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14. ABSTRACT
ARDEC's Target Behavioral Response Laboratory (TBRL) has designed, built, and tested indoor and outdoor crowd behavior test bed (CBT), outfitted with motion capture technology to record locomotor behavior toward and away from goal regions. Aggregate measures of crowd level behavior are derived from the recorded location data of individual participants. This poster presents the methods involved in using motion capture data to derive crowd level locomotor behavior and its implications on psychological forces affecting behavior.

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MOTION CAPTURE METHODS IN ASSESSING LOCOMOTIONS TOWARD AND AWAY FROM GOAL REGIONS

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Target Behavioral Response Laboratory

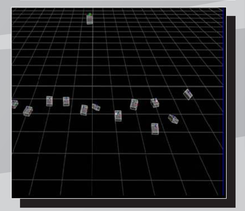
Abstract

ARDEC's Target Behavioral Response Laboratory (TBRL) has designed, built, and tested indoor and outdoor crowd behavior test bed (CBT), outfitted with motion capture technology to record locomotor behavior toward and away from goal regions. Aggregate measures of crowd level behavior are derived from the recorded location data of individual participants. This poster presents the methods involved in using motion capture data to derive crowd level locomotor behavior and its implications on psychological forces affecting behavior.

Background

The relation of locomotor behavior to psychological forces assumes that both share the same conceptual dimension. This is true for TBRL's crowd research where we theorize that both locomotion and psychological forces relate to strength of drive or motivation and not need. This theory is grounded in Lewinian field theory that relates behavior as the attractions and repulsions toward and away from goals.

For this reason the TBRL has configured two testbeds to collect data on human volunteers as they are engaged in experiments designed to encourage motivated approaches toward and returns from goal locations. There are few tools that one can use to accurately capture to movement of individuals. One widely used technology that is used in the re-creation of real life events, for video games, film, engineering, or research is Motion capture (MOCAP). For crowd behavior research, MOCAP allows a mathematical capture of behavior that may not be otherwise captured.



Methods & Technology

The TBRL has developed an indoor and outdoor Crowd Behavior Testbeds (CBT) that use optical and radio signals MOCAP technology to measure crowd behavior for small and large crowds respectively. The indoor CBT utilizes the Vicon™ 8i, MOCAP system with 24 infrared (IR) cameras to detect light reflected off the surface of 6 mm round Vicon™ retro-reflective markers . This system calculates the position of each marker with 6 degrees of freedom (DOF) to an accuracy of 10 mm. Participants in crowd experiments are outfitted with helmets that have a unique marker-pattern and can be tracked as it moves through a 120 m^2 arena. From this data the software, Vicon IQ™, computes the location and orientation of the helmets, yielding data that can be processed to assess crowd level metrics.

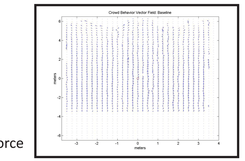
The TBRL outdoor CBT uses ten Ubisense™ Real Time Location System (RTLS) sensors, that function via Ultra-Wide Band radio signals and records movement with 3 DOF. Small active tags worn by individuals transmit signals radially which, if detected by nearby sensors, will be analyzed by Ubisense™ software through its Angle of Arrival (AoA) and Time Difference of Arrival (TDoA) to compute a position in space. The data produced is also processed to assess crowd level metrics.

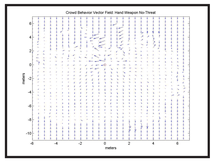
Metrics to Assess Locomotion

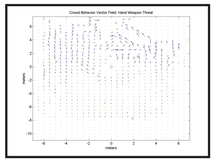
The location data collected during experiments serve as inputs to mathematical algorithms that determine averages for the metrics and produces outputs that characterizes the crowd. The TBRL uses individual and crowd level metrics to assess locomotion towards and away from goal regions. Individual Metrics are analyzed using vector fields calculated by parsing individuals' locations into cells throughout the testbed and computing resultant vectors for each cell from all the data the cell. Crowd level metrics are analyzed using average Leading and Trialing edge, Centroid, dispersion, and distance to control force. These metrics can be used to assess performance of non-lethal weapons on individuals and crowds.

Individual Metrics

- Distance covered in interval
- Instantaneous Velocity
- Interpersonal Distance between any pair of subjects
- Distance between control force-subject pairs
- Interpersonal Distance between any pair of control force







Crowd Metrics

- Geometric Center- *middle of extrema*
- Centroid- *mean of subject positions*
- Dispersion- *mean subject radii from centroid*
- Leading/Trailing Edge- *max/min along the approach axis*
- Density- *minimum distance between any subject-control force pair*
- Deviation of Orientation/Velocity- *StDev of all subjects' head orientation or velocity*
- Bulk Velocity of Crowd- *rate of change of centroid*