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Performance and Analysis of Image Filtering Techniques

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ABSTRACT *:*
Many image segmentation techniques have been developed over the past two decades for segmenting the images, which help for object recognition, occlusion boundary estimation within motion or stereo systems, image compression, image editing.The objective is to develop a combined approach for segmenting the image, which give better segmented output image. First we used histogram equalization to the input image, from which we get contrast enhancement output image .After that we applied median filtering which will remove noise from contrast output image .At last we applied fuzzy c-mean clustering algorithm to denoising output image, which give segmented output image. In this paper, we compare the performance of various segmentation techniques i.e. histogram equalization, median filter and fuzzy c means.
Keywords:Histogram equalization, Median filter, Fuzzy C-Means Introduction

I. INTRODUCTION

Image segmentation refers to the major step in image Processing in which the inputs are images and, outputs are the attributes extracted from those images. It is an important and challenging problem in image analysis as well as in high-level image interpretation and understanding such as robot vision, object recognition, and medical imaging. Segmentation divides image into its constituent Regions or objects. The level to which segmentation is carried out depends upon the problem being solved i.e. segmentation should stop when the objects of interest in an application have been isolated. Image segmentation refers to the decomposition of a scene into its components [1].

Quantitative studies have been performed based on populations of biological Images**.** Such studies extremely require methods for segmentation, feature extraction, and classification. A first step in many analysis pipelines is segmentation, which can occur at several levels (e.g., separating nuclei, cells, tissues). This task has been an active field of research in image processing over the last 30 years, the modality, quality, and resolution of the Microscopy images to analyze[2].

II. HISTOGRAM EQUALIZATION

Histogram equalization is a kind of contrast enhancement that stretches the histogram so that all values occur (more or less) an equal number of times. This often works well, especially for bringing out details in overly light or overly dark sections of a gray scale image. The transformation is scaled such that the least intense value in the original image is mapped to a zero intensity value in the equalized image. As well, the most intense value in the original image is mapped to an intensity value that is equal to the maximum intensity value determined by the bit depth of the image. This produces results that have a dynamic range that is slightly larger than produced by the histogram equalization algorithm described in Gonzalez and Woods (2008). **Adaptive histogram equalization** (AHE) is a computer image processing technique used to improve contrast in images. It differs from ordinary histogram in the respect that the adaptive method computes several histogram, each corresponding to a distinct section of the image, and uses them to redistribute the lightness values of the image. It is therefore suitable for improving the local contrast of an image and bringing out more detail

The algorithm has been tested to verify that performing further equalization on an already equalized image produces an output that is identical to the input. As well, it has been tested to verify that the histogram equalization of an input image with a constant probability distribution function produces an output image that is identical to the input. The MatLab script used to run these tests is provided in the Tests.m file [3]original image on the left and the equalized image on the right.

A. Histogram Equalization Method

Consider a discrete grayscale image $\{x\}$ and let n_i be the number of occurrences of gray level i. The probability of an occurrence of a pixel of level i in the image is

$$p_x(i) = p(x = i) = \frac{n_i}{n}, \quad 0 \le i < L$$

L being the total number of gray levels in the image, n being the total number of pixels in the image, and $p_x(i)$ being in fact the image. histogram for pixel value i, normalized to [0,1]. The cumulative distribution function corresponding to p_x as

$$cdf_x(i) = \sum_{j=0}^{i} p_x(j),$$

Which is also the image's accumulated normalized histogram? We would like to create a transformation of the form $y = T(x)$ to produce a new image $\{y\}$, such that its CDF will be linearized across the value range, i.e.

$$y = T(x) = cdf_x(x)$$

$$cdf_y(i) = iK$$

For some constant K. The properties of the CDF allow us to perform such a transform it is defined as,
Notice that the T maps the levels into the range [0, 1]. In order to map the values back into their original range, the following simple transformation needs to be applied on the result:

$$y' = y \cdot (\max\{x\} - \min\{x\}) + \min\{x\}$$

The above describes histogram equalization on a grayscale image [4]. However it can also be used on color images by applying the same method separately to the Red, Green and Blue components of the RGB color values of the image. However, applying the same method on the Red, Green, and Blue components of an RGB image may yield dramatic changes in the image's color balance since the relative distributions of the color channels change as a result of applying the algorithm. However, if the image is first converted to another color space, Lab color space, or HSL/HSV color space in particular, then the algorithm can be applied to the luminance or value channel without resulting in changes to the hue and saturation of the image [5]. There are several histogram equalization methods in 3D space. Trahanias and Venetsanopoulos applied histogram equalization in 3D color space[6].

I. MEDIAN FILTER

The median filter is a nonlinear digital filtering technique, often used to remove noise. To reduce noise several non-linear filters can be employed. One of the simplest techniques, the median filter, provided good noise reduction without affecting the borders of the objects on the image. The main idea of the median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal.
Consider median filter with three point window of W={-1, 0, 1} and the inputs are [x(n-1), x(n), x(n+1) = {-3,-6,8}. To formulate the function [9]

$$F(\theta) = \sum_{k=-1}^{1} | \theta - xn+k |$$

Often though, at the same time as reducing the noise in a signal, it is important to preserve the edges. Edges are of critical importance to the visual appearance of images, for example. For small to moderate levels of (Gaussian) noise, the median filter is demonstrably better than Gaussian blur at removing noise whilst preserving edges for a given, fixed window size[9]. However, its performance is not that much better than Gaussian blur for high levels of noise, whereas, for speckle noise12(impulsive noise), it is particularly effective[10]. Because of this, median filtering is very widely used in digital image processing.

III. FUZZY C-MEANS CLUSTERING

The fuzzy segmentation methods, which can retain more information from the original than hard segmentation methods [11-12].In hard clustering, data is divided into distinct clusters, where each data element belongs to exactly one cluster. In fuzzy clustering (also referred to as soft clustering), data elements can belong to more than one cluster, and associated with each element is a set of membership levels. These indicate the strength of the association between that data element and a particular cluster. Fuzzy clustering is a process of assigning these membership levels, and then using them to assign data elements to one or more clusters [13].

One of the most widely used fuzzy clustering algorithms is the Fuzzy C-Means (FCM) Algorithm (Bezdek 1981). The FCM algorithm attempts to partition a finite collection of n elements $X = \{x1,...,xn\}$ into a collection of c fuzzy clusters with respect to some given criterion. Given a finite set of data, the algorithm returns a list of c cluster centers $C = \{c1,...,cc\}$ and a partition.

.

$J=U = u\ i, j \in [0,1], i = 1,\ldots,n, j = 1,\ldots,c$

Where each element uij tells the degree to which element xi belongs to cluster cj.

In **fuzzy clustering**, each point has a degree of belonging to clusters, as in fuzzy logic, rather than belonging completely to just one cluster. Thus, points on the edge of a cluster may be *in the cluster* to a lesser degree than points in the center of cluster.
Any point x has a set of coefficients giving the degree of being in the kth cluster $wk(x)$. With fuzzy c-means, the centroid of a cluster is the mean of all points, weighted by their degree of belonging to the cluster:

$$Ck=\sum_x wk(x)x / \sum_x wk(x)$$

The degree of belonging, $wk(x)$, is related inversely to the distance from x to the cluster center as calculated on the previous pass. It also depends on a parameter m that controls how much weight is given to the closest center[14].

A. The algorithm of fuzzy c-means clustering

Step1. Choose a number of clusters in a given image.
Step2. Assign randomly to each point coefficients for being in a cluster.
Step3**.**Repeat until convergence criterion is met.
Step4. Compute the center of each cluster.
Step5**.**For each point, compute its coefficients of being in the cluster [4-5].

Experiment No 1:

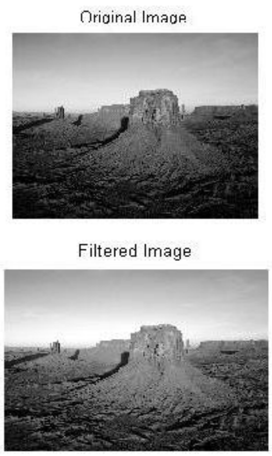

Fig.1 By using Normal Histogram

Fig.2 By using Adaptive Histogram

TABLE I

	TIME	MSE	PSNR	DATA LOSS
N H	2.49s	0.015dB	84.79dB	1.48%
AH	1.70S	0.005dB	93.59dB	0.53%

Experiment No 2:

Fig.3 By using Median Filter

TABLE II

	TIME	MSE	PSNR	DATA LOSS
MF	0.54S	0.055dB	73.42dB	-5.65%

Experiment No 3:

Fig. 4 By using Fuzzy c Means

TABLE III

	TIME	MSE	PSNR	DATA LOSS
FCM	87.80s	0.55dB	53.32dB	55.31%

TABLE IV

	TIME	MSE	PSNR	DATA LOSS
HE		√		
MF	√			
FCM			√	√

V. CONCLUSIONS

This paper presented a comparison study between histogram equalization, median filter and fuzzy c means. Future research will concentrate on the combined approach that is histogram equalization, median filtering, and fuzzy c-means algorithm for image segmentation which gives the better segmentation with reduced computational time.

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