All in the eyes: Disney Research demos technology for richly expressive 3D printed eyes

July 19 2013

Face-to-face communication begins with the eyes, a crucial factor in the design of interactive physical characters. By employing 3D printing, Disney Research, Pittsburgh has developed a new technology that is uniquely expressive, robust and adaptable for creating interactive characters' eyes.

The technology, PAPILLON, will be demonstrated at ACM SIGGRAPH 2013, the International Conference on Computer Graphics and Interactive Techniques, July 21-25 in Anaheim, California.

The classic approach in the entertainment industry is to build mechanically actuated eyes. Though these animatronic eyes can be compelling, they are complex, expensive and difficult to scale down to small characters. The animatronic approach also isn't suitable for characters derived from animated movies or cartoons whose eyes are non-realistic and highly exaggerated.

An alternative, video projection, can be very expressive; it's possible, for instance, to project hearts onto the eyes to express affection, or question marks to suggest confusion. They also don't have moving parts. But creating an optical path to the eyes is difficult in small characters and projection doesn't always work well for complex faces or for eyes that stick out or are deeply sunk into the face.

The advent of 3D printing, however, has made it possible to create customized optical elements, or "printed optics." These elements include such structures as light pipes, which can direct and bend light much like a fiber optical element. PAPILLON can thus enable video projection in even small characters and at a fraction of the cost of bundled fiber optics , said Eric Brockmeyer, a Disney Research, Pittsburgh research associate. Printed optics also enables unusual eye shapes and placements.

For the SIGGRAPH demonstration, the Disney Research, Pittsburgh team has created three characters – Beep, Boop and their dog-like pet Iggy – that are each about the size of softball. Though immobile, they have wildly expressive eyes. The characters respond to the gestures of human visitors and will demonstrate a broad range of possible interactions, such as playing music together.

"One of our goals was to create minimal displays, to figure out how much resolution do you really need to express emotion," Brockmeyer said. "It turns out you really don't need that much to convey a compelling interactive experience."

The arbitrary shapes of the display surface made possible by 3D printing would create a challenge for conventional video projection, but the PAPILLON team developed an algorithm based on Fibonacci spirals that minimizes distortions and other visible artifacts when images are projected onto the eyes.

"PAPILLON is a technology that is scalable and flexible," said Ivan Poupyrev, a senior research scientist who leads the interaction team at Disney Research, Pittsburgh. "We envision it being used for building interactive toys, supplemental characters for videogames, robots or perhaps eventually even human prosthetic eyes."

In addition to Poupyrev and Brockmeyer, the research team included

Moshe Mahler, James Krahe, Yuri Suzuki and Alex Rothera of Disney Research, Pittsburgh and Joanne Dauner, Disney Research, Pittsburgh intern and visual communications student at the Berlin University of Arts.

Provided by Disney Research

Citation: All in the eyes: Disney Research demos technology for richly expressive 3D printed eyes (2013, July 19) retrieved 19 September 2024 from https://phys.org/news/2013-07-eyes-disney-demos-technology-richly.html

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