Research and Application of Mathematical Morphology Algorithms on OSSC

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Long Abstract

Essential ideas of Mathematical Morphology lie in measuring and extracting corresponding shape of an image with certain forms of structure elements, which aims at image analysis and recognition. Practical application of Mathematical Morphology contributes to simplifying image data, maintaining basic features of shape of an image, and removing irrelevant structure. On the other hand, open source software for scientific calculations, such as Scilab, provide essential elements, like matrix operations and image instant display, for establishing professional Mathematical Morphology toolbox. This paper held a theoretical research on realization and application of algorithms of Mathematical Morphology on Scilab, and meanwhile built a toolbox entity which applies Mathematical Morphology to image processing.

Theoretical basis of practical application of Mathematical Morphology is to convert its algorithms and formulas into functions which can be called by open source software. In this research, we code Mathematical Morphology algorithms into functions with the forms of Scilab, using image and structure elements as parameters. Instant result will be displayed after function calling. Thus it provides access to process image using algorithms of Mathematical Morphology as a toolbox. It realized total 46 algorithm of Mathematical Morphology, including Erode, Dilate, Open (reconstruction), Close (reconstruction), Hit and Hit-miss, Distance transformation etc.; and 23 common image process functions, including binary logical operation, histogram, grayscale transformation etc. Binary, grayscale and color image are all available to be operated.

Two key techniques are adopted in this toolbox: Interface function utilization and image decomposition by RGB matrix. Interface function was used for the purpose of calling the dynamic link library. First, the two core functions of Mathematical Morphology - Dilate and Erode – were written in C language. Then these two functions were executed to generate object file. With the object file a correspondent “builder.sce” file was written to make a .dll file and to generate a file called “loader.sce”, which is called to load the Dilate and Erode into Scilab. Calling dynamic

link library will prevent from the weak performance caused by execution of loop sentences in Scilab. Image decomposition contributes to color image processing. A theoretical analysis shows that processing color image using Dilate or Erode function actually consists of three steps: image decomposition into RGB matrix, operating the three matrixes separately, and the re-composition of them. Extension of this method is utilized by other Mathematical Morphology functions.

Tests of correctness manifested that practical results of running all functions of this toolbox are in coincidence with the theoretical results. The performance test shows that it runs 297.8 times faster than SIP on the same operation (in the case of structure element by 15*15, with grayscale image). Moreover, it was designed to be a multiplatform toolbox which can run under Windows and Linux, using different format of dynamic link library (.dll file for Window and .so file for Linux). Its range of practical application covers various aspects of image processing, including objects recognition of hit/hit-miss transformation; image excision based on concepts of river basin; skeleton extraction and image coding compression based on erosion and open operation; image reconstruction based on geodesic distance; particle analysis based on morphological filter. etc.

Keywords: Mathematical Morphology, structure elements, toolbox, Scilab, Dilate and Erode