

MULTI-CORE PROGRAMMING
FINAL PROJECT REPORT

IMPLEMENTATION AND OPTIMIZATION OF IMAGE
TEMPLATE MATCHING IN CUDA

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the degree*

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Abstract

In most computer vision and image analysis problems, it is necessary to define a similarity measure between two or more different objects or images. Template matching is a classic and fundamental method used to score similarities between objects using certain mathematical algorithms[1]. In this project, we'll propose two implementations of image template matching in CUDA. Our first method is based on the *naive* version of the template matching and the second method is based on the *Fast Fourier Transform* algorithm.

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Chapter 1

Introduction

In this section we'll take a brief look at the recent researches on *Template Matching* task, its variants and the reliability of the models proposed in this task.

1.1 Background and Recent Research

1.1.1 Feature Based Approach

A featured-based approach is appropriate when both reference and template images contain more correspondence with respect to features and control points. In this case, features include points, curves, or a surface model to perform template matching. In this category, the final goal is to locate the pair-wise connections between the target or so-called reference and the template image using spatial relations or features. In this approach, spatial relations, invariant descriptors, pyramids, wavelets and relaxation methods play an important role in extracting matching measures[1].

1.1.2 Area Based Approach

Area-based methods, which are usually known as correlation methods or template matching, were developed for the first time by Fonseca et al. [6] and are based on a combined algorithm of feature detection and feature matching. This method functions very well when the templates have no strong features with an image, since they operate directly on the pixel values. Matches are measured using the intensity values of both image and template. The matching scores are extracted by calculating squared differences in fixed intensities, correction-based methods, optimization methods and mutual information[2].

1.1.3 Naive Template Matching

Naive template matching is one of the basic methods of extracting a given which is identical to the template from the image target. In this approach, with or without scaling (usually without scaling), the target image is scanned by the template, and the similarity measures are calculated. Finally, the positions with the strongest similarities are identified as potential pattern positions[1].

1.1.4 Image Correlation Matching

In this classic template matching method, the similarity metric between the target and the template is measured. Unlike the naive template matching algorithm, the target and the template might have different image intensities or noise levels. However, those images must be aligned. The similarity metric used in this approach is based on the correlation between the target and the template[3].

1.1.5 Sequential Similarity Detection Algorithms

Sequential similarity detection algorithms (SSDAs) are a more efficient alternative to correlation-based methods, including matched filters for translational registration. The measure of match is indirectly calculated based on an error for corresponding pixels in f and g in the images under comparison at any stage of the registration process[4].

1.2 Motivation

There are dozen optimized implementation of *Template Matching* techniques, but the main motivation for me to do so, was the ability to model and code a real-life problem from scratch. I've also improved my CUDA and C++ programming skills with this project. Also, there are multiple math concepts covered in the *Fast Fourier Transform* section which understanding them can bring an enhanced point of view in image and signal processing tasks.

Chapter 2

Problem Definition

The emerging need of image processing techniques in everyday life is inevitable. There have been lots of image processing algorithms proposed to increase the overall availability of tools in image understanding and using these tools to improve the human life. *Template Matching* is a task that its applications are obvious in everyday life. Computer vision tasks such as *object detection*, *object recognition* and other tasks based on these two main questions; Is there a certain object in the image? And if yes, where is it in the image?, can be classified as subproblems of *template matching* task. This task can be extended to counting the number of occurrences of an object in a given image. Given a main image and a template image, we want to find occurrences of the template image in main image. This problem can be solved in many ways. In the next chapter, we'll analyze the procedure of *naive* template matching to solve this problem. In further chapters, we'll provide the procedure of using *Fast Fourier Transform* to convert the images into frequency domain. We'll show that finding the maximum value of the result of the convolution of two images is where the template has occurred in main image.

Chapter 3

Work Done

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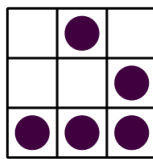


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3.1.5 §Sub-section title¿

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Chapter 4

Future Work

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Chapter 5

Conclusion

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