Curvature Estimation Algorithm's Implementation

NGUYEN Quang Anh, REBMANN Guillaume

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Abstract

Several curvature estimators along digital contours were proposed. In this paper, we show the implementation of *Osculating Circles Estimator* and *Binomial Convolution Curvature Estimator*. After that is an approach to parallel the calculations on GPU.

1 INTRODUCTION

The main target of this article is to implement different algorithms to calculate Curvature. To reach our goal, we studied differents scientific articles [**?**] and then implement the algorithm for an parallel use.
This article is composed of two parts: Osculating Circles Estimator & Binomial Convolution Curvature Estimator.
The purpose of the comparison is to find the best algorithm to use to find curvature to classify different insect species.

2 DGTal Library

In this project, we used DGtal for image and contour's realization. DGtal library is a project aimed at developing generic, efficient and reliable digital geometry data structures, algorithms and tools. This project is made by the cooperation between LIRIS, LAMA, LORIA, GREYC and IRCCyN.

3 Osculating Circles Estimator

Osculating Circles Estimator (CC) is an algorithm that calculate the curvature of a contour, by pointing out the tangent circle at each point of the contour.

For implementing this part, we used the definition of digital straight segment and digital straight line.

3.1 Digital Straight Line

Digital Straight Line (DSL) is defined by 4 values : $D(a, b, \mu, \omega)$, with $a, b, c, d \in \mathbb{Z}$ and $gcd(a, b) = 1$. a/b is called a sloped of D, μ is an intercept and ω is the thickness of D.

Every points that belong to $D(a, b, \mu, \omega)$ must satisfy :

$$\mu \leq ax - by < \mu + \omega$$

In DGtal, there are 2 types of DSL :

- Naive Digital Straight Line
- Standard Digital Straight Line

These type of DSL is made by specifying the value *thickness*.

- Naive DSL : $\omega = max(|a|, |b|)$
- Standard DSL : $\omega = |a| + |b|$

3.2 Digital Straight Segment

Digital Straight Segment (DSS) is the set of points that belong to a digital straight line. Just like DSL, in DGtal there are also two specifics DSS : Naive DSS and Standard DSS.

3.3 Implementation

In this project, we used the standard DSL and DSS to implement this algorithm. A class **ArithmeticalDSSComputer** will be used to analyze the points of the contour.

StandardDSS4Computer is the sub class of **ArithmeticalDSSComputer**, which is specialized which type of DSS that use to make the calculation. After extract all the points of the contour into a vector, we need to adjust this vector to be able to iterate through all the points of the contour.

The idea of CC algorithm is that at each point of the contour, called K point, we will try to extend the DSS, which is started at the point we are at, to the utmost left (resp. utmost right). The last point that can be added to the DSS called L point (resp. R point). The three points K, L, R form a triangle. Call the rayon of the circle that go through these three points R. Then the curvature's value of point K will be $sign(det(\overrightarrow{KR}, \overrightarrow{KL}))/R$

4 CONCLUSION

After finishing this project, I have obtained many knowledge, first of all, is the usage of *Rodin* and the way to define a system in a logical way. I have to think about the problems that I have never thought about before when programming. And most importantly, is that I could find out that all my knowledges about boolean algebra are still useful, and it could contribute to build a system in a clear and logical way.