SocioCrowd: A Social-Network-Based Framework for Crowd Simulation

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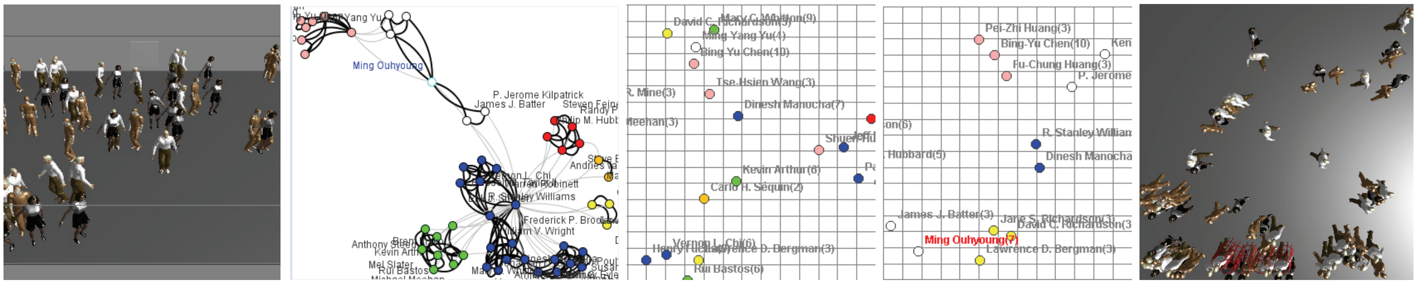

Figure 1. (a) Simulated result, (b) network view, (c) no community effect, (d) community flocking in 2D mode, (e) information spreading in 3D mode.

1. Introduction

The goal of crowd simulation is to produce potential collective behaviors by simulating the movement process of a number of characters or agents. Some famous models are proposed to simulate crowd, including social force (e.g. [Helbing 2000]), cellular automata (e.g. [Chenny 2004]), and rule-based models (e.g. [Reynolds 1987]). Others use physiological (e.g. locomotion, energy level) and psychological (e.g. impatience, personality attributes) traits of agents to trigger heterogeneous behaviors [Pelechano 2007]. However, existing approaches do not consider the real-world social interactions among agents, and thus are unable to produce social-dependent scenarios. In this work, we propose to leverage the underlying social network, which captures social relationships among agents, for crowd simulation. A novel social-network-based framework, SocioCrowd, is developed (figure 1(a)) shows the virtual world). Based on SocioCrowd, we simulate three social-based scenarios, including community-guided flocking, following leading persons, and spatio-social information spreading. They display certain real-world social behaviors which are hardly modeled by existing methods. To lift the performance, our SocioCrowd is implemented by pure Java with GPU programming in ways of GSGL and JCUDA.

2. SocioCrowd Framework

Our SocioCrowd framework consists of the following two parts.

Basic Architecture. We employ a traditional flocking model [Reynolds 1987], which is composed of separation, alignment, and cohesion rules, as the basic architecture of SocioCrowd. We further introduce two probabilities to control the movement status of agents. One changes agent's status from *walk* to *stop*, the other from *stop* to *walk*. In default setting, agents walk and stop randomly.

Social Network Construction. To exploit the social relationships in SocioCrowd, we collect real data from DBLP[1], which is an online database for Computer Science Bibliography. We construct the co-authorship social network, in which each node (i.e., agent) stands for an author and each link represents co-authorship between two authors. An example social subgraph around the author "Ming Ouhyoung" is shown in Figure 1(b).

3. Social-based Simulation

Based on SocioCrowd, we propose to simulate three scenarios:

Community-Guided Flocking. In a social network, a community can be regarded as a tightly intra-connected and loosely inter-connected subgraph. We use the Fast Newman algorithm [Newman 2004] for community detection. For agents in diverse communities, we draw different colors on both network view and 2D mode. Besides, to integrate communities within simulation, we then design two probabilities, $p_c$and p_{-c}, to control the potential an agent talks to others of the same community and of different communities respectively. The simulating results are shown in Figure 1(c), where p_c=1 and p_{-c}=0. It can be observed that agents belong to the same communities tend to flock. For figure 1(d) where p_c=0.5 and p_{-c}=1, agents belong to different communities have higher chance to flock. Note that only partial snapshots are created due to space limit.

Following Leading Persons. A general society usually has leaders who are chased by some followers. Our SocioCrowd simulates this kind of scenario by identifying the central individuals as the leading ones in a social network. Three centrality measures (i.e., degree, closeness, and eigenvector) [Wasserman 1994] are provided to find central individuals from different viewpoints. During simulation, we use a probability p_l which allows an individual to follow a leader given the leader appears in the visible region. A higher probability implies the leader attracts more followers.

Spatio-social Information Spreading. Here we would like to simulate how information is propagated from a single agent to agents around the environment. In conventional crowd simulation, agents spread messages only to others who are close one another in space. In real-world cases, however, people do not necessary communicate with spatially-closed individuals but rather socially-closed ones. With underlying social network, individuals are capable of interacting with socially-close ones. Our SocioCrowd combines spatial and social clues to perform such information spreading. We adopt the linear threshold model [Kempe 2003] as the spreading strategy, where an agent is influenced if the summation of the influence probabilities of its spatial and social neighbors is larger than a given threshold. A snapshot of influenced agents drawn in red cylinders is shown in Figure 1(e).

4. Conclusion and Discussion

We propose SocioCrowd leveraging real social networks to provide potential interactions among agents for crowd simulation. We also present three social-based simulations that can be further integrated to explore more social-based emerging behaviors. Our experiments show that real-world social-based behaviors can be generated through turning up the designed parameters.

References

Chenney, S. 2004. Flow Tiles. ACM SIGGRAPH/ Eurographics Symposium on Computer Animation 2004. 233-242.

Helbing, D., Farkas, J., and Vicsek, T. 2000. Simulating dynamical features of escape panic. Nature, 407, 487-490.

Kempe, D., Kleinberg, J., and Tardos E. 2003. Maximizing the spread of influence through a social network. ACM SIGKDD 2003, 137-146.

Newman, M.E.J. 2004. Fast algorithm for detecting community structure in networks. Physical Review, E 69, 066133.

Pelechano, N., Allbeck, J.M., and Badler N.I. 2007. ACM SIGGRAPH/ Eurographics Symposium on Computer Animation 2007, 99-108.

Reynolds, C.W. 1987. Flocks, herds and schools: A distributed behavior model. ACM SIGGRAPH 1987, 25-34.

Wasserman, S. and Faust, K. 1994. Social network analysis. Cambridge University Press.

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[1] DBLP: http://www.informatik.uni-trier.de/~ley/db/

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