Chapter 11

Behavioural Animation



Knowing the environment

Aggregate behavior

Primitive behavior

Intelligent behavior

Crowd management







Knowing the environment

Vision – what do you know about the present

Memory – what is recorded about the environment

More about AI than graphics



Vision

Geometric issue – what's in sight? OR Can I see X?

Computation v. accuracy

Perceptual issue – what do you see?

Cognitive modeling – necessary? At what level?



<u>Omniscience</u>

Everything in database is 'known'







Use surrogate bounding volumes, or sample points



Occluded Vision





Target-testing vision



Object Recognition

Cognitive modeling How much and what part is needed?

Application need? Not yet addressed in literature More AI than graphics





Other senses?

Hearing? Smell?

Model sensors & signal propagation

Spatial occupancy approach?

Applications?



Memory

What is recorded about the environment Spatial occupancy

Transience of objects: time-stamps

hierarchy: short-term, long-term







Aggregate Behavior: E pluribus unum Emergent Behavior

Typical qualities

Туре	Elements	Physics	Intelligence
		Env/Others	
Particles	10 ² -10 ⁴	Much/none	None
Flocking	10 ¹ -10 ³	Some/some	Limited
Crowds	10 ¹ -10 ²	Little/much	Little-much



<u> Primitive Behavior – Flocking</u>

Local control – for realism, the flock member only reacts to locally accessible information

Perception – FOV vision – angle can change with speed

Interacting with other members – stay with friends, avoid bumping into each other

Interacting with the environment – collision avoidance is primary



Primitive Behavior - Flocking Original work by Craig Reynolds

Global control – need control of flock script flock leader global migratory urge

Negotiating the motion

Collision avoidance – steer to avoid

Splitting and rejoining – difficult to tune parameters

Modeling flight – e.g., banking into turns



Negotiating the Motion





Navigating Obstacles



Attempt at parallel movement

Problems with repulsive forces



Attempt to fly directly toward a surface



Attempt at finding a passageway



Navigating using bounding sphere





Navigating Testing for being on a collision path with (bounding) sphere

Given: P, V, C, r





t < r





Department of Computer Science and Engineering

WRIGHT STATE

Navigating – finding a pass



To avoid collision: find closest point on edge to pass object Vision Options:

Render in z-buffer

Sample environments with rays



Modeling Flight -common in flocking





Modeling Flight





Modeling Flight





Modeling Flight





<u>Primitive Behavior – Prey-Predator</u>

unbalanced abilities vision - distance, movement, fov maximum velocity maximum acceleration maximum angular velocity maximum angular acceleration



<u>Prey-Predator - vision</u>





<u>Prey-Predator</u> agility: speed and turning





<u>Prey-Predator - hidden by forces</u>

Using pure forces May not prevent object penetration Prey can be 'hidden' by environmental repulsive forces



Intelligent Behavior

Autonomous behavior 'Self-animated' characters Perception & reasoning about environment Personality, emotions, dispositions

Manifestations of Individuality Body Expressions and Gestures Facial expressions Speech



Internal State

Models what the agent needs to do

Suggested precedence classes of internal state variables Imperatives Desires Suggestions







Expressions and Gestures

ToBI – Tones and Break Indices LMA – Laban Movement Analysis

BEAT EMOTE RUTH Greta



EMOTE

N. Badler at U.Penn

Expressive MOTion Engine (EMOTE)

Speech driven movement and gestures Torso & arms Laban Movement Analysis Effort Shape



BEAT

J. Cassell at M.I.T.

Input text – marked up

Generate non-verbal behavior in sync with speech

Facial expressions, head & body motions gestures





ruth

Doug DeCalro at Rutgers

http://www.cs.rutgers.edu/~village/ruth/





Facial Expression

http://expression.sourceforge.net/





Facial Expression

Ken Perlin: <u>http://mrl.nyu.edu/~perlin/</u>





SmartBody

https://www.youtube.com/watch?v=sD7Q777wIaQ



More videos: https://smartbody.ict.usc.edu/video



Modeling Personality

Personality – long term qualities

Emotions – short term

Mood – third level

Basic emotions: happy, sad, fear, disgust, surprise, anger



Personality Models

Biology/evolutionary approaches brain & anatomy biochemistry & personality genetics & personality **Psychoanalytic approach** psychometrics Freud, Adler, Jung **Adaptation Theory:** traits: passive, aggressive, withdrawn **Need theory: Freud + experiential learning Arousal Theory: absorb & discharge energy**



Type & Trait Theory

Type: individuals slotted into a type e.g. introvert v. extrovert

Trait: lie on gradation combination defines behavior in situation e.g.,

Internal states: how perceptions dictate emotional experience



Trait Theory

OCEAN: openness, conscientiousness, extroversion, agreeableness, neuroticism

PEN: extraversion, neuroticism, psychoticism

OCC: how perceptions dictate emotional experience



Modeling Individuality

Improv AlphaWolf



Dominant personality

11 Behavioural Animation

AlphaWolf: <u>http://alumni.media.mit.edu/~badger/alphaWolf.html</u> Simulation of a pack of wolves and their behavior





<u>Crowd Management</u>

Emergent behavior Statistical behavior v. believable individual behaviors Homogeneous activity v. Internal structure

> For evaluation Pedestrian traffic simulation Traffic flow Emergency response modeling For entertainment Background crowds



Crowds

Emergent behavior: similar to flocking collision avoidance 'intelligent' paths From a distance: statistical behavior nonsensical detailed motion reasonable visual effect **Internal structure** limited interaction among members group formation



Crowd Applications

For evaluation

Building evacuation, e.g. virtual fire drill Architecture evaluation, e.g. signage

For training Military scenarios, e.g. sniper training Emergency response, e.g. disaster response

For entertainment: e.g., background crowds

games films, e.g., Titanic, Saving Private Ryan, Lord of the Rings



Qualities of crowd

Emergent behavior - similar to flocking, flocking system Uniform – sameness of members Quantity & density - average distance between members Viewing distance – aggregate behavior, inspect individuals Function – simple traversal, background activity, main actions

Individual processing – amount of computation per member Physics – simulated reaction to environment Intelligence - reasoning capability - agents



<u>Uniformity, granularity</u>

Background noise: Activity without intention

Statistical behavior: On average, intentional activity

Individuality: Believable activity at level of individual



Execution environment

Real-time v. Off-line computation

simple computations

avoid n-squared algorithms

size limited



Spatial organization

Cellular decomposition: Regular 2D grid Adjacency accessible Density limited Cells define obstructions

Continuous space: Step in any direction Need to decipher obstructions Perception needed







Perception Modeling

Vision

Memory

Knowledge of environment



Navigation

Fluid flow: density fields, potential functions

Particle systems: Individual navigation

Flocking systems: individual perception, navigation

Rule-based

Cognitive modeling

Cellular automata



Panic & Congestion handling

Personal space

Packing people during evacuation

Stairwell traversal

Exit awareness



Motion & Navigation

Path planning

Roadmaps

Passing on pathways

Potential fields

Forming & maintaining subgroups



Structure in crowds

Homogenous – no individuality

Subgroups Group by belief systems

A collection of Individuals – personality modeling



Penn Station





Other topics

Heterogeneous – pedestrians and cars

Data driven crowds – image processing

Comparison to real-world situations



Massive

http://www.massivesoftware.com/ Commercial de facto standard





Examples





Examples





Examples



