A Synergy of Computer Graphics and Generative AI: Advancements and Challenges

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ABSTRACT

A traditional computer graphics domain has received an unprecedented boost from the newest developments in generative Artificial Intelligence (GenAI). It affects all areas: from image generation, to face recognition, to object detection, to aerial surveillance, to autonomous car vision systems. The newest deep learning architectures make it possible to generate new images from texts, to apply styles to portraits, to de-identify facial images, and to recognize human and objects in videos. This keynote will delve into some of the most exciting applications in medical AI diagnostics, human face recognition and aesthetics domains, while making a strong case for resulting image authenticity, bias mitigation, and trust.

Keywords

Generative AI, computer graphics, deep learning, biometrics, digital human, authenticity, bias, trust.

1. INTRODUCTION

The next generation Generative Artificial Intelligence (GenAI) algorithms have dramatically transformed not only research landscape, but the way society communicates and functions. At the same time, trust in AI-powered decision making, bias mitigation and responsible computing emerged as the key societal challenge of the 21st century [Gav23]. According to researchers, practitioners, industry experts, and the public, it is imperative to build in safety mechanisms in the ways AI is utilized in commercial and public domains [Anz22, Cha21]. Computer Graphics domain has witnessed significant transformation due to the development of advanced deep learning architectures. Text to image and reverse conversion allows for better storytelling, while style application to art works or advertisements inspire creative designs never possible before [Ska23].

2. MOTIVATION

The synergy between image processing and deep learning resulted in new advancements in medical diagnostics, patient-focused personalized healthcare delivery, and new drug developments. Another domain that benefitted from the newest deep learning architectures is information security. Biometric authentication systems based on convolution neural networks, transformer-type architectures, graph-based deep learning, and adversarial neural networks allow not only faster training with more accurate user identity authentication, but also allow for higher degree of privacy protection through situation awareness [Pau14] and facial de-identification [Gav21]. Those developments lead to the need for especially careful consideration of user's data privacy, ethical use of data, and bias free data collection. The ease of accessing abundant social medial data, which is frequently used for targeted advertisement, service delivery, political campaigns, and e-commerce, augments the need for protecting user's rights and enforcing ownership of data [Gav17]. At the same time, more and more researchers are starting to pay attention to the development of not only accurate and reliable decision-making systems, but to the urgent demand for ethical, responsible, and trustworthy computing [Col18, Lin20, Lyu21].

3. RECENT DEVELOPMENTS

This keynote starts with presenting state of the art in generative AI developments and the transformative changes in computer graphics, image processing, human aesthetics and biometric authentication domains. It proceeds with introducing concepts related to data representation, feature engineering, prediction and classification outcomes of AI models. It then introduces the concept of trustworthiness in decision-making as the ability of computer systems to perform a real-world task reliably, with decision being transparent, processes being explainable and algorithms being bias-free. Data privacy is discussed along with the issues of data authenticity, ownership, and ethics.

4. CONCLUSIONS

This invited keynote presents an overview of most recent advancements and challenges associated with rapid adoption of generative AI breakthrough in modern society. It elaborates on technological innovations that made broad adaptions of deep learning into consumer products and services possible, describes key research in the domains of fair, trustworthy and explainable decision-making systems powered by generative AI, and provides examples from the domains of cybersecurity, biometric and computer graphics. The keynote is based on the innovative research conducted at the Biometric Technologies Laboratory of the University of Calgary, Canada and supported by the Research Excellence Chair in Trustworthy and Explainable AI awarded to Prof. Marina Gavrilova.

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6. BIOGRAPHY

Marina L. Gavrilova is a Full Professor, an Order of the University of Calgary Inductee and a Head of the Biometric Technologies and the SPARCS Laboratories in the Faculty of Science. Her publications include over 300 refereed articles, edited special issues, books and book chapters in the areas of machine learning, information fusion, knowledge discovery and cybersecurity. She serves as a Founding Editor-in-Chief of Transactions on Computational Science Journal, Springer and an Editor-in-Chief of the International Journal of Digital Human, Inderscience. As a globally renown award-winning researcher and educator, Dr. Gavrilova has given over 50 keynotes, invited lectures and tutorials at major scientific gatherings worldwide. Dr. Gavrilova is a passionate advocate of equity, diversity and inclusion in academia, industry, and society.

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