Basic Approach to Image Contrast Enhancement with Fuzzy Inference System

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Abstract- This paper presents the design of the technique using fuzzy inference system for contrast enhancement. It has three main stages, namely, image fuzzification, modification of member ship function values, and defuzzification. Fuzzy image enhancement is based on gray level mapping into membership 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 that are farther from the mean. In the fuzzy framework of image enhancement and smoothing, two contributions merit an elaboration. The first one deals with 'IF..THEN..ELSE' fuzzy rules for image enhancement. Here, a set of neighborhood pixels forms the antecedent part of the rule and the pixel to be enhanced is changed by the consequent part of the rule. These fuzzy rules give directives much similar to humane-like reasoning. The second one proposes a rule based filtering in which different filter classes are devised on the basis of compatibility with the neighborhood. Fuzzy Image Enhancement treats image as fuzzy set and operates on those sets.

Index Terms- Defuzzification, Fuzzification, Fuzzy Inference engine, Membership function.

I. INTRODUCTION

The fuzzy systems are knowledge based systems and their performance can be optimized by an adaptive learning. Fuzzy Technique mainly contains three steps 1) Image Fuzzification 2) Enhancing Intensity component 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 (membership modification)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.

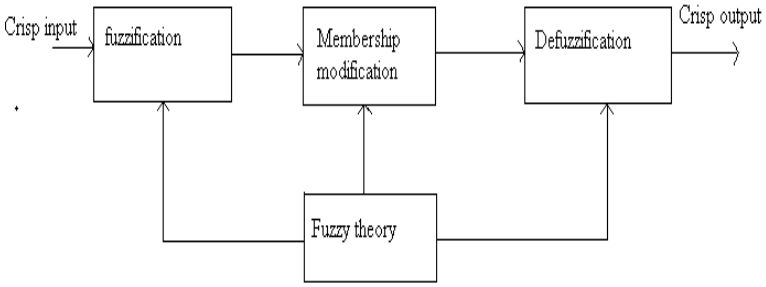

Figure1: Fuzzy Inference System

The step by step methodology to be followed for image enhancement:

Step1: Morphological Processing

Step 2: Conversion of image data into fuzzy domain data

Step 3: Membership Modifications

Step 4: Defuzzification

Step 5: Displaying the enhanced image

II. DESIGN AND IMPEMENTATION

- Passing parameter to the FIS. The process of fuzzy inference involves membership functions, logical operations and if then rules.
- Building (Mamdani type) system with fuzzy logic toolbox software.

Fuzzy Inference System Tools for Image Enhancement: We can use five GUI tools for building, editing and observing fuzzy inference systems.

1 .fuzzy inference system editor

2 .Membership function editor

3. Rule editor

4 .Rule viewer

5. Surface viewer

1. Fuzzy Inference System Editor

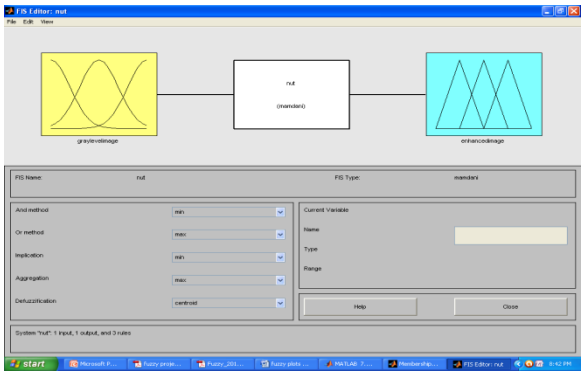

Figure 2.1: FIS editor window

- The FIS editor displays the general information about a fuzzy inference system.
- In the diagram shows the names of each input variable on the left,and those of each output variable on the right.
- Input variable is Gray Level Image and output variable is Enhanced Image.

2 .The membership function editor

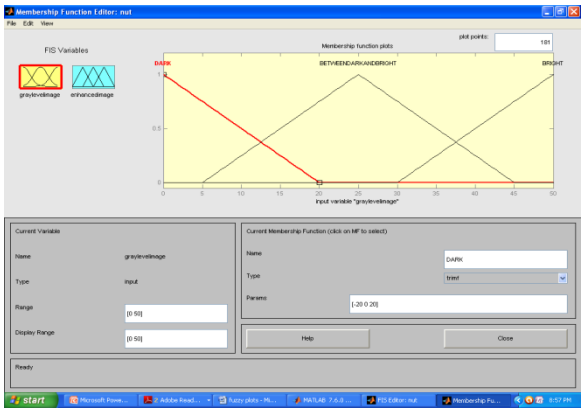

Figure 2.2: Input membership function editor window

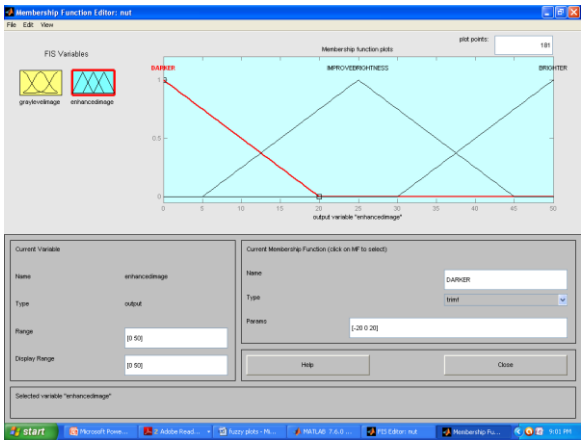

Figure 2.3: output membership function editor window

- The membership function editor is the tool that lets you display and edits all of the membership functions associated with all of the input and output variables for the entire fuzzy inference system.
- Input Membership functions are DARK, BETWEEN DARK AND BRIGHT, BRIGHT.
- Output Membership functions are DARKER, IMPROVE BRIGHTNESS, BRIGHTER.

3. The Rule Editor

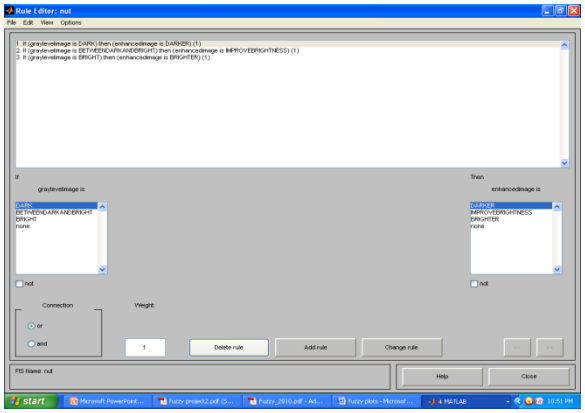

Figure 2.4: Rule editor window

- The Rule Editor allows us to construct the rule statements automatically by selecting one item in each input variable box, one item in each output box and one connection item.
- Here the Fuzzy Rules are:

If gray level image is (one input membership function) then enhanced image is(one output membership function).

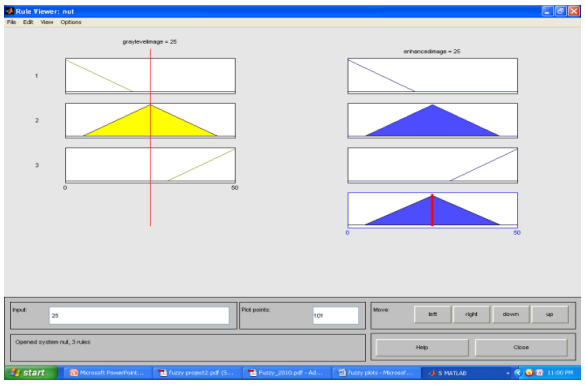

Figure 2.5: Rule viewer window

- The Rule viewer displays a road map of the whole fuzzy inference system.

5. The Surface Viewer

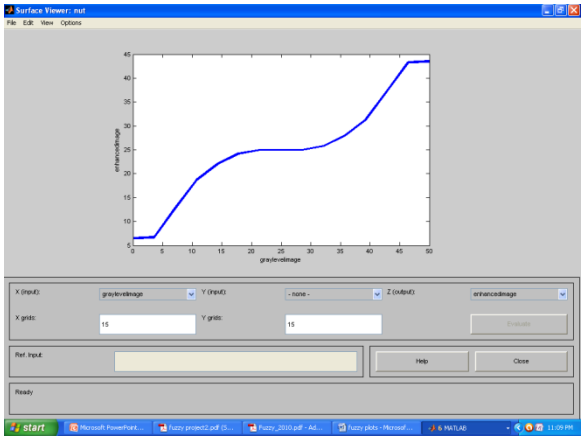

Figure 2.6: Surface viewer window

- The Surface Viewer presents a two dimensional curve that represent the mapping from gray level image to enhanced image.

III. ALGORITHM

1. Convert the image data into fuzzy domain data
2. Membership modification
3. Defuzzification

1. Pseudo code to convert image data into fuzzy domain data :

For X=0: M

For Y=0: N

If gray value between zero and min

Then f data=0;

Else if gray value between min and mid

Then f data= (1/ (mid-min)*min+ 1/ (mid-min))*data;

If gray value between mid and max

Then f data = (1 / (max-mid)*mid+ 1/ (max-mid))*data;

If gray level between max and 255

Then f data=1;

2. Membership Modification :

For X=0: M

For Y=0: N

A) If gray value between zero and min

Then f data=0;

B) If gray value between min and mid

i) If f data between 0 and 0.5

Then f data=2*(f data) ^2

ii) Else if f data between 0.5 and 1

Then f data=1-2*(1-f data) ^2

C) If gray value between mid and max

i) If f data between 0 and 0.5

Then f data=2*(f data) ^2

ii) Else if f data between 0.5 and 1

Then f data=1-2*(1-f data) ^ 2

iii) If gray value between max and 255

Then f data=1

3. Defuzzification :

For X=0: M

For Y=0: N

A) If gray value between zero and min

Then enhanced data=gray value

B) If gray value between min and mid

Then enhanced data= (mid-min)*f data +min

If gray value between mid and max

Then enhanced data= (max-mid)*f data +mid

IV. CONCLUSION

The proposed technique use fuzzy if-then rules are a sophisticated bridge between human knowledge on the one side and the numerical framework of the computers on the other side, simple and easy to understand .The proposed technique is able to overcome the drawbacks of spatial domain methods like thrsholding and frequency domain methods like Gaussian low pass filters.

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