Real-time monophonic guitar pitch estimation

The feasibility of Fourier transform based methods

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Abstract

Short summary.

1 Introduction

Pitch estimation, which is also referred to as f0 estimation, is an important subtask within the field of Automatic Music Transcription (AMT). The goal of pitch estimation is to estimate the pitch or fundamental frequency f_0 of a given signal. In the context of AMT, pitch estimation is used to determine what note is played in a given signal.

In this thesis, we will focus on real-time pitch estimation, meaning we want to estimate the note associated with the measured pitch while the musician is playing it with minimal latency. This entails we have to use the latest received signal. In contrast to non-real-time methods, we have no knowledge of what may happen ahead of time and signal corresponding to previous notes is irrelevant. This limits the different methods we can use.

This thesis builds upon a preliminary research project [2]. In our research project, we found that Fourier transform based pitch estimation methods might not be well suited for real-time use due to fundamental limitations of the Fourier transform. In this work, we will further research if Fourier transform based methods are viable

The goal of the paper is to research the limits of Fourier transform based pitch estimation methods and assess if the problem is solvable (real-time monophonic AMT, research effectiveness of commonly used methods) and our focus (using Fourier and other signal processing algorithms). Note about building upon research project.

Application (hexaphonic guitar pick-up to MIDI). If pitch estimation can accurately be performed in real-time, it can be used to create a digital (MIDI) instrument from an acoustic instrument. This digital instrument can then be used as an input for audio synthesizers, allowing musicians to produce sounds from a wide variety of instruments. Furthermore, accurate real-time pitch estimation can be used to automatically correct detuned instruments by pitch shifting the original signal to the closest harmonious note.

Note about other research (no usable code, no data sets).

2 Related work

Other papers. Sample citations [3] [4] [1].

3 Preliminaries

Jargon required to understand this paper.

3.1 Fourier transform

Emphesis on descrete (where most papers only mention continuous, which causes misconceptions). Effect of sampling rate (which is often chosen too low) and frame size. Sensitivity for specific frequencies. Quadratic interpolation

4 Paper content

Actual research etc.

5 Experiments

Test the system.

6 Conclusions

What we did in this paper. Reflection on the performance of the system. Final reference to the source code/dataset location.

7 Future work

What could still be improved/further researched.

References

[1] FFTW3 page about two times speed-up by omitting complex part. `http://www.fftw.org/fftw3_doc/One_002dDimensional-DFTs-of-Real-Data.html` Last accessed on 12-04-2021.

[2] Luc de Jonckheere. Real-time guitar transcription using Fourier transform based methods; a pitch estimation framework and overtone sieve algorithm. 2021.

[3] S.S. Limaye K.A. Akant, R. Pande. Accurate monophonic pitch tracking algorithm for QBH and microtone research. *The Pacific Journal of Science and Technology*, 11(2):342–352, 2010.

[4] K. M. M. Prabhu. *Window Functions and Their Applications in Signal Processing.* CRC Press, 2013.