The Eyes Have It: Comprehensive Eye Control for Animated Characters

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Figure 1: Phases of eye creation and shading. ©2017 Twentieth Century Fox Film Corporation. Not for sale or duplication

ABSTRACT

Eyes are often the most important feature in a character's performance, conveying emotion, timing and intention as well as hints about what comes next in the story. Stories are driven by characters and audience investment comes from their empathy for those characters. Unless the viewer is making a concerted effort to look elsewhere on screen, they usually concentrate on the eyes of the main character. Therefore, a great amount of effort and time is spent making the eyes of our characters look as expressive as possible. When done improperly, the eyes will make a character look dead and unappealing. Our technology utilized to create our characters' eyes gives artists the flexibility to push the boundaries of their craft; it helps them portray characters that communicate the emotions that a story requires. In order to achieve this we designed a set of techniques that compose our eye pipeline. It has been refined over many years in a continued effort and collaboration among several departments at our studio, from modeling to lighting passing through animation and rigging. It allows animators to follow their expressive style while also providing materials artists and lighters with the necessary input to achieve a realistic look.

CCS CONCEPTS

• **Computing methodologies** → *Shape modeling*; Rendering;

KEYWORDS

eyes, animation, rigging, shading

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1 INTRODUCTION

We face five major technical challenges related to our characters' eyes. Very often our cartoony animation style requires the eyeballs to be tremendously deformed. Depending on the desired effect animators may need to maintain perfectly circular pupil and iris (Fig. 2 left). In other occasions they may be looking for the opposite, iris and pupil deformation that fully matches the eyeball (Fig. 2 right). Or maybe something in between (Fig. 2 center).

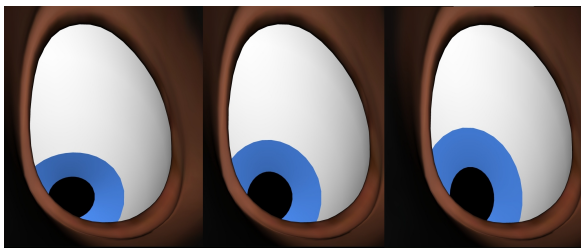

Figure 2: Deformed eyeball with three different degrees of iris/pupil deformation (from none on the left to full deformation on the right)

Secondly, artists require direct independent control over shape and size of iris and pupil to accentuate expressions. Animators need to be able to squash, stretch and rotate iris and pupil independently from the eyeball (Fig. 3).

Frequently, character design in animated films tends towards characters with larger eyes. This makes the eyes more visible and

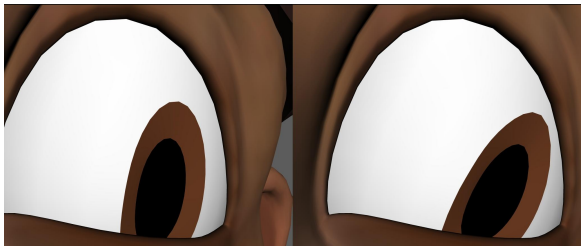

Figure 3: Iris/pupil stretched and squashed along X/Y axis. Additionally, iris/pupil rotation on the right

accentuates their expressiveness. When trying to accommodate large eyes inside a shallow head it is often necessary to "cut" the eyeball to avoid penetrating the character's skin.

A major challenge for animators is to convey the right gaze direction. In the past the eye was modeled as a sphere with a disk attached for the iris/pupil, but this required many iterations between animation and lighting because the gaze of the character looked different in the render compared to what animators saw in their scenes.

Lastly, making the eyes look alive is a conglomeration of subtle tweaks of reflections, specular highlights, color corrections and caustic refractions. Initially, this was all done with a special suite of lights linked directly to the eyes, but the cost of rerendering quickly made that prohibitive and unsustainable.

2 IMPLEMENTATION

In order to overcome these challenges we developed an iterative method to create an eyeball as close as needed to the anatomical eye; having cornea, iris and pupil clearly defined in the geometry. While aesthetic and quality performance are very important, we also want to achieve a computational performance that does not impede artists' workflow and allows them to work fluently. Our method provides quality tradeoff settings to help in this purpose. In addition, it allows them to overcome the challenges shown in Fig. 2 and Fig. 3. Before having this technique, animators were forced to counter deform the iris/pupil in the rig, to keep them round; a very difficult and time-consuming process. Our new implementation solved this problem giving more freedom to artists.

Figure 4: On the left, issue with big eyeballs showing when character opens its mouth. On the right, our cutting mechanism working to keep eyeballs from showing

We also developed a fast "cutting" mechanism to resolve the issue shown in Fig. 4. Our previous method used to have the rig responsible for this, but that reduced the rig performance when visualizing the eyes. Instead, we now use OpenGL shaders together with auxiliary geometries (planes and/or specific shapes) that allow riggers to "cut" the eye geometry, displaying only the area of the eye that stays inside the character's head. In Blue Sky's in-house raytracer renderer, CGIStudio, the cutting is done on the fly using CSG (Constructive Solid Geometry).

Additionally, we developed a fast solution that overlays a CGIStudio render for the eyes in the Maya viewport by using z buffer compositing so animators can determine the change in gaze caused by the refraction through the cornea bump (Fig. 5).

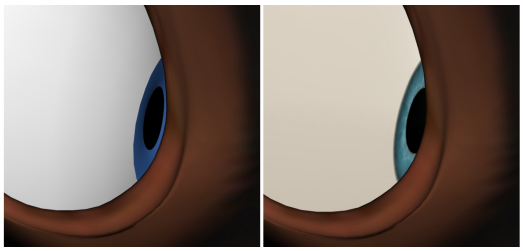

Figure 5: Normal animator viewport (left). Animator viewport with render overlay for eyeballs (right)

Finally, the lighting and compositing departments used a post process that allowed near real-time modification of many different parameters of the eyes in a single tool. Given the standardized eye rig and geometry used for all characters, a script was created to generate render layers for single or multiple characters. Once the layers were created and rendered our compositing tool allowed the lighters to control specular highlights, reflection maps and many other options. All in all the tool has over 100 parameters artists can manipulate to get the look they want. It is also flexible in how it generates the layers and looks for different eyes. For instance, in The Peanuts Movie, the eyes were very unique; unlike any other movie we had worked on. They were more like little odd shaped beans than spheres, yet the tool was easily modified to work with those eyes as well.

3 CONCLUSIONS

We present here our current eye pipeline forged as collaboration between the modeling, rigging, animation, materials, lighting, compositing and R&D departments. We consider this to be an ongoing effort as we keep trying to solve remaining challenges. In particular, we currently rely on having a fast approximate iris caustic. This approximation is done by pushing the iris and pupil back into the eye. This retrograde gives very appealing yet fast shading results. Using this geometric method however makes it harder for animators to achieve the desired gaze direction. The pupil becomes buried when characters look away from the camera depending on the depth of the retrograde. We are currently exploring ways to create the same effect without the retrograde. While we keep trying to improve our solution, our pipeline currently enables artists to achieve great results and get compelling character performances, while saving many person and machine hours.