STEP EDGE LOCATION WITH SUBPIXEL ACCURACY IN GRAY LEVEL IMAGES FROM BINARY SCENES

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Abstract

This paper describes a local method to locate step edges with subpixel accuracy in low-noise images. An algorithm that allows to get higher resolutions in the step edges in gray level images is proposed. The proposed local method takes into account the intensity values (in gray level images) in 5x5 neighborhoods of each pixel. A quadratic function over the middle pixel of these neighborhoods models each step edge.

Keywords: Step Edge Detection, Subpixel Accuracy, Image Reconstruction.

Edge detection is a common task present in almost all Computer Vision systems. Very often the better the accuracy obtained in step edge detection process, the better the results achieved by the vision system. Sometimes it is not possible to increase the resolution of the acquired image in order to obtain a higher accuracy. In this way, in some applications, subpixel accuracy is needed. The purpose of this paper is to present a procedure to estimate the position of step edges in gray level images from scenes with only a few intensity levels with subpixel accuracy. Some of the applications that need step edge location with subpixel accuracy include high precision measurement of flat objects, quality control, etc.

Step edge detection in one-dimensional signals can be evaluated by means of the centroid estimation over the difference image. In a continuous signal with step edges we can locate the position of these ones through the gradient of the signal.

$$\frac{\int f'(x)x dx}{\int f(x)dx} \tag{1}$$

Evaluating the local centroid over this sequence, the position of the step edge can be estimated:

$$\frac{m_1}{m_0} = \frac{\sum g_k k}{\sum g_k} \tag{2}$$

To detect and locate the step edges in digital images, the gray levels in a 5x5 neighborhood are investigated. First of all it is necessary to determine the existence or absence of step edges in the digital image. The procedure to evaluate the presence or absence of a step edge in the middle pixel of every 3x3 grid of the image is based on a local threshold. Once every neighborhood in the image has been evaluated, each edge-pixel found is classified in one of the following categories: horizontal edge, vertical edge or corner pixel. This classification is made according to the predominant direction of the gradient of the edge. Corner pixels are classified in a similar way.

The next step in the process to evaluate the edges is to model every edge depending on its classification obtained in the precedent stage. The edge-pixels previously classified as horizontal edge can be modeled as a quadratic function:

$$x = py^2 + qy + r \tag{3}$$

To find the values 'p', 'q' and 'r' that allow to model each step edge, three characteristic points of each 5x5 neighborhood are determined. For the edge-pixels with predominant horizontal gradient the three characteristic points are computed by means of applying the centroid estimation by each row of the neighborhood. Then the function that models this step edge is calculated from these characteristic points.

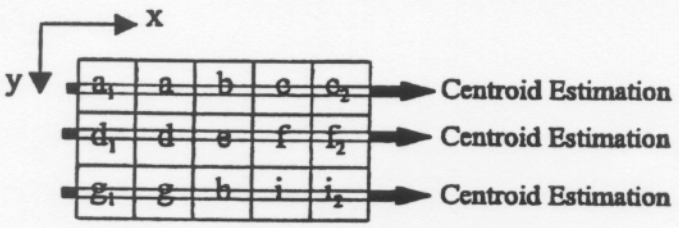

Figure V. Characteristics points for the horizontal edge.

Once every edge-pixel in the image has been determined it is necessary to carry out a continuity study between neighboring pixels.

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