Convolution with theoretical-number methods

Two dimensional convolutions of lengths 2^n

Denis Morozov, PhD
morozov.den@samsung.com

[1]Mobile Lab 2
Samsung R&D

[2]Department of Computer Science, doctoral studies
University of "Kiev-Mogyla Academy"

Presentation , 2011

Outline

Outline

Main Characteristics Of The Studied Algorithms

We study the convolution algorithms are well adapted for the processing of complex images

- pay special attention to ease of implementation and speed performance of these algorithms
- impose the condition of no computational errors in these algorithms

Main Characteristics Of The Studied Algorithms

We study the convolution algorithms are well adapted for the processing of complex images

- pay special attention to ease of implementation and speed performance of these algorithms
- impose the condition of no computational errors in these algorithms

Main Characteristics Of The Studied Algorithms

We study the convolution algorithms are well adapted for the processing of complex images

- pay special attention to ease of implementation and speed performance of these algorithms
- impose the condition of no computational errors in these algorithms

Applications Of Two-Dimentional Number-Theoretical Convolutions

Integer FFT applied in various areas related to image processing and finding a correlation, such as tomography and processing of images taken by satellite. The motivation to use number-theoretical FFT is

- 32 bit integer algorithms have good specifications for optimizing on existing processors
- number-theoretical Fourier transform works well for convolutions with large kernels

Applications Of Two-Dimentional Number-Theoretical Convolutions

Integer FFT applied in various areas related to image processing and finding a correlation, such as tomography and processing of images taken by satellite. The motivation to use number-theoretical FFT is

- 32 bit integer algorithms have good specifications for optimizing on existing processors
- number-theoretical Fourier transform works well for convolutions with large kernels

Applications Of Two-Dimentional Number-Theoretical Convolutions

Integer FFT applied in various areas related to image processing and finding a correlation, such as tomography and processing of images taken by satellite. The motivation to use number-theoretical FFT is

- 32 bit integer algorithms have good specifications for optimizing on existing processors
- number-theoretical Fourier transform works well for convolutions with large kernels

Outline

The Required Basic Information

Power of Algebra and Number Theory

We were studied classical works using algebraic methods for calculating the convolution. Different techniques, including the arithmetic of finite fields, linear algebra and group theory have been used.

They were adapting to the implementation of algorithms for discrete convolution in C++ language based processor architecture.

The Required Basic Information

Power of Algebra and Number Theory

We were studied classical works using algebraic methods for calculating the convolution. Different techniques, including the arithmetic of finite fields, linear algebra and group theory have been used.
They were adapting to the implementation of algorithms for discrete convolution in C++ language based processor architecture.

Outline

Main Result
Powers of two

Implemented a two-dimensional convolution with algebraic methods for the size of $2^n \times 2^m$

- $0 \leqslant m, n \leqslant 10$.

Main Result
Powers of two

Implemented a two-dimensional convolution with algebraic methods for the size of $2^n \times 2^m$

- $0 \leqslant m, n \leqslant 10$.

Outline

Base Technical Points

During construction of the algorithm we are

- reducing the number of using modulo field's size
- using the FFT algoritm of length 32 based on symmetry of transform matrix
- transition from 64-bit to 32-bit arithmetic

Base Technical Points

During construction of the algorithm we are

- reducing the number of using modulo field's size
- using the FFT algoritm of length 32 based on symmetry of transform matrix
- transition from 64-bit to 32-bit arithmetic

Base Technical Points

During construction of the algorithm we are

- reducing the number of using modulo field's size
- using the FFT algoritm of length 32 based on symmetry of transform matrix
- transition from 64-bit to 32-bit arithmetic

Summary

- In this work implemented a two-dimensional integer convolution
- Possible sizes are - 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024

- Outlook
  - Next task to investigate the possibility of constructing fast two-dimensional convolution for sizes that are not powers of two

Summary

- In this work implemented a two-dimensional integer convolution
- Possible sizes are - 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024

- Outlook
  - Next task to investigate the possibility of constructing fast two-dimensional convolution for sizes that are not powers of two

For Further Reading I

B. Bleihut
Fast Algorithms for Digital Signal Processing [Russian translation].
Mir, Moscow (1989)

D. Morozov.
The calculation of the convolution with the number-theoretical transforms
Report for Mobile Lab 2, 8 pages, December 2011.