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GPU acceleration of CCSDS Rice decoding

Bachelor's thesis
in **COMPUTER SCIENCE**

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Abstract

TBD

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CCSDS Rice coding, GPU, Compute Unified Device Architecture (CUDA)

Thesis domain (Socrates-Erasmus subject area codes)

11.3 Informatics, Computer Science

Subject classification

D. Software

D.1.3. Concurrent Programming

I.4.2. Compression (Coding)

Tytuł pracy w języku polskim

Akcerleracja GPU dekodowania CCSDS Rice

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Introduction

Data compression is a widely utilized technique for reducing the storage requirements and transmission time for large data sets. However, when it comes to training deep learning models, the decompression of compressed data can create a bottleneck in the machine learning pipeline, particularly when dealing with specialized data formats such as astronomy and medicine that employ custom compression algorithms that can be computationally expensive to decompress. One such specialized compression algorithm is RICE coding, which is widely used in the FITS data format in astronomy. To address this bottleneck, utilizing Graphics Processing Units (GPUs) and parallelization techniques have emerged as promising solutions for accelerating the decompression of large data sets by leveraging the parallel processing capabilities of GPUs. While established solutions for mainstream lossless compression algorithms like JPEG-2000 exist, this paper aims to investigate the potential of GPU acceleration and parallelization in enhancing the performance of RICE coding, a specialized and niche compression algorithm.

Chapter 1

Key terms

1.1. FITS

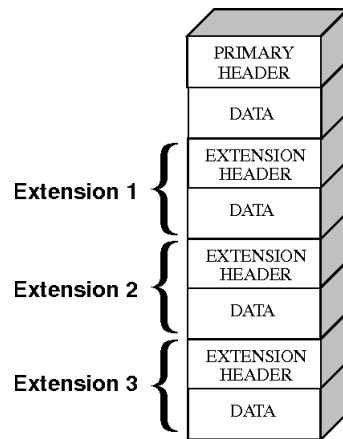
The Flexible Image Transport System (FITS) format is a digital file format that is commonly utilized in the field of astronomy for storing and transferring scientific data. FITS files typically contain images, data cubes, and tables of observational data, as well as associated metadata. One of the key characteristics of FITS is its ability to store multiple data arrays in a single file, which allows for the efficient storage and transfer of large data sets. The FITS format is an open standard and is supported by a wide range of software and data analysis tools. However, the FITS format is also known for its large file size, which can present challenges when working with large data sets. As a result, compression algorithms such as RICE compression are often applied to the data before storing in the FITS format.

Citing NASAs fits standard:

A FITS file shall be composed of the following FITS structures, in the order listed:

- Primary header and data unit (HDU).
- Conforming Extensions (optional).
- Other special records (optional, restricted).

Thus, FITS files have follwoing structure:



1.2. RICE

Chapter 2

GPU acceleration of CCSDS Rice decoding algorithm

2.1. Naive approach

Bibliography

- [Bea65] Juliusz Beaman, *Morbidity of the Jolly function*, *Mathematica Absurdica*, 117 (1965) 338–9.