Guest Editorial
Introduction to the Special Issue on AI-Generated Content for Multimedia

I. Introduction

OUR world is becoming rapidly dependent on data of increasing complexity, diversity, and volume which calls for robust and powerful tools to process such big data. Probabilistic generative models fulfill this goal by learning latent characteristic data relations, especially for the recent emergence of large-scale deep generative models that are able to create realistic content, namely, artificial intelligence-generated content (AIGC). The applications of AIGC span across various domains, and witness rich potential in multimedia content creation, including dialog generation, text-to-speech conversion, image/video generation, and cross-modal content generation.

Despite their success, existing AIGC models still encounter problems such as explainability and expressivity before being applicable in practice, along with ethical concerns regarding misuse and misconduct. More specifically, although being able to generate realistic content, the efficient way to scale up is still yet to be fully understood, as well as the generalization capability to various applications and scenarios. The explainability of AIGC is also of increasing importance by providing clear insights into how decisions and content are generated, to mitigate risks associated with bias, misinformation, and unintended consequences. On the other hand, effective methods to detect generated content are equally important to protect intellectual property between human-created and AI-generated content and maintain trust in digital communications by enabling the verification of content authenticity.

Therefore, this Special Issue focuses on improving AIGC methods for multimedia content, from perspectives of both foundations and applications.

II. Overview of Accepted Papers

After the discussion with the guest editors and reviewers, 20 relevant and high-quality papers from approximately 100 initial submissions are accepted, ranging from the very basics to the cutting-edge applications regarding recent advancements of generative models. We shall briefly review the contributions of the accepted papers, whilst highlighting their novelty that may motivate the follow-up research on AIGC for multimedia scenarios.

A. AIGC Models for Multimedia

Since multimedia data essentially include multiple modalities of content such as voice, images, and videos, there are several papers propose new AIGC models that aim at improving the generation performances across widely used modalities. In [A1], Nazarieh et al. provided the first overview regarding recent state-of-the-art visual content generation methods supported by multimodal information, e.g., text-to-vision and audio-to-vision, together with a comprehensive review of the benchmarking datasets and evaluation metrics. In [A2], Li et al. further proposed a comprehensive database for AI-generated images, which were obtained from extensive prompts and AIGC models. A benchmark experiment on existing widely used metrics was performed against the human subjective scores. For technical contributions, Wang et al. [A3] focused on the text-to-image task and connected the embedding feature from the contrastive language–image pre-training (CLIP) model to the latent generating space of StyleGAN via a proposed mapping network, such that the text-guided image generation is achieved by text-free training style. In [A4], Chen et al. proposed to disentangle identity-relevant information from sample-specific cues by different CLIP encoders, during the finetuning of a pre-trained diffusion model for text-to-image customization and generation. In this way, customization and control over the generated content are enhanced while avoiding common pitfalls associated with overfitting and entangled representations.

B. New Generated Multimedia Content

Moreover, there are also several papers addressing interesting and meaningful generation scenarios. In [A5], Pu et al. proposed new generative neural networks for rule creation and reinforcement learning models for rule assessment. Corresponding metrics were also proposed to control reasonable evolution and adaptation across varying environments, to replicate the dynamics of biological life through computational models. In [A6], Liu et al. proposed to generate talking heads from a single image and one driving audio, namely, one-shot generation, whilst constructing a motion space of video clips to achieve coherent and one-to-many head motion generation. In [A7], Jin et al. focused on generating artworks based on a large-scale generative pre-trained transformer (GPT), in which multi-modal information from user query is aggregated by a dense representation manager as the refined prompt to the GPT. Based on the prompt, multi-task generation is designed for outputting image, video, and music content. In [A8], Zhao et al. focused on generating regional traditional paintings by collecting five types of Chinese folk paintings. The proposed method mimics the human painting process by first introducing multiple content blocks to generate image content while

Digital Object Identifier 10.1109/TCSVT.2024.3427488

preserving the global layout, and then using style blocks to adjust the artistic style, with a focus on lines and edges.

C. Forgery Detection for Generated Content

Along with the development of AIGC methods, the detection of forgery is also crucial for maintaining the integrity of multimedia applications, thus preventing the spread of misguided content. In [A9], Yu et al. proposed to detect the inconsistency between visual and audio signals; this is achieved by comparing deepfake videos with the extracted audio-visual correspondences in real videos via a three-stream network and one cross-modal predictive alignment module. In [A10], Liu et al. further proposed to detect the temporal audio-visual forgery, which can locate the deepfake clips within videos. The proposed method consists of a cross-modal attention mechanism to fuse audio and visual embeddings, supervised by a multi-dimensional contrastive loss to exploit temporal inconsistency. In contrast, Huang et al. [A11] proposed to cheat existing detection methods by leveraging a learning-based notch filtering to remove periodic noise within fake images in an unperceived way, which successfully bypassed existing forgery detection methods. This, on the other hand, also opens a new avenue to improve forgery detection for future research.

D. Multimedia Applications upon AIGC Models

There are also several papers focusing on applications that further extend the scope of sophisticated AIGC models. One gradually agreed-upon application is the usage of AIGC models for image/video compression. Given the AIGC model that generates video frames via sketches, Du et al. [A12] proposed to represent videos by spatio-temporal sketch graphs such that the information is condensed for the follow-up compression. In [A13], Gao et al. further represented visual information into multiple fine-grained domains, including edge maps, regions, and texts, in which the rate-distortion reward function was maximized during training. On the other hand, Gao et al. [A14] developed an invertible image generation module to first transform images into compression-friendly format, such that the images can be compressed at extremely low bit-rates.

Moreover, Wu et al. [A15] proposed a dual transformer model with contrastive learning strategies, which benefits from increased diverse proxy data for the text-based person search task. In [A16], Qin et al. proposed to generate class attention maps as pseudo labels that are able to achieve weakly-supervised semantic segmentation. In [A17], Guan et al. proposed to generate high frequencies within images, and the image super-resolution task was achieved by aggregating low-frequency information obtained from the low-resolution image. In [A18], Liao et al. also applied the generative models for transferring optical images to inverse synthetic aperture radar formats, in which the overall framework was optimized by a meta-learning style. In [A19], Shi et al. combined text-to-image generative models to capture intrinsic semantic relationships between emotion labels, and then to classify object emotions within images. In [A20], Tian et al. further benefited the generative models to achieve noisy image watermark removal in a mixed learning style, i.e., the combination of supervised and self-supervised learning.

III. Conclusion and Acknowledgment

By including new ideas and contributions from the very basics to various applications, this Special Issue essentially responds to the enormous advancements and rapid developments of AIGC methods. We shall also express our gratitude to the authors for their insightful contributions, as well as the reviewers for their valuable comments. We sincerely wish that the methods introduced in this Special Issue could not only help enrich the understanding on the recent progress of AIGC techniques but also pave the way for future research in this exciting and ever-evolving field.

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Appendix: Related Articles

[A1] F. Nazarieh, Z. Feng, M. Awais, W. Wang, and J. Kittler, "A survey of cross-modal visual content generation," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 34, no. 8, pp. 6814–6832, Aug. 2024, doi: 10.1109/TCSVT.2024.3351601.

[A2] C. Li et al., "AGIQA-3K: An open database for AI-generated image quality assessment," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 34, no. 8, pp. 6833–6846, Aug. 2024, doi: 10.1109/TCSVT.2023.3319020.

[A3] Y. Wang, W. Zhou, J. Bao, W. Wang, L. Li, and H. Li, "CLIP2GAN: Towards bridging text with the latent space of GANs," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 34, no. 8, pp. 6847–6859, Aug. 2024, doi: 10.1109/TCSVT.2023.3294261.

[A4] H. Chen, Y. Zhang, X. Wang, X. Duan, Y. Zhou, and W. Zhu, "DisenDreamer: Subject-driven text-to-image generation with sample-aware disentangled tuning," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 34, no. 8, pp. 6860–6873, Aug. 2024, doi: 10.1109/TCSVT.2024.3369757.

[A5] J. Pu, H. Duan, J. Zhao, and Y. Long, "Rules for expectation: Learning to generate rules via social environment modelling," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 34, no. 8, pp. 6874–6887, Aug. 2024, doi: 10.1109/TCSVT.2023.3334526.

[A6] J. Liu et al., "OSM-Net: One-to-many one-shot talking head generation with spontaneous head motions," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 34, no. 8, pp. 6888–6900, Aug. 2024, doi: 10.1109/TCSVT.2024.3394850.

[A7] C. Jin, R. Zhu, Z. Zhu, L. Yang, M. Yang, and J. Luo, "MtArtGPT: A multi-task art generation system with pre-trained transformer," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 34, no. 8, pp. 6901–6912, Aug. 2024, doi: 10.1109/TCSVT.2024.3349567.

[A8] Y. Zhao, H. Li, Z. Zhang, Y. Chen, Q. Liu, and X. Zhang, "Regional traditional painting generation based on controllable disentanglement model," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 34, no. 8, pp. 6913–6925, Aug. 2024, doi: 10.1109/TCSVT.2023.3298811.

[A9] Y. Yu, X. Liu, R. Ni, S. Yang, Y. Zhao, and A. C. Kot, "PVASS-MDD: Predictive visual-audio alignment self-supervision for multimodal deepfake detection," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 34, no. 8, pp. 6926–6936, Aug. 2024, doi: 10.1109/TCSVT.2023.3309899.

[A10] M. Liu, J. Wang, X. Qian, and H. Li, "Audio-visual temporal forgery detection using embedding-level fusion and multi-dimensional contrastive loss," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 34, no. 8, pp. 6937–6948, Aug. 2024, doi: 10.1109/TCSVT.2023.3326694.

[A11] Y. Huang, F. Juefei-Xu, Q. Guo, Y. Liu, and G. Pu, "Dodging DeepFake detection via implicit spatial-domain notch filtering," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 34, no. 8, pp. 6949–6962, Aug. 2024, doi: 10.1109/TCSVT.2023.3325427.

[A12] Q. Du, Y. Duan, Z. Xie, X. Tao, L. Shi, and Z. Jin, "Optical flow-based spatiotemporal sketch for video representation: A novel framework," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 34, no. 8, pp. 6963–6977, Aug. 2024, doi: 10.1109/TCSVT.2023.3349130.

[A13] J. Gao, C. Jia, Z. Huang, S. Wang, S. Ma, and W. Gao, "Rate-distortion optimized cross modal compression with multiple domains," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 34, no. 8, pp. 6978–6992, Aug. 2024, doi: 10.1109/TCSVT.2024.3364153.

[A14] F. Gao, X. Deng, J. Jing, X. Zou, and M. Xu, "Extremely low bit-rate image compression via invertible image generation," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 34, no. 8, pp. 6993–7004, Aug. 2024, doi: 10.1109/TCSVT.2023.3317424.

[A15] H. Wu, W. Chen, Z. Liu, T. Chen, Z. Chen, and L. Lin, "Contrastive transformer learning with proximity data generation for text-based person search," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 34, no. 8, pp. 7005–7016, Aug. 2024, doi: 10.1109/TCSVT.2023.3329220.

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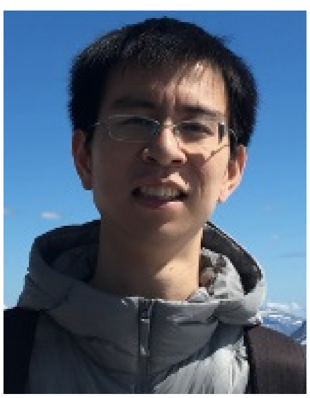
[A17] W. Guan, H. Li, D. Xu, J. Liu, S. Gong, and J. Liu, "Frequency generation for real-world image super-resolution," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 34, no. 8, pp. 7029–7040, Aug. 2024, doi: 10.1109/TCSVT.2024.3367876.

[A18] H. Liao, J. Xia, Z. Yang, F. Pan, Z. Liu, and Y. Liu, "Meta-learning based domain prior with application to optical-ISAR image translation," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 34, no. 8, pp. 7041–7056, Aug. 2024, doi: 10.1109/TCSVT.2023.3318401.

[A19] G. Shi, S. Deng, B. Wang, C. Feng, Y. Zhuang, and X. Wang, "One for all: A unified generative framework for image emotion classification," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 34, no. 8, pp. 7057–7068, Aug. 2024, doi: 10.1109/TCSVT.2023.3341840.

[A20] C. Tian, M. Zheng, B. Li, Y. Zhang, S. Zhang, and D. Zhang, "Perceptive self-supervised learning network for noisy image watermark removal," *IEEE Trans. Circuits Syst. Video Technol.*, vol. 34, no. 8, pp. 7069–7079, Aug. 2024, doi: 10.1109/TCSVT.2024.3349678.



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