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EDGE DETECTION USING POLYNOMIAL DIFFERENTIATION METHOD

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ABSTRACT

This paper introduces a polynomial differentiation threshold-based edge detection on contrast enhanced images. The histograms of an image have been processed by using a polynomial differentiation curve fitting method to match the data in a least square sense. The threshold value is calculated from the index value closest to zero. A polynomial differential threshold is applied to the gradient of image to detect the edges. Image quality metrics are calculated and it is found that proposed methodologies outperform earlier algorithms in terms of Entropy.

KEYWORDS

Polynomial differentiation Threshold, Edge Detection, Image enhancement.

1. INTRODUCTION

In image processing edge detection is a method of detecting the boundary lines of objects in images. The detection process is implemented by perceiving the variations of brightness changing of an image. Edge detection applications for image segmentation areas are digital image processing and computer vision (Gonzalez et al., 2003). A large number of researches and studies have been done for enhancement and edge detection of digital images. The edge quality has been judged from various quantitative aspects which established the superiority of the present method.

2. RELATED WORK

Robinson compass mask is utilized for edge detection. It has eight key compass directions and every compass will carry the edges in according to its direction (Čisar et al., 2013). Combined usage of compass masks of diverse directions can perceive the edges from different angles. The zero-crossing edge detector utilizes the Laplacian of Gaussian operator to filter out an image (Haralick, 1984). The zero crossings end result is strongly motivated via the size of the Gaussian for the smoothing the degree of this operator. Zero cross edge detection method looks for zero-crossings and then filters the image. If the threshold value is set to 0, then the resultant image has closed contours as it passes through all the zero-crossings in the images under test. Bwmorph morphological function is applied to a binary image for mathematical morphological operations (Meihua et al., 2009). An edge detection method to automatically detect and measure the particle size in various noises, overlapped particles, and irregular circumstances has been developed by authors Meng et al. in (Meng et al., 2017). The authors described a canny edge detection with local adaptive thresholding and modified circular Hough transform technique to automatic searching of the particles. Lin et al. proposed a WL (Wang and Lin) operator with a quasi high-pass filter for edge detections of various medical images (Zhao

et al., 2011). Optimal determination of parameters for Canny edge detection paper tested a method to restrict the adaptable constraints and set an improved Canny edge detection algorithm (Zhao et al., 2011). High and low thresholds values of the gradient of image magnitude are described on maximum cross-entropy among inter-classes and Bayesian judgment idea. Detection of edges of the grayscale pixel through polynomial assessment-primarily based Gabor filtering (PEBGF) a set of guidelines approach the histogram for locating the index of each pixel values (Biswas et al., 2016). Polynomial evaluation decompose the image harmonic mean rate and indexing values dependent on the threshold value, that discover the edges. Grayscale image edge can be detected through the DirecEdge method with a Gaussian operator as well as directional information (Lihaotiansky, 2020). DirecEdge utilizes Kirsch operator to find out the statistical direction, which is the direction of the edge. Several edge detection methods were proposed, however, Sobel, Prewitt, Robert, Laplacian of Gaussian (Log) and Canny are taken into consideration due to the maximum popular edge detectors (Sobel et al., 1968; Prewitt, 1970; Roberts, 1965; Canny, 1986). The present study addresses the problems of detecting the edges under poor lighting conditions with the aid of a series of operations. The proposed techniques had been determined to be appropriate for the enhancement of low contrast images and detecting the edges of the images. Image enhancement plays an important role in image processing and analysis. Image enhancement methods optimize the image contrast and quality for various applications computed on the original input image (Beghdadi et al., 1989; Singh et al., 2014). Image enhancement can play a vital role in detecting the edges of digital images shot in both low light and normal lighting environments. We have compared the edge detection results of the proposed method for both with and without image enhancement and it is observed from the results that edge detection from an enhanced image gives slightly better results than detecting edges before enhancement i.e., from an original input image. It is also observed from Matlab simulation results obtained from Entropy have been calculated (MATLAB, 2018a). The outcome via the proposed technique finds the edges precisely and keep the optimum image quality in comparison to the

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other existing methods. The remaining portion of the paper is prepared as follows. segment three gives the description associated with work. In segment four, and five gives the set of rules associated with the proposed approach is offered. The simulation and outcomes are described in segment six while segment seven, concludes the paper.

3. THE DETAIL STEPS OF THE PROPOSED ALGORITHM

3.1 Edge Detection Steps of Enhanced Image

Step 1: Colour image is taken as input image and converted to grayscale image for further processing.

Step 2: Polynomial evaluation has been calculated to smooth out the data obtained from the coefficients found applying polynomial differentiation.

Step 3: Compute first-order difference among the values obtained in step 2 from the polynomial evaluation.

Step 4: The minimum value of the second order difference is derived to compute the threshold value.

Step 5: Convolution is done for high pass filtering by assigning a minimum threshold value such that the over-segmentation can be prevented. So, two-dimensional convolution is computed on the image gradient and threshold value obtained, respectively and assign the pixel values according to a threshold value.

Step 6: Image thinning is done and the final edge detected image is displayed.

4. METHODOLOGY

4.1 Polynomial Derivative Based Threshold

The processed histogram of the image is indicated by a polynomial where

the number of pixels is exposed as a function of intensity levels. When a derivative operation is done on such polynomial, it gives the rate of variations of intensity levels with respect to the pixel numbers in the image. Pd returns the derivative of the product between BL and HC represents the image histogram bin locations (BL) and histogram counts (HC), respectively.

$$Pd(x) = \frac{d}{dx} [BL(x)HC(x)] \quad (22)$$

Polynomial evaluation is done on polynomial derivative value (Pd) and histogram bin points(x) and the function of Pd in x is shown in 23.

$$Pd(x) = Pd_1x^n + Pd_2x^{n-1} + Pd_3x^{n-2} + \dots + Pd_nx + Pd_{n+1} \quad (23)$$

5. PERFORMANCE EVALUATION

Matlab simulation is done for estimating the performance of the present algorithm over the publicly available Berkeley Segmentation Database (BSD) images. The hardware and software configuration to run all the algorithms are Intel Core i7 central processing unit (CPU) and 8 Giga Bytes (GB) random access memory (RAM) on Windows 10 operating system, and the algorithms are simulated in MATLAB R2018a through the default parameters specified in the different methods. Visual quality demonstration and quantitative analysis are done on the output images.

5.1 Quantitative Assessment

Table 1: Entropy results of various algorithms								
BSD Image	Original Image	Canny	Sobel	Robert	Log	Direcedge	Robinson	Proposed
126039	0.9369	0.4409	0.19798	0.18976	0.31848	0.49731	0.43387	0.67796
176035	0.972	0.4997	0.18518	0.16904	0.32824	0.89816	0.37194	0.73394
202012	0.9422	0.7261	0.24161	0.14071	0.54192	0.72773	0.80781	0.89470
227040	0.7016	0.5103	0.27627	0.21433	0.43148	0.79308	0.64451	0.71395
239096	0.9435	0.4296	0.21521	0.19221	0.32816	0.34516	0.46889	0.57478
12074	0.7667	0.3418	0.17613	0.18079	0.25805	0.16436	0.39476	0.48890
Average	0.8771	0.4914	0.21539	0.18114	0.36772	0.57096	0.52029	0.68070

5.2 Entropy

The entropy of an image shows the quality objectively. Entropy determines the detail information content of the image.

$$Entropy = -\sum(HC \cdot \log_2(HC)) \quad (32)$$

Where HC comprises the normalized histogram counts returned from imhist. Table 1. shows the results and it is observed that the proposed method gives higher average Entropy 0.68070. The second-best average Entropy is 0.57096 which is given by Direcedge edge detection method.

5.3 Visual Assessment

Visual quality assessment is done through Matlab simulation shown in Fig.1 and from the result it is observed the proposed algorithm is performed better compare to other state-of-art algorithms.

The BSD image '227040' of 'The ancient architecture' and its detected edges found through processing several algorithms are shown in Fig.5. Sobel filter output is showing edges with some missing and broken edge lines. The output of Canny is found better than Sobel but many details of edges are absent. Roberts filter displays less significant output with missing edge details. The edge obtained from Log filter is improved and showing more details of edges with few broken lines. Direction detector is not improved, showing unidentifiable edge lines with artifacts. Robinson compass detector output is showing the better quality of edges. The

present algorithm establishes edges with all the vital information and discarded the unwanted details.

Figure 1: Original BSD image '227040' of 'The ancient architecture' and output of various edge detection methods

6. CONCLUSION

This paper presents curve fitting method for image edge detection. Edge detection is done by polynomial differentiation curve fitting and polynomial evaluation methods. This is used to fit the histogram data. Polynomial threshold is computed from the derivative value and applied to a gradient image for effectively detecting objects from an image. Matlab simulation shows that the present algorithm is giving better consequences related to the prevailing methods in terms of Entropy.

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