PAPILLON: Expressive Eyes for Interactive Characters

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1. Introduction

PAPILLON is a technology for designing highly expressive animated eyes for interactive characters, robots and toys. Expressive eyes are essential in any form of face-to-face communication [2] and designing them has been a critical challenge in robotics, as well as in interactive character and toy development.

The classic approach to designing eyes, in the movie and location-based entertainment industry, is to build mechanically actuated, *animatronic* eyes [1]. This may produce highly realistic eyes that can indicate gaze direction and blink, but they tend to be complex, expensive and difficult to scale down to fit into small characters, where space for motors and driving electronics may not be available. Crucially, the animatronic approach is not applicable to fictional characters from animated movies, comics and cartoons whose eye expressions are non-realistic and highly exaggerated. Indeed, the eyes of a character in animated features can take any size and shape to communicate a character's emotions and display all sorts of symbols to indicate its intentions, e.g. “dollar signs” for greed or a “heart” for romance.

Video projection has also been used to back-project images of eyes and faces onto surfaces shaped as a character's face. This allows for the design of animated and highly expressive eyes for large-scale characters and robots [2]. It is, however, not scalable to small characters due to limited space. Furthermore, popular characters often take on a broad variety of appearances, from a talking sea sponge to a chameleon, with complex faces and bodies, where eyes could be sunk deep inside or stick out. Designing free air optical paths for these characters is difficult and often impossible unless we can design a technology that can effectively guide light between any two locations on the body of the character. This is the approach that we investigate in *PAPILLON*.

2. PAPILLION eyes

PAPILLION uses a new *printed optics* technology [3] where eyes are designed as a bundle of optical fibers guiding images projected on the receiving end of the bundle to the surfaces of the character eye (Figure 1). The eyes are 3D printed slice-by-slice using transparent photopolymers separated by a translucent support material. We designed an algorithm that implements classic Fibonacci spirals for efficient packing of fibers on a surface of an eye and in the bundle. This allows creating arbitrary curved display surfaces while minimizing visible artifacts, such as distortions on the edges of the eye. A Voronoi tessellation computes shapes of optical elements on the eye surface, optimizing the distribution of light.

The *PAPILLION* eye design has the following advantages:

Arbitrary eye shapes and placements. Our eye elements are digitally designed and 3D printed, therefore, they can take any shape and any location that is required by the design of the character. In fact, it is easily extended to characters with multitude of eyes.

Passive, non-instrumented characters. The characters and toys implemented with *PAPILLION* technology do not have any active electronic elements, moving parts, wires and power requirements. In fact, they are completely passive. This allows creating engaging, yet easily replaceable and very robust interactive characters.

Rich communication and interaction. Because images are projected into the character eyes, they can communicate rich set of emotions and intentions (Figure 2). To enable interaction, we use a depth camera that tracks user hands and body and initiate characters response, creating highly engaging experiences (Figure 1).

3. Siggraph Demonstration

At the SIGGRAPH 2013 Emerging Technology exhibition we will demonstrate interactive story telling applications where characters respond to the visitors hand and body gestures with rich eye animations synchronized with pre-recorded audio narratives.

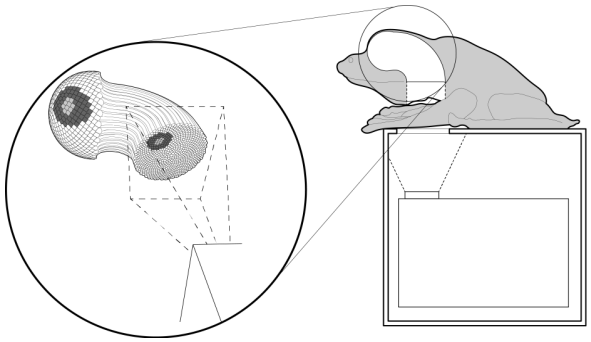

Figure 1*. Interactive character with animated PAPILLON eyes*

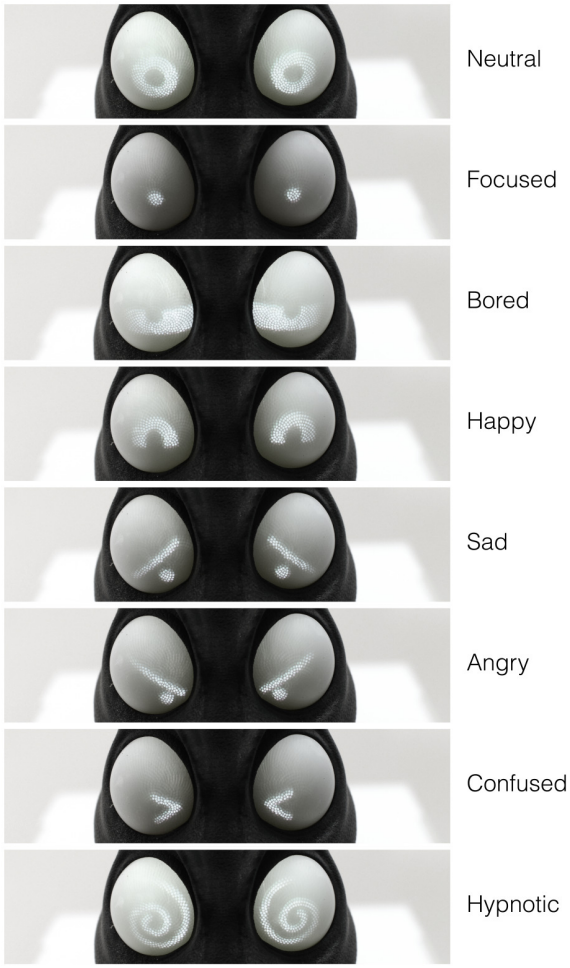

Figure 2*. PAPILLION eyes express rich set of emotions*

4. References

1. Basset, K., Hammon, M., Smoot, L. A Fluid-Suspension, Electromagnetically Driven Eye with Video Capability for Animatronic Applications, In *IEEE Humanoid Robots,* 2009. pp. 40-46
2. Delaunay, F., de Greeff, J., Belpaeme., T. A Study of a Retro-Projected Robotic Face and its Effectiveness for Gaze Reading by Humans. In *ACM/IEEE Human-Robot Interaction*, 2010. pp. 39-44
3. Willis, K., Brockmeyer, E., Hudson, S., Poupyrev, I. Printed Optics: 3D Printing of Embedded Optical Elements for Interactive Devices. In *ACM UIST 2012*, pp. 589-598

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