Universidade do Minho
Escola de Engenharia
Departamento de Informática

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Study on FFT on the GPU

January 2022

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Master dissertation
Integrated Master's in Informatics Engineering

Dissertation supervised by
Supervisor
Co-supervisor (if any)

January 2022

ABSTRACT

Write abstract here (en) or import corresponding file

KEYWORDS keywords, here, comma, separated.

RESUMO

Escrever aqui resumo (pt) ou importar respectivo ficheiro

PALAVRAS-CHAVE palavras, chave, aqui, separadas, por, vírgulas

CONTENTS

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INTRODUCTION

1.1 CONTEXTUALIZATION

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1.2 MOTIVATION

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1.3 OBJECTIVES

The main objective of this dissertation is to provide efficient FFT alternatives in GLSL compared with dedicated tools for high performance of FFT computations like NVIDIA cuFFT library, while analysing the intrinsic of a good Fast Fourier Transform implementation on the GPU. To accomplish the main objective there are two stages taken in consideration, "*Analysis of CUDA and GLSL kernels*" to be well settled in their differences and to have a reference for the second stage "Analysis of cuFFT and GLSL FFT" which will cluster the study's main objective.

To compose a final verdict conclusion, we will use as case of study applications with implementation of the FFT in the field of Computer Graphics that require realtime performance.

test Brigham (1988)

1.4 DOCUMENT ORGANIZATION

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STATE OF THE ART

2.1 FOURIER TRANSFORM

2.1.1 *What is Fourier Transform*

The **Fourier Transform** is a mathematical method to transform the domain refered to as *time* of a function, to the *frequency* domain, intuitively the Inverse Fourier Transform is the corresponding method to reverse that process and reconstruct the original function from the one in *frequency* domain representation.

Although there are many forms, the Fourier Transform key definition can be described as:

$$X(\omega) = \int_{-\infty}^{+\infty} x(t) e^{-i\omega t} dt \qquad \text{Forward Fourier Transform}$$

$$x(t) = \frac{1}{2\pi} \int_{-\infty}^{+\infty} X(\omega) e^{-i\omega t} d\omega \qquad \text{Inverse Fourier Transform}$$

- $x(t) \rightarrow$ function in *time* domain representation
- $X(\omega) \rightarrow$ function in *frequency* domain representation
- $i \rightarrow$ imaginary unit $i = \sqrt{-1}$

This model of the fourier transform applied to infinite domain functions is called **Continous Fourier Transform** and its targeted to the calculation of the this transform directly to functions with only finite discontinuities in $x(t)$.

2.1.2 *Where it is used*

2.1.3 *Discrete Fourier Transform*

The Fourier Transform of a finite sequence of equally-spaced samples of a function is the called the **Discrete Fourier Transform** (DFT), it converts a finite set of values in *time* domain to *frequency* domain representation. Its the most important type of transform since it deals with a discrete amount of data, which can be implemented in computers and be computed by specialized hardware.

$$X_k = \sum_{n=0}^{N-1} x_n \cdot e^{-\frac{i2\pi}{N}kn}$$ Forward Discrete Fourier Transform

$$x_n = \frac{1}{N} \sum_{k=0}^{N-1} X_k \cdot e^{\frac{i2\pi}{N}kn}$$ Inverse Discrete Fourier Transform

2.2 FAST FOURIER TRANSFORM

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2.2.1 *Computation of FFT*

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2.3 RELATED WORK

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BIBLIOGRAPHY

E Oran Brigham. *The fast Fourier transform and its applications*. Prentice-Hall, Inc., 1988.

NB: place here information about funding, FCT project, etc in which the work is framed. Leave empty otherwise.