1 Introduction
We present an interactive system for creating crowd animation, focusing on making the CG crowd shots suitable for a TV program. Our system cannot make such "advanced" crowd animations as those for a blockbuster movie, which were made, for example, using AI techniques. However, our system allows a user to quickly make the crowd scenes under a limited time and budget. Our "handy" crowd system is currently available as a Maya plug-in in our workplace, offering several features, which we believe would be useful enough to quickly make various crowd shots.

2 Crowd scene on TV
Most crowd scenes in a TV program would be relatively simple in the sense that (1) The scene may include thousands of the characters, but not million; (2) The behavior of each character is basically similar and simple; and (3) events that could happen during animation are not many or complex. Therefore, use of a particle-based system, where character attribute and animation are assigned to each particle, is one of common strategies in making crowd animation. A simulation-based approach, such as the boid technique in [Reynolds 1987], could be easily combined with this particle-based system. We then have to consider the following practical demands:

A. Quick turnaround and preview of the crowd animation:
Unlike feature films, we usually don’t have enough time to make a CG crowd shot, even if each step of crowd setting, animation and rendering is laborious and time-consuming. On TV production, while the rendering quality is a little bit modest, we still have to make it quick, which will be illustrated in section 4. If we use a simulation-based method, such as for evacuation simulation, the simulation turnaround should also be fast, but generally not.

B. Local editing in time and space: One of the drawbacks in a simulation-based approach is that, if the resultant animation is not satisfactory, we have to make another simulation from the beginning. Therefore it would be desired to serve a function that allows the user to easily specify the time and place where the crowd should be "edited" locally, and to recreate the locally edited crowd scene, while the created animation should smoothly be connected with the rest of the crowd animation.

C. Separate editing of the main character(s): In many situations, there is a hero/heroine character whose behavior is strictly prescribed by a director. Most characters surrounding the main character would behave as a part of the crowd. Therefore we would desire a function to edit the main character’s behavior first and to make animation of the crowd surrounding the main.

Our system has thus been developed and still improved in order to meet these requirements, as will be illustrated next.

3 The system
Our crowd system as a Maya plug-in is combining the boid algorithms [Reynolds 1987] and the method based on a behavioral science [Unuma et al. 1995]. This method defines a personal space so as to easily prescribe relation among characters, such as "friend" or "enemy" to each other. We can then manipulate a parameter to define the sensing area, where the character can sense the outer world. This means that, for example, if two characters, who are defined as friends to each other, incidentally find each other in a certain distance, then they come closer. Likewise, we can design several character relations, which allow us to easily make a behavioral simulation of the CG crowd.

Our system starts with initial positioning of the characters, along with setting up the 3D scene including the obstacles by Maya. The user then assigns each character the goal position, and defines several events that could happen among the characters during simulation. Basically collision avoidance among characters and among a character and the obstacles is performed without using a conventional technique. Instead this is achieved by tuning the parameters provided by our system, some of which are derived from the behavioral science, which leads us too easily to make “AI-oriented” and sophisticated crowd animation. The overall process flow is illustrated in Figures 1(a)-(e), to describe the pedestrians near the crossing shown in (f).

4 Experimental results
Figure 2 shows the crowd animation examples. It took the user approximately 2 hours to create the scenes for the simulations ((a) crowd who wanders in maze, (b) battle scene, and (c) human letters formation by characters in (b)). It also took our PC (3.6GHz Xeon *2CPU with 4G bytes of main memory) approximately 4 minutes to simulate one-minute animation of 200 characters.

References