Advanced Science and Technology Letters
Vol.28 (EEC 2013), pp.58-61
http://dx.doi.org/10.14257/astl.2013.28.11

Certainty Measurement with Fuzzy Entropy for Video Up-Sampling

Gwanggil Jeon and Young-Sup Lee

Department of Embedded Systems Engineering, Incheon National University,
12-1 Songdo-dong, Yeonsu-gu, Incheon 406-772, Korea
{gjeon,ysl}@incheon.ac.kr

Abstract. In this paper, we propose a new upsampling algorithm based on certainty measurement concept of fuzzy entropy. The conventional entropy was introduced by C.E. Shannon. We study the vagueness and ambiguous uncertainties of fuzzy entropy. Simulation results show that our presented upsampling algorithm is better than famous ELA method.

Keywords: fuzzy entropy, upsampling, image upscaling.

1 Introduction

Traditional television display does not yield full-frame at once and only can display odd and even lines in every 1/60 (in North America and Korea) and 1/50 (European counties) second [1]. This issue was brought by insufficient bandwidth. However, current television displays full video images at once, therefore interlace scanning format videos must be changed to progressive one [2,3].

There have been different upsampling methods to enhance video format conversion. Those methods can be classified into two categories. One category is motion based method [4-6], and the other is non-motion based method [7-10]. Generally motion based method is called temporal domain approach and non-motion based method is called spatial domain method. The edge-based line average (ELA) method is one of non-motion based methods, which is widely used in video deinterlacing application.

Information theory was introduced by C.E. Shannon. According to information theory, entropy is an uncertainty measure in a random variable. We assume Shannon entropy is a conventional one, which is average unpredictability in a random variable. Shannon entropy gives an absolute limit on the possible lossless coding or compression of any communication and video. In this paper, we use fuzzy entropy concept to improve video upsampling. The fuzzy sets were studied by Zadeh with a purpose to solving issues where indefiniteness resulting from a inherent vagueness plays a fundamental function. In this paper, we research fuzzy information computation with fuzzy entropy that is employed to choose the applicant method [7-10]. It is known that the principal difference between Shannon entropy of information theory and fuzzy entropy is that the former one deals with stochastic uncertainties and the later one deals with unclarity and ambiguous uncertainties.

ISSN: 2287-1233 ASTL

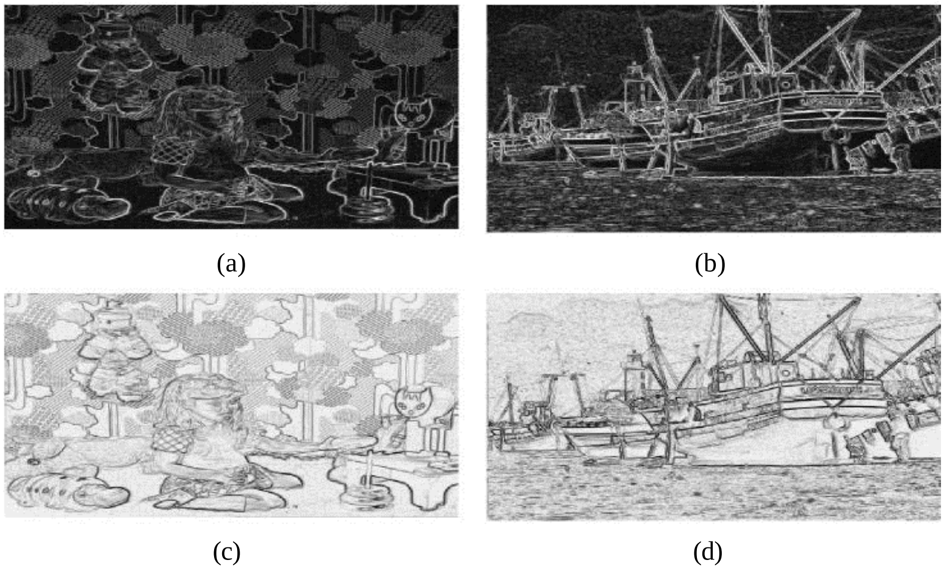


Fig. 1. Fuzzy entropy map for Girl and Boat images: (a,b) original entropy map, (c,d) reversed images.

This paper is organized as follows. In Section 2, we compare conventional Shannon entropy with the proposed fuzzy entropy. Moreover, the fuzzy entropy-based upsampling method is introduced. Section 3 gives the visual results with traditional methods. Section 4 finalizes the paper with the concluding remarks.

2 Shannon Entropy vs. Fuzzy Entropy

The Shannon's entropy is calculated as Eq. (1).

$$H_{Shannon}(\Delta_n) = -\sum_{i=1}^{n} l_i \log(l_i). \qquad (1)$$

where $\Delta_n=\{L=l_1,...,l_n\}$: $l_i \geq 0$, and $n \geq 2$ be a set of n-complete likelihood distributions. De Luca and Termini [11,12] defined fuzzy entropy for a fuzzy set A (A) as,

$$H_{DeLuca} = fuzzyentropy = -\frac{1}{n}\sum_{i=1}^{n}\{\mu_A(x_i)\log\mu_A(x_i) + (1-\mu_A(x_i))\log(1-\mu_A(x_i))\} \qquad (2)$$

Our algorithm is Based on fuzzy entropy of H_{DeLuca}.

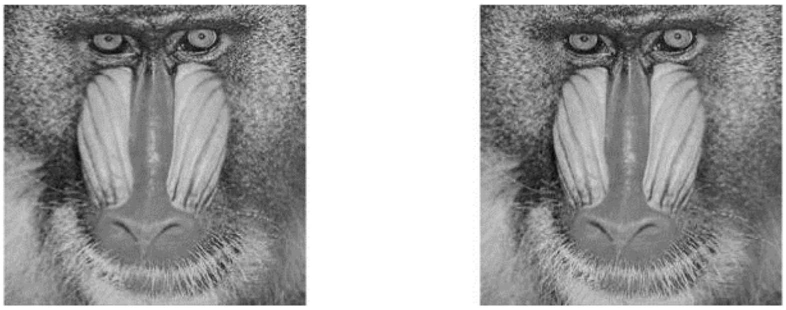
Figures 1(a,b) show fuzzy entropy map of $_{HDeLuca}$ for Girl and Boat images. Figures 1(c,d) show reversed images.

3 Experimental Results

We employed 24 image\video sequences to assess the visual performance comparison. The threshold value was determined empirically, which is chosen as 0.3 [13]. Equation (3) shows structural similarity (SSIM) formula, which takes into account image degradation as noticed alter in structural information.

$$SSIM(a,b)=\frac{(2\propto_a\propto_b+c_1)(2\int_{ab}+c_2)}{(\propto_a^2+\propto_b^2+c_1)(\int_a^2+\int_b^2+c_2)} \tag{3}$$

Figure 2 shows subjective performance comparison on Baboon and Man images. As we can see, our proposed entropy based method gives better results than conventional ELA method.



(a) (b)

Fig. 2. Subjective performance comparison: (a) original Baboon image, (b) ELA method, and (c) proposed fuzzy entropy-based method.

(a) (b)

Fig. 3. Subjective performance comparison: (a) original Man image, (b) ELA method, and (c) proposed fuzzy entropy-based method.

4 Conclusions

A new image/video upsampling method was proposed in this paper. The presented method is based on De Luca and Termini's fuzzy entropy. When it compared to conventional ELA method, the proposed entropy-based method gives better performance.

Acknowledgment. This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Science, ICT and Future Planning (2013R1A1A1010797)

References

1. K. Jack, Video Demystified - A Handbook for the Digital Engineer, 4th ed., Elsevier, Jordan Hill, Oxford, 2005.
2. T. Doyle, "Interlaced to sequential conversion for EDTV applications," in Proc. 2nd Int. Workshop Signal Processing of HDTV, pp. 412-430, Feb. 1990.
3. C.E. Shannon, "A mathematical theory of communication," Bell System Tech. J. 21 (1948) 379-423; 623-656.
4. L. Zadeh, "Fuzzy sets," Information and control, vol. 8, no. 3, (1965), pp. 338-353.
5. T. Chen and Y.-C. Wang, "Fuzzified FCM for mining sales data and establishing flexible customer clusters," International Journal of Hybrid Information Technology, vol. 5, no. 4, pp. 79-84, Oct. 2012.
6. M. Saeidi, L. C. Anzabi, and M. Khaleghi, "Image sequences filtering using a new fuzzy algorithm based on triangular membership function," International Journal of Signal Processing, Image Processing and Pattern Recognition, vol. 2, no. 2, pp. 75-90, June 2009.
7. J. L. Fan and Y. L. Ma, "Some new fuzzy entropy formulas," Fuzzy sets and Systems, vol. 128, no. 2, pp. 277-284, 2002.
8. D. S. Hooda, "On generalized measures of fuzzy entropy," Mathematica Slovaca, vol. 54, no. 3, pp. 315-325, 2004.
9. M. Dhar, R. Chutia, and S. Mahanta, "A note on the existing definition of fuzzy entropy," International Journal of Energy, Information and Communications, vol. 3, no. 1, pp. 17-21, Feb. 2012.
10. B.Kosko, Neural Networks and Fuzzy Systems, Prentice-Hall, Englewood Cliffs, NJ, 1992.
11. A. De Luca, S.Termini, "Vagueness in scientific theories," Systems and Control Encyclopedia, pp. 4993-4996, 1988.
12. A. De Luca, S.Termini, "Entropy measures in fuzzy set theory," Systems and Control Encyclopedia, 1467-1473, 1988.
13. Z. Wang, A. C. Bovik, H. R. Sheikh and E. P. Simoncelli, "Image quality assessment: From error visibility to structural similarity," IEEE Trans. Image Processing, vol. 13, no. 4, pp. 600-612, Apr. 2004.

