# Flexible Eye Design for Japanese Animation

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**Figure 1: Examples of eyes shapes and appearances achieved with our system. ©Nintendo · Creatures · GAME FREAK · TV Tokyo · ShoPro · JR Kikaku ©Pokémon ©2019 PIKACHU PROJECT**

## ABSTRACT

Eyes are crucial in depicting the emotions and psychology of a character. In this talk, we present the eye system we developed at OLM Digital to design and control eyes for Japanese animation where they typically come in a lot of different shapes and colors. Our tool is straightforward and provides a lot of control to the users. Our artists can create elongated irises and pupils, add the cornea bump and refraction and add lighting effects like caustics and catchlights. The render pass exports the necessary information to provide the ability to adjust the final appearance at compositing time, giving a lot of creative freedom to the artists.

## CCS CONCEPTS

• **Computing methodologies** → **Rendering**; **Animation**.

## KEYWORDS

character design, eye, rendering, compositing

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## 1 INTRODUCTION

During the production of *Pokémon The Movie: Mewtwo Strikes Back Evolution*, we were faced with the challenges of creating and animating eyes for many characters and Pokémon. Typically in Japanese animation, the eyes vary a lot from character to character, as shown in Figure 1. They range from spherical, to elliptical, to completely custom shapes. For these reasons, modeling and animating the eyes anatomically like in [Lopez and Richards 2017] is impractical at best, and impossible when the eyes are too stylized like in Kingler's case (Figure 1, right column).

The production of a movie such as *Pokémon The Movie: Mewtwo Strikes Back Evolution* has a very tight schedule and hard budget constraints. It is crucial for artists to be able to create and animate every aspect of a character efficiently, especially the eyes. They need a straightforward system that provides them with a lot of creative flexibility to match the design of the characters at every step of the production pipeline, including compositing.

## 2 PREVIOUS SHADER-BASED EYE SYSTEM

In this system, the eyeball is modeled by hand, offering artists the ability of creating any shape: spherical, elliptical or customized (see Figures 1 and 2). The appearance of the eye, including the light effects, is captured by a shader that is driven by a texture. In [Ogaki 2015], we introduced some features of this shader-based system. The center of the eye is computed by placing the pupil according to the gaze direction. It is controlled directly by the artist, facilitating the animation of the eye.

The general appearance of the eye is governed by a hand painted texture. We use a custom UV polar mapping around the center of the pupil. The eye texture is made with round pupil and iris and the shader allows for elliptical or slit deformations of both. Our parameterization accounts for these deformations and remains continuous to prevent artifacts, matching the texture's continuity.

Since in our system, the eyes are not modeled anatomically, we fake the light effects with a specifically designed shader. In [Ogaki 2015], we detailed some of our system's features such as cornea refraction or light effects like catchlights and caustics. The most requested feature by the artists was the ability to adjust these light effects during compositing. For this reason, while adding new features to the system during the production of the movie, we started delegating the rendering of the light effects to the compositing phase.


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**Figure 2: Examples of light effects rendered with our system. ©Nintendo · Creatures · GAME FREAK · TV Tokyo · ShoPro · JR Kikaku ©Pokémon ©2019 PIKACHU PROJECT**

## 3 RENDERING

We added new features to our shader to give artists more range in the design of eyes.

*Improved polar UV mapping.* In the previous system, the polar UV mapping was working only up to the iris. However, in some cases, artists require to add blood vessels on the white of the eye, or want to stylize it using a texture. For this, we extended the existing polar UV mapping to take into account the white of the eye. This mapping remains continuous, even in the case where the pupil and the iris are deformed, which is frequent in Japanese animation.

*Cornea bump.* The cornea shows as a bump on the eyeball. When closing up on a character's eyes, this bump is perceptible. A simple bump mapping is not enough as it gives the impression that the cornea is pushed back into the eyeball. Applying a displacement map has the effect of changing the geometry which was problematic for us as the eyeballs started intersecting with the eyelids. To prevent this, we decided to fake the displacement and only simulate it in the eye shader. To represent the cornea, we use a virtual ellipsoid centered at the pupil and use it to simulate the displacement map. We intersect the incoming ray with the virtual ellipsoid and project the intersection point back onto the eyeball to evaluate the shader.

*Shadow from eyelid and eyelashes.* It is very common in Japanese animation to have a shadow at the top of the eye due to the eyelid and the eyelashes (see Figure 1, left column). In most cases, this shadow is not detailed. It is a continuous line and does not represent a physically plausible shadow. It is mostly used for styling purpose and thus must be easily manipulated by the artists. We add it to our shader by computing some ambient occlusion on the eye with a proxy object added on top of the eye. We cast rays in a cone of directions at the intersection point and add a shadow when the virtual object is intersected. The angle and direction of the cone give artists control over the shape of the shadow.

## 4 LIGHT EFFECTS AND COMPOSITING

We made some modifications to our shader to allow more control at compositing time. We present in this section the new features of the catchlight effect and how we adapted it to our new pipeline. Two types of catchlight effects are provided: a static one that is attached to a specific point in the eye, and a dynamic one that is given by a directional key light. The former is obtained by projecting a texture onto the eye along the gaze direction. This texture is painted to create the catchlight effect. It is equivalent to painting the original texture of the eye but offers full control in post-process. The latter is derived from the concept of lit sphere [Sloan et al. 2001]. The texture of the lit sphere is computed from the direction of the catchlight and the normal at the intersection gives how the point is lit by the catchlight.

Traditionally in production, we use AOVs to separate the effects of each light on the scene and reconstruct the final rendering in a post-process. Following this approach, we postpone some of the lighting effects in the eye shader to the compositing phase. To make this possible, we added to our shader the possibility of exporting the information needed to produce the effects. For example, the dynamic catchlight effect exports the normals, the direction of the key light and the camera matrix. The static catchlight exports the projected UV mapping. From there, during compositing, it is easy to reconstruct both catchlight effects, adjusting at will the color or shape of the light without needing to re-render the whole frame.

## 5 CONCLUSION

We presented our new system for designing and rendering eyes in production. Our tool satisfies the typical Japanese animation constraints and has been used in the production of movies and TV shows. It gives the artists in our company the needed creative freedom while remaining easy and straightforward to use.

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