Analysis of Gaze Patterns during Aesthetic Photo Quality Assessement

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***Abstract*— This paper investigates the relationship between gaze patterns and aesthetic photo quality based on an eye-tracking experiment. For aesthetic quality, we consider not only average rating scores but also rater-wise variations, i.e., subjectivity. For gaze pattern analysis, we consider both intra-viewer and inter-viewer aspects. It is demonstrated that notable relationship between aesthetic quality and gaze patterns exists, which varies depending on the topics of the photos.**

***Keywords*— Aesthetic quality, eye-tracking, subjectivity**

I. INTRODUCTION

Nowadays, thanks to the prevalence of camera-integrated-mobile devices and digital cameras, people can easily take pictures. Naturally, people are interested in taking and enjoying aesthetically attractive photos. Thus, there is a need of a system that can automatically evaluate aesthetic quality of images, which can be used to help users take aesthetically pleasing photos, to automatically enhance already taken photos, etc.

Traditionally, several studies have analyzed which features make a photo aesthetically good (or bad) and attempted extraction of such features for automatic aesthetic quality assessment. In [1], it was studied which features are important in visual landscape quality assessment. Li et al. [2] constructed a system for automatic assessment of aesthetic visual quality of paintings. In [3][4], automatic evaluation of aesthetic quality of digital photos was tried based on machine learning. Franke et al. [5] analyzed that human users are more attracted by multi-perspective images than single perspective images.

The aforementioned studies focused on analyzing the general opinion of multiple users, i.e., mean opinion score (MOS). However, Kim et al. [6] raised the importance of considering subjectivity in aesthetic quality assessment recently.

This paper reports our eye-tracking study that aims at revealing the relationship between users' aesthetic ratings and gaze patterns. In particular, we consider both the general opinion and subjectivity appearing in the aesthetic rating scores.

II. METHOD

A. Setup

1) *Data:* We obtained photos and their aesthetic quality scores (1 to 10) from DPChallenge (http://dpchallenge.com), an online photo-sharing community. We considered five topics: Animal, Architecture, Landscape, People, and Transportation. We chose the photos based on users' ratings. We calculated the average (AVG) and standard deviation (STD) of the scores of many photos, and observed that the distribution of the scores in the AVG-STD plane forms roughly a diamond shape. Thus, five regions in the plane were considered, from each of which we chose two photos for each topic (Fig. 1). Therefore, we obtained 50 images (2 photos × 5 regions × 5 topics) for our experiment.

2) *Equipment:* The experiment was performed using Smart Eye Pro eye-tracking equipment and a 40-inch LCD monitor having a full HD resolution. The participants' gazes were recoded at a rate of 60 Hz.

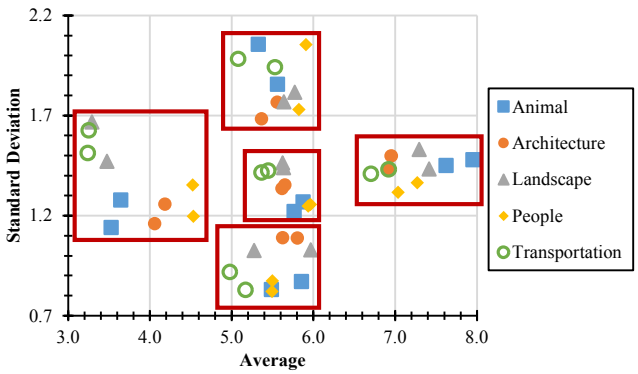

Fig. 1. Rating statistics of the photos used in the experiment.

B. Experiment

Twenty-one participants (15 males and 6 females) were hired, whose ages were between 20 and 36 with a mean of 24.95. All of them had normal or corrected-to-normal vision.

Each participant sat in front of the monitor at a distance of three times the average image height. Calibration of the eye-tracker was conducted. Then, the procedure of the experiment was explained to the participant with example photos that were different from those used in the experiment. Ten dummy images were shown at the beginning to help the participant adapt to the experiment. Then, the 50 test images were shown in a random order. Each image was shown for five seconds and the participant was asked to aesthetically rate the shown image on a discrete scale of 1 to 10 for two seconds. Before each image was shown, a plus mark on a black background was shown at the center of the screen for a second to set the initial gaze point as the center.

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C. Data Processing

One participant was detected as an outlier, whose data were excluded in the analysis [7]. We calculated the average and standard deviation of the rating scores of 20 participants for each of the 50 photos. From the eye-tracking data for each photo, a time-aggregated heat map for each participant was obtained.

We considered two aspects of gaze patterns, namely intra-participant and inter-participant aspects, which are hypothesized to be involved in the relationship between the gaze and rating patterns. First, we calculated the entropy of each heat map, which were averaged over the 20 participants, measuring how focused or spread a viewer's gaze points are. Second, we calculated the linear correlation coefficient (LCC) between a participant's heat map and the average of the remaining 19 heat maps, which were averaged over the 20 participants, indicating how different a viewer's gaze points are from those of the others. Then, the correlation between the entropy (or heat map LCC) and AVG (or STD) of the rating scores was obtained in terms of LCC.

III. Results

When the results for all images are aggregated, no meaningful outcome is observed. When the results for each topic are examined, however, noticeable observations can be made, which are shown in Fig. 2.

In Fig. 2(b), a significant negative correlation is observed for Landscape, implying that a viewer's gaze points are spread for photos having low rating subjectivity (see examples in Fig. 4). For the photos in this topic, overall harmony of different image regions in terms of composition, color, etc. is important for aesthetics. Thus, a viewer needs to examine all areas of a photo to make proper aesthetic judgment that is consistent across viewers. In addition, Fig. 2(d) shows that photos in Landscape have high subjectivity when viewers look at different regions in the photos. Therefore, we can say that similar gaze patterns across viewers all over the photos are obtained for landscape photos (or those of similar other topics) having low subjectivity.

In Fig. 2(a), significant negative correlations are observed for Animal and Transportation. This means that the average aesthetic score is high when each viewer focuses on small areas. This is understandable because the photos of these topics usually have clearly distinguished main objects in the central region (see examples in Fig. 3). For the same context, the two topics show significant positive correlations in Fig. 2(c), i.e., the average score is high when viewers' gaze points are similar. Therefore, it can be said that, for the photos containing clear main objects such as animals or transportations, aesthetically pleasing photos tend to induce viewer-independent, focused gaze patterns.

For the other topics, analysis of the results is not so straightforward, which needs further research. For instance, viewers' aesthetic evaluation of photos containing people is often complicated, because high-level perception such as emotion is also involved in the evaluation process, which may not be easily captured only by gaze patterns.

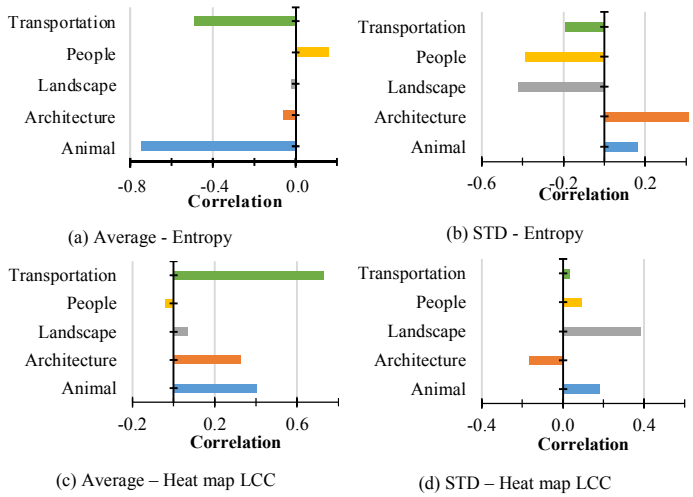

Fig. 2. Correlation between AVG (or STD) of the rating scores and the entropy (or heat map LCC) of the eye-tracking data.

(a) High AVG (7.95) (b) Low AVG (3.15)

Fig. 3. Heat maps of photos in Animal for participant #11

(a) High STD (1.99) (b) Low STD (1.59)

Fig. 4. Heat maps of photos in Landscape for participant #11

IV. Conclusion

We have investigated the relationship between aesthetic quality and gaze patterns. It was shown that for some particular image topics, there exist noticeable relationship between the average ratings or subjectivity and the intra-participant or inter-participant gaze patterns. We are currently conducting further analysis, such as the temporal dimension of the gaze patterns.

References

[1] M. Arriaza, J. F. Cañas-Ortega, J. A. Cañas-Madueño, and P. Ruiz-Aviles, "Assessing the visual quality of rural landscapes," *Landscape and Urban Planning,* vol. 69, no. 1, pp. 115-125, 2004.

[2] C. Li and T. Chen, "Aesthetic visual quality assessment of paintings," *IEEE J. Sel. Topics Signal Process.*, vol. 3, no. 2, pp. 236 -252, 2009.

[3] H. Tang, N. Joshi, and A. Kapoor, "Learning a blind measure of perceptual image quality," in *Proc. CVPR*, 2011, pp. 305-312.

[4] L. Marchesotti, F. Perronnin, D. Larlus, G. Csurka, "Assessing the aesthetic quality of photographs using generic image descriptors," in *Proc. ICCV,* 2011, pp. 1784-1791.

[5] I. S. Franke, S. Pannasch, J. R. Helmert, R. Rieger, R. Groh, and B. M. Velichkovsky, "Towards attention-centered interfaces: An aesthetic evaluation of perspective with eye tracking," *ACM Trans. Multimedia Computing, Communications, and Applications*, vol. 4, no. 3, 2008.

[6] W.-H. Kim, J.-H. Choi, and J.-S. Lee, "Subjectivity in aesthetic quality assessment of digital photographs: Analysis of user comments," in *Proc. ACM Multimedia*, 2015, pp. 983-986.

[7] ITU-R Rec. BT. 500-13, "Methodology for the subjective assessment of the quality of television pictures," 2012.