Perceptual Quality Evaluation of Partially-Artificial Visual Signals

Weisi Lin

***Abstract*—There have been more and more scenarios to make use of partially-artificial (PA) images and videos. PA visual content may be generated as screen-content, retargeted, stitched, HDR tone-mapped, style-transferred and DIBR images, and beyond. The applications include screen capturing/analysis/ matching, content editing/creation/browsing, smart cameras, enhancing TV and movies, distance learning, advertisement, visual data augmentation for model training, and so on. In this work, the new concept of PA and different computational models are explored in quality evaluation of PA visual signals, and the related potential extensions and future directions will be also analyzed, since quality assessment plays crucial roles in benchmarking, shaping and optimizing related algorithms and systems, to achieve alignment with perception of intended users toward system resource saving.**

I. Introduction

The technological history of imaging is briefly illustrated as Fig.1. As can be seen, people relied on artificial (subjective) drawing for communication and visual description of the physical world and happenings for long. The invention of the camera in early 1800's made the change leading to the dominance of camera-captured (objective) images in depicting the world, in both work and life. Enabled by modern visual computing technology, however, increasingly more artificial (generated) visual components have again appeared in various forms. Indeed, imaging technology has been on a spiral rise, which is expected to be further fueled by AI, especially the emerging AI-Generated Content (AIGC).

One domain of the afore-mentioned rise has been the use of partially artificial (PA) visual signals; for instance, screen content images (SCIs) [1], retargeted images (RTIs) [2], DIBR (depth-image-based rendering) [3], super-resolution (SR) [4], stitched panoramic images (SPIs) [5], and HDR (high dynamic range) [6]. Even more PA content will be generated and adopted with advancement of sensing and computing, e.g., effective and economic availability of 3D point clouds [7] facilitates 3D model-based visual content rendering and integration of computer vision and computer graphics, aiming at missions impossible otherwise.

II. Exploration of Different Technologies

In general, PA visual signals contain two categories of content: i) naturally-captured visual components, and ii) artificial (generated) or partially artificial ones. A corresponding pioneer systematic investigation has been performed.

In this work, the new concept of PA content, as well as the characteristics and implication of PA signals, is to be firstly demonstrated, analyzed, and discussed. Then, practical devised computational models have been substantially explored for perceptual quality evaluation of SCIs, RTIs, DIBR, style transfer, SR, computational photography (SPIs and HDR), etc. Artificial visual components may be also directly generated from 3D models (like 3D point clouds or meshes) or machine learning based processes. The last part of the work has been devoted to further exploration toward possible related future research, especially in the AI context, aesthetic aspects [8], full multimedia [9] and green computing [10], for both academic research and industrial deployment.

User-centric quality evaluation of PA visual content enables to turn the characteristics of human perception into advantages of systems, for creation of new functionalities, performance improvement and resource saving (for computation, bandwidth, memory space, energy/battery, processing speed, device size, material usage, and so on).

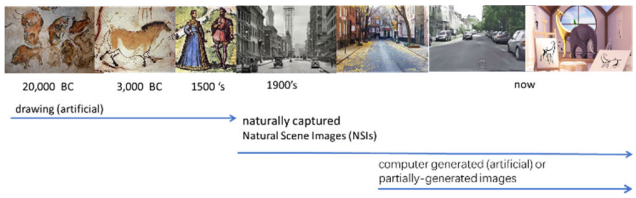

Fig. 1 Evolution of Imaging

Acknowledgement: This study is supported under the RIE2020 Industry Alignment Fund – Industry Collaboration Projects (IAF-ICP) Funding Initiative, as well as cash and in-kind contribution from the industry partner(s).

References

[1] S. Wang, et al, "Reduced-Reference Quality Assessment of Screen Content Images", IEEE Trans. Circuits Syst. Video Technol., 28(1): 1-14, 2018.

[2] Z. Peng, et al, "LGGD+: Image Retargeting Quality Assessment by Measuring Local and Global Geometric Distortions", IEEE Trans. Circuits Syst. Video Technol., 32(6): 3422-3437, 2022.

[3] V. Jakhetiya, et al, "Perceptually Unimportant Information Reduction and Cosine Similarity-Based Quality Assessment of 3D-Synthesized Images", IEEE Trans. Image Process., 31(2): 2027-2039, 2022

[4] Q. Jiang, et al, "Single Image Super-Resolution Quality Assessment: A Real-World Dataset, Subjective Studies, and An Objective Metric", IEEE Trans. Image Process., 31: 2279-2294, 2022.

[5] J. Hou, et al, "Content-dependency Reduction with Multi-task Learning in Blind Stitched Panoramic Image Quality Assessment", IEEE Int'l Conf. Image Process. (ICIP), 2020.

[6] Q. Jiang, et al, "BLIQUE-TMI: Blind Quality Evaluator for Tone-Mapped Images Based on Local and Global Feature Analyses", IEEE Trans. Circuits Syst. Video Technol., 29(2): 323 - 335, 2019.

[7] C. Lv, et al, "Intrinsic and Isotropic Resampling for 3D Point Clouds", IEEE Trans. Pattern Anal. Mach. Intell, accepted, 2022.

[8] H. Wu, et al, "Exploring Video Quality Assessment on User Generated Contents from Aesthetic and Technical Perspectives", ICCV 2023.

[9] W. Lin, G. Ghinea, "Progress and Opportunities in Modelling Just-Noticeable Difference (JND) for Multimedia", IEEE Trans. Multimedia, 24: 3706-3721, 2022.

[10] K. Xu, et al, "Efficient Joint Optimization of Layer-Adaptive Weight Pruning in Deep Neural Networks", ICCV, 2023.

*Weisi Lin is with School of Computer Science and Engineering, Nanyang Technological University, Singapore (wslin@ntu.edu.sg).