Morphable Crowds

Supplemental Material

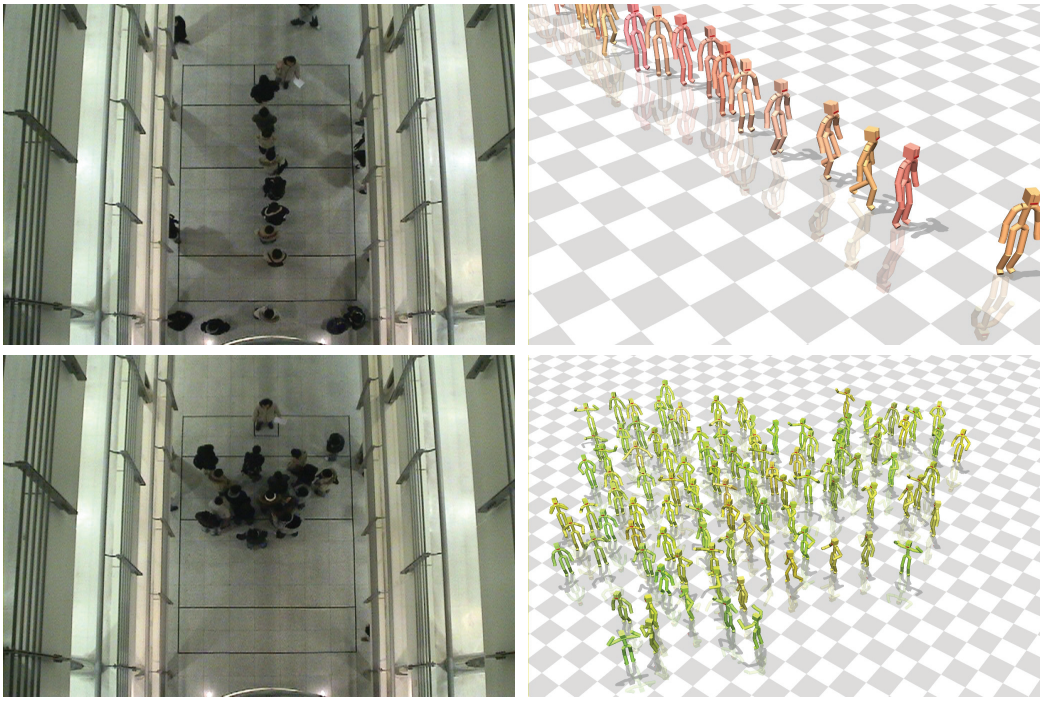

Figure 1: The synthetic crowds (Right) learned the spatial arrangements and locomotion styles from the real crowds (Left). These show lining up at a ticket booth (Up) and spectating at a performance (Bottom).

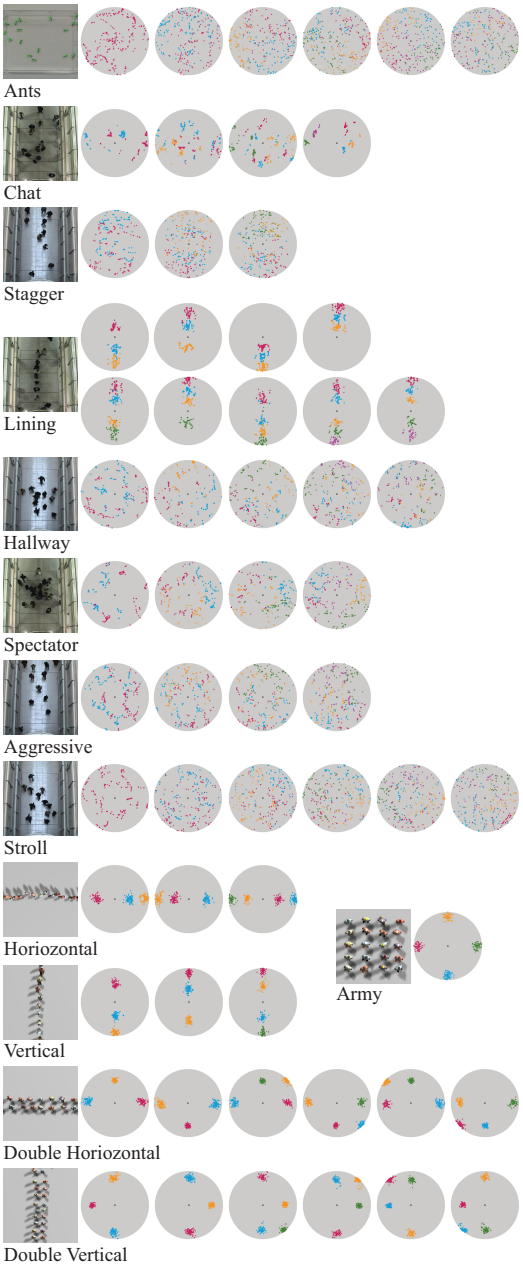

Figure 2: The formation model of various crowd styles. The top eight crowd data were captured from real human/animal video and the bottom five were from synthesized crowd simulation. The ants video at the top used courtesy of BioTracking project at Georgia Institute of Technology.

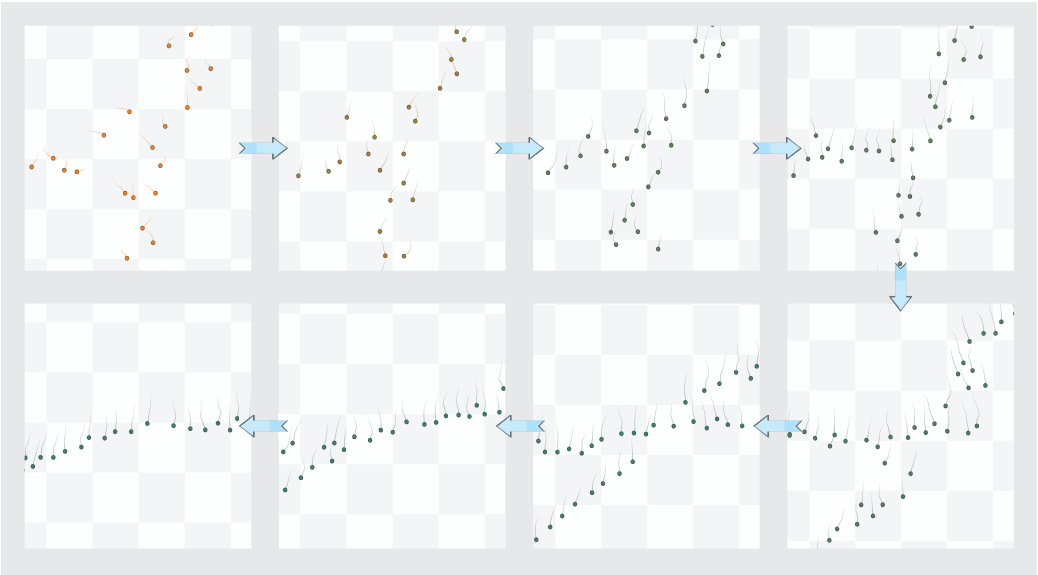

Figure 3: Smooth transition from Stagger to Horizontal.

Two-Way Blending. Our system allows any pair of morphable models to be interpolated to produce their intervening crowd styles with arbitrary affine weights. Smooth transition from a source to a target can be easily produced by gradually increasing the blending weight for the target crowd from zero to one. Figure 3 shows the process of transitioning from randomly distributed, staggering folks to a horizontal line formation.

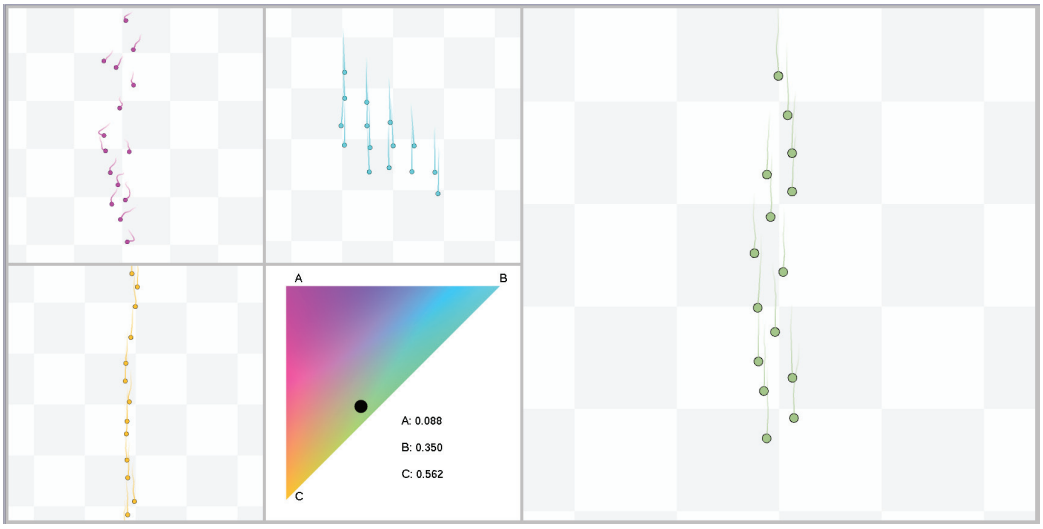

Figure 4: Three-way blending.

Multi-Way Blending. We can blend more than two crowd models simultaneously (Figure 4). The user simply pick a point in the triangle palette to decide the blending weights of three example data. The agents in the synthesized crowd then change their formations and locomotion styles gradually to make transition in the crowd style palette. A variety of new crowd styles can be produced by mixing many morphable models. We implemented a painting interface to create a crowd of agents with mixed styles and personality (Figure 5). The user selects the style in the palette and creates a group of agents in that style using the paint brush metaphor.

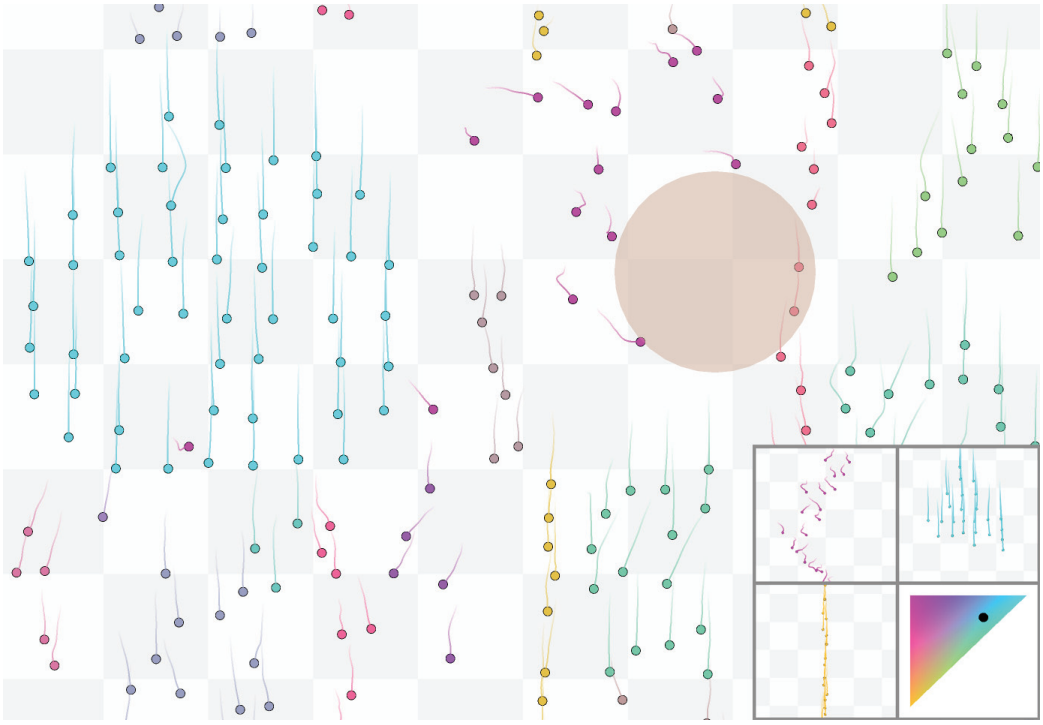

Figure 5: A crowd painting interface based on three-way blending. The bottom-right triangle palette represents a spectrum of intermediate crowd styles of three example crowds. Stroking a brush creates a set of agents in the stroke shown as a pink disk.

Painting Crowds. We implemented a painting interface to create a crowd of agents with mixed styles and personality(Figure 5). The user selects the style in the palette and creates a group of agents in that style using the paint brush.

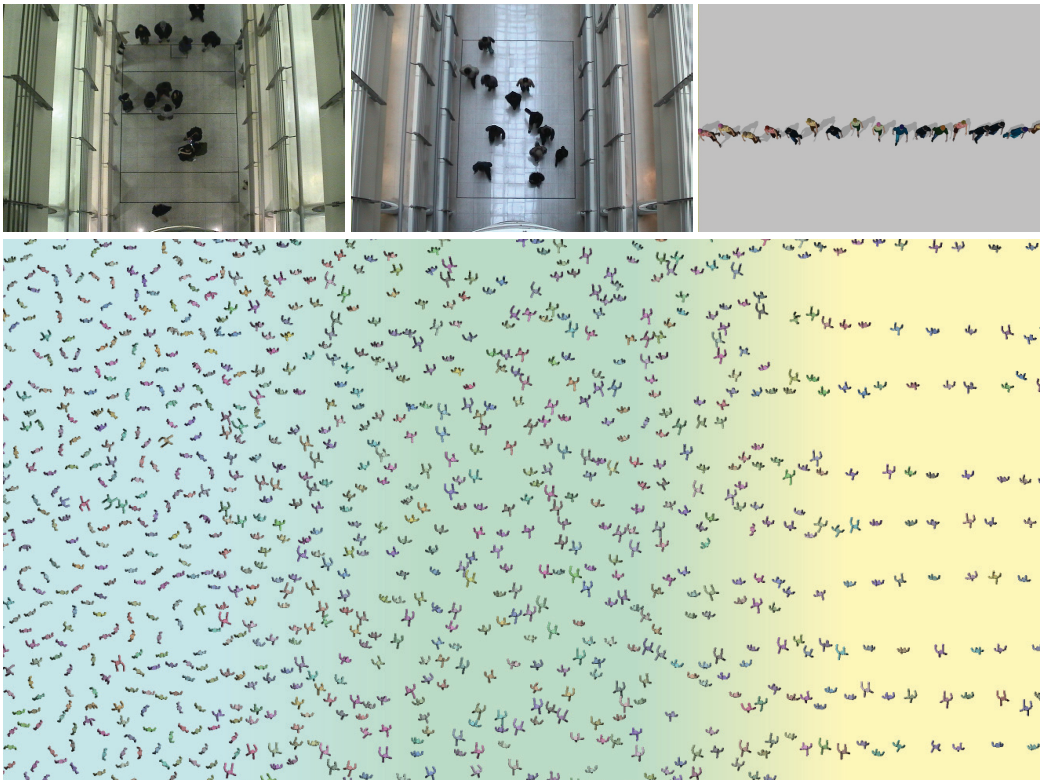

Figure 6: Spatial transition.

Spatial Transition. Smooth transition of crowd styles allows multiple crowd styles to be laid out seamlessly in space. We partitioned a rectangular ground vertically into three subregions (Figure 6). Three crowd styles (Chat, Aggressive, Horizontal) were associated with the subregions. The Chat model generates a near-stationary, clustered distribution of agents. The Aggressive model generates a randomly distributed, fast-moving agents. The Horizontal model generates lines of agents moving in moderate speed. The morphable models are smoothly blended along the boundary of subregions to visualize the transition between different styles.

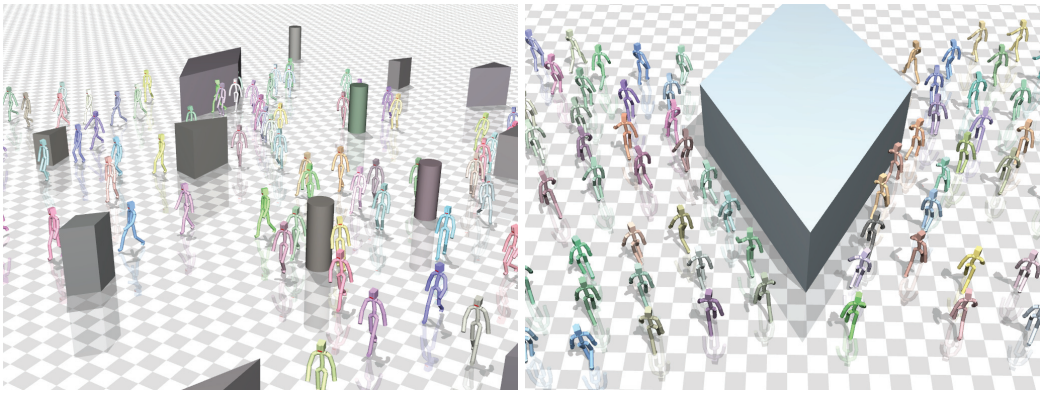

Figure 7: Collision avoidance.

Collision avoidance. Our simulation algorithm can readily prevent the collision between agents and with obstacles (see Figure 7) as long as the agents are not tightly packed. Handling tightly packed pedestrians is beyond the scope of our work. Our simulation algorithm avoids collisions by rejecting any trajectory segment on a collision course and searching an alternative until it find a collision-free trajectory. Therefore, the algorithm would slow down for collision-prune, dense crowds.

Preprocessing analysis

Each crowd data is pre-processed to construct its generative model and they took one or two seconds to generate one single crowd model. Another preprocessing is to establish correspondences between formation distributions for crowds blending. They took about one minute and detail timing information for each example is exhibited as follows.

Examples	Blending models	Finding matching (sec)
Two-Way Blending	Horizontal and Stagger	39.547
Three-Way Blending & Painting Crowds	Stagger and Army	37.843
	Army and Vertical	48.781
Spatial Transition	Hallway and Stroll	47.125
	Stroll and Army	54.687
	Army and Chat	61.078
	Chat and Aggressive	50.156
	Aggressive and Horizontal	84.453
	Horizontal and Ants	78.781
	Ants and Stagger	59.875

Table 1: Pre-processing analysis for each example.

Runtime analysis

Runtime process consists of generating an initial formation of given number of agents and proceeding every agent by the length of a trajectory segment. Table 2 shows general and timing information for each example.

Examples		General Information			Time information	
		# of motion data	# of agents	Simulation duration (sec)	Initial formation generation (sec)	Average synthesizing time (sec)
One Crowd Synthesis	Lining	1	100	30	0.141	0.038
	Spectator	1	100	30	0.031	0.013
Two-Way Blending	Stagger to Horizontal	2	20	60	0.001	0.061
Three-Way Blending		3	15	20	0.001	0.121
Painting Crowds		3	376	10	Incremental addition	0.089
Spatial Transition		8	3699	30	27.156	29.511
Collision Avoidance	Many obstacles	1	170	20	0.094	0.752
	One obstacle	1	135	15	0.063	1.161

Table 2: Runtime analysis for each example.