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A Review on Image Enhancement using Artificial Neural Network and Fuzzy Logic

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***Abstract*— Images and pictures are sources of information for interpretation and analysis. When an image is converted from one form to another such as, digitizing, scanning, transmitting, storing, etc., the output image is degraded up to some extent. Thus it is important for an output image to undergo through a process called image enhancement. Literature shows that many approaches proposed till date for enhancing an image like Histogram Equalization, Spatial Averaging, Median Filter, Un-sharp Masking & High Boost filtering etc. are still have some restrictions. This paper deals with a rigorous review of the research work in the field of image enhancement. The authors have discussed the various techniques used for image enhancements with their pros and cons and the comparative analysis is presented. In addition to that, a system for image enhancement using ANN and Fuzzy Logic is proposed.**

***Keywords* — ANN, BBHE, DHE, Fuzzy Logic, Median Filter.**

I. INTRODUCTION

An image is a two-dimensional function which is denoted by f(x,y) [18], where x and y are spatial coordinates and intensity or gray level of that point is given as amplitude of f at any pair of co ordinates (x,y). The image is called as digital image when the amplitude values of f, x and y are all finite discrete quantities. A digital image is composed of a finite number of elements which is referred as a pixel and it has a particular location and value. The elements of a digital image is usually denoted by the pixel. Image enhancement consists of techniques that seek to improve the visual appearance of an image or it makes an image better suited for analysis by a human or a machine [16].

Fig. 1 Image Enhancement

A. Image Enhancement Techniques

The Image enhancement techniques can be categories into three groups-

1. Spatial domain methods: It directly operate on pixels.
2. Frequency domain methods: It operate on the Fourier transform of an image.
3. Fuzzy domain: When it comes to human perception ,it is difficult to determine what good image- enhancement is. If it looks good, we say it is good. However, quantitative measures are used to determine which techniques is most appropriate, when image enhancement techniques are used as pre-processing tools for other image processing techniques.

This paper is organized as follows. In section II we introduce an Artificial Neural Network and Fuzzy logic technique. In section III, we discuss related work carried in the same field and conclusion is discussed in section IV.

II. OVERVIEW OF ARTIFICIAL NEURAL NETWORK AND FUZZY LOGIC

In this section, we are presenting the brief overview of the Artificial Neural Network and Fuzzy logic.

A. Artificial Neural Network

It is usually called as "Neural Network" (NN), is a computational system that tries to simulate the structure and functional aspects of neural networks. The basic processing element of neural network are called neurons. They processes information using connectionist approach to computation. NN are nonlinear statistical data modeling tools. They can be used to find patterns in data & also to model complex relationships between inputs and outputs.

It is one of the simplest mathematical model which is defined as a function f: X→Y. NN is very popular because of its learning capability. Learning can be supervised, unsupervised and recurrent. An important concept in learning is a C i.e cost function which is a measure of how far away we are from an optimal solution to the problem that we are solving. In order to find a function that has the smallest possible cost, learning algorithm search through the solution space[24].

For image enhancement[26], Pushpavalli et al proposed a class of neural filter.The first step is to filter corrupted image by two special classes of decision based filter. The output is then combined with a Feed forward neural network[28].

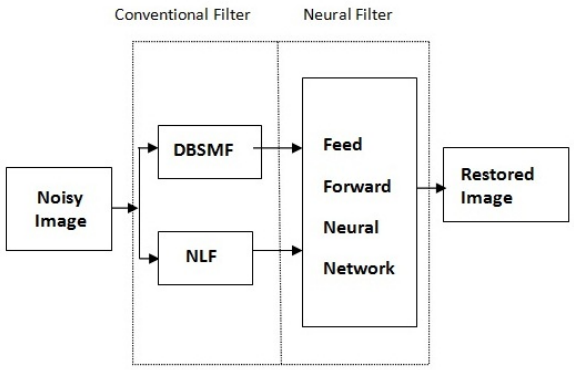

Fig. 2 Block diagram of Artificial Intelligent Technique[27]

Fig. 2 shows the structure of impulse noise removal filter. Noisy image is given to the conventional filters like DBSMF[26] and Nonlinear filter(NF).Then neural network assemble information to compute restored value of noisy image.

When digital image consisting of higher level impulse noise, a feed forward neural network with back-propagation learning algorithm is used. It eliminates noise and preserves edges and fine details [27].

Fig. 3 shows the architecture of Feed forward neural network.

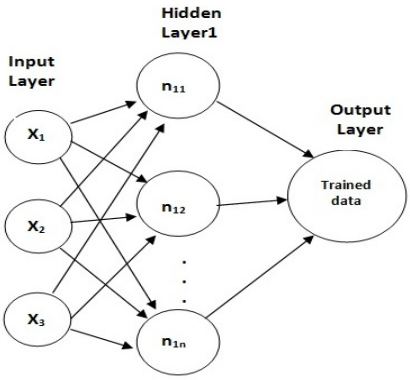

Fig. 3 Feed forward neural network architecture[27]

B. Fuzzy Logic

Fuzzy image processing consists of fuzzy sets which is the collection of all approaches that understand, represent and process the images, their segments and features[2]. The processing and representation depend on the selected fuzzy technique as well as on the problem to be solved. As the structures of qualitative description used in everyday language can built fuzzy logic and also it is easy to use.

A mathematical framework for representation and processing of expert knowledge is provided by the fuzzy logic. The if-then rules plays an important role in approximation of the variables likes cross over point. Within image processing tasks randomness, vagueness and ambiguity results in the uncertainties. We can effectively manage these problems by a fuzzy technique. For formulating the mapping from a given input to an output using fuzzy logic we used a process known as Fuzzy inference system. This technique forms a sophisticated bridge between human knowledge and the numerical framework of the computer by using fuzzy if – then rules. Also it is simple and easy to understand.

Fuzzy image processing consisting of three main steps: image fuzzification, membership modification and image defuzzification as shown in fig.

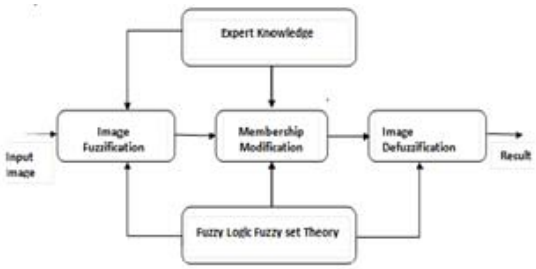

Fig. 4 Fuzzy Image Processing[29]

Since, we don't have any fuzzy hardware, fuzzification (coding of image data) and defuzzification (decoding of the results) steps are required[27]. Fuzzy Technique (FT) processes image using Fuzzification and defuzzification. Membership modification step plays an important role in Fuzzy image system (FIS).Fuzzification transfers image data from gray level plane to the membership plane then the membership values are modified by FT. These may be a fuzzy rule based approach, fuzzy clustering, fuzzy integration approach and so on.

Implementation of image enhancement can takes place by using Artificial Neural Network (ANN) and Fuzzy Logic. The fuzzy set theory can handle uncertainties. The fuzzy inference process involves If-Then Rules ,Membership Functions and Logical Operations. This work is a blend of Artificial Neural Network and fuzzy Logic. This technique is able to improve the contrast of the image. An algorithm is design to enhance image using fuzzy technique. It converts the image properties into fuzzy data and fuzzy data into defuzzification.

Fuzzy if-then rules are used to segment the image into different regions, when we interpret the image features as linguistic variables. A simple fuzzy segmentation rule is given as follows [3]:

IF the pixel is dark AND its neighborhood is also dark AND homogeneous

THEN it belongs to the background.

III. RELATED WORK

In this section, we are presenting a research work of some authors who works in the same field.

Pal and King[12], introduced a model for enhancement of an grey-tone image. They proposed an algorithm for both primary and final enhancement which consists of an extraction of fuzzy properties of the pixels and then successive application of the fuzzy operator. They used three different smoothing techniques like defocusing,

averaging and min-max rule over the neighbor of the pixel. It performed much better in terms of ambiguity.

Chang Pu, et al[18], proposed a novel HVS directed neural network based adaptive interpolation scheme. They built the fuzzy decision system from the characteristics of HVS (Human Visual System).It classifies input image pixel into human perception sensitive class and non-sensitive class. They trained the neural network using high resolution digital images along with supervised learning algorithm. The proposed system is superior than the conventional bicubic and bilinear interpolation in terms of smoothness and clarity in edge regions also visual quality of the interpolated images.

Shunshan li el at[5],discussed Gabor filter and a refined Gabor filter for image enhancement image processing. The first Gabor filter reduces the noise and it provides more accurate distance between two ridges for the next filter. It gets a rough ridge orientation map. The adjustment parameters significantly enhances the ridge, connects ridge breaks and it ensures the maximal gray values of the image located at ridge center. It also compensates nonlinear deformation.

Nieuwenhuis et al[6], introduced a method in which a guided filter is created that incorporates high level knowledge in the filtering process which adjust parameter of any given filter. Low level knowledge such as gradient information is utilized by the adaptive image enhancement algorithm to guide filtering parameters. The performance of the network is improved by applying multiclass PCA and binarized rotation of the sample data.

Hanmandlu, et al[16],introduce a Global contrast intensification operator (GINT),which is based on three parameters intensification parameter, fuzzifier and the cross over point for enhancement of an image. A gradient descent learning is used for optimization. The pros of this approach is that it enhanced under exposed image properly because of the property of global intensification operator and the choice of fuzzification function. But it will not perform properly for over exposed images.

Kundra Harish et al [15], proposed an effective method for image enhancement was presented by Russo, which was controlled by tuning of one parameter. Here filter is introduced which will remove the noise and improve the contrast of the image. To achieve this goal fuzzy-logic-control based approach is used. The algorithm mainly involves two broad steps: Removal of impulse noise & Improving contrast of the image.

Maini et al[17], focused on spatial domain techniques for image enhancement, with particular reference to point processing methods and histogram processing. The most primitive methods are point processing which are essential for image processing operations. It is used for contrast enhancement. Histogram equalization redistributed the gray-level values uniformly and thus stretches the contrast. Only the global histogram equalization is completely automatic.

G.G.Bhutada, et al[19], proposed an approach to computational performance of denoising using adaptively defined learning step size. They tuned the parameters of thresholding function by changing steepest gradient-based learning step size of wavelet transform-based thresholding neural network (WTTNN) to the proposed adaptively defined learning step size. Instead of using multiplicative noise they used homomorphic approach.This improved edge preservation features as well as increase the learning speed.

Jadon et al [14], focused on the fact that image Edge detection not only preserves the important structural properties of an image but also reduces the amount of data by filtering out unnecessary information. It presents a fuzzy rule base algorithm .The detection of spurious edges corresponds to noise is avoided by using edge string information. Three edge strength values is given as an input to the Fuzzy system. It uses fuzzy if-then rules to modify membership classes. The final edge image is produced by applying mamdani defuzzifier method. It improves quality of an image as well as less computationally expensive.

Rajal et al [1], presented a fuzzy grayscale enhancement technique for low contrast image containing Gaussian noise. The existing techniques for image enhancement cannot handle imprecise, vague and uncertain information. They proposed a new algorithm to avoid these problems. First input image is resized and converted to gray scale image if it is RGB image. After adding gaussian noise, he preprocessed noisy image. Then different enhancement methods are applied and compared with each other. This method enhance image also preserves edges as compared with conventional methods.

Kaur et al [3], presented a review of histogram techniques for image enhancement. BBHE, average intensity of all the pixel value is calculated. This is called as mean brightness value and presented as separation intensity. Then two histograms are equalized separately. MBPHE consists of two main groups bisection and multi-section. Bisection MBPHE separates input histogram into two sections and equalized independently. Multi-section MBPHE has better mean brightness preservation.DHE can enhance an image without losing any details. MMBEBHE, RMSHE, BBHE can cause side effects on the variation of gray level distribution. DHE preserves image details.

Hasikin, et al [21], proposed a new fuzzy intensity for low contrast and non-illumination image enhancement. This measure is computed by averaging the intensity and deviating intensity distribution of an image. Power-law transformation is used to enhance input image. This algorithm improves the finer details and contrast also produces more even illumination. It also improves image quality without enhancing noise in an original image. It required less computation time.

IV. CONCLUSION

We have rigorously reviewed the different research methodologies used by various researchers for image enhancement. The comparative study of reviewed work is presented in the summarized form along with their pros and cons. However, it is observed that there is a need of improved technique which is a hybrid approach of ANN and fuzzy logic, which could enhanced the image effectively and efficiently.

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