by turning the special machine heads at the end of the guitar neck. By turning the heads the tension of the strings in regulated. This directly corresponds to the frequency of which the strings vibrate when plucked. Most guitars are tuned by the standard tuning:E2-A2-D3-G3-B3-E4. This guitar tuner is implemented to correspond to this tuning(table below).

String	Frequency	Tone
1 (E)	329.63 Hz	E4
2 (B)	246.94 Hz	B3
3 (G)	196.00 Hz	G3
4 (D)	146.83 Hz	D3
5 (A)	110.00 Hz	A2
6 (E)	82.41 Hz	E2

The guitar tuner detects the string that is played and gives feedback if it is tuned, or needs strengthening or loosening.

2. Methods

This application was implemented with the programming language MATLAB. In order to realize the function of the guitar tuner I used discrete Fourier transform(fft) to analyze the frequencies of the signal. The amplitude spectrum shows us the amplitudes of the frequencies of the signal. The fundamental frequency(tone) of the signal is the one with the highest amplitude. After finding the fundamental frequency, the script checks to which string it is closest to, and executes the function “tuner(inputFreq, note)”.
Tuner compares the frequency of the original tone and the input frequency if the string is tuned, or needs to be strengthened or loosened. After this the program waits for new input.
There are two versions of the program, one if the input is in the form of audio files(“Seminarska_File_Mode.m”) and the other is for using the microphone as an input(“Seminarska_recorder.m”). The second version makes audio recordings in an interval of 4 seconds. During the development I used the provided audio files and also tested it with my guitar(the function audiorecorder from MATLAB).

3. Results

As mentioned above the testing was done on the provided audio files and in an interactive way(with a guitar and using a microphone to record).
It was found that the guitar tuner picks up and detects all the strings and gives correct feedback, unless the strings are tuned out by a drastic amount(more than 20-30 Hz) and are closer to another note than the original one. Also, when recording, background noise can lower the accuracy of the tuner.

4. Discussion

I noticed that the application can give wrong results if the sting is plucked closer to the bridge. In this case it usually gives a result that is double than the original frequency. My hypothesis is that this may be caused by the sting harmonics (overtones), that may be mistakenly picked up with an amplitude higher than the fundamental frequency. The background noise can also sometimes cause problems. The application can be improved by adding a background noise filter and addressing the first problem.