DYNAMIC MILITARY CIVILIAN CROWD SIMULATIONS THROUGH ALLEGIANCE GROUPING

David J. Kaup* (Mathematics and IST), Linda Malone and Susan Lanham (Industrial Engineering), Rex R. Oleson II, Mohammad Sepehrifar, Ping Chen, and Galen T. Kaup (Mathematics)
University of Central Florida
Orlando, Florida 32816-1364

Thomas Clarke
Institute for Simulation and Training (IST)
Orlando, FL 32826

ABSTRACT

Most of the techniques that have been developed for modeling crowds of individuals are based around interactions with the surrounding environment. The purpose of this study is to develop a means for modeling a grouping dynamic for individuals without being dependent on exterior influences from the environment. The goal of this study is to show potential application for military combat simulations.

1. INTRODUCTION

The military operates simulations of various scenarios in a number of different settings for the purpose of preparing themselves and training soldiers for these possible encounters. One group of scenarios for which there is a current military need involves civilian areas. A Semi-Automated Forces (SAF) system is usually used for these simulations (Clarke, 1995). These systems were designed specifically for military force modeling and have some limited features for modeling individuals, but are quite limited when attempting to model crowds.

Dynamic grouping models are not new. There have been various studies conducted in the past. For example, Heïgeas, Luciani, Thollot, and Castagné (2003) modeled crowds based on a particle system and focused on determining the emergent crowd phenomena. The study indicated that groups and flows form spontaneously as part of a self-organization. In addition, Vicsek, Helbing, and Farkas (2000) studied grouping of individuals through an attraction based on individuals being in the same family and on their likelihood of assisting another individual. Another example is the research by McPhail and Wohlstein (1983) that points toward the phenomena that as individuals group together, they then become more likely to act as a single unit. Even though these individuals do make their own individual choices, the individuals surrounding them were found to heavily influence their decisions.

The focus of this research is to develop a model for grouping dynamics in civilian crowds. The driving force behind this research is the current lack of models for real-time simulation of crowds, wherein agents are influenced by their own considerations by other agents' considerations. Current models cannot be easily integrated into a SAF simulation. Our primary goal is to define a model that can be used in cooperation with SAF style systems.

2. SIMULATION

An initial model has been developed which pulls together aspects of some of the previously discussed models, along with allowing it to be implemented in a real-time simulation. In this model, the attraction and repulsive forces acting on the agents are based on i) their individual allegiance to either an enemy or the allied force and ii) the allegiances of other agents in the vicinity of that agent. Initially, each agent has an individual allegiance. As the simulation proceeds, an agent (for example, agent A) is associated with, by location, a group of agents whose average allegiance is not too different from agent A's initial (chronic) allegiance (see Figure 1). Agent A's allegiance will be swayed closer toward the average of those nearby and will tend to move in a direction to become spatially associated with them. However, if agent A's allegiance is sufficiently different from the allegiances of other agents nearby, agent A will be repelled away from those agents, and will seek to move elsewhere (see Figure 2).

3. METHOD

Using SWARM, preliminary data are presented of simulation runs of the model. The simulations were run with the agents placed in an open field with no obstacle, and periodic boundaries on the field. The model contains parameters that i) define which regions in the "allegiance space" are attractive and which ones are repulsive and ii)

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
00 DEC 2004	**N/A**	-

4. TITLE AND SUBTITLE
Dynamic Military Civilian Crowd Simulations Through Allegiance Grouping

5a. CONTRACT NUMBER
5b. GRANT NUMBER
5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

5d. PROJECT NUMBER
5e. TASK NUMBER
5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Engineer Research and Orlando, Florida 32816-1364; Institute for Simulation and Training (IST) Orlando, FL 32826

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release, distribution unlimited

13. SUPPLEMENTARY NOTES
See also ADM001736, Proceedings for the Army Science Conference (24th) Held on 29 November - 2 December 2005 in Orlando, Florida. , The original document contains color images.

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**UU**	**2**	

the strength and direction of the associated attractive/repulsive forces. Changing the values of the parameters in the model varies the outcome of the simulation. This provides the means for attaching certain crowd behavior to a certain combination of parameters. Sizes and orderings of groups that arise to these parameters will be correlated.

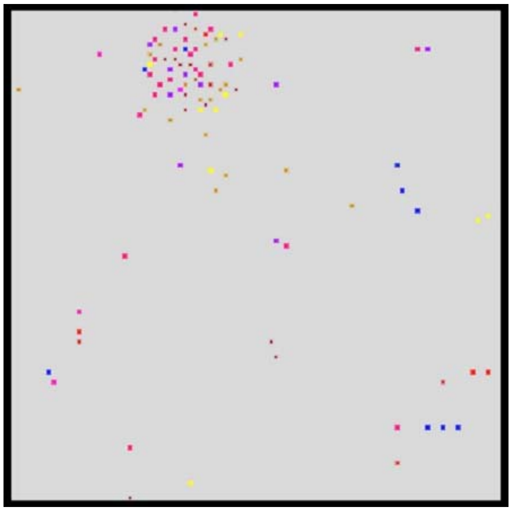

Figure 1. Simulation of one group.

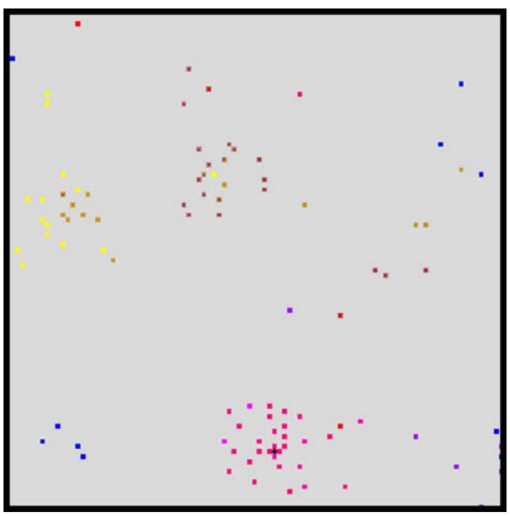

Figure 2. Simulation of three groups.

4. CONCLUSION

This model demonstrated that a natural grouping could occur during a simulation, based on the allegiance (or other traits) of individual agents. Most groups were noted to be firmly established within the first 700 time steps. This was not only a sufficient time for groupings to be formed, but also a sufficient time for the groupings to grow further by attracting other individuals passing by.

REFERENCES

Clarke, T.L. (1995). *Distributed Interactive Simulation Systems for Simulation and Training in the Aerospace Environment*. SPIE Press, SPIE.

Heïgeas, L., Luciani, L., Thollot, J., & Castagné, N. (2003). A physically-based particle model of emergent crowd behaviors. *GraphiCon*.

McPhail, C. & Wohlstein, R. T. (1983). Individual and collective behaviors within gatherings, demonstrations, and riots. *Annual Review of Sociology*, *9*, 579-600.

Vicsek, T., Helbing, D., & Farkas, I. (2000). Simulatind dynamical features of escape panic. *Nature*, *407*, 487-490.