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An Enhanced Approach for EDGE Image Enhancement using Fuzzy set theory and CLA

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Abstract: The most common degradations in images is their poor contrast quality. Edge Enhancement is the art of examining images for identifying objects and judging their significance. The proposed paper uses the concept of hybrid edge detection method based on fuzzy sets and cellular learning automata to detect the gray level changes of neighbors of every pixel, and to detect the edge by using the changing regular of one-order or two-order directional differential coefficient, But sometimes there is uncertainty of the edge, and man can't distinguish whether it is the edge or not. In order to turn the fuzzy edge to be clear and solve the problem above, this paper mentions fuzzy enhancement and cellular learning automata to realize improve image edge detection. In the end, we compare it with popular edge detection methods such as Sobel and Canny.

INTRODUCTION

PROPOSED APPROACH

In this section the proposed approach is described First, the original image is divided into windows with the size of w× w-sized windows for which the heuristic membership function is then found using fuzzy set. After this stage, the edges of the image, including thick and unwanted ones, are detected. If the pre-defined patterns match each w× w window, the central pixel is penalized, otherwise rewarded. Later, the final image is produced using thresholding.

FUZZY PREPROCESSING

In recent years, many fuzzy techniques for edge detection are suggested [8,9,10]. The edge pixels are the pixels whose gray level have high difference with the gray levels of their neighborhood pixels. However, the definition of "high" is quite fuzzy and application-dependant. To deal with the ambiguity and vagueness of edge pixel, edge image should be defined according to fuzzy logic [11]. In this section, a fuzzy approach, which can detect edges accurately within a reasonable time [12] is used for preprocessing. The purpose of using such technique is to determine a proper heuristic membership function for image pixels.

IMAGES AS FUZZY SETS

Let an M x N image X be the set of all pixels $g_{mn} \epsilon (0, L)$, then X can be regarded as an array of fuzzy single tons $\mu mn \epsilon [0,1]$ indicating the degree of brightness of each gray level g_{mn}.

$$x = \bigcup_{m=1}^{M} \bigcup_{n=1}^{N} \frac{\mu_{mn}}{g_{mn}} \qquad (1)$$

The membership function could be achieved as:

$$\mu_{mn} = \frac{g_{mn}}{\max\limits_{i\in[1.M],j\in[1,N]} g_{mn}} \qquad (2)$$

The x' containing all edges:

$$x' = \bigcup_{m=1}^{M} \bigcup_{n=1}^{N} \frac{\hat{\mu}_{mn}}{g_{mn}} \qquad (3)$$

where $\hat{\mu}_{mn}$ indicates the degree of edginess for each pixel. The task of edge detection is, therefore, the determination of the membership function $\hat{\mu}_{mn}$ for each pixel.

HEURISTIC MEMBERSHIP FUNCTIONS

For calculation of edginess, The simplest way for defining a edge detector is the determination of proper membership function μ_{mn} for each pixel g_{mn} at the position (m, n) with a surrounding w x w spatial window. Based on general properties of an edgy neighborhood and based on heuristics different membership functions $\hat{\mu}_{mn}$ is given as:

$$\hat{\mu}_{mn} = \frac{\Sigma_i \Sigma_j |g_{ij} - g_{mn}|}{\Delta + \Sigma_i^w \Sigma_j^w |g_{ij} - g_{mn}|} \qquad (4)$$

where $\Delta \epsilon [0, L)$ is a proper parameter. Meaningful values are in [L/2, t]. The lower Δ the more edges are detected. The advantage of defining the degree of edginess as a fuzzy membership function is that in this case the entire fuzzy set theory becomes applicable for further modifications

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