An Extensive Review on Fuzzy Contrast Mapping for Image Enhancement

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Abstract: - Present day applications require various kinds of images and pictures as sources of information for interpretation and analysis. Whenever an image is converted from one form to another such as, digitizing, scanning, transmitting, storing, etc., some of the degradation occurs at the output. Hence, the output image has to undergo a process called image enhancement which consists of a collection of techniques that seek to improve the visual appearance of an image. Image enhancement is basically improving the interpretability or perception of information in images for human viewers and providing 'better' input for other automated image processing techniques. The fuzzy set theory is incorporated to handle uncertainties (arising from deficiencies of information available from situation like the darkness may from incomplete, imprecise, and not fully reliable, vague).

Keywords- Fuzzy logic; histogram equalization; Contrast; Contrast enhancement;

I. INTRODUCTION

Digital Image Processing

An image may be defined as a two-dimensional function f(x, y), where x and y are spatial (plane) coordinates, and the amplitude of f at any pair of coordinates (x, y) is called the intensity or gray level of the image at that point. When x, y, and the amplitude values of f are all finite, discrete quantities, we call the image a digital image. The field of digital image processing refers to processing digital images

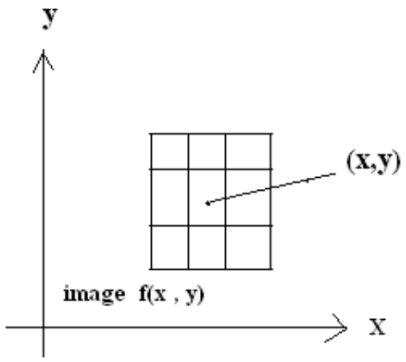

Fig1.1. Digital image

by means of a digital computer. Note that a digital image is composed of a finite number of elements, each of which has a particular location and value. These elements are referred to as picture elements, image elements, pels, and pixels. Pixel is the term most widely used to denote the elements of a digital image.

Image Enhancement

The aim of image enhancement is to improve the interpretability or perception of information in images for human viewers, or to provide 'better' input for other automated image processing techniques. Image Enhancement (IE) transforms images to provide better representation of the subtle details. It is an indispensable tool for researchers in a wide variety of fields including (but not limited to) medical imaging, art studies, forensics and atmospheric sciences. It is application specific: an IE technique suitable for one problem might be inadequate for another. For example forensic images or videos employ techniques that resolve the problem of low resolution and motion blur while medical imaging benefits more from increased contrast and sharpness. To cater for such an ever increasing demand of digital imaging, companies have released commercial softwares for users who want to edit and visually enhance the images.

Image Enhancement Techniques

The Image enhancement techniques can be divided into three broad categories:

a. Spatial domain methods, which operate directly on pixels, and
b. Frequency domain methods, which operate on the Fourier transform of an image.
c. Fuzzy domain, unfortunately, there is no general theory for determining what 'good' image-enhancement is when it comes to human perception. If it looks good, it is good!, when image enhancement techniques are used as pre-processing tools for other image processing techniques, then quantitative measures can determine which techniques is most appropriate.

Fuzzy image enhancement is based on gray level mapping into a fuzzy plane, using a membership transformation function. 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 closer to the mean gray level of the image than to those that are farther from the mean. An image I of size M x N and L gray level scan be considered as an array of fuzzy singletons, each having a value of membership denoting its degree of brightness relative to some brightness levels.

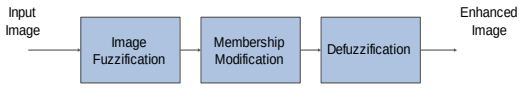

Fig. 1.2 The main principles of Fuzzy Image Enhancement.

II. FUZZY IMAGE PROCESSING MODEL

Fuzzy image processing is not a unique theory. It is a collection of different fuzzy approaches to image processing. Nevertheless, the following definition can be regarded as an attempt to determine the boundaries:

Fuzzy image processing is the 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 [9]. Here is a list of general observations about fuzzy logic:

Fuzzy logic is conceptually easy to understand.

The mathematical concepts behind fuzzy reasoning are very simple. Fuzzy logic is a more intuitive approach without the far-reaching complexity.

Fuzzy logic is flexible.

With any given system, it is easy to layer on more functionality without Starting again from scratch.

Fuzzy logic is tolerant of imprecise data.

Everything is imprecise if you look closely enough, but more than that, most things are imprecise even on careful inspection. Fuzzy reasoning builds this understanding into the process rather than tacking it onto the end.

Fuzzy logic can model nonlinear functions of arbitrary complexity.

You can create a fuzzy system to match any set of input-output data. This process is made particularly easy by adaptive techniques like Adaptive Neuro-Fuzzy Inference Systems (ANFIS), which are available in Fuzzy Logic Toolbox.

Fuzzy logic can be built on top of the experience of experts.

In direct contrast to neural networks, which take training data and generate opaque, impenetrable models, fuzzy logic lets you rely on the experience of people who already understand your system.

Fuzzy logic can be blended with conventional control techniques.

Fuzzy systems don't necessarily replace conventional control methods. In many cases fuzzy systems augment them and simplify their implementation.

Fuzzy logic is based on natural language.

The basis for fuzzy logic is the basis for human communication. This observation underpins many of the other statements about fuzzy logic. Because fuzzy logic is built on the structures of qualitative description used in everyday language, fuzzy logic is easy to use.

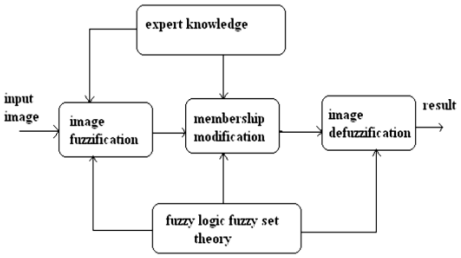

Fig. 1.3 Fuzzy Image Processing.

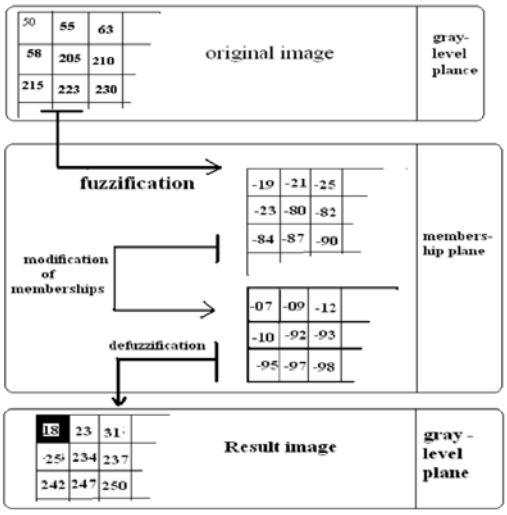

Fig.1.4 Example Steps of Fuzzification and Defuzzification process on image Processing.

The last statement is perhaps the most important one and deserves more discussion. Natural language, which is used by ordinary people on a daily basis, has been shaped by thousands of years of human history to be convenient and efficient. Sentences written in ordinary language represent a triumph of efficient communication [3].

Fuzzy image processing has three main stages: image fuzzification, modification of membership values, and, if necessary, image defuzzification.

The fuzzification and defuzzification steps are due to the fact that does 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. After the image data are transformed from gray-level plane to the membership plane (fuzzification), appropriate fuzzy techniques modify the membership values. This can be a fuzzy clustering, a fuzzy rule- based approach, and a fuzzy integration approach and so on.

III. LITERATURE REVIEW

Thakur and D. Mishra, [1] Human visual system appeases by a good contrast Images. Image enhancement techniques are best solution for improving the visual appearance of images to a human viewer. It also preserves the structure features of the image. Enhancement of the noisy image data without losing any significant information is very challenging. There are many uncertainties involved while capturing image and the performance of image enhancement varies with subject. It is well established that Fuzzy logic and fuzzy sets are very good at handling many uncertainties. The application of fuzzy theory to improve contrast of low contrast image is area of recent interest. To investigate and establish the application of fuzzy theory for enhancing a low contrast image, they propose a fuzzy based contrast enhancement of gray level images. A There's outcome asserts that method has not to good performance than conventional methods. The image quality of the system has been evaluated based on visual appearance, peak signal to noise ratio and entropy.

Balasubramaniam Jayaram, Kakarla V.V.D.L. Narayana,V. Vetrivel, [2] In this work, they propose a fuzzy inference system based contrast enhancement of gray level images. they propose a new method of generating the fuzzy if-then rules specific to a given image based on the local information available to be used by a fuzzy inference system. To this end, they only generate a partial histogram and not a complete histogram thus saving on computational costs. They also give a comparative study of theirs approach and some classical and existing fuzzy techniques, and show that the enhanced images from the proposed algorithm are comparable.

N. Unaldi, P. Sankaran, V. K. Asari and Z. u. Rahman, [3] A new wavelet-based image enhancement algorithm is proposed to improve performance of face detection in non-uniform lighting environment with high dynamic range. Wavelet transform is used for dimension reduction so that dynamic range compression with local contrast enhancement algorithm is applied only to the approximation coefficients. The normalized approximation coefficients are transformed using a hyperbolic sine curve which achieves dynamic range compression. Contrast enhancement is realized by tuning the magnitude of each coefficient with respect to its surroundings. The detail coefficients are also modified to prevent the edge deformation. Experimental results on the proposed algorithm show improvement on the performance of the Viola-Jones face detector when compared to other prominent enhancement techniques.

A. P. Dhawan, G. Buelloni and R. Gordon, [4] X-ray mammography is the only breast cancer detection technique presently available with proven efficacy. Mammographic detection of early breast cancer requires optimal radiological or image processing techniques. They has been presented an image processing approach based on adaptive neighborhood processing with a new set of contrast enhancement functions to enhance mammographic features. This procedure brings out the features in the image with little or no enhancement of the noise. They also find that adaptive neighborhoods with surrounds whose width is a constant difference from the center yield improved enhancement over adaptive neighborhoods with a constant ratio of surround to center neighborhood widths.

R. L. J. Martens and A. N. Venetsanopoulos, [5] Histogram windowing, a local statistic-based edge detector, an adaptive window size, and a median filter are compared to the median filter, the SAM filter, and the moving average filter. The five filters are compared using the peak-to-peak signal-to-noise ratio (PSNR). Four different images are used for comparison: (1) Lenna, (2) geometrical, (3) harbour, and (4) face. Three noise types are used: (1) additive, (2) impulse, and (3) a combination of the two. The results of the work show that the PSNR depends very much on what kinds of image are used.

IV. PROBLEM IDENTIFICATION

Algorithm is implemented on blurred images and visual quality is compared with conventional methods like histogram methods. This has been given algorithm is able to overcome the drawbacks of spatial domain methods like thresholding, histogram equalization and frequency domain methods. The novel part of the proposed algorithm is to come up with a fuzzy contrast representation and fuzzy contrast mapping function. The introduction of fuzzy parameter in fuzzy contrast representation, significantly improve the performance of the algorithm. With their experimentation assert that the proposed algorithm is able to get good contrasted image which increases the

brightness of the low contrasted images. Previous work algorithm is tested on different type of images and results are encouraging.

V. CONCLUSION

One of the most important issues in the image processing is contrast enhancement. The point of picture enhancement is to enhance the impression of data in pictures for human watchers or interpretability, or to offers the 'best' input benefit to the various automated image processing approaches. A digital image processing technique is proposed in order to enhance image contrast without significant noise enhancement. Double threshold segmentation algorithm (DTS) is the main base for the operation of contrast enhancement. DTS divides the image into three effective basic zones such as object zone, transition zone and background zone. DTS delivers two threshold points which can be used for controlling the contrast adjust curve. Fuzzy techniques are a very suitable to manage the elusiveness of this approach efficiently. To signify and process the knowledge of human-being in the form of fuzzy, the fuzzy logic is a potential tool. In recent investigations, many research authors have used fuzzy logic to improve novel image processing algorithms.

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