Crowd Behavior Modeling in COMBAT XXI

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Agenda

- Motivation
- Crowd modeling
- Digital pheromone systems
- COMBAT XXI
- Project description
- Questions

Motivation

- Context important for military operations.
  - Physical constraints.
    - Terrain, weather, time of day, visibility, etc.
  - Social functionality constraints.
    - Cultural artifacts (religious buildings, hospitals, schools, etc.
  - Indigenous Population
    - The people themselves.
    - Customs, social rules, etc.

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Our goal is to address some aspects of this problem.

Crowd Modeling

- Representation requirements:
  - Large numbers of people – ideally should be much larger than the force being represented.
  - Dynamic behaviors – no scripting.
  - “Realistic” movement and aggregation.
  - Reactive – behaviors can change based on what force agent do.
  - Coordinated behaviors
    - Communication.
    - Memory.
- Usage requirements:
  - Computationally efficient
  - Easy to set up

Digital Pheromone Models

- Derived from natural systems of self organization.
- Based on mechanism used in insect colonies to coordinate activity.
- Pheromone based models used in many areas:
  - Manufacturing process modeling.
  - Cell phone network optimization.
  - Autonomous vehicle modeling.

A Digital Pheromone System (DPS)

- Pheromone (scent)
  - Flavor
  - Dispersion
  - Evaporation
- Can be deposited and sensed by agents.
- Deposited at locations in environment based on local conditions and entity state.
- Pheromone provides a way for entities to communicate and also to keep a collective memory.
- Only need very simple agents
  - Sense
  - Deposit
  - Simple state transition based on pheromone strength
- Simple Cellular Automata based model for the pheromone infrastructure.

COMBAT XXI Background

- Target simulation is COMBAT XXI
  - Closed form analytical model
  - Stochastic
  - Agent based model
  - Developed/used Army and Marine Corps
    - TRADOC Analysis Center
    - Marine Corps Combat Development Command
  - Brigade and below studies
    - Scenario sizes ranges ~50 – 10,000+ entities
    - Typical sizes – low 100s to 1500
  - Effects model
- Several other projects at NPS involve COMBAT XXI

Past Pheromone Work

- Demonstration of Pheromone based reactive behaviors.
  - TRAC-MTRY/ALTARUM
  - Demonstrated feasibility of DP approach.
  - Loosely coupled to model.

Objective of Current Work

- Build a Pheromone Layer into COMBAT XXI
  - Tightly connected to native environment
- Add behavior hooks to the Pheromone Layer
  - Allow agents in the model to access the PL as part of the general behavior mechanism
- Demonstrate pheromone based “ambient” behavior.
  - e.g. having entities move from home to a “market”, spend time there and then return home.

Status

- Basic pheromone synthetic environment complete.
  - Connected to COMBAT XXI core code.
  - Standalone component.
- Simple behavior infrastructure developed.
- Sample scenarios created to show basic functionality.

Future Work

- Performance improvements
  - Optimize code to reduce computational load
- Interface enhancements
  - Develop tools to allow for more intuitive control of parameters
  - Better visualization tools
- Behavior refinement
  - Combine ambient and reactive behaviors

Questions ?