A Basic Approach to Enhance a Gray Scale Image

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Abstract: This paper describes a Gray scale image enhancement technique using Fuzzification. The images can be enhanced by improving the quality regarding the pixels value. It has three main stages, namely, image fuzzification, modification of membership function values, and defuzzification. Fuzzy image enhancement is based on gray level mapping into membership function. The proposed technique enhanced the interpretability of images that is input for other image processing technique.

Keywords- Image, Defuzzification, Fuzzification, Membership function.

Introduction

Image enhancement processes consists of a collection of techniques that seeks to improve the visual appearance of an image, or to convert the image into a form better suited for analysis for a human or a machine perception[2,13]. 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. Fuzzy Technique mainly contains three steps

1) Image Fuzzification
2) Membership Function Modification
3) Image Defuzzification.

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 (modification of membership values)[1]. After the image data are transformed from gray-level plane to the membership plane (Fuzzification), appropriate fuzzy techniques modify the membership values. A fuzzy system consists of four functional blocks as shown in Figure(see figure 1).

![Image Processing with Fuzzy System](image.png)

Step by step methodology to be followed for image enhancement is as follows:

1) Morphological Processing
2) Conversion of Image data into Fuzzy domain data.
3) Membership Modification.
4) Defuzzification
5) Get Enhanced Image.

Design

Image enhancement techniques can be divided into three broad categories:

1) Spatial Domain method, which operates directly on pixels.
2) Frequency domain methods, which operate on the Fourier transform of an image.
3) Fuzzy domain methods, which involves the use of knowledge-base systems that are capable of mimicking the behavior of a human expert[5,8,9].

Fuzzy Inference System tools for Image Enhancement:

1) Fuzzy Inference System Editor(see figure 2)
2) Membership Function Editor(see figure 3.)
1. Implementation

Fuzzy Inference System is process of formulating the mapping from given input to output using fuzzy logic. The mapping thus involves a basis through which decisions can be made[11,9]. The process of fuzzy inference involves all of the piece that are described in previous sections: membership functions, fuzzy logic operator and if-then rules. There are two types of fuzzy inference system that can be implemented in the fuzzy logic toolbox: Mamdani- type and Sugeno-type. Fuzzy Inference System has successfully implemented in fields such as automatic control, data classification, decision analysis, expert system and computer vision. Because of it multidisciplinary nature, fuzzy inference system are associated with a number of names, such as fuzzy rule based system, fuzzy expert system; the following are the steps which are carried out in sequence to get the desired output[4,10,12].

Algorithm to enhance the color of image

The algorithm starts with initialization of image parameter. Size, min, mid, maximum gray level. The Fuzzy based approach is powerful and universal method for many task in the image processing.

The algorithm is described below:

Step 1-Morphological Processing

- Read the image
- Convert it into gray scale image if it is RBG
- Find the size of image (MxN)
- Add noise to image
- Find min, maximum gray level of image also find gray level of image

Step 2: convert the data into fuzzy domain data

- Crop the image and new image is d.
- Find maximum and minimum intensity of I
  \[ mx = \max(\max(d)) \]
  \[ mn = \min(\min(d)) \]
One image function $\mu_{mn}$ can be calculated as:

$$\mu = \frac{d - mn}{mx - mn}$$

Where $mn$, $mx$, $d$ denotes minimum gray and maximum gray and any gray level.

**Step 3: Membership modification**

Define all the pixels $(i,j)$th inside the image

For $i=1:m$

For $j=1:n$

- If($(\mu (i,j) \geq 0 )\&\&(\mu (i,j) \leq 0.5 ))$
  
  input $(i,j) = 5*\mu(i,j)^3$

- Elseif ($(\mu (i,j) > =0.5 )\&\&(\mu (i,j) <= 1 ))$
  
  input $(i,j) = 1-5*(1-\mu(i,j))^3$

end

**Step 4: Defuzzification (if necessary)**

Now convert fuzzy data into grayscale enhanced data. Set maximum intensity and minimum intensity for enhanced image.

maxI = 255 , minI = 0

For $i=1:m$

For $j=1:n$

- if $(d(i,j) <= mn)$
  
  enhanceimage$(i,j) = 0$

- elseif ($(d(i,j) > mn)\&\&( d(i,j) < mx))$
  
  enhanceimage$(i,j) = (maxI - minI)*input(i,j) + minI$

- else
  
  enhanceimage$(i,j) = 255$

end

**Step 5: Displaying the enhanced image**

- Show the original image
- Show the enhanced image

2. Result

We write our code in MATLAB to implement the proposed algorithm and then run this code after saving it as m file in MATLAB workspace[4]. Experiment was done on several poor quality images. Some of the results are as shown below:

![Figure 5. Pout](image)

![Figure 6. Cake](image)

![Figure 7. Coin](image)
3. Conclusion And Future Scope

The main focus of this research is on image enhancement using fuzzy image enhancement techniques. Many images like medical images, satellite images, microscopy images, aerial images and even real life photographs suffer from poor contrast and noise. It is necessary to enhance the contrast and remove the noise to increase image visual quality. Future work can be extended for other images than grayscale images to obtain better result with accuracy. Image enhancement is a field that is being used in various areas and disciplines. Image enhancement plays a vital role in every field where images have to be understood and analyzed. In future modification of the algorithm can produce the better result for the images.

4. References


