A SURVEY ON FUZZY BASED TECHNIQUES FOR CONTRAST ENHANCEMENT

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Abstract—*Fuzzy based techniques are useful in handling various unknown in computer vision and image processing applications. Fuzzy image processing is a combination of fuzzy approaches to image processing that can represent and process the image. Three steps of fuzzy techniques are image fuzzification, modification of function values, and defuzzification. Fuzzy contrast enhancement is based on gray level mapping into membership functioning. This technique gives the output of an image of much higher contrast with compare to original image, by means of giving a larger weight to the gray levels which are closer to the average gray level of the image. In this survey, we provide an overview of the existing methods based on their ability to handle enhancement of low contrast images as well as how these methods can be generalized. This survey will help researchers to identify the proper methods available to address each of the challenges faced and their limitations. From this review, we have draw conclusions regarding how well a challenge has been solved, and we recognizeprospective research areas that require auxiliaryeffort.*

***Index Terms*—**Fuzzification, Membership Function, Defuzzification, Fuzzy Contrast Enhancement.

1. INTRODUCTION

Image enhancement processes consist of a collection of different techniques that seek to improve the visual appearance of an image or to convert the image to a form better suited for analysis by a machine or a human. The principle objective of image enhancement techniques is to process an image so that the result is more suitable than the original image for a specific application.It is often used to increase the contrast that are substantially dark or light in images. Image enhancement entails operations that improve the appearance to a human viewer, or operations to convert an image to a format better suited to machine processing.

Image enhancement refers to only those image processing operations that improve the quality of input image in order to overcome the weakness of the human visual system as shown in figure 1.The aim of image enhancement is to improve the perception or interpretability of information in images for human viewers, or to provide 'better' input for other automated image processing techniques. This Fuzzy techniques can manage the vagueness and ambiguity efficiently (an image can be represented as fuzzy set). Fuzzy logic is a also powerful tool to represents and process human knowledge in form of fuzzy if-then rules and the manipulation of these concepts leads to theory of approximation using fuzzy systems in image processing. In recent years, many researchers have applied the fuzzy logic to develop new and different image processing algorithms. The fuzzy image processing is one of the important application areas of fuzzy logic.

Fuzzy set theory is thus useful in handling various uncertainties in computer vision and image processing applications. Fuzzy image processing is collection of different fuzzy approaches to image processing that can represent, understand and process the image. It has main three stages, namely, image fuzzification, modification of membership function values, and defuzzification. Fuzzy image enhancement is based on gray level mapping into membership function and the aim is to generate an image of higher contrast than the original image by giving a larger weight to the gray levels that are much closer to the mean gray level of the image that are farther from the mean. In this survey, we provide an overview of the existing methods based on their ability to handle enhancement of low contrast images as well as how these methods can be generalized. Such systematic survey will help researchers to identify thedifferent suitable methods available to address each of the challenges faced and their limitations. From this review, we draw conclusions regarding how well a challenge has been solved, and we recognize prospective research areas that require auxiliary effort.

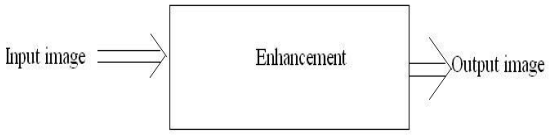

Figure 1: Contrast Enhancement Operation

2. Literature Review

There is a lot of work has been done in the field of contrast enhancement. In this section, work done in the area of contrast enhancement and fuzzy set is focused to improve the quality of image.

Image Enhancement alters an image to makes its meaning clearer to human observers. It is often used to increase the contrast in images that are dark or light. Enhancement algorithms often play attention to human's sensitivity to contrast. The main objective of image enhancement is to process the image so that the result is more suitable than the original image. Image enhancement techniques such as contrast stretching, map each grey level into another gray level by predetermined transformation.

In 1991 J.S. Kim, H.S. Cho and S.K. Kim used to fuzzy rule based enhancement algorithm for noisy image. In contrast to the classical approach, the fuzzy approach makes use improve the quality of image. A new edge relaxation algorithm that enhances the noisy boundary informations in image. The algorithm employs relaxation process that reduces or even eliminates of derivative operator response via contextual information. The contextual informations are the neighborhoods patters of a central edge which are estimated using the fuzzy pattern matching techniques [8].

In 1994 Kaijun Tang, JaakkoAstola, Member, IEEE, and YrjoNeuvo, Fellow, IEEE worked multichannel Edge Enhancement in Color Image Processing. A multichannel edge enhancing filter (MEEF) based on the vector median which is introduced for enhancing degraded edges in color images. An input multichannel signal is filtered with filters, and the final output is determined by comparing the outputs and their vector median. Root signaland edgeMEEF areexamined indetail [9].

In 1998 FarzamFarbiz, Seyed Ahmad Motamedi, Mohammad BagherMenhaj Electrical Engineering Department of Amirkabir University method for image enhancement based on fuzzy logic ,A new filtering approach based on fuzzy logic which has high performance in mixed noise environments. This mainly based on the idea that each pixel is not allowed of the fuzzy rules. It performs several test experiments in order to highlight the merit the proposed method. The results are very much promising and indicating the high performance of the proposed filter in image restoration in compared with those of the filters which have been recently cited in image processing literature. As an important task in image enhancement, noise filtering can be viewed as replacing the gray-level value of each pixel in the image with a new value depending on the local context. Ideally, the filtering algorithm should vary from pixel to pixel which is based on the local context. For example, if the local region is relatively smooth, then the new value of the pixel is worth being determined by the averaging neighboring pixels values. On the other hand, if the local region contains edge or impulse noise pixels, a different type of filtering should be used. However, it is extremely hard, if it is not impossibleto set the conditions under which a certain filter should be selected, since can be evaluated only vaguely in some portions of an image. Therefore, a filtering system needs to be capable of performing reasoning with vague and uncertain information [10].

In 2000 I.Nedeljkovic, Zahumska Belgrade, Serbia and Montenegro worked image classification based on fuzzy logic worked Fuzzy logic is relatively young theory. Major advantage of this theory is that it allows the natural description, in linguistic terms, of problems that should be solved rather than in terms of relationships between precise numerical values. This advantage, dealing with the complicated systems in simple way, is the main reason why fuzzy logic theory is widely applied in technique. It is also possible to classify the remotely sensed image (as well as any other digital imagery), in such a way that certain land cover classes are clearly represented in the resulting image. A prior knowledge about spectral information for certain land cover classes is used in order to classify SPOT image in fuzzy logic classification procedure. Basic idea was to perform the classification procedure first in the supervised and then in fuzzy logic manner. The later was done with Matlab's Fuzzy Logic Toolbox.As Some information, needed for membership function definition, was taken from supervised maximum likelihood classification [11].

In 2008 Milindkumar V. Sarode, Dr. S.A.Ladhake, Dr. Prashant R. Deshmukh worked Fuzzy system for color image enhancement. This paper involves the use of knowledge-base (fuzzy expert) systems that are capable of mimicking the behavior of a human expert. Fuzzy approach of knowing severity of tumor is more essential to determine if there is a need for the biopsy and it gives to user a clear idea of spread and severity level of tumor. Fuzzy based enhancement of color feature of tumor is an

application of fuzzy feature is extraction for enhancement of a peculiar featurein the area of color. It has been found that RGB color model is not suitable for enhancement because the color components are not decoupled. While On the other hand, in HSV color model, hue (H), the color content, is separate from saturation (S), which can be used to dilute the color content and V, the intensity of the color content. By preserving H and changing only V and S, it is possible to enhance color image. Therefore, we need to convert RGB into HSV for the purpose. A Gaussian type membership function is used to model S and V property of the image. This membership function uses only one fuzzifier and is evaluated by maximizing fuzzy contrast. Here Our aim is be to analyze and enhance the features that are related to a specific disease. The biomedical images will be sent for fuzzification and decisions related to classification of colors will be done and accordingly output will be consisting of only the serious tumor region and noisy pixels will be filtered and image will be enhanced in the features we desire. Fuzzy logic addresses such applications perfectly as it much resembles human decision making with an ability to generate precise solutions from certain information. It fills an important gap in engineering design methods are left vacant by purely mathematical approaches (e.g. linear control design), and purely logic-based approaches (e.g. expert systems) in system design [12].

In 2013 SasiGopalan, Madhu S Nair and Souriar Sebastian Cochin University of Science and Technology (CUSAT), worked an approximation Studies on Image Enhancement Using Fuzzy Technique and fuzzy entropy measuring the image which increases the sharpness of its argument image decreases and uses three parameters such as the intensification parameter the fuzzifier and crossover point. It considered five different types of images and enhanced an image [13].

In 2015 Mr. Harish Kundra, Er. Aashima, Er. Monika Verma worked Image Enhancement Based on Fuzzy Logic in this papera filter is introduced which willimprove the contrast of the imageand remove the noise . To achieve this goal fuzzy-logic-control based approach is used. The filter is tested on the colored images [14].

3. Fuzzy inference system

Fuzzy systems are made of a knowledge base and reasoning mechanism called fuzzy inference system. A fuzzy inference system (FIS) consists of four functional blocks as shown in Figure

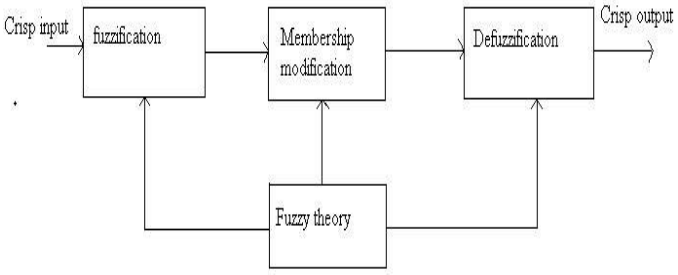

Figure 3.1: Fuzzy Inference System

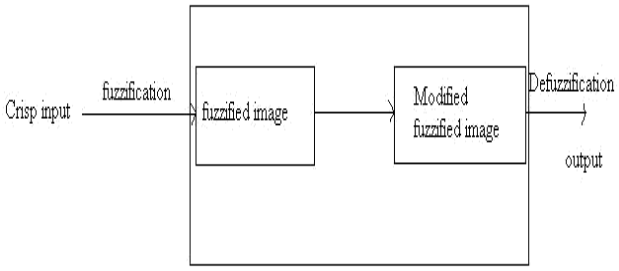

Figure 3.2: Membership Function Modification

A. **Fuzzification:** Transforms the crisp inputs into degrees of match with linguistic values. Reverse process of defuzzification.

B. **Knowledge Base**: Consists of a rule base and a database. A rule base contains a number of fuzzy if-then rules. A database defines the membership function of the fuzzy sets used in the fuzzy rules.

C. **Fuzzy Inference Engine**: Fuzzy Inference engine performs the inference operations on the rules.

D. **Defuzzification:** This conversion of fuzzy set to single crisp value is called defuzzification.

4. Fuzzy image enhancement

Fuzzy image processing is collection of all approaches that understand, represent and process the images, their segments and features as fuzzy sets. The representation and processing depend on the selected fuzzy technique and on the problem to be solved.

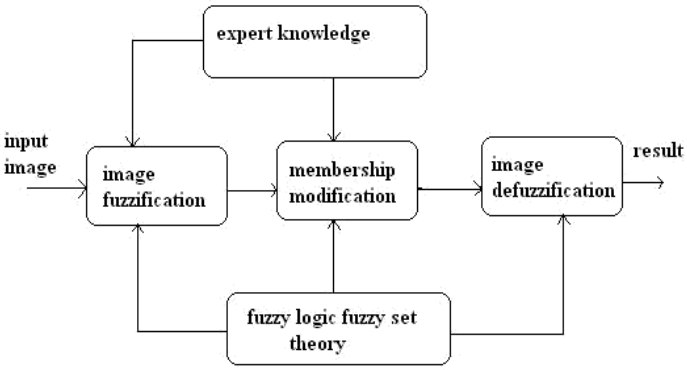

Figure 3.3: Fuzzy Image Processing

The fuzzification and defuzzification steps are due to the fact that we do not possess fuzzy hardware. Therefore, the coding of image data (fuzzification) and decoding of the results (defuzzification) are steps that make possible to process images with fuzzy techniques. The main power of fuzzy image processing is in the middle step (membership modification) [15].Fuzzy logic concept, an image is a property set. An image X of size M*N .in fuzzy set the image is expressed as:

$$X = \sum_{m=1}^{m=M} \sum_{n=1}^{n=N} Xmn, \mu_{mn} \quad \ldots 4.1$$

Wherem = 1,2,….., M, n = 1,2,….., N, and $(0 \leq \mu_{mn} \leq 1)$ denotes the grade of the membership function. Then define the membership function

$$\mu_{mn} = e^{-(Xmax-Xmin)^2}/(Xmax - Xmin) \quad \ldots 4.2$$

Where, Xmax is the maximum grey level of the pixel in an image, Xmin is the minimum grey level pixel in an image.If Xmin=0 then consider μ_{mn} has a finite value r,Where

$$r = e^{-Xmax^2}/Xmax \quad \ldots 4.3$$

So fuzzy membership grade between [r 1].Then the grey values of the image change to membership values. The values of membership values are different for different values ofXmax.The intensifier operation defined as:

$$I = 2[\mu_{mn}]^2 \quad \text{if } 0 \leq \mu_{mn} \leq 0.5$$

$$= 1\text{-}2[1 - \mu_{mn}]^2 \quad \text{if } 0.5 \leq \mu_{mn} \leq 1$$

The fuzzy based methods gives best contrast enhancement of poor contrast images belongs to several fields like multimedia, medical and geostationary images. Following are the few results showing the contrast enhancement.

Figure 4.1: Color Image contrast enhancement

Figure 4.2: Gray Scale Image contrast enhancement

5. CONCLUSION

The purpose of this survey is to study existing methods used for contrast enhancement of low contrast images, also to identify the outcomes and shortcomings of the earlier work. It has been observed that in recent years many researchers have applied fuzzy logic to develop different image processing algorithms for various applications like virtual restoration, astrophotography, medical imaging and atmospheric sciences etc. while very less work has been reported for contrast enhancement based on fuzzy.

Developing a unified approach that is robust to all issues may require explorations into new fields and new ideas. This survey is the first step toward identifying challenges that have not yet been resolved. In turn, this will researchers in this area focus their research effort on t issues identified as bottlenecks and to eventually develop a robust contrast enhancement technique.

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