BLIND IMAGE BLUR ASSESSMENT BASED ON MARKOV-CONSTRAINED FCM AND BLUR ENTROPY

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Introduction

The image blur assessment is practically useful in such as the feedback of microscope dynamic focusing, assessment of the quality of pictures in social media.

Proposed a new algorithm of Image Quality Assessment (**IQA**) with **sensitivity**, **accuracy** and of **high speed** is of great importance in the field of image analysis.

Methods

- Defined the boundaries of the color patches by improved FCM, then evaluate the membership uncertainty of the pixels in the edge zone.
- Introduced **Markov Constraints** to the **Fuzzy-C-Means** (**MC-FCM**) clustering algorithm to improve the robustness to noise (Minimize $J(u_{ij})$) ;

$$J(u_{ij}) = \sum_{i=1}^{N}\sum_{j=1}^{C} u_{ij}^{m}\left((1-\alpha_i)d_{ij}^2 + \alpha_i \sum_{k\in N_i} d_{kj}^2\right) + \lambda \sum_{i=1}^{N}\sum_{j=1}^{C} u_{ij}\log(\frac{u_{ij}}{\pi_i})$$

$$\alpha_i = 1 - \sum_{j\in N_i} \exp\left(\frac{d_{ij}}{\max_{l\in N_j} d_{lj}}\right)/N_i$$

- Adding Markov Field restriction to the FCM;
- Obtained the **fuzzy membership** of pixels via the MC- FCM;

$$\textbf{Def}: x_i \in \mathbf{E} \iff \frac{\max_{j\in C} u_{ij}}{2^{nd}\max_{j\in C} u_{ij}} \le T_h$$

- Leveraged fuzzy membership from MC-FCM, the blur assessment toward pixels in the edge zone is "**Blur Entropy**" provided by modifying Shannon's entropy.

$$BE = -\frac{1}{N}\sum_{x_j\in \mathbf{E}}\sum_{k=1}^{C} u_{kj}\log u_{kj}$$

- The more an image blurs, the membership degree of pixels in the edge zone will be more evenly distributed.

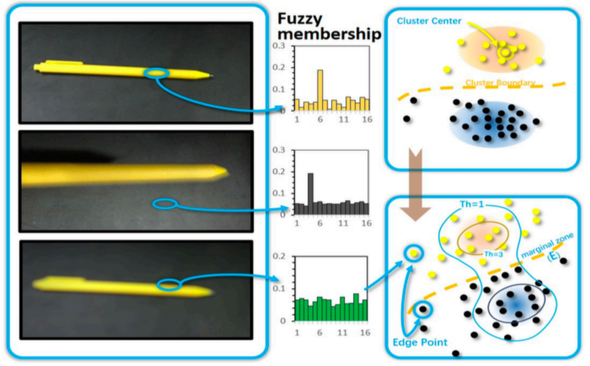

Fig.1. The difference of membership degree of pixels between the edge zone and center of color patches.

Results

- Comparisons are made on two public blur image databases[1][2] over five recent image blur assessment algorithms.
- The proposed method has lower computation complexity compared with existing approaches.

Metric	Average Processing Time (in seconds)
BE (This paper)	0.1017
LPC [12]	2.2371
MLV [13]	0.2981
DOM [14]	1.0012
RFSV [15]	3.6429
Method in ref [16]	0.4831

Table 1. The lowest Computation Complexity by BE

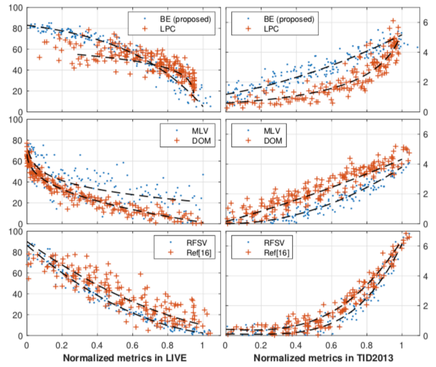

Fig.2. Proposed method has better performance in sensitivity and accuracy of assessment

- Blur assessment results demonstrate that more flat curve of proposed method refers to **higher sensitivity** and the upper concave shape of curve of proposed algorithm refers to **better resolutions for mildly blurred images**.

Conclusion

We proposed a novel image blur evaluation method based on the improved FCM clustering and blur entropy. Then designed experiments to test the performance of our algorithm on two public databases. The results showed the proposed method has good blur resolution and the evaluation speed among two public databases against five recently proposed methods.

Reference

[1] Hamid R Sheikh, Muhammad F Sabir, and Alan C Bovik, "A statistical evaluation of recent full reference image quality assessment algorithms," IEEE Transactions on image processing, vol. 15, no. 11, pp. 3440– 3451, 2006.

[2] Nikolay Ponomarenko, Lina Jin, Oleg Ieremeiev, Vladimir Lukin, Karen Egiazarian, Jaakko Astola, Benoit Vozel, Kacem Chehdi, Marco Carli, Federica Battisti, et al., "Image database tid2013: Peculiarities, results and perspectives," Signal Processing: Image Communication, vol. 30, pp. 57–77, 2015.