Abstract

The work presented in this thesis concerns the fields of image analysis and discrete geometry. Image analysis aims at automatically describing the visual content of a digital image and discrete geometry provides tools devoted to digital image processing. A two-dimensional analog signal is regularly sampled in order to be handled on computers. This acquisition process results in a digital image, which is made up of a finite set of discrete elements. The topic of discrete geometry is to study the geometric properties of such kind of discrete spaces.

In this work, we consider homogeneous regions of an image having a meaning for a user. The objective is to represent their digital contour by means of geometric patterns and compute measures. The scope of applications is wide in image analysis. For instance, our results would be of great interest for segmentation or object recognition.

We focus on three discrete geometric patterns defined by Gauss digitization: the convex or concave part, the digital straight segment and the digital circular arc. We present several algorithms that detect or recognize these patterns on a digital contour. These algorithms are on-line, exact (integer-only computations without any approximation error) and fast (simplified computations thanks to arithmetic properties and linear-time complexity). They provide a way for segmenting a digital contour or for representing a digital contour by a reversible polygon.

Moreover, we define a measure of convexity, a measure of straightness and a measure of circularity. These measures fulfil the following important properties: they are robust to rigid transformations, they may be applied on any part of a digital contour, they reach their maximal value for the template with which the data are compared to.

From these measures, we introduce new patterns having a parameter that ranges from 0 to 1. The parameter is set to 1 when the localisation of the digital contour is reliable, but is set to a lower value when the digital contour is expected to have been shifted because of some acquisition noise. This measure-based approach provides a way for robustly decomposing a digital contour into convex, concave or straight parts.