# INCORPORATING "BIG FIVE" PERSONALITY FACTORS INTO CROWD SIMULATION

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## ABSTRACT

The simulation and modeling of crowd behavior has become an active research area in recent years. This area of research has been applied to a wide variety of domains such as military, education, training, entertainment and human factors analysis.  Most crowd simulations do not consider the effects of cultural or personality diversity within the crowd.  We incorporate these effects by modifying the social force terms within the Helbing-Molnar-Farjas-Vicsek (HMFV) crowd model implemented within the MASON (Multi-Agent Simulation of Neighborhoods) environment.  The modification are based on the "Big Five" personality factors (neuroticism, extroversion, openness, agreeableness and conscientiousness) which have been found to be applicable across cultures.

In addition to detailing the modifications, this paper reports on comparison of the Big Five modifications of the HMFV model to videos of crowds.  An expert panel of behavioral scientists found the modified HMFV simulations to be realistic models.  In addition a preliminary version of a technique used based on optical flow analysis of the videos showed good correlation.

Keywords: Crowd Simulation, HMFV, Big Five, Optical Flow, Personality interaction

## 1.  BACKGROUND

Recently, a considerable amount of research has been performed on simulating the collective behavior of pedestrians in the street or of people finding their way inside a building or a room. A comprehensive review of the state of the art can be found in Batty et al (2002). In all these simulation studies, one area that has been lacking is accounting for the effects of human personalities and cultural characteristics on the outcome.

Existing crowd models such as Helbing-Molnár-Farkas-Vicsek (HMFV) [Helbing et al 2002] do not take individual personality and cultural factors into account in attempting to model and simulate human crowds, Nevertheless, it is recognized that personality, in addition to other factors, is a significant determinant of individual behavior [Helbing and Molnar, 1995].

## 2.  ADDITION OF PERSONALITY AND CULTURAL EFFECTS

The most popular approach among psychologists for studying personality traits is the Big Five factors or dimensions of personality [Soldz et al 1999 and Saucier et al 1998]. The five factors are neuroticism, extroversion, openness, agreeableness and conscientiousness.

A quantitative model has been developed based on the Big Five [Jaganathan, 2007].  An individual's personality composition is represented as a column vector. In addition, a personality interaction matrix (MPF) is also implemented which defines the interaction parameter between different types of personalities. The interaction between two individuals, Ind1 and Ind2 with their personality combinations, is modeled as a quadratic form:

$$interaction=[Ind1.vpers]^{transpose} [MPF]\{Ind2.vpers]$$

Where MPF is a 5 by 5 matrix describing the interaction between different personality factors.

To implement the simulation, the MASON multi-agent simulation toolkit was used. This framework is available for developers from the George Mason University (cs.gmu.edu/~eclab/projects/mason/).  The interpersonal social forces used in the HMFV model were modified with a personality dependent multiplier as outlined above.

## 3.  COMPARISON WITH CROWD OBSERVATIONS

A face validity measure was used as reported in Jaganathan [2007]. Face validity  is concerned with how a measure or procedure appears generally to a group of subject matter experts. In this research the establishing of face validity, provided a reasonable way to gain confidence in the research methods and the tools that were developed as part of this research.

The expert panel consisted of three Ph.D. behavioral scientists all of whom have significant experience in research relating to behavior and personality. The research experience of the three panelists ranges between 10 and 40 years. The panelists were interviewed individually, but the analysis below is a combined summery of the points that they made. The panelists commented on the videos and simulations as they were shown and then made some additional observations. They remarked favorably on how the personality modified HMFV model could capture aspects of the crowds leaving the church.

The optical flow analysis of the crowd videos similar to that reported in Clarke et al [2007] also agreed with the results of the simulation confirming both the validity of the Big Five HMFV model and the observations of the expert panel.

## 4. CONCLUSION

By adding personality factors to the base simulation we have developed a significant modification to the HMFV model. This incorporation of Big Five personality factors into the base HMFV model has helped make the individuals in the crowd behave more realistically. Grouping and sub grouping of individuals within the crowds demonstrate that there are some social skills exhibited by the individuals in the crowd. For example, the simulation depicting a crowd exiting a church, was considered to be a highly social situation in which individuals would show high levels of the personality factor of extroversion.

Ongoing research aims at considering individual differences in age, gender, culture and ethnicity to increase the value of crowd simulation both in operational and training contexts. The explicit incorporation of gender, ethnicity, age, and cultural differences as factors in the model will ensure broad applicability of the research to crowd control in nations other than the U.S. Cultural differences have a significant effect on personal space and thus the interpersonal forces.

## REFERENCES

Batty, M., J. DeSyllas, and E. Duxbury. 2002. The discrete dynamics of small-scale spatial events: Agent-based models of mobility in carnivals and street parades, http://www.casa.ucl.ac.uk/workingpapers/Paper56.pdf.

Clarke, Thomas L. , D. J. Kaup, Linda Malone, Rex Oleson, Mario Rosa, 2007, Crowd Model Verification Using Video Data, EMSS 2007.

Helbing, D., I. J. Farkas, P. Molnar, and T. Vicsek. 2002. Simulation of pedestrian crowds in normal and evacuation situations, in *Pedestrian and Evacuation Dynamics*, edited by M. Schreckenberg and S. Deo Sarma, pp. 21-58, Springer-Verlag, Berlin.

Helbing, D. and P. Molnar,. 1995. Social force model for pedestrian dynamics, Phys.Rev. E, 1995, 51, pp. 4282-4287.

Intel. 2001. Open Source Computer Vision Library: Reference Manual. Intel, Santa Clara, CA.

Jaganathan , Sivakumar, 2007, On the Incorporation of the Personality Factors Into Crowd Simulation, UCF Phd Dissertation.

Kaup, D. J., J. E. Fauth, L.J. Walters, L. Malone, T. Clarke. 2006. Simulations as a mathematical tool, SIAM Conference on the Life Sciences, Raleigh, NC, Aug. 3, 2006.

Saucier, G., & Goldberg, L. R. (1998): What is beyond the Big Five? Journal of Personality, 66, 495-524.

Soldz, S., & Vaillant, G. E. (1999): The Big Five personality traits and the life course: A 45-year longitudinal study. Journal of Research in Personality, 33, 208-232.

## BIOGRAPHIES

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