Modeling Individualities in Groups and Crowds

Daniel Thalmann, EPFL VRlab
Nadia Magnenat Thalmann, Un.Geneva, MIRALab
Stéphane Donikian, IRISA
Julien Pettré, IRISA

S1: Daniel Thalmann

- Introduction
- Objectives
- State-of-the-Art and Related Work

Virtual Reality Laboratory

S2: Nadia Magnenat Thalmann

Real-Time Individualized Virtual Humans
- Creation of individualized Virtual Humans
- Automatic construction of unlimited number of population models
- Motion retargeting and Virtual Try-On
- Modeling and Animating Faces
- Defining personaliy and autonomy

Virtual Reality Laboratory

S3: Stephane Donikian

Individualized versus collective behaviors
- Introduction to experimental studies made about collective behaviours
- Presentation of the different models (macroscopic, microscopic and multi-layered).
- Discussion about the respective advantages and drawbacks of the preceding models
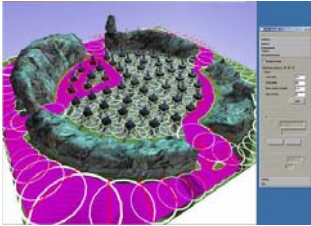
Virtual Reality Laboratory

S4: Julien Pettré

Individualized Path Planning and Navigation
- **Introduction to Navigation Planning and Control: path planning, steering methods, handling crowds.**
- **Exploring limits, from passive to interactive crowds: sources of complexity, bottlenecks, need for variety.**
- **In Practice: dedicated path planners and simulators, hybrid approaches, levels-of-detail.**

Virtual Reality Laboratory

S5: Daniel Thalmann

The impact of individualized crowds on rendering
- **Fidelities: dynamic meshes, static meshes, impostors**
- **Colors and textures**
- **Animation models for each fidelity: walking**
- **Accessories handling**

Conclusions and Further Discussion (all speakers)

Virtual Reality Laboratory

VRlab

Virtual Reality Laboratory

What is a crowd ?

"A large group of individuals in the same physical environment sharing a common goal and may act in a different way than when they are alone"

What is a virtual crowd ?

"A large group of individuals in the same virtual environment sharing a common goal and may act in a different way than when they are alone"

The main problem: many many people

They should not look all the same

They should not behave all the same

State-of-the-Art

State-of-the-Art

• **Flocking systems (Boids) (Reynolds, 1987)**

• **Procedural animation of flocks (Girard, 90) Film Eurythmy**

Maintain proper position and orientation:

~Avoid collisions
~Match velocities of neighbours
~Move towards the centre of flock

Virtual Reality Laboratory

Hodgins et al. used a grouping algorithm extended from [Reynolds, 1987] to make bicyclists move as a group while avoiding obstacles [Hodgins et al., 1995].

Virtual Reality Laboratory

Crowd Evacuation Simulators
Model movement of large number of people in usually closed, well-defined spaces like:

· inner areas of buildings (Simulex, Thompson & Marchant 95),
· subways (Hareesh et al. 2000),
· ships (Klüpfel et al. 2000)
· airplanes (Owen et al. 98).

Virtual Reality Laboratory

LEGION

· Early prototype of Legion™ developed by Still (2000) for simulation/analysis of crowd dynamics (stadiums).
· Each individual scans local environment and chooses action to minimise effort.

Virtual Reality Laboratory

Crowd Management Training Systems

· CACTUS (Williams 1995)
· to assist in planning and training for public order incidents.

· Small Unit Leader Non-Lethal Training System (Varner 98)

· simulator for training US Marines
· crowd profiles –fanaticism, arousal state, prior experience with non-lethal munitions

Virtual Reality Laboratory

State-of-the-Art: 3D systems

Exodus

• Bouvier (1996-97)
• avoid obstacles using attraction and repulsion forces analogous to physical electric forces.
• Higher level behavior modeled by transition networks

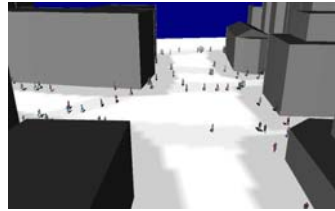Virtual Reality Laboratory

State-of-the-Art: Crowd rendering

• Tecchia and Chrysantou (2001)
• Medieval Total War
• Fast rendering (billboards)
• - Lot of pre-processing
• - Static animations

Dobbyn et al. combined rigid meshes with impostors to render large crowds and keep high appearance quality close to camera [Dobbyn et al., 2005].

Virtual Reality Laboratory

Wand and Straßer (2002), use hierarchy of points and triangles.

Example of simulation obtained by [Loscos et al., 2003] based on 2D map and probabilistic rules.
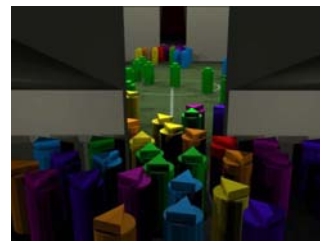
Lamarche and Donikian 2004: Indoor and outdoor navigation

Cromos Lab (Soraia Raupp Musse)

Continum Crowds (Popovic et al. SIGGRAPH 2006) (Force field approach)

van den Berg et al., 2008 simulate agents in crowded environments Each agent senses environment independently and computes collision-free path based on extended Velocity Obstacles and smoothness constraints

State-of-the-Art: Movies

Lord of the Rings

The Chronicles of Narnia: Prince Caspian
FRAMESTORE CFC

NARNIA

A battle simulated with MassiveTM in the movie: "The Chronicles of Narnia: PrinceCaspian"
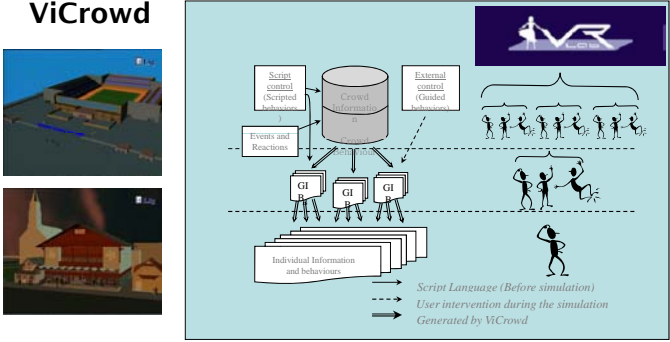

Games: Act Of War

Emeutes à Londres… une bonne partie des missions proposées dans Act of War se jouent en milieu urbain. Stress garanti !

ViCrowd

Script control (Scripted behaviors)

Crowd Information Control

External control (Guided behaviors)

Events and Reactions

GI   GI   GI

Individual Information and behaviours

Script Language (Before simulation)
User intervention during the simulation
Generated by ViCrowd

S. Raupp Musse, D.Thalmann, Hierarchical Model for Real Time Simulation of Virtual Human Crowds, IEEE Transactions on Visualization and Computer Graphics, 2001, Vol.7, No2, pp.152-164.

Hierarchical State Machines
PhD Branislav Ulicny, 2003

- **Goal:**
  - **Every agent has its own behavior.**
- **Agent Management**
  - **Chained Hierarchical State Machine**
  - **State Machine Transitions described within Lua Metatables**
  - **Agent's tasks are prioritized in order to avoid unnecessary checks. (E.g. updating every state at each frame)**
- **Scenario Authoring**
  - **Designers can create their own behaviors using scripting interfaces**

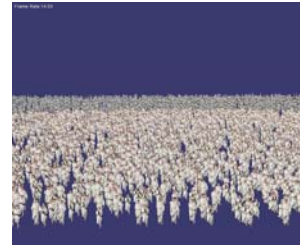**MSc Miguel Garcia Arribas, 2004**
Agent-based Case: Riot in the city

Virtual Reality Laboratory

Use of GPU
PhD Pablo de Heras, 2005

Navigation graphs for crowds
Postdoc Julien Pettré, 2006

Virtual Reality Laboratory

PhDs: Jonathan Maïm, Barbara Yersin 2009

· Large crowds
· Hybrid Navigation Graphs –Potential Fields
· Accessories
· Patches

Virtual Reality Laboratory