

Video Effects

CS5245 Vision & Graphics for Special Effects

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Video Effects

Two kinds of video effects:

- Video Texture
- Controlled Animation of Video Sprites

Video Texture

Video Texture

- A term coined by the authors [2].
- A continuous infinitely varying stream of images.
- Can be created from a finite video stream.

Main Idea:

- Find similar pairs of frames.
- When playing the video, can jump from one of the pairs to the other one.

Main Stages:

- 1 Analyze video: look for similar pairs of frames.
- 2 Generate sequence: sequence the video frames.
- 3 Render sequence: render the final video.

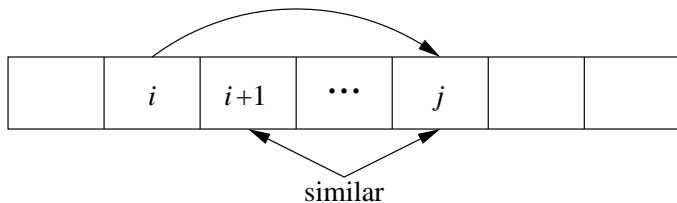
Video Analysis

- Equalize brightness of frames.
- Stabilize video, if necessary.
- Compute difference between any two frames I_i and I_j :

$$D_{ij} = \|I_i - I_j\|. \quad (1)$$

Can use, e.g., L_2 distance, i.e., Euclidean distance.

- Create a transition from frame i to frame j if the successor of i is similar to j , i.e., when $D_{i+1,j}$ is small.



- A simple way is to map distances to probabilities:

$$P_{ij} \propto \exp(-D_{i+1,j}/\sigma) \quad (2)$$

and normalized probabilities so that

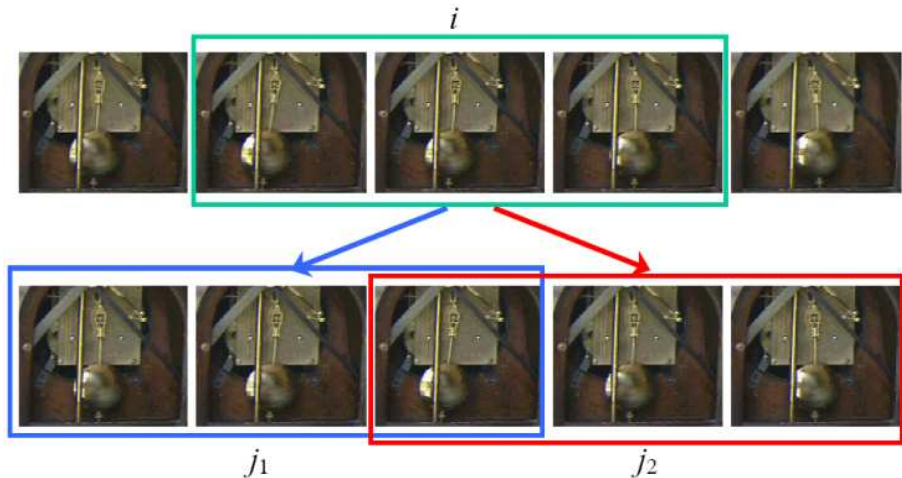
$$\sum_j P_{ij} = 1 \quad (3)$$

Transit if probability is high.

- Use small σ to get good transition.

Preserving Dynamics

Need to preserve the dynamics of the sequence also.



- In the pendulum sequence, each frame in left-to-right swing has a similar frame in the right-to-left swing.
- Transition from a frame to another similar frame in a different swing direction will create abrupt and unnatural change in pendulum's motion.

To preserve dynamics:

- Make sure the corresponding frames and their temporally adjacent frames are similar.
- That is, match subsequences instead of individual frames.
- This is achieved by computing weighted average subsequence distance:

$$D'_{ij} = \sum_{k=-m}^{m-1} w_k D_{i+k, j+k} . \quad (4)$$

$m = 1$ or 2 .

- Compute new P'_{ij} as in the previous case.

Other details to take care of (see [2] for details):

- Avoiding dead ends: plan ahead.
- Pruning transition: select only local maxima in transition matrix P'_{ij} .

Sequence Generation

Two possible types of sequences:

- random play
- video loop

Random Play

- Start at any point before the last non-zero-probability transition.
- Repeat indefinitely:
After playing frame i , select next frame j according to P_{ij} .

Notes:

- Next frames are selected probabilistically.
- High probability transitions are selected more often.
- Low probability transitions can still be selected.
- The sequence never repeats itself exactly because of probabilistic selection.

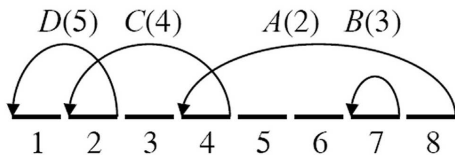
Video Loop

A short video that can be played repeatedly (loop-play) without apparent abrupt transition.

Main Ideas:

- Consider a transition $i \rightarrow j$.
- For $i \rightarrow j$ to form a cycle, need $i > j$. This is a **primitive loop**.
- Range of loop is $[j, i]$, cost of loop D'_{ij} .
- Can combine primitive loops into **compound loops**.

Example compound loops obtained from dynamic programming:



length	$A(2)$	$B(3)$	$C(4)$	$D(5)$
1		$B(3)$		
2		$B^2(6)$		$D(5)$
3		$B^3(9)$	$C(4)$	
4		$B^4(12)$		$D^2(10)$
5	$A(2)$	$B^5(15)$	$CD(9)$	$CD(9)$
6	$AB(5)$	$AB(5)$	$C^2(8)$	$D^3(15)$
		\vdots		

- Length = number of transitions in the loop.
- Number in brackets are costs.
- This method is used to find the list of primitive loops in the lowest-cost compound loop of a given length.

Next, schedule primitive loops found in lowest-cost compound loop.

Use $\{A, B, C, D\}$ as example:

- 1 Schedule the transition $i \rightarrow j$ at the end of the sequence as the first transition, i.e., A .
- 2 Remove scheduled transition A .
- 3 Now the primitive loops are divided into two continuous-range sets $\{C, D\}$ and $\{B\}$. Frame j of transition A is in the set $\{C, D\}$. Now, schedule next transition in set $\{C, D\}$ after frame j of transition A , i.e., C .
- 4 Repeat steps 2 and 3 until all primitive loops in the set are scheduled, i.e., D .
- 5 Repeat from step 2 to schedule primitive loops in other disjoint sets, i.e., B .

The loops are scheduled in this order A, C, D, B .

Finally, render the sequence to obtain a video loop.

Controlled Animation of Video Sprites

Video Sprites [1]

- Animations created by rearranging recorded video frames of a moving object.
- Uses same idea as for video texture, i.e., find similar pairs of frames that form good transitions.

Main Stages:

- 1 Capture natural animal motion with green screen.
- 2 Extract sprites using chroma keying.
- 3 Find good transitions by comparing all pairs of frames.
- 4 Find sequence of frames that show desired animation.
- 5 Render sequence.

Capture and Extract Sprites



Data capture



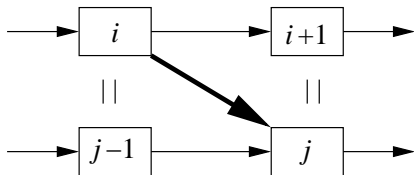
Extract sprites
using chromakeying

- After extracting sprites, also perform perspective correction so all sprites fall on same depth plane.
- This is to reduce size variation due to perspective projection.

Finding Good Transition

A transition from frame i to j is a good transition if

- frame i is similar to frame $j - 1$, and
- frame $i + 1$ is similar to frame j .



Cost of transition is

$$C_{ij} = D_{i,j-1} + D_{i+1,j}. \quad (5)$$

Train a classifier to find good transition pairs.

Sequencing Video Sprites

Let $S = \{s_1, s_2, \dots, s_n\}$ denote the new sequence.

The cost of visual smoothness of transition $C_S(S)$ is

$$C_S(S) = \sum_{i=1}^{n-1} C_{s_i, s_{i+1}}. \quad (6)$$

To constrain the motion to desired animation, add another control cost $C_C(S)$.

Then, total cost $C(S)$ is

$$C(S) = C_S(S) + C_C(S). \quad (7)$$



So, the new sequence is obtained by finding the sequence S that minimizes $C(S)$.

For details of optimization algorithm, refer to [1].

Examples



References

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Controlled animation of video sprites.
In *Proc. ACM SIGGRAPH*, pages 121–127, 2002.
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Video textures.
In *Proc. ACM SIGGRAPH*, 2000.