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The last Author is John Riedener.

14. ABSTRACT
This poster describes the Army-funded exploratory work in progress at the Target Behavioral Response Laboratory. Crowd behavior data collected under controlled laboratory conditions form the basis for mathematical models of human behavior, which are then coded into computational models of crowd human behavior. Verification and validation can then proceed with comparisons between outputs from simulations and behavioral data. The results of these preliminary efforts will initiate further work in the methods of incorporating human behavioral data into models and procedures for their validation.

15. SUBJECT TERMS
data, human behavior, model building, verification, validation, crowd simulation, non-lethal weapons, Lewin, Field Theory, Target Behavioral Response Laboratory

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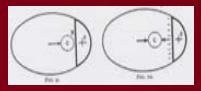
Mathematical Capture of Human Crowd Behavioral Data for Computational Model Building, Verification, and Validation

E. Mezzacappa, G. Cooke, G. Reid, R. DeMarco, C. Sheridan, & J. Riedener *Army's Target Behavioral Response Laboratory*

Goal: To develop M&S processes for predicting crowd response to non-lethal weapons via a symbiosis between laboratory and computer

Conceptual Model

Lewinian Field Theory "Behavior results from field of psychological forces"



Control teams with non-lethal weapons in crowd scenarios form regions of negative valence blocking regions of positive valence. Control teams control crowd locomotion toward goals.

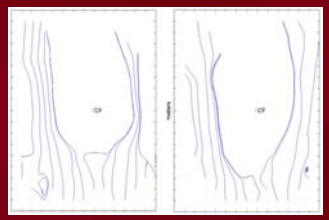
How crowd members move in response to non-lethal weapons use is an index of the psychological forces induced by the weapon.

Mathematical Model

Use motion capture to record location and locomotions of crowd members in response to non-lethal weapons.

Time	Subject	x	y	Distance to Goal	Distance to Control Force	Distance to Next Crowd Member	Stand-off Range of Weapon	Rules of Engagement	Rewards	Penalties	Martyr/ Instigator	Sociometrics
t_0	001											
t_1	001											
t_2	001											
t_3	001											
t_4	001											
t_5	001											
t_6	001											
t_7	001											

Derive vector regression equations predicting location/velocity at a given time point from e.g., previous time point, distance from goal/control team/weapon, etc.



Calculate HUMAN aggregate crowd level metrics of leading edge, centroid, dispersion, vector fields, streamlines.

Computational Model

Use vector regression equations as computational models to calculate location and locomotions of virtual crowd members in response to non-lethal weapons.

$$\vec{B} = f(p,e) \qquad \vec{B} = \vec{G_1} + \vec{G_2} + \cdots + \vec{G_n}$$

$$\vec{B} = \vec{G_1} + \vec{G_2} = \vec{G_{Target}} + \vec{G_{Weapon}}$$

$$\vec{G_{Target}} = \begin{bmatrix}\Delta X \\ \Delta Y\end{bmatrix} = [\alpha]\begin{bmatrix}p \\ e\end{bmatrix} = [\alpha]\begin{bmatrix}x_i \\ y_i \\ x_G \\ y_G \\ \vdots \\ M\end{bmatrix} \qquad \vec{G_{Weapon}} = \begin{bmatrix}\Delta X \\ \Delta Y\end{bmatrix} = [\beta]\begin{bmatrix}p \\ e\end{bmatrix} = [\beta]\begin{bmatrix}x_i \\ y_i \\ x_G \\ y_G \\ \vdots \\ M\end{bmatrix}$$

Run the simulation.

Inputs:

1) *model building* parameters
2) *novel* parameters for which human data are available

Outputs:

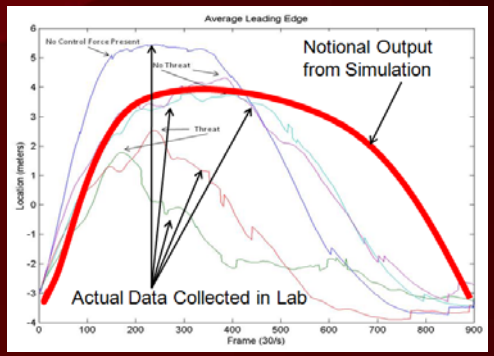
location and locomotion data on virtual agents

Calculate VIRTUAL aggregate crowd level metrics of leading edge, centroid, dispersion, vector fields, streamlines.

Verification and Validation

Verification: Comparisons of HUMAN crowd aggregate metrics with VIRTUAL aggregate metrics derived from simulation outputs from runs with *model building* parameters

Validation: Comparisons of HUMAN crowd aggregate metrics with VIRTUAL aggregate metrics derived from simulation outputs from runs with *novel* parameters



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