Video Textures Exploiting Symmetric Movements

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Abstract
In this paper, an extension to the traditional method for creating video textures is presented. By exploiting the symmetric properties of the frames in a given video sequence, a new endless video stream or video loop is generated by reversing video playback when appropriate. We aim at a larger set of possible input video’s for video texture creation, including captured motions containing no smooth transitions (e.g. turbulent plant movements).

To achieve this, good turn points, instead of transitions are extracted from the video data, after which a simple algorithm synthesizes a new video sequence while optimally exploiting the original frame data. Visual artifacts caused by varying lighting conditions are reduced significantly.

Video Analysis

Observation:

In the case of symmetric motions, the movement away from a reference position and the returning movement are (sometimes exact) opposites. Most of the time this holds for several frames in the neighbourhood of the point where the motion turns. This implies that while playing the video sequence, a large number of frames can be reused when an extreme position in the captured motion is reached, allowing a reversed playback of that action.

A: Locating highly symmetric frames

\[ \text{Sym}_i = \frac{1}{n} \sum_{j=1}^{n} \left| \frac{a_i - a_{i+j}}{a_{i+j} - a_{i-j}} \right| \] (L2 norm)

Compare frames located over the same distance before and after the test position \(i\). The L2-norm grades the equivalence of the corresponding frames. The influence of nearby frames is more important than the similarity of more distant frames. Thus, a weighted sum of these distances is used, by means of binomial coefficients.

B: Scaling to (0,1) interval

\[ b_i = \frac{a_i - a_{\text{min}}}{a_{\text{max}} - a_{\text{min}}} \]

C: Reducing the candidates (extracting local maxima)

\[ \text{Sym}_i = \left\{ \begin{array}{ll} \text{Sym}_{\text{max}} & \text{if Sym}_i = \max \left( \text{Sym}_{i-r}, \ldots, \text{Sym}_{i+r} \right) \\ 0 & \text{otherwise} \end{array} \right. \]

Mapped on the unit interval [0..1] the Sym values are more meaningful.

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Video Synthesis

A: Extracting probabilities (red curve)

A frame with a Sym value of 1.0 should have a 50% probability to turn the video playback. The first and last “sufficient” peaks always have a probability equal to 1.0: video playback always reverses at these points.

B: Basic algorithm

1. Start video playback at a random position.
2. Use the precalculated probabilities to decide for each frame if a reverse will be made.

Problem: Most of the times, the same turns are taken. A portion of the available frames remains unused.

C: Extended algorithm (green curve)

1. Start with initial turn probabilities equal to 50% of the maximum allowed probability.
2. Encourage changes in the behaviour of the turn points:
   a. the turn is taken: lower the probability to decrease the chance to turn again at this point.
   b. the turn is not taken: the opposite behaviour is provoked by increasing the corresponding probability.

\[ P_i = \left\{ \begin{array}{ll} \max \left( P_i - \text{inc.} \right) & \text{if turned at frame } i \\ \min \left( P_i + \text{inc.}, P_{\text{max}} \right) & \text{otherwise} \end{array} \right. \]

Overview

This paper describes a method for the creation of video textures, by exploiting the symmetric properties of short sequences of video frames, and can be divided into three steps:

1. locate highly symmetric frames within the video data,
2. derive probabilities from this data, indicating the chance for each frame to reverse video playback,
3. use these probabilities to generate an infinite videostream or video loop from the original data.

Contributions and results

- a larger set of possible input video’s for video texture creation.
- no actual transitions in de video data required (i.e. more suitable for most natural phenomena).
- usable as an extension to the original method (Shödl et al.), allowing a hybrid technique that increases the randomness and improves the realism of the results.
- less visual artifacts caused by varying lighting conditions.
- optimal use of the available frame space.
- very short processing times (a few seconds).

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