Pixels to Parks: New Animation Techniques for Fantasyland

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(a) Computer graphics rig

(b) Audio-animatronic robot

1   Introduction

We present the innovative techniques that brought to life an audio-animatronic Lumiere for Disney World's newest attraction--*Enchanted Tales With Belle*. Walt Disney Imagineering and Walt Disney Animation Studios collaborated to create a pipeline that was flexible and intuitive for feature film animators. First, motion was digitally choreographed on the computer with a virtual rig. Next, the software detected constraints and motion limitations that would exist on the physical audio-animatronic. This allowed the artist to resolve them and animate physically plausible motions. Finally, the performance was transferred to the audio-animatronic, faithfully recreating the artist-produced motion using motors and machinery.

2   Animating Digitally

The audio-animatronic Lumiere developed for this project represents state-of-the-art engineering that combines a projected computer graphics face and a motorized body. Traditional audio-animatronic animation techniques require a physical prototype to be present at all times. Knowing that the projected face would be digitally animated, we also embraced a digital animation pipeline for the body as well. Since feature film animators are accustomed to working in entirely digital environments, we created a workflow that allowed all animation to be done in Maya. As with traditional feature film animation, the voice actor was recorded first and provided as an audio soundtrack. Since animators commonly block their animation pose-to-pose with step function curves--which are not physically possible with mechanical devices--the digital setup allowed for this workflow. Not limited by the physical constraints of the mechanical robot, the animators could further refine their performances with interactive scrubbing, alternate takes, and timing alterations. In addition to Lumiere, the attraction's show room (including scenery, seats, even guests of various heights) was modeled for the animators to verify sight lines and to validate the performance from all perspectives.

3   Rigging For Animation vs Rigging for Real

Rigging was faced with a particularly unique challenge, requiring them to rig on three different levels. First was the animator interface, which consisted of a series of inverse kinematic controls to bend the torso from Lumiere's neck, wave his candlestick hands, and pose his face. Second was the mapping between this set of controls and the bind skeleton that links joints to the skin weights and blendshapes of the previz mesh in Maya. The previz mesh had to plausibly recreate the motion that the physical model would undergo. Last, was the unique challenge to constrain the animator's rig interface to the restrictions of the physical robot. Computer graphics characters, which live entirely in virtual environments, only have to look plausible for the camera and frequently violate real world mechanics. In our project, joint rotation limits had to be enforced so motion did not exceed the physical capabilities of the robot itself. Lengths of rods, springs, silicone, etc. were rigged to change color and warn animators when pulled beyond their stretchable limits.

4   Final Check

Despite the great care taken to rig according to the robot specifications, a motion that could potentially break the physical robot would have been both costly and dangerous. Additional software checks were developed to ensure that rotation and length limits were enforced. Additionally, animation curves were analyzed at their first and second derivatives to check that velocity and acceleration did not happen in discontinuous ways or at speeds faster than the machinery could handle. If any checks failed, the values would be adjusted by the animator to assess the aesthetics of the changes and update the performance if necessary. Once both the software and the artist were content, the data was exported from Maya, filtered, and then imported into a real-time, proprietary show system to be played on the robot.

5   Conclusion

We have developed a successful audio-animatronic animation pipeline that combines the flexibility of digital workflows with the constraints of the physical world. The ability to carry a single animator's performance through from beginning to end was among the most important successes of this project, and a workflow we plan to continue on future projects.