Line Segment Detection – white paper

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saiwa

simple artificial intelligence web application

Line Segment Detection is an important and classical problem in image processing and computer vision. Line segments carry important information about the geometrical content of images corresponding to edges. Most human-made objects have flat surfaces, and many shapes are able to be more simply described in terms of straight lines. Line segments can be used as basic or fundamental elements in the efficient detection of more elaborate shapes, if done correctly. Line segment detection has applications like stereo analysis, crack detection in materials, indoor scene layout recovering, simultaneous localization and mapping (SLAM), image compression, satellite image indexation, and so on [1].

Line segment detection is an old problem. Classic algorithms start by edge detection using, for instance, the well-known Canny method. The next step is then to apply the Hough transform to form global lines that contain a certain number of edge points. Global lines are finally broken into line segments using gap and length thresholds [2].

More recently a linear-time line segment detector (LSD) has been proposed that gives accurate results, a controlled number of false detections, and requires no parameter tuning [1 and 3]. LSD uses *a contrario* validation approach to control the number of false detections according to the Helmholtz principle [4]. With the saiwa Line Segment Detection service, we employ the open-source implementation of LSD as distributed by the original paper authors [5]. Figure 1 shows results of applying LSD on natural images.

Line Segment Detection

LSD algorithm starts by computing a level-line field of vectors that are tangent to the level line going through their base point. This field is then segmented into connected regions of pixels which share the same level-line angle up to a certain threshold. These connected regions are called line support regions, represented in Figure 2. Next, a rectangle is estimated from the line support region. Finally, *a contrario* based validation is applied over this rectangle. An event of an observed rectangle of aligned points is validated as meaningful if the expected number of events as good as the observed one is small on the a contrario model. For more technical information of the LSD algorithm and Helmholtz principle, please refer to [1].

Figure 1. LSD results on natural images using saiwa Line Segment Detection service interface.

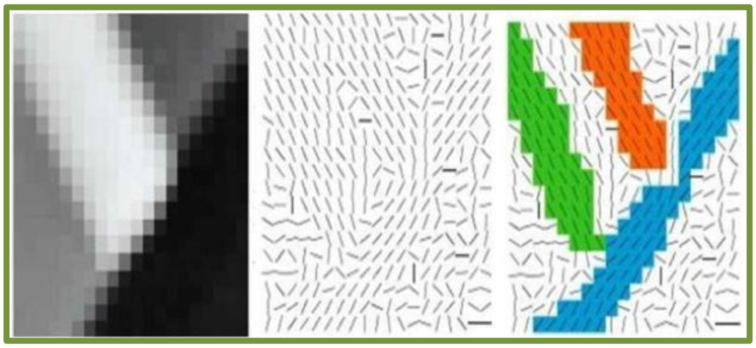

Figure 2. An instance of level-line field and corresponding line support regions (printed from [3]).

References:

[1] Von Gioi, Rafael Grompone, et al. "LSD: A fast line segment detector with a false detection control." IEEE transactions on pattern analysis and machine intelligence 32.4 (2008): 722-732.

[2] Akinlar, Cuneyt, and Cihan Topal. "EDLines: A real-time line segment detector with a false detection control." Pattern Recognition Letters 32.13 (2011): 1633-1642.

[3] Von Gioi, Rafael Grompone, et al. "LSD: a line segment detector." Image Processing On Line 2 (2012): 35-55.

[4] Desolneux, Agnes, Lionel Moisan, and Jean-Michel Morel. From gestalt theory to image analysis: a probabilistic approach. Vol. 34. Springer Science & Business Media, 2007.

[5] http://www.ipol.im/pub/art/2012/gjmr-lsd/.

info@ saiwa.ai

720 Guelph Line Burlington, ON L7R 4E2 Building
+15148131809
www.linkedin.com/company/saiwa
www.instagram.com/saiwa.ai