Acting with Contact in *Ratatouille* - Cartoon Collision and Response

Gordon Cameron Robert Russ Adam Woodbury
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Contact is natural in the real world but often avoided in 3D animated features. Animators tend to make acting decisions that minimise or avoid contact within and between their characters and the world, and when apparent contact _does_ occur, it can tend to feel both ”floaty” and unrealistic. ’Ratatouille’ called for dynamic, tactile characters that would feel very much a part of their animated environment, squashing into and against each other, props and the world itself. The contact needed to be compelling and believable within that cartoon world, and with that in mind we aimed to develop and deploy technology that would allow animators to easily setup collision relationships, make acting decisions with contact response interactively, and alter the resultant shapes.

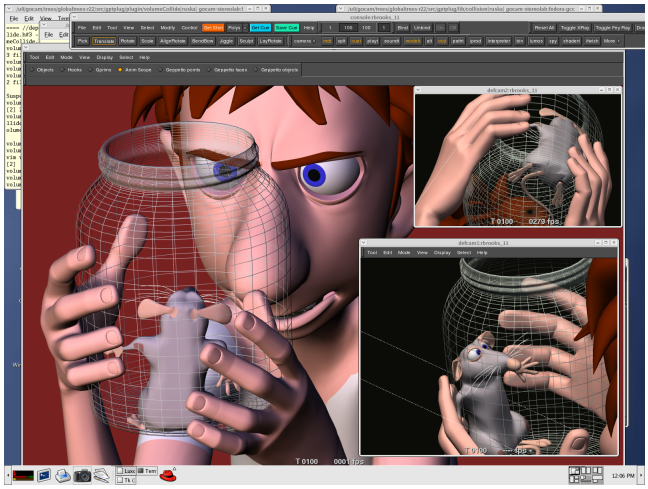

Figure 1: Acting with Contact in *Ratatouille*. ©Disney / Pixar. All rights reserved.

1 Developing a Look for Contact

Our initial design required a solution that yield good shapes out of the box with minimal tweaking, but still allow for easy subsequent reshaping (our charter was always to give animators final control over shape & silhouette). The technology would need to be interactive, both in terms of response speed and in setup. In terms of shape, while we needed to give a compelling feel of contact and response, we did not need to supply ‘real’ volume preservation, ballistics or a history based response. Any ballistic secondary motion would be crafted by animators rather than relying on a final simulation pass.

After identifying typical contact scenarios (e.g. characters sitting, holding props, leaning against each other, etc) and sketching how we would like the resultant shapes to look, we settled on a cartoon contact look comprising two parts. A primary dent would move points in collision out of the way of the contact, while a bellcurve-shaped secondary response would bulge more distant points up and away from the surface depending on the contact depth, helping to ’sell’ the feeling of touch. We would offer animation control to allow the sculpting of the shape out of the contact and through the bulge and do so with familiar spline-like shaping controls.

2 Collision Pipeline Implementation

We developed a multithreaded deformer that would respond to contact and move skin surface points, and placed it inside all our lead characters, both human and rat. It works by first checking for character (collidee) and collider intersections. Points in contact are tagged and the direction and magnitude they should be pushed is estimated (using normals of, and distances between collider and collidee) and stored. The contacting points are pushed out of the way to resolve the collision, and offsets are applied to neighboring points to smoothly ramp in the deformation. Next, more distant neighboring points are bulged away from the surface - the deformation is based on collision proximity and maximum contact depth, and is shaped via a bezier profile function whose slope can be tweaked by animators. As the contact pushes deeper, the bulging extends higher & further from the contact yielding a cartoon ’plunger’ effect. Finally, we optionally perform a relaxation of affected points.

Each of our characters has several built-in weight maps that alter the response across the surface. There are maps for controlling the degree of bulging/denting (e.g. the belly tends to bulge much more than the back of the hands), for avoiding bleed between regions of the body, altering the direction that points are pushed, limiting how far we can press, etc. The animator has the ability to override these maps and controls per body part as they see fit.

Characters are supplied with a set of built-in colliders (e.g. for the hand, elbow, head, belly etc). These are ellipsoid fitted approximations to body parts that track with the articulation. They size and align to sample points on the skin, but pose prior to the final collision deformation. It is simple for the animator to specify that they want a characters hand collider to contact their own face, or indeed that of another character. We can also resolve bidirectional contact using these proxy colliders.

Many of the props on the show are automatically built for ’out-of-the-box’ use as colliders, but we also crafted primitive objects for animators to use (e.g. planes, ellipsoids and primitive subdivs) that implement their own efficient contact algorithms, and rendered 2.5d collidable ground maps for many of our shots. For arbitrary objects that lack the contact & collision deformers, we can use FFD lattices that can be collided into.

3 Results & Usage

Animators made extensive interactive use of the technology for both broad and subtle contact when posing and crafting motion. For example, in Figure 1 Remy squishes against the inside a jar as Linguini’s fingers contact and are deformed by the outside. Other typical uses included hand contact into faces & against bodies, characters leaning against the world, touching, holding and brushing props, deforming and being deformed by furniture, and in much body and foot contact with the ground. Less expected uses included shots where scooter tires deformed by lattices squashed against ground maps, inverted colliders cheated food inside mouths, built-in rigged colliders prevented teeth/cheek penetration and aided in cheek/shoulder contact, and simulation could rapidly fix intersecting geometry when cloth simulation yielded ’surprising’ results.