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Feature-Preserving Fuzzy System for Color Image Enhancement using MATLAB

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Abstract: The main objective of image enhancement is to process the image so that the result is more suitable than the original image for a specific application. Image enhancement is a field that is being used in various areas and disciplines. Advances in computers, microcontrollers and DSP boards have opened new horizons to digital image processing, and have opened many avenues to the design and implementation of new innovative techniques. In this paper we 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 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 in the area of color feature extraction for enhancement of a peculiar feature. It has been found that RGB color model is not suitable for enhancement because the color components are not decoupled.

Keywords- Image Enhancement, Fuzzy Logic, Fuzzy Image, FIS, MATLAB.

I. INTRODUCTION

Many colleagues (not only the opponents of fuzzy logic) ask why we should use fuzzy techniques in image processing. In many image processing applications, we have to use expert knowledge to overcome the difficulties (e.g. object recognition, scene analysis). Fuzzy logic has rapidly become one of the most successful of today's technologies for developing sophisticated control systems. The reason for which is very simple. Fuzzy logic addresses such applications perfectly as it resembles human decision making with an ability to generate precise solutions from certain or approximate information. Fuzzy set theory and fuzzy logic offer us powerful tools to represent and process human knowledge in form of fuzzy if-then rules. NOISE smoothing and image enhancement are conflicting objectives in most image processing applications. The objectives of image enhancement are to remove impulsive noise, to smooth no impulsive noise, and to enhance features for a specific color, such as RED color in BIOMEDICAL SURGERIES or other salient structures in the input image. Noise filtering can be viewed as replacing every pixel in the image with a new value depending on the fuzzy based rules. Ideally, the filtering algorithm should vary from pixel to pixel based on the local context. For example, if the local region is relatively DARK RED, then it will be allowed to appear in image while LIGHT RED or COFUSED RED will not be allowed to appear in output image. However, it is extremely hard, if not impossible, to set the conditions under which a certain filter should be selected, since the local conditions can be evaluated only vaguely in some portions of an image. Therefore, a filtering system needs to be capable of reasoning with vague and uncertain information; this suggests the use of fuzzy logic. Fuzzy logic has rapidly become one of the most successful of today's technologies for developing sophisticated control systems. The reason for which is very simple. Fuzzy logic addresses such applications perfectly as it resembles human decision making with an ability to generate precise solutions from certain or approximate information. It fills an important gap in engineering design methods left vacant by purely mathematical approaches (e.g. linear control design), and purely logic-based approaches (e.g. expert systems) in system design.

II. LITERATURE REVIEW

Fuzzy image processing is a collection of different areas of fuzzy set theory, fuzzy logic and fuzzy measure theory. The following topics represent the most important theoretical components of fuzzy image processing:

- Fuzzy Geometry (Metric, topology, ...)
- Measures of Fuzziness and Image Information(entropy, correlation, divergence, expected values)
- Fuzzy Inference Systems (image fuzzification, inference, image defuzzification)
- Fuzzy Clustering (Fuzzy c-means, possibilistic c-means, ...)
- Fuzzy Mathematical Morphology (Fuzzy ersion, fuzzy dilation, ...)
- Fuzzy Measure Theory (Sugeno measure/integral, possibility measures, necessity measures,...)
- Fuzzy Grammars

- Combined Approaches (Neural fuzzy/fuzzy neural approaches, fuzzy genetic algorithms, fuzzy Wavelet analysis)
- Extension of classical methods (Fuzzy Hough transform, fuzzy median filtering, ...)

A fuzzy rule-based approach to image enhancement is presented that addresses seemingly conflicting goals:

- Removing impulsive noise;
- Smoothing out non impulsive noise;
- Enhancing edges or other salient features.

Three different filters for each task are derived using the weighted least mean squares method. Criteria for selecting each filter are defined. The criteria are based on the local context as well as the particular application. They constitute the antecedent clauses of the fuzzy rules, and the corresponding filters constitute the consequent clauses of the fuzzy rules. The overall result of the fuzzy-rule-based system is computed as a combination of the results of the individual filters, where each result contributes to the degree that the corresponding antecedent clause is satisfied. This approach gives us a powerful and flexible image enhancement paradigm.

A. Measures of Fuzziness and Image Information

If we understand an image (or its segments) as fuzzy sets, then we have to answer the question how fuzzy is the image. The increase or decrease of image fuzziness can be used in processing tasks such as enhancement, segmentation and classification. Arnold Kaufmann introduced the (linear) index of fuzziness as follows:

$$\gamma_1 = \frac{2}{MN}\sum_m \sum_n \min\left(\mu_{mn}, 1-\mu_{mn}\right)$$

Where, we have an image of size M.N, and calculate the fuzziness regarding to the difference between the membership values and their complements. The quadratic index of fuzziness can be defined in a similar way:

$$\gamma_q = \frac{2}{\sqrt{MN}}\left[\sum_m \sum_n \left\{\min\left(\mu_{mn}, 1-\mu_{mn}\right)\right\}^2\right]^{\frac{1}{2}} .$$

The amount of fuzziness is zero if all memberships are 0 or 1 (ordinary set: e.g. binary image).

Let us go through basics of Fuzzy Logic. Fuzzy logic is all about the relative importance of precision: How important is it to be exactly right when a rough answer will do? All books on fuzzy logic begin with a few good quotes on this very topic, and this is no exception. Fuzzy logic has rapidly become one of the most successful of today's technologies for developing sophisticated control systems. The reason for which is very simple. Fuzzy logic addresses such applications perfectly as it resembles human decision making with an ability to generate precise solutions from certain or approximate information. It fills an important gap in engineering design methods left vacant by purely mathematical in system design.

While other approaches require accurate equations to model real-world behaviors, fuzzy design can accommodate the ambiguities of real-world human language and logic. It provides both an intuitive method for describing systems in human terms and automates the conversion of those system specifications into effective models.

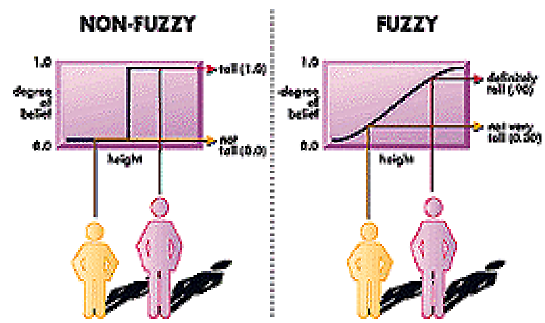


Figure 1. Difference between NON-FUZZY and FUZZY Design**.**

However our project is basically IMAGE ENHANCEMENT using Fuzzy Logic. Our aim will be to analyze and enhance the features 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.

III. PROBLEM DEFINATION

The main objective of image enhancement is to process the image so that the result is more suitable than the original image for a specific application. Image enhancement is a field that is being used in various areas and disciplines. Advances in computers, microcontrollers and DSP boards have opened new horizons to digital image processing, and have opened many avenues to the design and implementation of new innovative techniques. Fuzzy approach of knowing severity of tumor is 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 in the area of color feature extraction for enhancement of a peculiar feature. It has been found that RGB color model is not suitable for enhancement because the color components are not decoupled. 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 S and V, 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. MATLAB Based Fuzzy Logic Toolbox, Image Processing Toolbox and General Commands in MATLAB, will be used as an environment for our project. The Fuzzy Logic Toolbox for use with MATLAB is a tool for solving problems with fuzzy logic. Image Processing Toolbox with Fuzzy Logic Toolbox in MATLAB will serve our purpose. This project will find application to surgery and knowing severity of tumor and need to perform surgery

IV. SIMULATION

A. *Fuzzy Inference Systems*

Fuzzy inference is the process of formulating the mapping from a given input to an output using fuzzy logic. The mapping then provides a basis from which decisions can be made, or patterns discerned. The process of fuzzy inference involves all of the pieces that are described in the previous sections: membership functions, fuzzy logic operators, and if-then rules. There are two types of fuzzy inference systems that can be implemented in the Fuzzy Logic Toolbox: Mamdani-type and Sugeno-type. These two types of inference systems vary somewhat in the way outputs are determined. Fuzzy inference systems have been successfully applied in fields such as automatic control, data classification, decision analysis, expert systems, and computer vision. Because of its multidisciplinary nature, fuzzy inference systems are associated with a number of names, such as fuzzy-rule-based systems, fuzzy expert systems, fuzzy modeling, fuzzy associative memory, fuzzy logic controllers, and simply (and ambiguously) fuzzy systems.

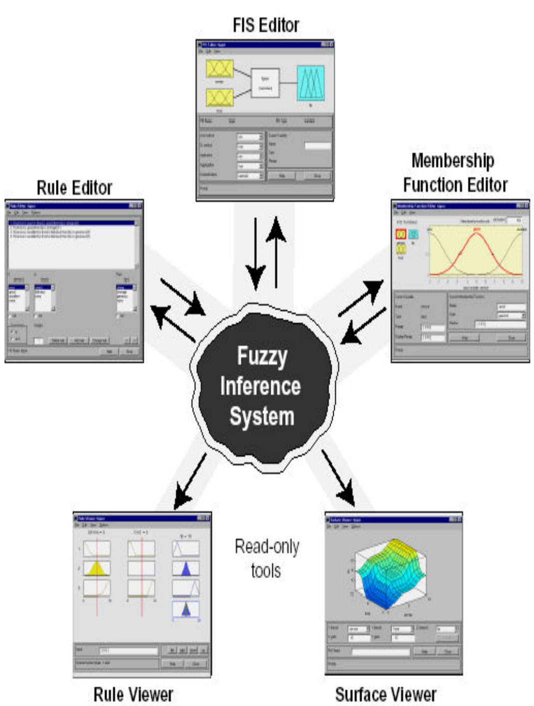


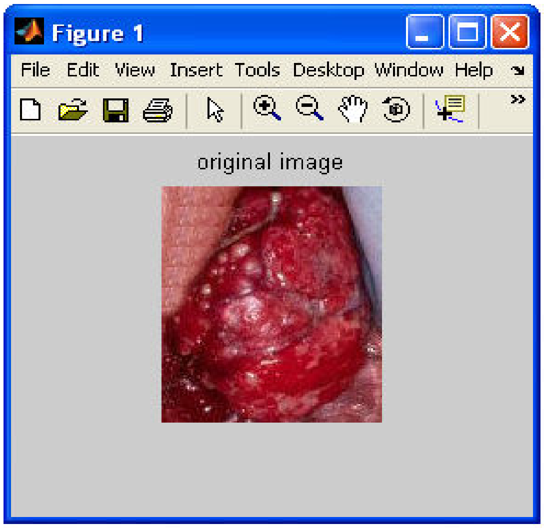
Figure 2. Fuzzy Interface System

The FIS Editor handles the high level issues for the system: How much input and output variables? What are their names? The Fuzzy Logic Toolbox doesn't limit the number of inputs. However, the number of inputs may be limited by the available memory of your machine. If the number of inputs is too large, or the number of membership functions is too big, then it may also be difficult to analyze the FIS using the other GUI tools. The Membership Function Editor is used to define the shapes of all the membership functions associated with each variable. The Rule Editor is for editing the list of rules that defines the behavior of the system.

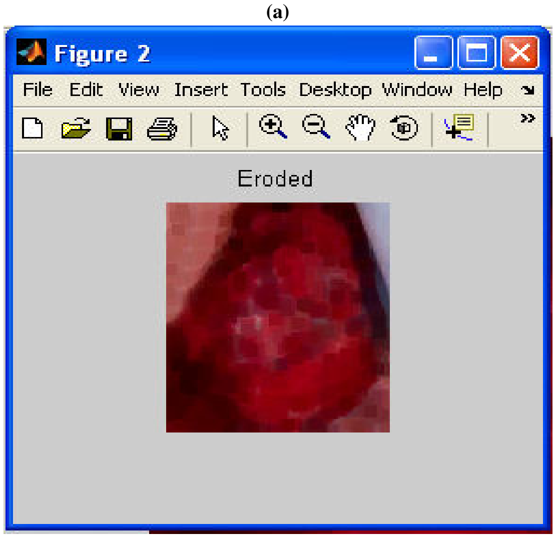
The Rule Viewer and the Surface Viewer are used for looking at, as opposed to editing, the FIS. They are strictly read-only tools. The Rule Viewer is a MATLAB-based display of the fuzzy inference diagram shown at the end of the last section. Used as a diagnostic, it can show (for example) which rules are active, or how individual membership function shapes are influencing the results. The Surface Viewer is used to display the dependency of one of the outputs on any one or two of the inputs—that is, it generates and plots an output surface map for the system.

V. RESULTS

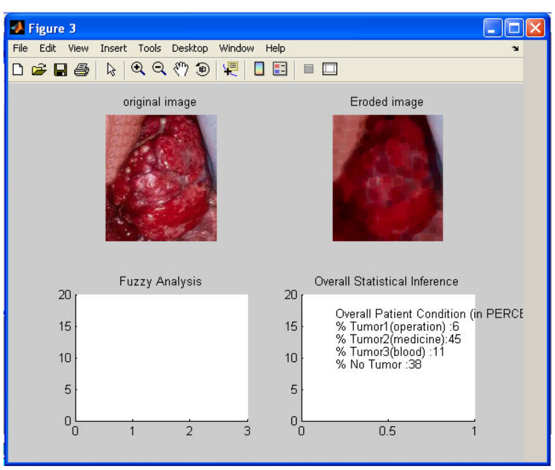
We have implemented the image enhancement with help of MATLAB and carried out a series of performance experiments in order to check the effectiveness of our approach. We are going to enhance the images in the field of biomedical applications. Images in biomedical applications pose a great problem for surgeon since the image features particularly color is not distinguishable, due to wide variety of colors and mixed complexity of healthy and diseased portion. In this section, we present the experimental results. In this we will enhance the true tumoured region based on fuzzy logic and use fuzzy logic toolbox. RGB Values of image will be passed to fuzzy logic toolbox. Rules will be framed in Fuzzy Sense to differentiate between different levels and shades of colors in human sense. ("TOO DARK, TOO THIN, NOT MUCH RED LIGHT RED MEDIUM RED etc).Fuzzy output will differentiate between ambiguous colors. Decision making algorithm will be written which will enhance, only tumored region. Thus every pixel on image will be discriminated using fuzzy rules and hence output picture will enhance only special features of image.



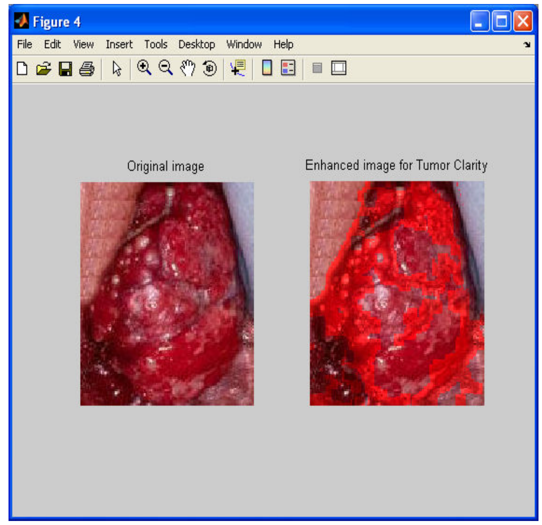
(a)



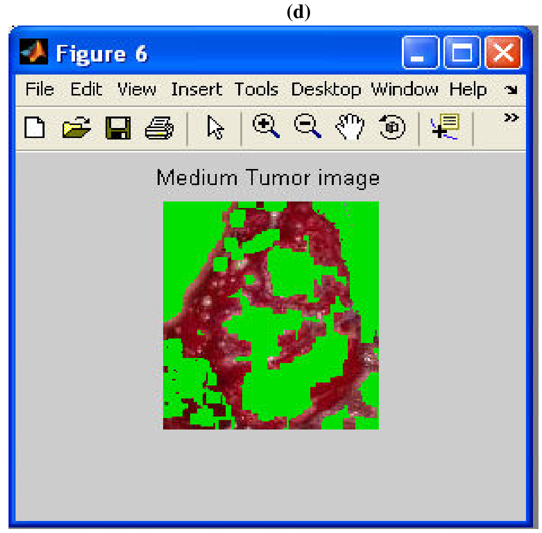
(b)



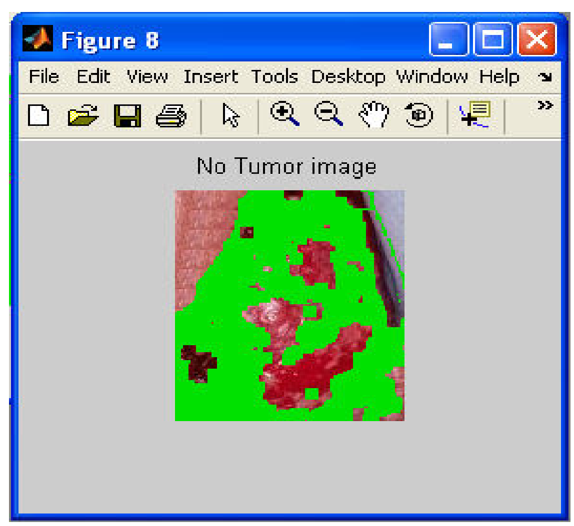
(c)



(d)



(e)



(f)

Figure 3. (a) Shows the original image of the tumor take for experiment proposed. (b) Shows Image after an Erosion operation on original Image. (c) Showing the overall statistics of the patient after performing fuzzy analysis. (d) Showing Original and Enhanced Image of Tumor.(e) Showing

Medium Tumor Image. (f) Showing the region which is not affected by tumor

V. CONCLUSION

In this paper we have used the knowledge-base (fuzzy expert) systems that are capable of mimicking the behavior of a human expert. Fuzzy approach of knowing severity of tumor is 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 in the area of color feature extraction for enhancement of a peculiar feature. Fuzzy logic addresses such applications perfectly as it resembles human decision making with an ability to generate precise solutions from certain or approximate information. Many of the toolbox functions are MATLAB M-files, a series of MATLAB statements that implement specialized image processing algorithms. It fills an important gap in engineering design methods left vacant by purely mathematical approaches (e.g. linear control design), and purely logic-based approaches (e.g. expert systems) in system design.

VI. REFERENCES

[1] G. A. Mastin, "Adaptive filters for digital image noise smoothing: An evaluation," *Comput. Vis., Graph, Image Process*, vol. 31, pp. 103–121, 1999.

[2] Kosko, *Neural Networks and Fuzzy Systems*. Englewood Cliffs, NJ: Prentice-Hall, 2000.

[3] J. C. Bezdeck and S. K. Pal, Eds., *Fuzzy Models for Pattern Recognition*, New York: IEEE Press, 1997.

[4] S. K. Pal, "Fuzzy sets in image processing and recognition," in *Proc. 1st IEEE Int. Conf. Fuzzy System*, 1992, pp. 119–126.

[5] R. Krishnapuram and M. Keller, "Fuzzy sets theoretic approach to computer vision: An overview," in *Proc. 1stIEEE Int. Conf. Fuzzy Systems*, 1992, pp. 135–142.

[6] J. S. Kim and H. S. Cho, "A fuzzy logic and neural network approach to boundary detection for noisy imagery," *Fuzzy Sets Syst.*, vol. 65, pp. 141–159, Aug. 1994.

[7] F. Russo and G. Ramponi, "Edge detection by FIRE operators," in *Proc. 3rd IEEE Int. Conf. Fuzzy System*, 1994,pp. 249–253.

[8] "Combined FIRE filters for image enhancement," in *Proc. 3rd IEEE Int. Conf. Fuzzy Systems*, 1994, pp. 261–264. filter," in *Proc. 1995 IEEE Int. Conf. Systems, Man, Cybernetics, Intelligent Systems Century*, vol. 1, 1995, pp. 845–848.

[9] Van De Ville, M. Nachtegael, D. Van der Weken, W. Philips, I. Lemahieu, and E. E. Kerre, "A new fuzzy filter for Gaussian noise reduction," *Proc. SPIE Visual Communication and Image Processing*, pp. 1–9, 2001.

[10] Van De Ville, M. Nachtegael, D. Van der Weken, E. E. Kerre, and W. Philips, "Noise reduction by fuzzy image filtering," *IEEE Trans. Fuzzy Syst.*, vol. 11, no. 2, pp. 429–436, Aug. 2003.

[11] M. Nachtegael, D. Van derWeken, and E. E. Kerre, "Fuzzy techniques in image processing: Three case studies," *Int. J. Comput. Anticipatory Syst.*, vol. 12, pp. 89–104, Aug. 2002.

[12] E. Kerre, *Fuzzy Sets and Approximate Reasoning*. Xian, China: Xian Jiaotong Univ. Press, 1998.

[13] Cornelis, G. Deschrijver, and E. E. Kerre, "Classification of intuitionistic fuzzy implicators: An algebraic approch," in *Proc. 6th Joint Conf. Information Sciences*, 2002, pp. 105–108.

[14] http://www.eng.mu.edu/~craigk/Mechatronics%20Notes/Fuzzy%20Logic%20Control.pdf

[15] R. C. Gonzalez and R. E.Woods, *Digital Image Processing*. Reading, MA/Englewood Cliffs, NJ: Addison Wesley/Prentice Hall, 1992.

[16] V. Zlokolica and W. Philips, "Motion and detail adaptive denoising of video," in *IS&T/SPIE Symp. Electronic Imaging*, 2004, pp. 1417–1421.

[17] S. Schulte, M. Nachtegael, V. De Witte, D. Van der Weken, and E. E. Kerre, "A new two step color filter for impulse noise," in *Proc. East West Fuzzy Colloq.*, 2004, pp. 185–192.

[18] "A fuzzy impulse noise detection and reduction method," *IEEE Trans. Image Process.*, vol. 15, no 5, pp.1153–1162, May 2006.

[19] T. Chen, K. K. Ma, and L. H. Chen, "Tri-state median filter for image denoising," *IEEE Trans. Image Process.*, vol. 8, no. 12, pp. 1834–1838, Dec. 1999.

[20] R. C. Hardie and C. G. Boncelet, "LUM filters: A class of rank-order-based filters for smoothing and sharpening," *IEEE Trans. Signal Process.*, vol. 41, no. 3, pp. 1061–1076, Mar. 1993.

[21] Androutsos, K. N. Plataniotis, and A. N. Venetsanopoulos, "Colour image processing using vector rank filter," in *Proc. Int. Conf. Digital Signal Pprocessing*, 1998, pp. 614–619.

[22] Vertan and V. Buzuloiu, , E. E. Kerre and M. Nachtegael, Eds., "Fuzzy nonlinear filtering of color images, "in *Fuzzy Techniques in Image Processing*, 1st ed. Heidelberg, Germany: Physica Verlag, 2000, vol. 52, pp. 248–264.

[23] R. Lukac, "Adaptive vector median filtering," *Pattern Recognit. Lett.*, vol. 24, pp. 1889–1899, Aug. 2003.

