NIFS 11 (2005), 5, 15-23

Intuitionistic Fuzzy Image Processing

R.Parvathi[1] and Dr.N.Palaniapan[2]

[1] Vellalar College for Women, Erode – 638 009, Tamilnadu, INDIA
[2] Alagapa University, Karaikudi – 630 003, Tamilnadu, INDIA

Abstract

Human visual system can only perceive a few colours at a time. The proposed system attempts to obtain low-level colour features that incorporate knowledge of human perception. One of the most important characteristics of human colour perception is that the human eye cannot simultaneously perceive a large number of colours.

In the proposed system, the contrast which is added in the output helps to segment the image as well as to mine some knowledge about the image using the chromocity coordinates of the image processed.

Keywords

Intuitionistic Fuzzy Image Processing (IFIP), Contrast intensification, Intuitionistic fuzzy sets of Second Type (IFSST)

1. Introduction

The operations concentration, dilation and contrast intensification have the effect of altering the intuitionistic fuzziness in a fuzzy set A. Effect of DIL is opposite to that of CON which reduces the magnitudes of $\mu_A(x)$ by relatively smaller amounts for those x having higher membership value in A compared to those with low $\mu_A(x)$ values.

Contrast intensification, as its name implies, reduces the fuzziness of A by increasing those of $\mu_A(x)$ which are above 0.5, and decreasing those which are below it. Their applications in image processing problems are discussed in this paper.

2. Image Definition

A monochrome image, or simply, image (having various shades of grey) is represented mathematically by a spatial brightness function f (m, n) where (m, n) denotes the spatial coordinate of a point in the (flat) image. The value of f (m, n), $0 < f(m, n) < \infty$, is proportional to the brightness value or grey level of the image at the point (m, n). For computer processing, the continuous function f (m, n) has been discretised both in spatial coordinates and in brightness. Such an approximated image X (digitized) can be considered as an $M \times N$ array.

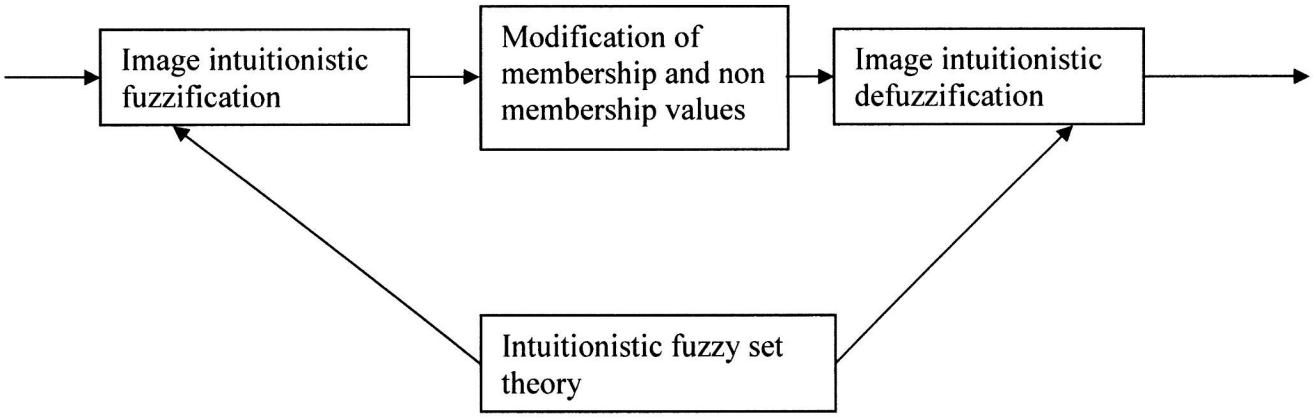


Fig 2.1. Stages of IFIP

$$X = f(m,n) \approx \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} & \cdots & x_{1N} \\ x_{21} & x_{22} & \cdots & x_{2n} & \cdots & x_{2N} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} & \cdots & x_{mN} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ x_{M1} & x_{M2} & \cdots & x_{M3} & \cdots & x_{MN} \end{bmatrix} \qquad (2.1)$$

which row and column indices identify a point (m,n) in the image and the corresponding matrix element value x_{mn} denotes the grey level at that point. The right side of the equation (2.1) represents what is called a digital image. Each element of the matrix, which is a discrete quantity, is referred to as an image element, picture element (pixel). From now on the terms 'image' and 'pixel' will be used to denote a digital image and its elements respectively.

For the purpose of processing, this image along with the coordinates of its pixels is stored in the computer in the form of an array of MN numbers.

In recent years, many researchers have applied the fuzzy set theory to develop new techniques for contrast improvement. This paper describes the application of intuitionistic fuzzy sets and their extensions to develop a technique for the contrast improvement.

With the concept of intuitionistic fuzzy set, an image X of $m \times n$ dimension and L levels can be considered as an array of intuitionistic fuzzy singletons, each with a value of membership function denoting the degree of having brightness relative to some brightness level l , l = 0,1....L-1 and a value of non membership function denoting the degree of not having brightness relative to the same level l .

Intuitionistic Fuzzy Image Processing (IFIP) has three main stages:

- Image intuitionistic fuzzification
- Modification of membership and non membership values
- Image defuzzification (See fig 2.1).

3. System Analysis

3.1. Existing System

The existing fuzzy image processing system helps to change the contrast in the output image using only the membership values. To improve the impactness on the output image, we have applied the operators on IFSST to develop a new system.

3.2. Developed System

In the new system, non membership values have also been included that shows more improvement in the output image contrast.

3.3. Developing Environment

3.3.1. Hardware Environment

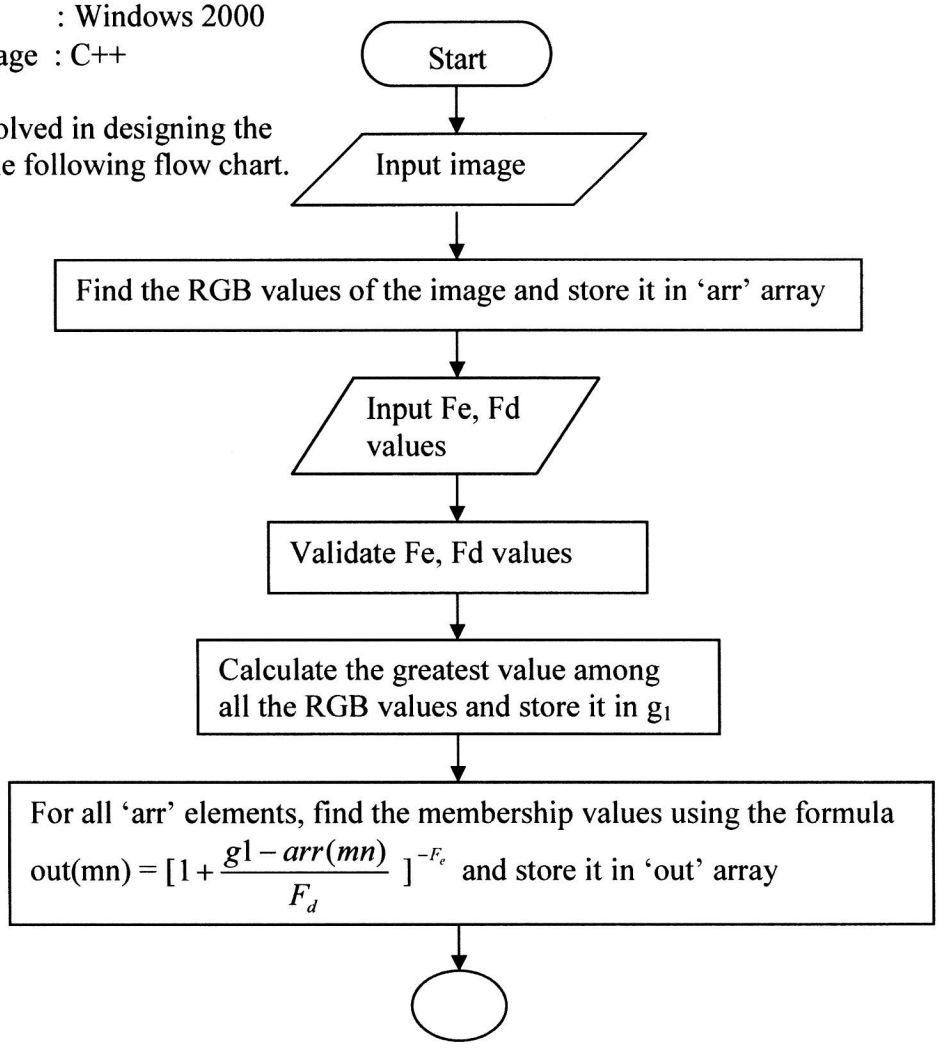
- CPU type : Pentium 4
- CPU Clock Speed : 200 MHz
- Base Memory : 640 Kb
- HDD : 20/40 GB
- FDD : 1.44
- Monitor : 15" Colour
- Keyboard 101

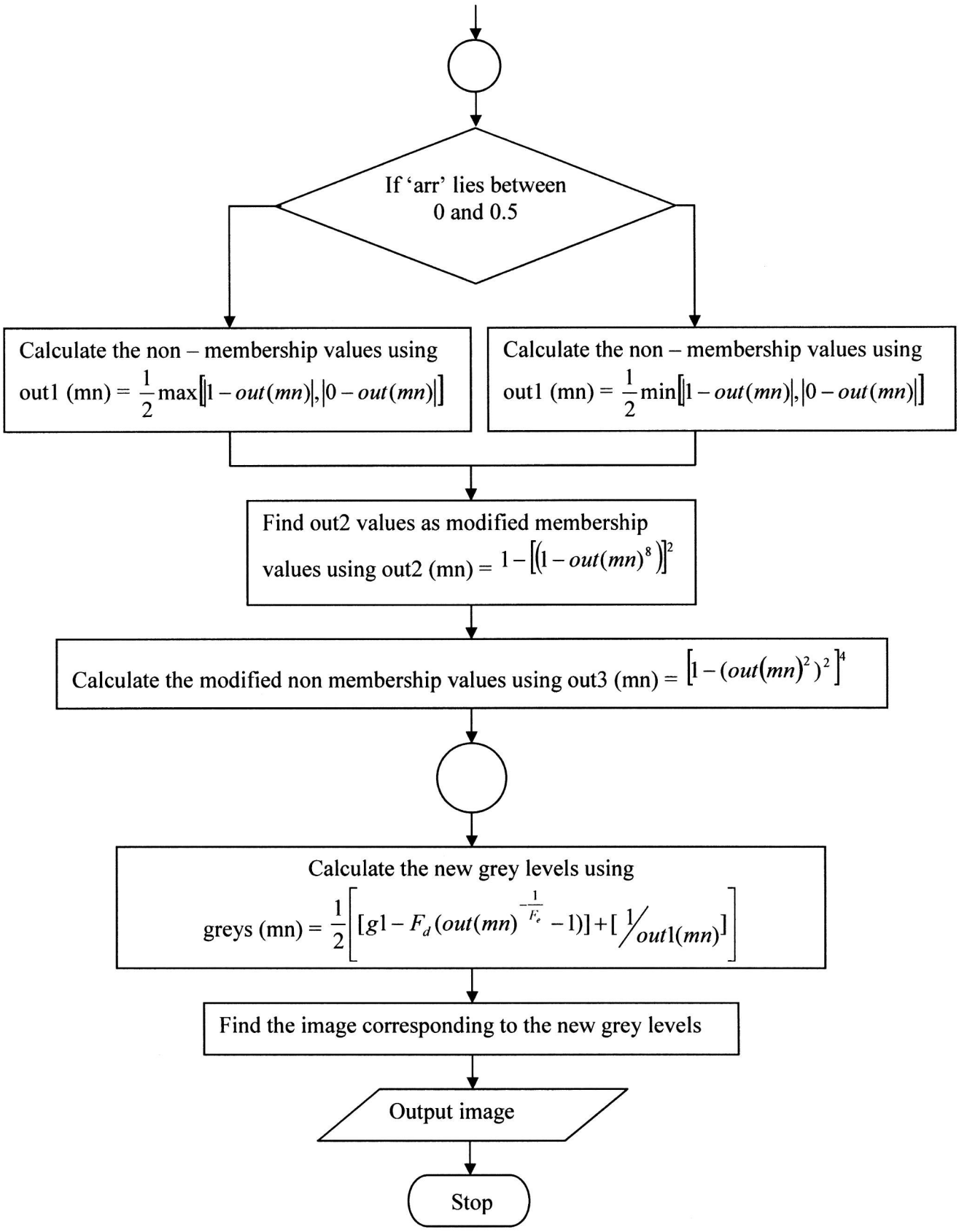
3.3.2. Software Environment

- OS : Windows 2000
- Language : C++

3.4. System Design

The various steps involved in designing the system are given in the following flow chart.




If 'arr' lies between 0 and 0.5
Calculate the non – membership values using out1 (mn) = $\frac{1}{2}\max[|1-out(mn)|,|0-out(mn)|]$
Calculate the non – membership values using out1 (mn) = $\frac{1}{2}\min[|1-out(mn)|,|0-out(mn)|]$
Find out2 values as modified membership values using out2 (mn) = $1-[(1-out(mn)^8)]^2$
Calculate the modified non membership values using out3 (mn) = $[1-(out(mn)^2)^2]^4$
Calculate the new grey levels using greys (mn) = $\frac{1}{2}\left[[g1-F_d(out(mn)^{-\frac{1}{F_e}}-1)]+[1/out1(mn)]\right]$
Find the image corresponding to the new grey levels
Output image
Stop

3.5. Testing

Testing is an important phase without which the system cannot be released to the users. Testing is vital for the success of any system. It is aimed at ensuring that all processes function accurately according to the specification. The logical and physical designs are continually examined to ensure that the system will work perfectly when implemented. Our system is tested against a sample image and output image is obtained as desired. (Refer appendix I).

4. Conclusion

This is only the beginning of the applications of Intuitionistic Fuzzy Set theory and we wish further elegance in logical computing. Further enhancements in the operator may increase the quality of the output image.

APPENDIX – I
INTUITIONISTIC FUZZY IMAGE PROCESSING
****

Enter file name: god1.bmp

Menu of options:
1.Display BMP
2.Convert to grey scale
3.Quit program

Enter your choice: 2

COLOUR VALUE OF THE GIVEN IMAGE

0	0	0
128	0	0
0	128	0
128	128	0
0	0	128
128	0	128
0	128	128
192	192	192
192	220	192
166	202	240
64	32	0

The greatest value in the membership matrix is 240.

Enter Fe value: 1

Enter Fd value: 3

ARRAY – MEMBERSHIP VALUES

0.012346	0.012346	0.012346
0.026087	0.012346	0.012346
0.012346	0.026087	0.012346
0.026087	0.026087	0.012346
0.012346	0.012346	0.026087
0.026087	0.012346	0.026087
0.012346	0.026087	0.026087
0.058824	0.058824	0.058824
0.058824	0.130435	0.058824
0.038961	0.073171	1
0.012346	0.012346	0.012346

ARRAY: NON – MEMBERSHIP VALUES

0	0	0
0.486957	0.493827	0.493827
0.493827	0.486957	0.493827
0.486957	0.486957	0.493827
0.493827	0.493827	0.486957
0.486957	0.493827	0.486957
0.493827	0.486957	0.486957
0.470588	0.470588	0.470588
0.470588	0.434783	0.470588
0.480519	0.463415	0
0.493827	0.493827	0.493827

MODIFIED NON – MEMBERSHIP VALUES

0.030536	0.033638	0.033638
0.033638	0.030536	0.033638
0.030536	0.030536	0.033638
0.033638	0.033638	0.030536
0.030536	0.033638	0.030536
0.033638	0.030536	0.030536
0.024065	0.024065	0.024065
0.024065	0.013735	0.024065
0.027842	0.021605	0
0.033638	0.033638	0.033638
0	0	0

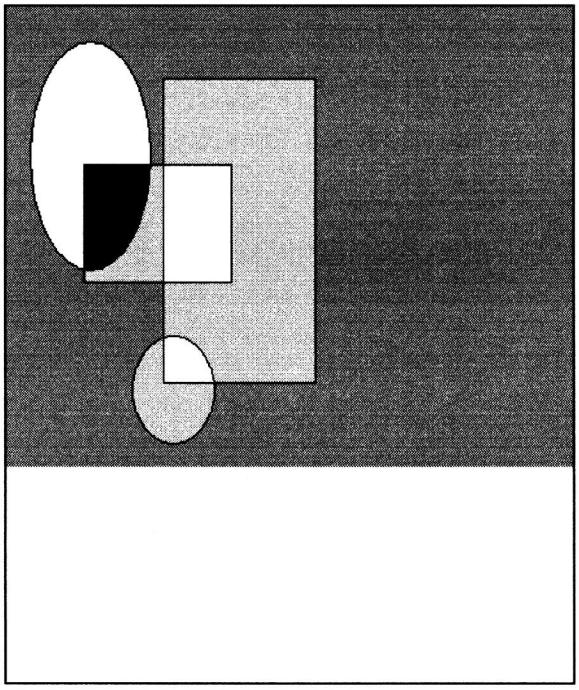
MODIFIED MEMBERSHIP VALUES

0.033638	0.033638	0.033638
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	1
0	0	0

NEWLY GENERATED GREY LEVEL MATRIX

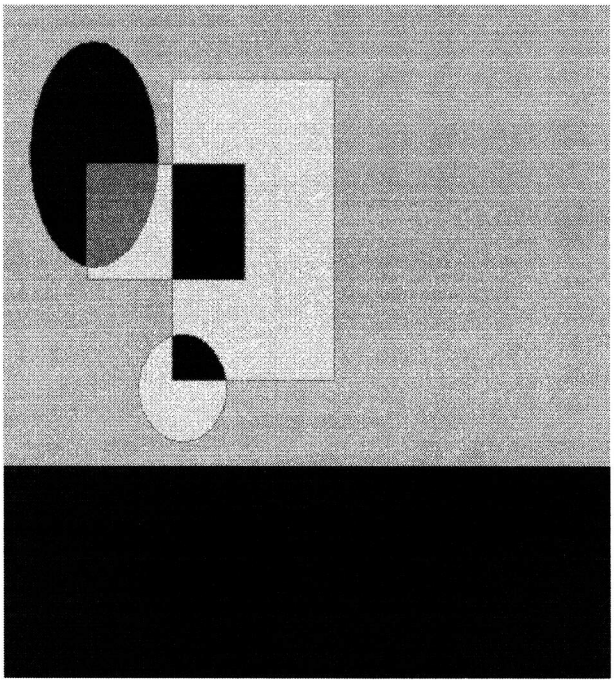
0.003087	0.003087	0.003087
64.006523	0.003087	0.003087
0.003087	64.006523	0.003087
64.006523	64.006523	0.003087
0.003087	0.003087	64.006523
64.006523	0.003087	64.006523
0.003087	64.006523	64.006523
96.014709	96.014709	96.014709
96.014709	110.032608	96.014709
83.009743	101.018295	120.25
0.003087	0.003087	0.003087

INPUT IMAGE



after processing.....

OUTPUT IMAGE



Enter Fe value: 2

Enter Fd value: 34

ARRAY – MEMBERSHIP VALUES

0.015398	0.015398	0.015398
0.054232	0.015398	0.015398
0.015398	0.054232	0.015398
0.054232	0.054232	0.015398
0.015398	0.015398	0.054232
0.054232	0.015398	0.054232
0.015398	0.054232	0.054232
0.171921	0.171921	0.171921
0.171921	0.396433	0.171921
0.099108	0.222994	1
0.015398	0.015398	0.015398

MODIFIED MEMBERSHIP VALUES

0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0	0	0
0.000002	0.000002	0.000002
0.000002	0.00122	0.000002
0	0.000012	1
0	0	0

ARRAY: NON – MEMBERSHIP VALUES

0	0	0
0.472884	0.492301	0.492301
0.492301	0.472884	0.492301
0.472884	0.472884	0.492301
0.492301	0.492301	0.472884
0.472884	0.492301	0.472884
0.492301	0.472884	0.472884
0.414039	0.414039	0.414039
0.414039	0.301783	0.414039
0.450446	0.388503	0
0.492301	0.492301	0.492301

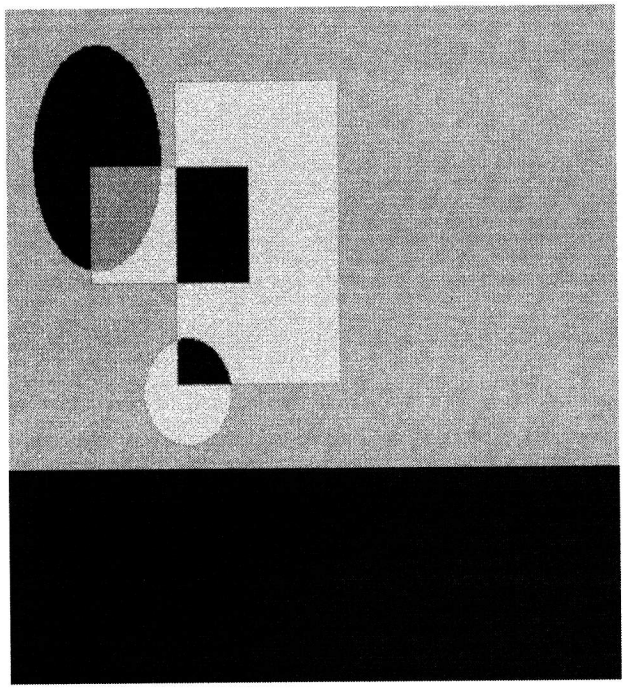
MODIFIED NON - MEMBERSHIP VALUES

0.024899	0.032928	0.032928
0.032928	0.024899	0.032928
0.024899	0.024899	0.032928
0.032928	0.032928	0.024899
0.024899	0.032928	0.024899
0.032928	0.024899	0.024899
0.009656	0.009656	0.009656
0.009656	0.000914	0.009656
0.017678	0.006067	0
0.032928	0.032928	0.032928
0	0	0

NEWLY GENERATED GREY LEVEL MATRIX

0.003087	0.003087	0.003087
64.006523	0.003087	0.003087
0.003087	64.006523	0.003087
64.006523	64.006523	0.003087
0.003087	0.003087	64.006523
64.006523	0.003087	64.006523
0.003087	64.006523	64.006523
96.014709	96.014709	96.014709
96.014709	110.032608	96.014709
83.009743	101.018295	120.25
0.003087	0.003087	0.003087

OUTPUT IMAGE



REFERENCES

[1] Atanassov K.T., Intuitionistic Fuzzy Sets (Theory and Applications), 1999, Springer – Verlag, Newyork.

[2] De S.K, Ranjit Biswas, Roy A.R, Some operations on intuitionistic fuzzy sets. *Fuzzy sets and systems*, 114 (2000), 477 – 484.

[3] Mondal Tapas Kumar, Samanta. S.K, Generalised intuitionistic fuzzy sets, internet.

[4] Parvathi R, Palaniappan.N, Some operations on intuitionistic fuzzy sets of second type. *Notes on Intuitionistic Fuzzy sets*, Vol.10, No.2 (2004), 1-19.

[5] Parvathi R, Palaniappan.N, contrast intensification of second type generalised intuitionistic fuzzy sets, *Notes on Intuitionistic Fuzzy sets*, Vol.11and 12 (2005).

[6] Philips Dwayne, Image Processing in C, 1995, BPB publications, New Delhi.

[7] Subburaj. R, Programming in C, 2000, Vikas publishing house ltd., New Delhi.

[8] www.cplusplus.com