Video Textures

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Problem Statement

video clip  video texture

Approach

How do we find good transitions?

Finding Good Transitions

Compute $L_2$ distance $D_{i,j}$ between all frames vs. frame $i$

frame $j$

Similar frames make good transitions

Markov Chain Representation

Similar frames make good transitions
**Transition Costs**

Transition from $i$ to $j$ if successor of $i$ is similar to $j$

Cost function:

$$C_{i \rightarrow j} = D_{i, j} + 1$$

**Transition Probabilities**

Probability for transition $P_{i \rightarrow j}$ inversely related to cost:

$$P_{i \rightarrow j} \propto \exp\left(-\frac{C_{i \rightarrow j}}{\sigma^2}\right)$$

**Preserving Dynamics**

- High $\sigma$
- Low $\sigma$
Preserving Dynamics

Cost for transition \( i \rightarrow j \)

\[
C_{i \rightarrow j} = \sum_{k = -N}^{N-1} w_k D_{i+k+1, j+k}
\]

Deadends

No good transition at the end of sequence

Future Cost

- Propagate future transition costs backward
- Iteratively compute new cost

\[
F_{i \rightarrow j} = C_{i \rightarrow j} + \alpha \min_k F_{j \rightarrow k}
\]
Future Cost

• Propagate future transition costs backward
• Iteratively compute new cost

\[ F_{i\rightarrow j} = C_{i\rightarrow j} + \alpha \min_{k} F_{j\rightarrow k} \]

Future Cost

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• Q-learning
Future Cost – Effect

Finding Good Loops
- Alternative to random transitions
- Precompute a good set of loops up front (using dynamic programming)

Visual Discontinuities
- Problem: Visible “Jumps”

Crossfading
- Solution: Crossfade from one sequence to the other.

\[ \ldots \quad A_{i-2} \quad A_{i-1} \quad A_i \quad \frac{2}{4} \quad B_{i-2} \quad B_{i-1} \quad B_i \quad \frac{3}{4} \quad A_{i+1} \quad B_{i+1} \quad \ldots \]

\[ \ldots \quad A_{i-2} \quad A_{i-1} \quad A_i \quad \frac{2}{4} \quad B_{i-2} \quad B_{i-1} \quad B_i \quad \frac{3}{4} \quad A_{i+1} \quad B_{i+1} \quad \ldots \]
Morphing

• Interpolation task:
  \[
  \frac{2}{5} \text{A} + \frac{2}{5} \text{B} + \frac{1}{5} \text{C}
  \]

• Compute correspondence between pixels of all frames

• Interpolate pixel position and color in morphed frame

• based on [Shum 2000]

Results – Crossfading / Morphing
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Jump Cut  Crossfade  Morph

Crossfading

Frequent Jump & Crossfading

Video Portrait

Useful for web pages
Combine with IBR techniques

Region-based Analysis
- Divide video up into regions
- Generate a video texture for each region

Automatic Region Analysis

User-controlled Video Textures
slow  variable  fast
User selects target frame range
**Time Warping**

- Shorter
- Original
- Longer

Lengthen / shorten video without affecting speed

**Summary**

- Video clips → video textures
  - define Markov process
  - preserve dynamics
  - avoid dead-ends
  - disguise visual discontinuities

**Summary**

- Extensions
  - regions
  - external constraints
  - video-based animation

**Discussion**

- Some things are relatively easy
Discussion

• Some are hard