Generalized Harmonic Analysis Speed-up technique by FPGA

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1 introduction

STFT(Short Time Fourier Transform) that applies the Fourier series is chiefly used for the analysis of the acoustic signal. However, STFT with the basic frequency decided according to the length of the analysis window. There is a fault that only the frequency analysis only on the overtone element can be done. Recently, an analytical method that handles the model composed of the harmony of the sine wave that doesn't depend on the length of the analysis window is researched. It is expected of encoding the musical instrument sound and the voice. Signal model A great amount of time hangs in the parameter estimation and there is a problem in practical use.

Generalized Harmonic Analysis (GHA) is equipped with exellent time-frequency resolution better than that of conventional Short Time Fourier Transform. The technique for uniting an analytical speed to accuracy is not found though the algorithm that efficiently analyzes the generalized harmonic analysis is researched. The sum total operation of the square error margin that becomes a calculation load most in the calculation of the generalized harmonic analysis is made hardware by FPGA (Field Programable Gate Array).

2 Generalized Harmonic Analysis(GHA)

The generalized harmonic analysis is a time-frequency analysis technique advocated by wiener[1] in 1958. It is rest error energy of object signal x and the sine wave model signal as N as for the length of an analytical window.

$$W = \sum_{i=0}^{N-1} \Big\{ A\cos(2\pi(ft_i + \phi)) - x_i \Big\}^2$$

Becoming it parameter A , f, and ϕ are extracted as an analytical result. The problem of the generalized harmonic analysis is that a great amount of time hangs in the parameter

estimation to which the cost value is minimized. The analysis that both analytical accuracy and the speed coexist cannot be done though ABS(Analysis By Synthesis) method [2], [3], and algorithm of Hirata [4] are proposed as a past analytical algorithm.

In this proposal technique, a highly accurate, high-speed analysis is achieved by doing a rough parameter estimation with hardware, and applying the nonlinear least squares method with software based on the result.

3 GHA Hardware

The generalization harmony analysis hardware that uses FPGA is constructed. It searches for this hardware by the range and the number of partitions for which parameter A, f, and ϕ that energy is minimized are specified. FPGA(XC2V6000) [5] of Xilinx Co. VirtexⅡ series was used in this thesis. Throughput is improved by making the cost value calculator a pipeline, and making it to the parallel, and 16 was able to be parallel, and to compose the hardware of operation frequency 48MHz in the maximum.

4 Software Processing

The sine wave parameter value presumed with hardware is assumed to be an initial value, the nonlinear least square method is applied with software, and the parameter presumption accuracy is improved. In this thesis, newton method is used as a method of the nonlinear least squares method. A highly accurate parameter estimation becomes possible because it divides the parameter estimation with software into three procedures. it efficiently analyzes it by executing the pipeline of hardware and software.

5 Summary

Execution times when hardware and going by the pipeline execution of software in case of the case to execute all the proposal techniques with software were compared. As a result, the case with hardware was able to be analyzed by about ten times the speed. Moreover, a frequency that was more highly accurate than the technique was able to presume so far.

References

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