

# 学位論文要旨

題目 A Study of Loss-Less Data Compression Method  
Optimized for GPU Decompression  
(GPU 上での展開に適した可逆データ圧縮方式に関する研究)

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A *GPU* (Graphics Processing Unit) is a specialized circuit designed to accelerate computation and designed for general purpose computing. Data compression is one of the most important tasks in the area of computer engineering. Usually, data in a large archive are stored in a compressed format to save the space. If archived data stored in a data center are accessed by users, and they are processed on the GPU for display, such data compression method optimized for GPU decompression should be used. This dissertation shows GPU implementation of LZW decompression and a new loss less data compression method optimized for GPU decompression.

In Chapter 1, we describe the introduction of the dissertation including the research background and contributions. We then go on to introduce NVIDIA GPU architecture and CUDA in Chapter 2. Latest GPUs are designed for general purpose computing and can perform computation in applications traditionally handled by the CPU. CUDA is a parallel computing architecture provided by NVIDIA.

In Chapter 3, we show loss-less data compression methods and, related works for GPU implementations of loss-less compression and decompression. Loss-less data compression creates compressed data, from which we can obtain the exactly same original data by decompression. We show existing researches about parallel algorithms and GPU implementations of loss-less data compression and decompression methods.

In Chapter 4, we present GPU implementation of LZW compression and a work-optimal parallel algorithm for LZW decompression and to implement it in a CUDA-enabled GPU. LZW is a patented lossless compression method used in Unix file compression utility “compress” and in GIF image format. The idea of LZW compression is to create a dictionary to map a substring of 8-bit numbers into a code. The dictionary is created by reading the input string from the beginning. We first present a work-optimal parallel

LZW decompression algorithm on the CREW-PRAM, which is a standard theoretical parallel computing model with a shared memory. The key idea of parallel LZW decompression algorithm is to create a dictionary by parallel pointer traversing. We then go on to present an efficient implementation of this parallel algorithm on a GPU. Our parallel LZW decompression on the global memory of the GeForce GTX 980 GPU is 43.6 times faster than a sequential LZW decompression on the main memory of the Core i7-4790 CPU for this image.

In Chapter 5, we present a new lossless data compression method that we call Adaptive Loss-Less (ALL) data compression. It is designed so that the data compression ratio is moderate but decompression can be performed very efficiently on the GPU. ALL coding includes several data compression techniques: *run-length coding*, *segment-wise coding*, *adaptive dictionary coding*, and *Huffman-based byte-wise coding*. To show the potentiality of ALL data compression method, we have evaluated the running time using five images and five text data and compared ALL with previously published lossless data compression methods implemented in the GPU, Gompreso, CULZSS, and LZW. The data compression ratio of ALL data compression is better than the others for eight data out of these 10 data. Also, our GPU implementation on GeForce GTX 1080 GPU for ALL decompression runs 84.0-231 times faster than the CPU implementation on Core i7-4790 CPU. Further, it runs 1.22-23.5 times faster than Gompreso, CULZSS, and LZW running on the same GPU.

In Chapter 6, we conclude our works.