I. Commentary on Crowd Behavior Simulations

○ Crowd Behavior Model

When people find themselves in crowds, they decide how fast and in what direction to walk while accounting for their location in relation to other people, walls, and other obstacles so that they can proceed as comfortably as possible. Accordingly, a crowd behavior model considers points of dynamic behavior exhibited by people as they acquire information about their location.

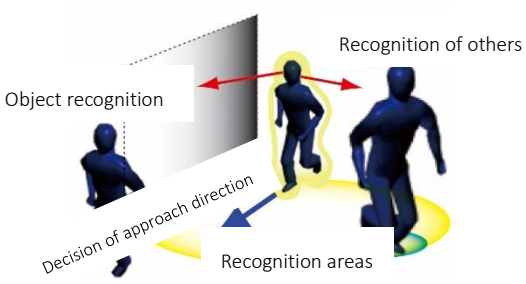


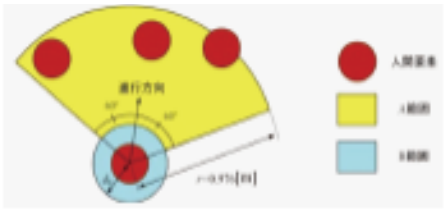
Image of expression of forces between elements

Classified by age and gender to account for physical abilities forces between elements

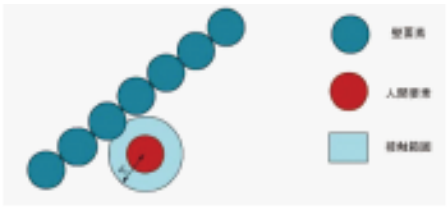
Example of setting specifications for physical abilities

○ Distinct Element Method

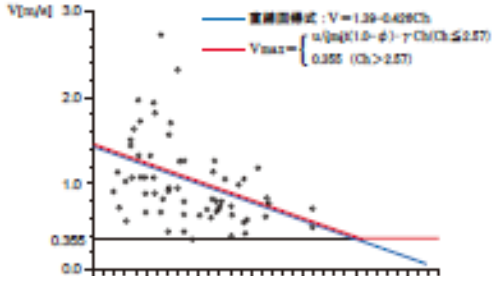
In the crowd behavior model, the movements of individual people are interpreted as physical flow phenomena of particles, and expressed using the distinct element method. Under the distinct element method, individual activity is calculated by considering mutual senses of distance and collision-avoiding behavior as forces between elements.



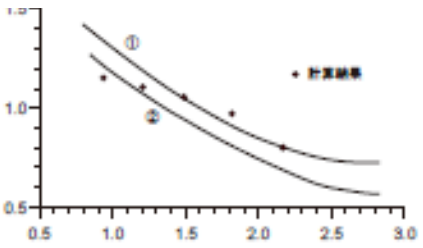
Judgment of expression of forces between elements (people to people)



Judgment of expression of forces between elements (people to people)

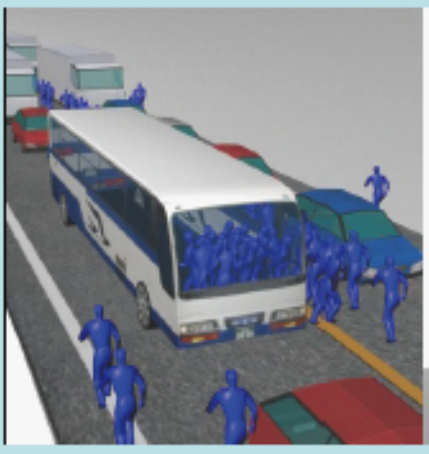


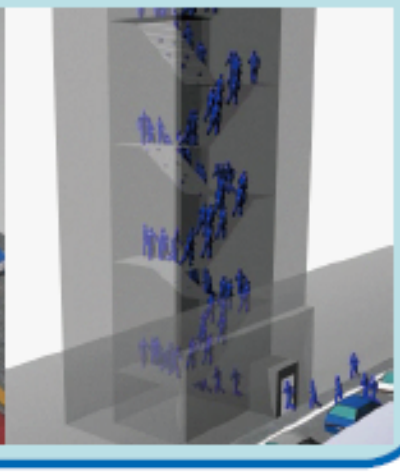
Example of relationship between crowding and walking speed



Example of correlation with past observations

Simulation of evacuation from a tunnel fire



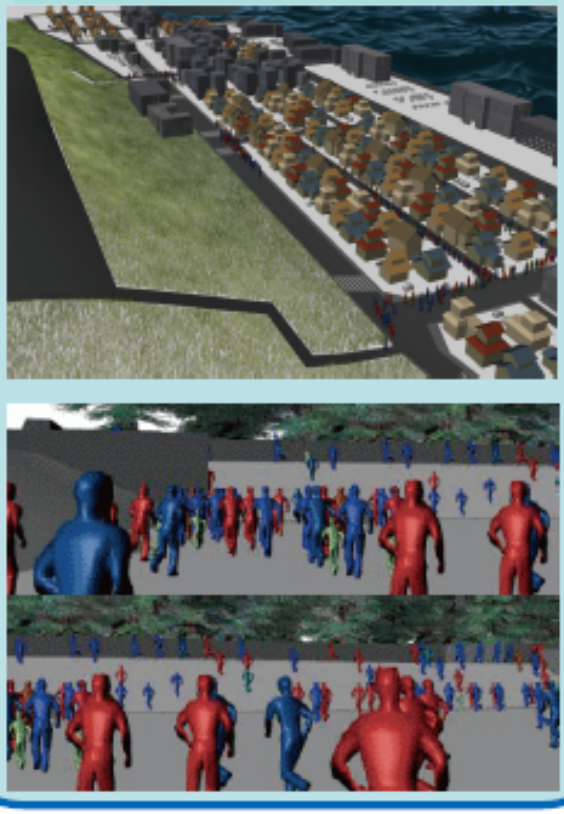


II. Useful Situations for Crowd Behavior Simulations

Crowd behavior simulations are particularly effective for efficiently ascertaining quantitative data on pedestrians under various conditions in high-traffic locations with ample volatility, such as around train stations and busy shopping areas under normal circumstances, and urban areas, sidewalks, and entrances and exits during disasters. They can also be used in virtual social experiments.

	Type of use	Location	Considerations
Disaster risk reduction	Evacuation simulation: Earthquake/fire (coupled with smoke diffusion simulation)	・Tunnels ・Underground ・Elevated areas ・Buildings ・City centers ・Busy shopping areas ・Urban areas, densely populated residential areas	- Ascertaining time required for evacuation - Ascertaining personal injury and loss - Considering methods of guidance for evacuation routes and areas - Considering installation scales for evacuation routes and areas - Formulating evacuation guidance plans - Formulating disaster risk reduction facility arrangement plans - Considering design conditions for roads and structures
	Evacuation simulation: Tsunami	・Coastal areas	
	Evacuation simulation: River overflow	・Places where rivers could overflow	
	Evacuation simulation: Landslide	・Places where landslides could occur	
Safety/ comfort	Pedestrian environment simulation	・Sidewalks ・Corridors ・Stairways	- Projecting congested areas - Considering sidewalk width, staging areas - Considering pedestrian traffic guidance, access restrictions - Considering pedestrian paths of movement - Considering methods of dealing with intersections
	Large crowd simulation	・Venues for events attended by large crowds ・Tourist attractions, beaches	
	Intersection simulation (coupled with traffic flow microsimulation)	・Intersections with many pedestrians ・Intersections with many motor vehicles	

Evacuation simulation: Tsunami



Pedestrian environment simulation in a busy shopping area