Quality Assessment and Perception in Computer Graphics

Guillaume Lavoué ▪ *University of Lyon*

Hantao Liu ▪ *Cardiff University*

Karol Myszkowski ▪ *MPI Informatik*

Weisi Lin ▪ *Nanyang Technological University*

The computer graphics community has successfully exploited our knowledge about the human visual system and its limitations for years. For instance, some researchers have explored visual perception limits to simplify the simulation of light photons in rendering systems and thus saved computational time while maintaining a high visual quality. Following previous research efforts involving natural images and videos, researchers have introduced perceptually based quality assessment metrics for computer-generated data, for example, to evaluate the visibility of artifacts attributed to tone mapping, approximations in rendering algorithms, or geometry processing. This domain of perceptual computer graphics is still a rich research area, mostly because it must keep the human being at the center of the process. The increasing needs for more realism and better visual quality in synthetic worlds have made the understanding of the human vision mechanisms and their integration in the computer graphics processes even more crucial.

From a total of 15 submissions, we selected four outstanding articles for this special issue that explore innovative techniques related to quality assessment and perception in computer graphics.

In "Applying Computational Aesthetics to a Video Game Application Using Machine Learning," Ali Naci Erdem and Uğur Halici address the problem of automatically selecting highly aesthetic camera viewpoints in video games. They leverage regression machine learning to create an aesthetic quality predictor that is computed in real time on rendered game scenes and used to adjust the camera direction. Providing automatic and intuitive mechanisms for camera control in 3D scenes remains an open research question. Using high-level perceptual considerations like aesthetics for this task is promising and can inspire further work in this direction.

Eakta Jain, Yaser Sheikh, and Jessica Hodgins also address a camera control problem in "Predicting Moves-on-Stills for Comic Art Using Viewer Gaze Data," but they focus on a totally different context. Their objective is to automatically create effective and visually appealing camera moves-on-stills for comic art images. A typical application of their research is the conversion of 2D comic book art for viewing on a handheld digital display. Unlike the previous article in which the leading criterion was aesthetics, here the camera move must also support the narrative and respect the artistic intent. To capture such high-order cognitive processes, the authors draw on recorded gaze data from viewers and propose an algorithm that computes camera displacements according to clustered eye-fixation locations. They show that their algorithm successfully mimics professionally created camera moves.

In "Measuring Visual Salience of 3D Printed Objects," Xi Wang, David Lindlbauer, Christian Lessig, Marianne Maertens, and Marc Alexa investigate human gaze behavior in an effort to validate the assumption that the saliency found in flat stimuli can be related to the underlying 3D scenes. They recorded the eye-fixation positions of 30 subjects observing 15 different printed 3D models. After mapping these gaze positions onto the 3D shapes, the authors demonstrate that a significant agreement exists among the observers in their gaze fixations. They also show that the most common mesh saliency estimators fail to predict these fixations. This work constitutes a first step in understanding human gaze behavior regarding physical 3D shapes. The authors created a ground truth database of 3D eye fixations and have made it publicly available. This constitutes a precious asset for the research community and should greatly stimulate the field of 3D saliency analysis and 3D shape perception.

Lastly, in "The Accuracy of Gauge-Figure Tasks in Monoscopic and Stereo Displays," Matthias Bernhard, Manuela Waldner, Paskal Plank, Veronika Soltészová, and Ivan Viola also explore the perception of 3D shapes. The gauge-figure task (GFT) is a widespread method used to evaluate how an observer perceives a 3D shape represented in a 2D image; in this task, the observer is asked to align a flat circle tangentially with the stimulus object's surface. The authors conducted a large-scale experiment to evaluate the accuracy of GFT outcomes using the ground truth surface for different shapes as well as both stereoscopic and monoscopic viewing conditions. They show that the stereoscopic viewing condition improves the accuracy of the observers' estimation for unknown objects, but observed no effect for well-defined shapes such as a cylinder. Their results provide important insights on the reliability of this task and should be of great interest for the computer graphics and visualization communities.

This special issue represents a good sample of the huge diversity of challenges in the perceptual computer graphics area: aesthetics evaluation, user gaze analysis, shape perception, and the wide scope of targeted applications. Much research remains in this area, including increasing our understanding of 3D shapes, the perception of materials, and the evaluation of their quality, and the study of the perceptual interactions between different 3D scene elements (lighting, shape, and material). We hope that this special issue will motivate readers to further explore all these exciting research issues.

***Guillaume Lavoué** is an associate professor of computer science at the University of Lyon, France. His research interests include geometry processing and visual quality assessment in computer graphics. He is currently chair of the IEEE Systems, Man, and Cybernetics Society's Technical Committee on Human Perception and Multimedia Computing. Lavoué has a PhD in computer science from the University of Lyon, France. Contact him at glavoue@liris.cnrs.fr.*

***Hantao Liu** is an assistant professor in the School of Computer Science and Informatics at Cardiff University, UK. He is the chair of IEEE Communications Society's Multimedia Communications Technical Committee Interest Group on Quality of Experience for Multimedia Communications. His research interests include visual quality assessment, visual attention modeling and applications, and medical image perception. Liu has a PhD in computer science from Delft University of Technology. Contact him at hantao.liu@cs.cardiff.ac.uk.*

***Karol Myszkowski** is a senior researcher at the MPI Informatik, Germany. His research interests include global illumination and rendering, perception issues in graphics, high dynamic range imaging, and stereo 3D. Myszkowski has a PhD in computer science from Warsaw University of Technology. Contact him at karol@mpi-inf.mpg.de.*

***Weisi Lin** is an associate professor in the School of Computer Engineering at Nanyang Technological University, Singapore. His research areas include image processing, perceptual signal modeling, video compression, and multimedia communication. He is a fellow of IEEE and an associate editor of the* IEEE Transactions on Image Processing *and* IEEE Transactions on Circuits and Systems for Video Technology. *Lin has a PhD in computer vision from King's College London. Contact him at wslin@ntu.edu.sg.*