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Real-time Image Processing Could Enable Live Broadcasts from High Dynamic Range Video

Disney Research scientists have developed a method for converting high dynamic range (HDR) video into standard dynamic range (SDR) video in real-time, making it possible to stream broadcasts of sports and other live events while preserving the rich visual detail obtained with this advanced imaging technology.

Just as the human eye constantly adjusts to changes in lighting, HDR captures images with a greater range of lighting and contrast than is possible with standard photography. Images that shift from shadow to bright sunlight thus look more natural when shot in HDR. But regular televisions can't handle this greater dynamic range, so to show HDR video within the limitations of these displays it must be converted to SDR using a process called tone mapping.

"Tone mapping is tricky because it can result in artifacts, such as abrupt flickering of light and ghosting," said Markus Gross, vice president at Disney Research. "We're pleased we were able to develop a tone-mapping technique that eliminates most of those artifacts and does it fast enough to enable live-streaming of the video."

The real-time processing not only enables live HDR broadcasts, but could be useful in post-production by providing instant feedback as technicians adjust parameters of the video, said Tunç Ozan Aydin, research scientist at Disney Research.

Simone Croci, research engineer at Disney Research, presented the real-time tone-mapping technique Sept. 25 at the IEEE International Conference on Image Processing in Phoenix, Ariz.

Aydin, Croci and other Disney researchers developed a tone-mapping technique, or tone mapping operator (TMO), two years ago that was able to preserve most of the rich detail of HDR

while eliminating ghosting, flickering and other artifacts. But that TMO required extensive computation and thus could only be performed off-line.

Like that TMO, the group's new TMO decomposes the HDR signal into a base layer and a detail layer. The dynamic range of the base layer can thus be reduced while preserving much of the detail and fine-scale contrast.

But where the earlier technique used a temporal filter on the detail layer and a spatiotemporal filter on the base layer, the new TMO uses a simplified method called tone-curve-space filtering. Aydin said this type of filtering ensures that the overall brightness changes smoothly over time. Notably, it requires far less computational muscle.

"The differences in image quality between the two methods are subtle and only noticeable after careful visual inspection," Aydin said. "For most practical purposes, the real-time method achieves comparable image quality with respect to the off-line method, with the advantage of being significantly more efficient.

"There are other real-time tone mapping methods," he added, "but they don't achieve the same level of contrast as we do."

In addition to Aydin, Croci and Gross, the research team included Nikolce Stefanoski and Aljoscha Smolic. For more information and a video showing some of the tone-mapped HDR footage, visit the project web site at https://www.disneyresearch.com/rt-hdr-tmo/.

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About Disney Research

Disney Research is a network of research laboratories supporting The Walt Disney Company. Its purpose is to pursue scientific and technological innovation to advance the company's broad media and entertainment efforts. Vice Presidents Jessica Hodgins and Markus Gross manage Disney Research facilities in Los Angeles, Pittsburgh and Zürich, and work closely with the Pixar and ILM research groups in the San Francisco Bay Area. Research topics include computer graphics, animation, video processing, computer vision, robotics, wireless & mobile computing, human-computer interaction, displays, behavioral economics, and machine learning.

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