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Research on speed-up of contents fingerPrinting using FPGA

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1 Introduction

In recent year illegal music distribution via network with the file exchange software in recent years becomes a serious problem such as copyright infringements and CD sales number decreases. Thus the technique for using the contents management technology for DRM (digital copyright management) technology is paid to attention as the measures. (For instance, contents that flow on the network are identified.)Some identification methods like the digital watermark and the fingerprint, etc. are proposed as the number of music in recent years increases.An audio fingerprint is a compact representation of the perceptually relevant parts of audiocontent. A suitable audio fingerprint can be used to identify audio files, even if they are severely degraded due to compression or other types of signalprocessing operations. It was thought that it was not possible to adjust to the DRM system only by jast implement the algorithm hardware in this research. Therefore, I achieved a more high-speed fingerprint system on FPGA by using the technique of the loop unrolling of the computing unit and the parallel processing that used the pipeline register. In the evaluation of the processing time, about 10.6 times the performance were obtained compared with processing with software.

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2 About the audio fingerprint

There are many researches about audio fingerprint from view point of Shortening strength, convenience, and the calculation order etc. Cano at el. proposed the outline of audio FP system to be a prototype. He also provides a good overview of existing audio fingerprinting systems. All audio fingerprinting systems derive their fingerprint from some kind of time-frequency representation, e.g. using short-term Fourier transforms. Main differences are due to the features they use to construct the fingerprint, e.g. spectral flatness features , spectral peaks , Fourier coeffi- cients , Mel-Frequency Cepstrum Coefficients (MFCC). and differences in energy between frequency bands.To achieve the construction of the hardware implemented fingerprint system with a high-speed, small circuit and high reliability, I examined feature for fingerprint implementation considering following points.

- It is very robustness to compression and deterioration in the quality.
- The step of the feature generation algorithm is a simple composition by addition and the subtraction, etc.
- Neither multiplication nor division are multiused.
- The fingerprint size must be compact to store it by space-saving in FPGA.

Result of examining the above-mentioned, Philips audio fingerprint system by Haitsma and Kalker decided to be improved in this research for hardware, and to mount.

3 Hardware construction

The TOP composition of the system that is speed-up with hardware is three step composition. Our two of that are the feature generation parts of the fingerprint and another oen is the music retrievals and identification parts as well as an existing fingerprint system. Another is interface parts where the reading and writing control is done synchronizing with special

API of VirtualTurbo. The fingerprint feature generation part is the one that fingerprint algorithms of Haitsuma were improved for hardware. Hardware does the C++ program on host PC to synchronization. Music file (wave,16bit,44.1KHz) is transmitted by executing API function for writing by the program of host PC, and algorithms of Haitsuma composed of the logical circuit generate the fingerprint. The fingerprint feature generation part aimed at the improvement of the performance by the parallel processing that used the pipeline register and the technique of the loop unrolling of the comparator. RAM composed by BRAM from which the standard is installed in FPGA and CLB is arranged in the music identification circuit, and the fingerprint of music is stored in the memory area beforehand. Parallel arrangement of the music identification circuit does two or more identification processing at the same time, and they are high-speed and robustness.

4 Evaluation

The evaluation did the item of the fingerprint processing time measurement, the music identification, the retrieval time measurement, the amount of the circuit, the critical path measurement, robustness, and the reliability assessment. About the fingerprint processing time, When radix-4FFT was mounted with 650ms (about 5.1 times the processing speed with software) when radix-2FFT was mounted, it achieved it with 314ms (about 10.6 times the processing speed with software). It is thought that this was an effect of two policies for speed-up in the fingerprint feature generation circuit. The pipeline register that examined the grain degree of the function arranged one . And, another is a loop unrolling of the comparator to reduce the clock. Moreover, it was also effective for the conversion step where the calculation load was the highest in the fingerprint processing process to able to arrange best FFT. owever, it caused the size of the delay of the critical path of the music identification part to lower the maximum operating frequency of the TOP composition greatly.The increase of the critical path by parallel development more than the parallel 30 of the music identification part showed that arrangement not the acute problem but more than the parallel 100 was also possible. The tolerance by the change in tone quality

was evaluated about robustness. And,robustness was proven to the processing of almost commonsense tone quality. It is reformative for an audio fingerprint process with software a general field to mount the fingerprint algorithm that is theoretical robustness on hardware, and to have verified the robustness and reliability by the experiment.

5 Summary and view in the future

The hardware constructed with this research generated the fingerprint from the audio data at high speed, and achieved the identification of two or more musics simultaneously. Processing at the speed of 213Mbps was possible, and about 10.66 performance times improved were obtained compared with processing with software at the identification of 30 musics simultaneously. As for this, a profitable result was obtained in the point of processing performance improvement of contents management as catching the music file on the network of wideband became possible. However, it is understood that it is capacity shortage if it says to a lot of numbers of titles of music that exists in the world for the number of data bases of musics so that the system that we proposed may identify only small number of titles. The number of titles of music that the major record company such as HMV is delivering in the Internet keeps increasing with 600,000-700,000 titles. Therefore, the large-scale storage medium that can be communicated with FPGA at high speed is necessary so that our proposal may become practicable further. Moreover, the finger Printing circuit constructed with FPGA can be applied as built in a part of large-scale audio fingerprint service (It is composed by the server) as an accelarator.