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A FUZZY IMPULSE NOISE DETECTION IN COLOR IMAGE

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ABSTRACT

This paper mainly focuses on the noise detection technique using soft computing approach like fuzzy sets. Image enhancement is a necessary part of image processing field as before going to any kind of processing works with the image that picture must be noise free. So it should cover noise detection and reduction from digital color image. An inter and intra color co-relation of made between the pixels of the color image to overcome the color disorder on edge and texture pixel. This proposed method in this paper provides significant improvement as compared to the other non-fuzzy and fuzzy filters in detecting the noisy pixels from the color image.

Keywords: Image processing, impulse noise, RGB Color, fuzzy logic, membership function.

I. INTRODUCTION

Image processing is a vast area today. This is the type of signal processing where it takes an image as input and produces processed output image or image information. Now-a-days image processing is used in various fields as essential features of technology. Where image is used one major source of information then finding the accurate data is very essential. So here comes the need of image enhancement or improvement. The image is mainly corrupted by different kind of noises generally produced while transmitting it through various medium.

One color image is the 3 dimensional data storing in image form where Red, Blue and Green are the three dimensions. Each component like Red, Green and Blue of the image is one 2D image like one gray scale image having two spatial co-ordinates. These image elements are called pixels and the amplitude of the pixels are called intensity of that pixel. Noise reduction is a vital problem in image processing as after the noise reduction any other image processing techniques can be applied like image segmentation, edge detection etc. Noise generates in an image due to various reason basically during acquisition and transmission in channels, faulty memory location in hardware, high energy spikes generates during transmission. Various types of noises are there like Gaussian noise, impulse noise, speckle noise etc. Impulse noise i.e. salt & pepper noise is very common type of noise generated in image. Salt & pepper noise is an impulse noise that digitized the original image pixel values to two extreme intensities. Before processing the noisy image to any further steps of image processing field this corrupted image should be filtered to remove those noise to get good quality image. The conventional median filters and its further modifications generally used to filter this salt & pepper kind of noise but it produces blurring effect in the image. The filtering technique is applied to all the pixels in the image which creates a blurring effect in the image in the previous traditional approach. Many vector based noise reduction technique has also been introduced later for removal of impulse noise but they have some disadvantage that is they consider each pixel as a whole vector in vector based approach and their capacity of noise reduction is inversely proportional to noise level. A better way to come out from these drawbacks is to apply some technique to differentiate between noisy pixel and noise-free pixel so that the filtering technique can only be applied to those noisy pixels.

Fuzzy logic is introduced in 1965 by L. A. Zadeh professor in Computer science at the University of California in Berkelay[11]. It is a fastest growing area which is applied to many research areas. It processes human knowledge in the form of fuzzy if-then rules which have a partial truth value ranging between 0 and 1[1].Fuzzy logic deals with both qualitative and quantitive kind of problem domain. Fuzzy logic is applied in image processing as it can differentiate between image characteristics and noise characteristics. Fuzzy theory is employed as extensions to the modified median filter which is giving better result in noise removal. Fuzzy based filters are capable of removing noise from an image by keeping the details of image intact and preserving the edge sharpness. Many fuzzy based filters has been introduced so far like Fuzzy Similarity-based filter (FSF) [6], Fuzzy Random Impulse Noise Reduction Method (FRINRM) [9] , Adaptive Fuzzy Switching Filter (ASFS) [2], Histogram Adaptive Fuzzy filter (HAF) [8], Fuzzy Impulse Noise Detection & Reduction method (FIDRM) [12], Fuzzy Adaptive Noise Filter etc.

But these filters are well suited for 2-D grey scale images. Basic problem with these approaches were that it causes disorderness in the texture of the image and also affects the edge sharpness this is due to the filtering algorithm of 2-D grey scale is applied to each color component of color image as each component R, G, B are one 2-D images. In this paper we are using fuzzy technique for detection and removal of impulse noise using color components of the color image by co-relating them with each other with the help of R-G-B color model. In this paper Fuzzy technique is used efficiently to differentiate between noisy and noise-free pixels and the filtering technique is applied only to the corrupted or noisy pixels without affecting the color, the age sharpness and the image details.
In this paper in section 2 color model is described. In section 3 of this paper detection technique i.e. to detect the noisy pixels and filtration or we can say de-noising part of this detected noisy pixels is described using fuzzy logic. In section 4 result analysis is done and the paper is concluded in section 5.

II. R-G-B Color Model

It is a mathematical model describing the way colors can be represented as a vector of numbers, typically as three values of color component. It has three basic color components which are essential to constitute a color image. The purpose of a color model is to facilitate the specification of colors in some standard acceptable manner. The main purpose of the RGB color model is for the sensing, representing and displaying images in electronic systems, such as television and computers, though it has been used in conventional photography, where the three components of the image are Red, Green and Blue and all other colors are represented as three values of these three color components. The RGB color model is shown in figure 1.

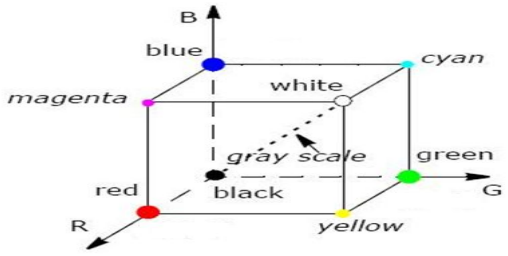

Figure-1 : R-G-B Color Model

III. Proposed Detection Method using Fuzzy Techique

Detection phase is the vital stage in the filtering process as the filtering will be applied only to those detected noisy pixels.
In the detection part two steps are followed to detect the noisy pixel
1.each pixel is processed by taking a 3 X 3 window filter where its value is compared with its neighbours to calculate similarity level in each color component pixels individually 2. then comparing similarity level of each pixel of each color component with the other two components at the same position.
Each pixel is processed here by taking a 3 X 3 sliding window to test each pixels with its neighbours shown in the figure 1.

P_1	P_2	P_3
P_4	P_0	P_5
P_6	P_7	P_8

Figure-2: 3 X 3 sliding window

In this above 3 X 3 sliding window P_o is the test pixel which is processed its similarity degree is calculated with its neighbours P_1 to P_8 to know the similarity level between them. By going through the proper steps specified in the algorithm, these generated absolute value differences are converted to fuzzy values to know the similarity level i.e. if pixels have 'LARGE' similarity level or 'SMALL' degree of similarity level [1]. To convert them to fuzzy values absolute value differences are added with membership function [1] which gives us the similarity degrees. Here to

convert the absolute values to fuzzy values we are using Z-shaped membership function as when the absolute values differences [1] are relatively small then membership degree will be high and it gradually decreases with increasing differences and after a certain value it decreases faster as compared to previous rate and finally becomes zero [5][7]. Z-membership function [1] can be defined as 1- SMF [1].

In the first step there will be calculation of absolute value differences between the pixels of each color component. If P_0 is the text pixel the in RED component then the absolute value difference can be calculate as

$$\Delta P_k^R = | P_0^R - P_k^R | \quad (1)$$

Where K= 0 to n^2-1 in n X n window. This is similar way calculated for all the three color components for all the pixels. Then the calculation of similarity degree involves calculation of each color component pixel with its neighbour pixels by adding membership function Z-MF as F_1 having parameter values as a= 20, b=75 with the absolute value differences. Here S stands for the similarity level (2)

Then the inter color similarity degree calculation involves calculation of similarity level of each color component pixel with the other two color component pixel at the same position by adding membership function F_2 having parameter values a=0.01 , b=0.15 with the differences (3)

Then the next step is the calculation of the joint similarity for all till k^{th} pixel can be given as by taking the conjunction(AND) i.e. t-norm operation (4)

After calculation of similarity degrees Noise-freeness of the test pixel P_0 for all RED, GREEN, BLUE component is calculated using fuzzy If-Then rules which is given as

IF *((S^R is large) AND (S^G is large) AND (S^{RG} is large))*

OR

((S^R is large) AND (S^B is large) AND (S^{RB} is large))

Then

(Noise-free (P_0^{RED}) is large)

IV. Results

Similarly the fuzzy if-then rules are fired for the other two Green and Blue components. The detection phase is explained by taking some standard images as input for example lena image and fruit image with different noise level using the proposed fuzzy method which is given below in the figure.

V. Conclusion

In this paper we have applied fuzzy based approach to detect noisy pixels in an image for further filtration phase to get a good quality image by keeping image details preserved .We have examined and explained noise detection phase that is detecting the noisy pixels by using standard color image of Lena by giving specified noise level to it. Main focus in this paper is the fuzzy based noisy pixel detection phase using the RGB color components of the digitized color image and their co-relations to detect the noise. Here We have find that this proposed method detection phase detects the noisy pixels very efficiently by using fuzzy approach without affecting the color and the edge sharpness of that image by preserving the image details.

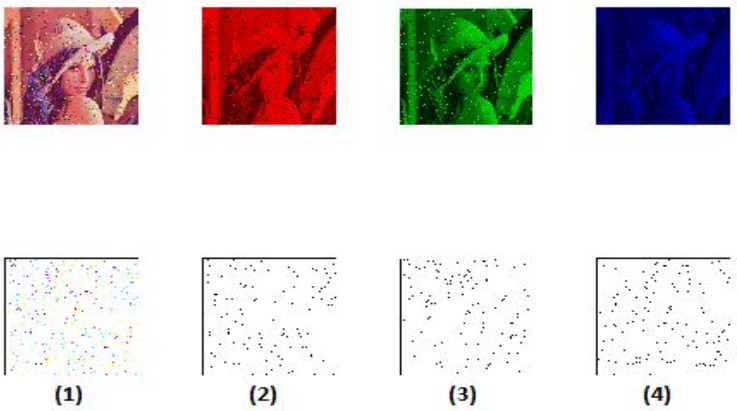

Figure-2: First rows (1) Lena image with 5% noise (2) RED-component of noisy image (3) GREEN-component of noisy image (4) BLUE-component of noisy image; second row (1) Membership degree *Noise-free* of original image (2) Membership degree *Noise-free(RED)* (3) Membership degree *Noise-free(GREEN)* (4) Membership degree *Noise-free(BLUE)*

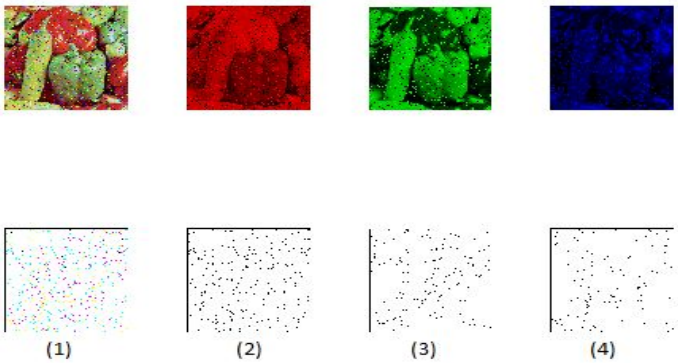

Figure-3: First rows (1) fruit image with 10% noise (2) RED-component of noisy image (3) GREEN-component of noisy image (4) BLUE-component of noisy image; second row (1) Membership degree *Noise-free* of original image (2) Membership degree *Noise-free(RED)* (3) Membership degree *Noise-free(GREEN)* (4) Membership degree *Noise-free(BLUE)*

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