Crowds at Monsters University

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Figure 1: Ambient crowd. ©Disney/Pixar. All rights reserved.

Monsters University features a college campus which required a pipeline that could handle a large number of medium-scale "ambient" crowd shots. A diverse student body with a variety of rig types, from mono-peds to septi-peds, necessitated a flexible animation system.

We primarily leveraged pose-cached animation, as opposed to live rigs, for simplicity and animation fidelity. We focused on layout of crowd characters in our system, and the application of our animation library to both stationary and path-animated characters. Ours is an art-directed crowds placement and animation system, rather than a simulation.

1 Population Editor

To help with selecting population distributions from our pool of 270 crowd characters, we created a cross-platform web tool usable by members of our Art department. This presents a visual preview grid of a "mini crowd," making it easy to create and publish "population presets" for use later in the Layout editor. Furthermore, to inform casting decisions, we generate lineup images for each of these published "populations", bookended with hero characters for scale reference.

2 Crowd Placement Editor

Next, our spatial placement tools simplify mass character layout by authoring per-character attributes (position, orientation, pose cache playback index, etc) and metadata (intended starting animation action, etc), as opposed to defining the crowd via a simulation or persistent procedural network.

Our casting tool allows layout artists to make decisions about character placement by projecting 2d grids, discs, or sketched regions onto the set geometry. Additionally, users cast characters probabilistically with art-directed distributions describing character variety and animation poses.

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The placement tool provides a variety of operations for arranging batches of characters; such as ground locking, orientation towards a group centroid, clustering, mesh relaxation-based de-intersection, and spatial noise.

We define initial "poses" for our characters to express intent about their starting states during animation application. We allow the user to easily select from a pool of pre-made poses and apply them to a group of one or more characters. This allows for Layout involvement in specifying the activity of a crowd early in the life of a shot.

3 Path Animation

Futhermore, our toolset provides high-level fully directed locomotion for small crowds. New character paths are created by offsetting linear approximations of *guide curves*, which can be either pre-existing bezier paths or user-defined 2D sketches. Points sampled from guide curves are projected onto the ground plane and used for a bezier curve fit. Adaptive sampling is used to provide greater resolution in areas of quickly-varying terrain.

Characters are initially dispersed along paths to minimize collisions between one another over time. Layout translation along the path is applied to each character based on a valid speed determined from our inventory of indexed animation.

4 Crowd Choreography

We developed a new tool to select sequences of compelling and directorially-motivated animation clips for large groups of crowd agents. Our choreography tool allows the creation of a high-level crowd action specification consisting of a stack of layered timelines spanning the frame range of a shot. Timelines are associated with groups of characters, and consist of sequential *Beat* meta-clips.

Beats were conceived to succinctly express a directorial note such as the relative likelihood of characters performing a particular action during a particular part of a shot. They span a fuzzy frame range and are hierarchical probabilistic overlays of our animation clip inventory. Our system evaluates this high-level sequencing of generalized behavior specification over the fuzzy time range into a specific sequence of animation clips for each crowd agent.

The implicit topology of our animation network allows our choreography tool to insert appropriate transition animation between *Beats* which evaluate to disjoint poses. Also, the layered nature of the tool encourages working "rough to fine" through the creation of overriding timelines expressing different instructions for subsets of the crowd.

5 Conclusion

Overall, this system proved efficient and flexible on a variety of shots, and facilitated collaboration across our Art, Layout, Crowds, and Animation departments. Our overall pipeline efficiency was roughly two times greater than on previous similar shows.