Towards Virtual Life in 3D Cities

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Our contributions since more than 10 years


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YaQ Architecture Overview

3 Components:

• Variety
• Navigation
• Real-Time

**Complex Accessories** (shopping bags, balloons, mugs)

- **Offline:**
  - For each complex accessory:
    - Which joint to constrain
    - How to constrain
      - Clamping \([\text{minAngle}, \text{maxAngle}]\)
      - Freezing \([\text{angle}]\)
  
- **At runtime:**
  1. Update animation as usual
  2. Overwrite frozen joints
  3. Use exponential maps to clamp joints

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What is Motion Planning?

Path Planning
Collision Avoidance
Group Cohesion


Navigation Graph

- Vertices = Walkable Space
- Edges = Gates
- Navigation Flow = Set of Paths
- Provides Next Waypoint

Related Work: Continuum Crowds

- Create a Grid
- Group Pedestrians
- Compute Potential
- Provide Next Waypoint

Hybrid architecture

Regions of Interest

• Level 2: No Interest
  – Navigation Graph for Path Planning
  – No Dynamic Collision Avoidance

• Level 1: Low Interest
  – Ruled by Navigation Graph
  – Short - Term Obstacle Avoidance

• Level 0: High Interest
  – Ruled by Potential Fields
  – Long and Short - Term Avoidance

• Observation of interesting emergent behaviors, e.g., lane formations or panic effects, => crowd motion planning more realistic

Group Cohesion

• 4 step process
  1. Init: create groups
     – 2 – 4 pedestrians
     – Different templates
     – First member = leader
  2. Change Security Check
     – No intwp for members
  3. Speed Adaptation
     – Leader forward direction
  4. Waypoint Adaptation
Walking – navigation graph

• Rendered geometry

Walking – navigation graph

• Geometry semantics
**Walking – roman crowd behavior**

<table>
<thead>
<tr>
<th>geometry semantics</th>
<th>behavior</th>
<th>actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>shop</td>
<td>get amphora</td>
<td>walk inside, get out with amphora.</td>
</tr>
<tr>
<td>bakery</td>
<td>get bread</td>
<td>walk inside, get out with bread.</td>
</tr>
<tr>
<td>young</td>
<td>rich</td>
<td>only rich people go there.</td>
</tr>
<tr>
<td>old</td>
<td>poor</td>
<td>only poor people go there.</td>
</tr>
<tr>
<td>door</td>
<td>look at</td>
<td>slow down, look through door.</td>
</tr>
<tr>
<td>window</td>
<td>look at</td>
<td>slow down, look through window.</td>
</tr>
<tr>
<td></td>
<td>stop look at</td>
<td>accelerate, stop looking.</td>
</tr>
</tbody>
</table>

**Walking – shops**
Walking – bakeries

Walking – bakeries/shops result
Walking – look at

Walking – stop look at
Walking – look at results

Crowd Patches

Patches: Static Objects

- No animation
- Constant position
- $\tau(0) = \tau(\pi)$
- Examples:
  - Tree
  - Signal
  - Bench
  - Trash
  - …

Patches: Endogenous Objects

- Animated and/or moving
- Remain inside a patch
- $\tau(0) = \tau(\pi)$
- Examples:
  - Wandering people,
  - Chatting people,
  - Wandering pets,
  - Shopping people,
  - …
Patches: Exogenous Objects

- Animated and moving
- Enter / leave patches
- $\tau(0) = \tau(\pi)$
- Examples: Walking people, Cars, ...

Overview
Real Trajectory Reuse

• **Initial step**: analysing recordings of multiple synchronized video cameras.

• **Second off-line stage**: fit as long as possible trajectory segments within predefined paths made of a succession of region goals.

• Pedestrians detector integrates binary masks from cameras.
• Ground-plane partitioned into grid cells.
• In each frame, detector estimates probability of each grid cell to be occupied by a person
• Tracking algorithm efficiently solves detection association task as global optimization problem
• Finally, post-process trajectories to obtain smooth and accurate trajectories.
Interaction Design

- Natural interface for user
- Device
  - MS Kinect Sensor
- Method
  - Template-based gesture recognition
- Interactions
  - Walk
  - Pick
  - Direct
  - Gather
  - Disperse
  - Lead
  - Stop

Two scenarios

- gathering the agents to a specific orientation.
- making agents disperse after gathering around the avatar
Thank you for your attention.

Questions ?…