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All in the Eyes: Disney Research Demos Technology for Richly Expressive 3D Printed Eyes

3D Printing Enables Lively Interactions with Characters of Many Shapes and Sizes

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 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.

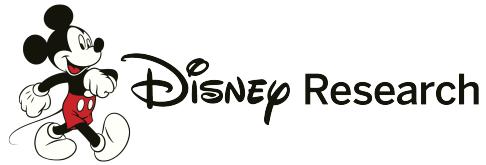
An alternative, video projection, can be very expressive; it's possible, for instance, to project hearts onto the eyes to express affection, or question marks to suggest confusion. They also don't have moving parts. But creating an optical path to the eyes is difficult in small characters and projection 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 a SIGGRAPH demonstration in July 2013, the Disney Research Pittsburgh team created three characters – Beep, Boop and their dog-like pet Iggy – each about the size of a softball. Though immobile, the characters had wildly expressive eyes. They responded to the gestures of human visitors and demonstrated 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."

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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 includes Moshe Mahler, James Krahe, Yuri Suzuki and Alex Rothera of Disney Research Pittsburgh, Joanne Dauner, a Disney Research Pittsburgh intern and visual communications student at the Berlin University of Arts, and Scott Hudson of the HCI Institute at Carnegie Mellon University.

More information about PAPILLON is available online at
<http://www.disneyresearch.com/project/papillon/>.

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