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Fuzzy Technique for Color Quality Transformation

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Abstract. This paper develops a new quality enhancement algorithm. We first propose three Bell-shape membership functions. The shape of the membership functions employed in fuzzy logic are formed in an adaptive manner according to the parameters. By applying fuzzy rules, we obtain a relationship between input and output. The results of computer simulations show that the proposed method gives fairly good results.

Keywords: quality enhancement, membership function, fuzzy model.

1 Introduction

Fuzzy sets are employed to combine knowledge in the problem solutions, where formulation is based on vague concepts. Fuzzy set theory has achieved great popularity in the image processing field in the last decades. Imprecise knowledge can be treated if this vagueness begins from ambiguity rather than randomness. Figure 1 shows block diagram of general fuzzy image processing. The process has three steps, fuzzification, suitable operation on membership values and defuzzification.

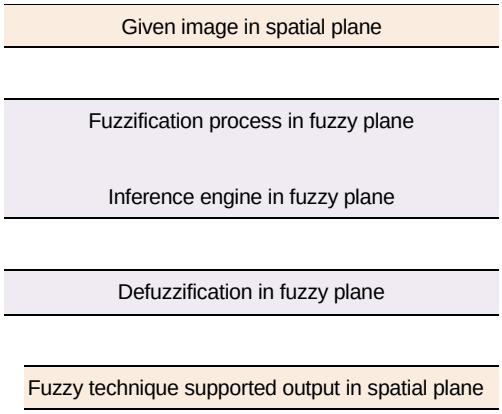

Fig. 1. General structure of fuzzy image processing.

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2 Fuzzy Image Processing

Fuzzy sets theory provides an appropriate structure for the development of new image processing approaches because they are knowledge-based nonlinear methods. In literature, Russo introduced fuzzy inference ruled by else-action (FIRE) operators which is used for image filtering [1]. In general, fuzzy filters are principally based on fuzzy *if-then* rules, where the requested filtering outcome can be achieved using a suitable set of linguistic rules.

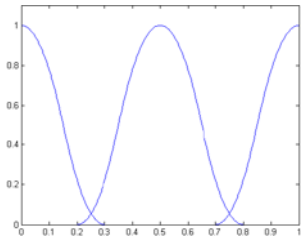


Fig. 2. Fuzzy bell-shape membership functions for the proposed method.

The membership functions of our proposed method are shown in Fig. 2. As we can see, we adopted bell shape function, which is defined as,

$$MF_{Bell}(c) = \begin{cases} MF_S(c,a,b), & c<b \\ MF(2b-c,a,b), & b\le c \end{cases} \quad (1)$$

where $MF_S(z,a,b)$ is S-shape membership function which is defined as

$$MF_S(c,a,b) = \begin{cases} 0, & c<a \\ 2\left(\frac{c-a}{b-a}\right)^2, & a\le c<p \\ 1-2\left(\frac{c-a}{b-a}\right)^2, & p\le c<b \\ 1, & b\le c \end{cases} \quad (2)$$

We have three membership functions, low (L), medium (M), and high (H). Our employed fuzzy *if-then* rules are,

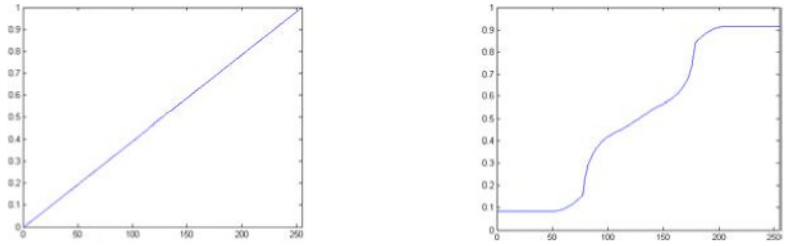
FIRE1: if *condition* is L, then employed *operation* is result$_L$.
FIRE2: if *condition* is M, then employed *operation* is result$_M$. (3)
FIRE3: if *condition* is H, then employed *operation* is result$_H$.

3 Experimental Results

In this section, a visual quality comparison is made. We used 18 McM color images with 500×500 size for the comparison. These image are shown in Fig. 3.

Fig. 3. Test McM dataset.

The contrast enhancement map is shown in Fig. 4. Figure 4(a) is unchanging intensity map, and Fig. 4(b) is the proposed fuzzy technique-based intensity map.



(a) (b)

Fig. 4. (a) Unchanging intensity map, (b) proposed fuzzy technique based intensity map.

The result images are shown in Figs. 5-7. Figure 8 shows the histogram transition of Fig. 7.

4 Conclusions

A new image quality enhancement algorithm was proposed. Three bell-shape membership functions where used for fuzzy logic. The visual performance comparison shows that our proposed method gives a good quality.

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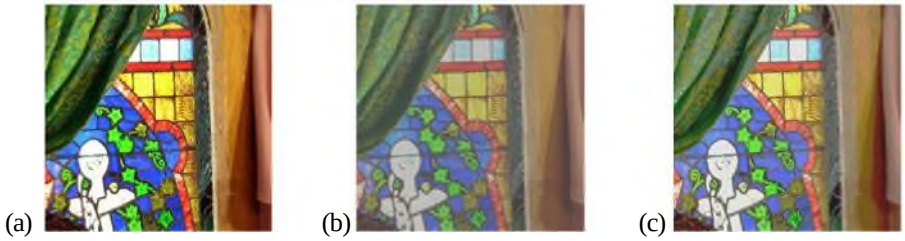

Fig. 5. (a) Original McM #1 image, (b) low-contrast image, and (c) result of the proposed method.

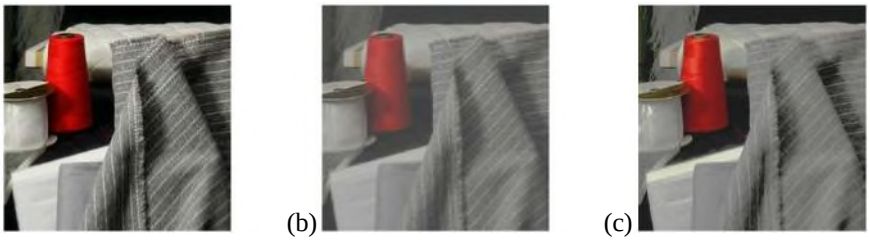

Fig. 6. (a) Original McM #7 image, (b) low-contrast image, and (c) result of the proposed method.

Fig. 7. (a) Original McM #17 image, (b) low-contrast image, and (c) result of the proposed method.

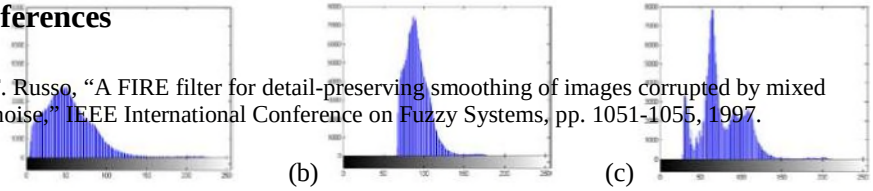

Fig. 8. Histograms of the McM #17 images: (a) Fig. 7(a), (b) Fig. 7(b), and (c) Fig. 7(c).

References

1. F. Russo, "A FIRE filter for detail-preserving smoothing of images corrupted by mixed noise," IEEE International Conference on Fuzzy Systems, pp. 1051-1055, 1997.