Crowd Character Complexity on *Big Hero 6*

Yasser Hamed John Kahwaty Andy Lin Evan Goldberg Lawrence Chai
Walt Disney Animation Studios *

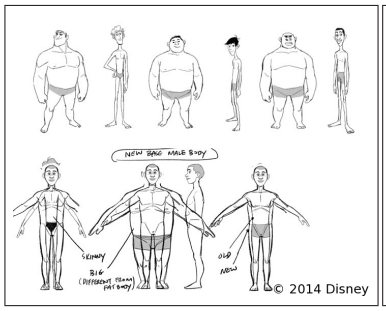

Fig 1: *Denizen blends between body types*

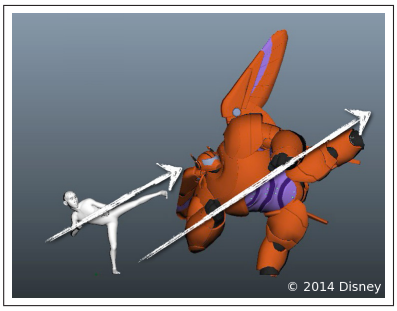

Fig 2: *Retarget animation for different body types*

Fig 3: *Crowd shot in "Big Hero 6"*

Abstract

On Disney's *Big Hero 6*, we needed to create the city of *San Fransokyo* with unparalleled levels of visual complexity. The cityscape has more buildings and more geometry than any prior Disney film. Inhabiting this city are hundreds of unique characters, each performing a high caliber of animation individually and as a group. These challenges prompted a major upgrade to our existing crowd pipeline and the development of several new technologies in authoring crowd characters, generating crowd animation cycles, and instancing crowds for rendering.

1 Authoring Characters

Character creation needed to be rethought to accommodate the diverse, vibrant, and living city that is captured in the design of *San Fransokyo*. Hundreds of high-quality characters had to be created, two times more than any previous film. The process also needs to be trackable and easily updatable.

Denizen was created to fill these needs. Its user-friendly interface allows both technical and non-technical artists to create characters on-the-fly. Sliders adjust character proportions, and clothing is available from a library of options. Once settings are picked, the press of a button will generate a high quality model, look, character rig, cloth rig, and hair rig ready for use by production. This allows asset creation to be driven by and come straight from Visual Development artists. In fact, the crew of *Big Hero 6* was invited to author themselves in *Denizen*, and many of our production artists' avatars can be seen in the movie.

With *Denizen*, we created almost 700 unique characters. Each one was handcrafted by an artist and completely procedural, rebuildable, upgradable, and trackable.

2 Retargeting Animation

For each of the 700 individual *Denizen* characters, we then generated 200 unique actions (walks, runs, stands, claps, cheers, transition cycles, etc). When batch processed on our queue, this resulted in 140,000 total animation cycles (700 characters x 200 cycles). The action cycles were first animated on base male and female rigs of average proportion. We then used an automated retargeting process to properly transfer the 140,000 animations onto crowd characters of significantly different proportions.

The retargeting tool is based on Maya's *Human IK* (HIK), with a number of in-house functions written on top to adjust for hand-to-hand contact, calculate knee pole vectors, preserve clean foot roll, and resolve body mesh interpenetration. For example, when retargeting to a character with a fat body type, interpenetration between the arms and upper torso is likely to occur. To automatically resolve this, we developed a novel interpenetration correction system based on *Pose Space Deformation* (PSD). The algorithm calculates which arm angles generate significant collision with the body. As the arm animation approaches these positions, PSD adjusts the control angles to avoid interpenetration but preserve the proportionally adjusted animation.

3 Instancing for Rendering

On previous shows, small-scale crowds were keyframed and handled by the animation department. Larger-scale crowds were created by instancing geometry with baked animation cycles or by using third-party packages. On *Big Hero 6*, we needed a more flexible workflow that could scale to meet the demands of the film, as well as efficiently feed more complex crowds to our new renderer, *Hyperion*, used on the film. The crowds' animation data is generated from the retargeted animation cycles augmented with secondary procedural animation, in-house scripting tools, and third-party applications, and is saved as particle data for rendering.

To render the crowds, this particle data is read into *Aurora*, our internally-developed instancer. *Aurora* is typically used to procedurally generate different types of geometry (points, meshes, volumes, etc.) at render time. It was modified for *Big Hero 6* to allow instancing of character rigs onto particle instances with attributes containing secondary procedural animation. When instancing crowds, *Aurora* uses a bind rig along with a set of FK animation data attached as per-particle attributes which is used to deform the mesh at render time. Additional customization steps could also be taken at this point to render different accessories, materials, and hairstyles to further vary the look of the characters.

4 Conclusion

With the new crowd system, *Big Hero 6* created crowd shots of previously unthinkable size, scale, and quality. Novel tools such as *Denizen*, retargeting, and *Aurora* provide great efficiency for handling the complexity of authoring, animating and rendering, and continue to be used and evolve on upcoming productions.

* {yasser.hamed|john.kahwaty}@disneyanimation.com
{andy.lin|evan.goldberg|lawrence.chai}@disneyanimation.com

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