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DIGITAL IMAGE LINE EXTRACTION USING ADAPTIVE FILTERING AND EDGE SMOOTHING USING CLUSTER ANALYSIS

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ABSTARCT:
The digital image line extraction and edge smoothing in general provides abstracted rendering of an image. It simplifies the visual interpretation of an image and convey certain features of it more effectively. In this paper we are presenting a method using 2-D adaptive filtering which is used for preserving the edges while extracting the lines from image. Also a colour based edge detection method is proposed using which chromatic components of an image are extracted through cluster analysis. This line extraction and edge detection scheme is shown to be very effective in preserving the important features of an image. The quality analysis part is calculating Mean Square Error (MSE) and consequently Peak Signal to Noise Ratio (PSNR) which is an approximation to human perception of reconstruction quality.

Keywords: *Digital Image Line Extraction, Edge Detection, cluster analysis, Adaptive Filtering, Mean Square Error, Peak Signal to Noise Ratio.*

1. INTRODUCTION

Edge detection plays an important role in image processing and analyzing expert systems. Success in detection of edges provides us a means of processing the image properties with the help of region segmentation, object detection, and hiding the spatial features of an image .Edge detection may be used in several image processing applications where we need to figure out the important properties of an image[4].The edge detection process serves a lot in analyzing images by significantly reducing the amount of data to be processed, while at the same time preserving useful information about object boundaries [3]. In general, feature extraction refers to the transformation of the observed image into one or more generalized images on which the actual detection of edges is based [5]. Adaptive filtering smooth's images and extracts the lines from images by means of a combination of nearby image values like intensity and texture. This method combines the features of an image based on the techniques of line extraction and image smoothing with edge detection. In contrast with filters that operate on the three bands of a colour image separately, an adaptive Wiener filter can enforce the perceptual metric underlying the CIE-Lab colour space, and smooth colours and preserve edges in a way that is tuned to human perception [3]. In contrast with standard filtering, adaptive filtering produces no imaginary colours along edges in colour images, and reduces noise where they appear in the original image [1].Finally, the performance of an edge detection scheme is expressed as the Peak signal-to-noise ratio and the root-mean-square of the localization error or Mean Square Error (MSE) [4].

2. OVERVIEW

We shall define low level feature to those basic feature that can be extracted automatically from an image without any shape information (information about spatial relationship).As such adaptive filtering is actually a form of low level feature extraction performed as a point operation. Naturally all of these approaches can be used in high level feature extraction, where we find shapes in images[9].The first order detector are equivalent to first order differentiation and naturally the second order edge detector operator are equivalent to one higher level of differentiation. A large number of studies have been published in the field of image edge detection, which attests to its importance within the field of image processing. Many edge detection algorithms have been proposed, each of which has its own strengths and weaknesses. A good edge detector should be able to detect the edge for any type of image and should show higher resistance to noise [7].

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Examples of approaches to edge detection include algorithms such as the Sober, Prewitt and Roberts's edge detectors which are based on the first order derivative of the pixel intensities. The Palladian-of-Gaussian (Log) edge detector is another popular technique, using instead the second order differential operators to detect the location of edges [6].In point of conceptual view, the edge detection methods are categorized into contextual and non-contextual approaches. The non-contextual methods work autonomously without any prior knowledge about the scene and the edges. They are flexible in the sense that they are not limited to specific images. However, they are based on local processing focused on the area of neighboring pixels [8].

The contextual methods are guided by a priori knowledge about the edges or the scene. They perform accurately only in a precise context. It is clear that autonomous detectors are appropriate for general-purpose applications. However, contextual detectors are adapted to specific applications that always include images with same scenes or objects. Structurally, the edge detection methods incorporate three operations: differentiation, smoothing and labelling. Differentiation consists in evaluating the desired derivatives of the image. Smoothing lies in reducing noise and regularizing the numerical differentiation. Labelling involves localizing edges and increasing the signal-to-noise ratio (SNR) and decreasing the Mean Square Error of the detected edges by suppressing false edges [7].

Further clustering is used to provide the extraction of features from the image. Clustering methods are usually iterative methods to partition an image into a number of clusters or groups. The initial clusters has to be re order to make it include only similar characteristics at the end of the operations. K-means clustering is an example of clustering method. The basic algorithm or operations picks K cluster centers, either randomly or based on some heuristic. Then assign each pixel in the image to the cluster that minimizes the distance between the pixel and the cluster center. Re-compute the cluster centers by averaging all of the pixels in the cluster .Repeat steps 2 and 3 until convergence is attained (e.g. no pixels change clusters). This algorithm is guaranteed to converge, but it may not return the optimal solution. The quality of the solution depends on the initial set of clusters and the value of K. When the number of clusters is fixed to k, k-means clustering gives a formal definition as an optimization problem: find the k cluster centers and assign the objects to the nearest cluster center, such that the squared Euclidean distances from the cluster are minimized [2].

3. LITERATURE REVIEW

3.1. *Flow Based Image Abstraction*

In this paper, an automatic technique was suggested that generates a stylistic visual abstraction [2] from a photograph. Our method is designed to convey both *shapes* and *colours* in an abstract but feature-preserving manner. First, it captures important shape boundaries in the scene and displays them with a set of smooth, coherent, and stylistic lines. Second, it abstracts the interior colours to remove unimportant details on the object surface while preserving and enhancing local shapes. What separates our approach from previous abstraction techniques is the use of a *flow-based filtering* framework. We employ existing filters for *line extraction* and *region smoothing* and adapt them to follow a highly anisotropic kernel that describes the "flow" of salient image features. We show that our approach improves the abstraction performance considerably in terms of feature enhancement and stylization, resulting in the production of a high-quality illustration from a photograph that effectively conveys important visual cues to the viewer. Such information reduction could facilitate quick data deciphering, as well as efficient data transmission over the network

3.2. *Edge and Line Feature Extraction based on Covariance Model*

The purpose of this work is to build a feature extractor for Signals with multiple edges (or lines) with varying heights. As such, this work is an extension of Canny's work and others. Since we don't want to prejudice the design towards a filter, we prefer to use the term feature extractor rather than detection filter [9].The starting point in the development of the feature extractor is a model in which the occurrence of edges in 1-D signals is described in terms of conditional auto covariance functions. Application of the Bayes criterion (minimum risk) with unit cost function for both the detection and the localization of the edges results in a feature extractor, the output of which can be interpreted as a sequence of log-likelihood ratios associated with the input signal

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3.3. *A Computational Approach to Edge Detection*

This paper describes a computational approach to edge detection. The success of the approach depends on the definition of a comprehensive set of goals for the computation of edge points. These goals must be precise enough to delimit the desired behavior of the detector while making minimal assumptions about the form of the solution. Here the author defined detection and localization criteria for a class of edges, and present mathematical forms for these criteria as functions on the operator impulse response. A third criterion is then added to ensure that the detector has only one response to- a single edge. He used the criteria in numerical optimization to derive detectors for several common image features, including step edges [3].

3.4. *Bilateral Filtering for Grey and Colour Images*

Bilateral filtering [3] smoothens images while preserving edges, by means of a nonlinear combination of nearby image values. The method is non-iterative, local, and simple. It combines grey levels or colours based on both their geometric closeness and their photometric similarity, and prefers near values to distant values in both domain and range. In contrast with filters that operate on the three bands of a colour image separately, a bilateral filter [3] can enforce the perceptual metric underlying the CIE-Lab colour space, and smooth colours and preserve edges in a way that is tuned to human perception. Also, in contrast with standard filtering, bilateral filtering produces no phantom colors along edges in colour images, and reduces phantom colours where they appear in the original image in this paper, we propose a no iterative scheme for edge preserving smoothing that is non-iterative and simple. Although it claims no correlation with neurophysiological observations, it point out that our scheme could be implemented by a single layer of neuron-like devices that perform their operation once per image. Furthermore, this scheme allows explicit enforcement of any desired notion of photometric distance. This is particularly important for filtering colour images.

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4. PROBLEM IDENTIFICATION

Given an image that we view as a height field of pixel intensities, the task of Feature extraction involves the following sub problems:

1. **Line extraction.** Extract the lines from the image using 2-D adaptive wiener filter which uses a fuzzy inference system to extract the lines from objects.
2. **Edge smoothing.** Remove and cluster the objects with the help of K-Means clustering method and subsequently smoothen the edges of the image
3. **Quality Analysis.** Analyze the quality of the produced images by calculating Peak signal to noise ratio and mean square error.

Solving the first problem results in a “line extraction” while the second results in a “smoothened” image surface. The combination of these two solutions often results in an image as feature extracted. Finally the reconstructed image and the original image is compared so that we can analyze the quality of reconstructed images.

5. PROPOSED METHODOLOGY

The feature extraction is done on the following steps:

1. The image is applied to a 2-D adaptive Wiener Filter so that the lines may be extracted from the image and the noise may be reduced in the image with the help of fuzzy inference system.
2. The object detection and edge smoothing is done through color based segmentation using K-means clustering.
3. The combination of above two steps provides us the image reconstructed in such a way that has some important features extracted from the original image.
4. The quality approximation of the reconstructed image after edge detection and line extraction is done by calculating PSNR and MSE values for reconstructed image.

Furthermore, the MSE and PSNR values must be calculated progressively for the proper approximation of our end results so that the error incurred in the resulting abstracted image must be clearly understood and properly reduced to a level of accuracy. The output of the proposed methodology must provide us a way to extract the image properties in a manner such that the extracted image features may be carried out for the iterative

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abstraction process. Hence we apply the methodology for extracting the important features from a digital image

BLOCK DIAGRAM OF PROPOSED METHODOLOGY

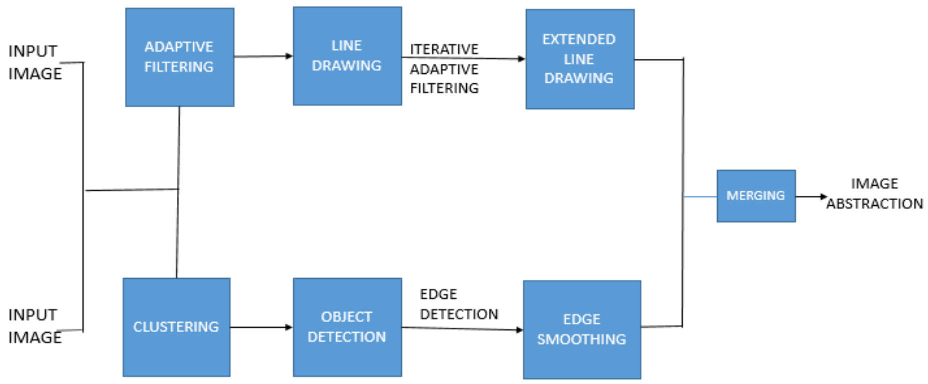

Fig. 1. The figure above represents the intermediate steps involved in the proposed methodology

and must use it for further processing of the image.

6. RESULTS

The proposed method described here is providing some important feature extracted from the original image like object removal, Edge detection and line extraction so that it can be used in many other image processing applications. Firstly the adaptive filtering provides us a low level feature extraction from a digital image which provides us a better view of those low level features like line drawing of the principle edges and boundaries. The clustering provides us a collection of objects which must be differentiated by the similarities between the objects. Further the line drawing capitalizes on the output of the adaptive filtering and provides us a nearly sketch of our original image. The object detection feature provides us with objects based upon some kind of similarities. At the final step, the edge smoothing provides us with sharp edge boundaries and higher level of drawing and merged together with the extended line drawing output providing us an abstraction of the image.

7. CONCLUSIONS AND FUTURE WORKS

To summarize, whatever I study I found that every model having some advantages and some limitation. This paper is focussing on the feature extraction of a digital image and analysing the quality of the original image and the reconstructed images. This will help us in the interpretation of an image in such a manner that will provide the abstracted look of various objects of an image like animals, plants, buildings, still objects, and outdoor scenes.As for future work, we will try to find out better filtering techniques to remove the small islands of false edges from our results. We also plan to modify our algorithm to detect edges from color images directly without converting it to grayscale.

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