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FAST SYNTHESIS OF DYNAMIC COLOUR TEXTURES

The textural appearance of many real-world materials is not static, but changes over time. If such change is spatially and temporally homogeneous, these materials can be represented by means of dynamic textures. Dynamic textures modelling is a challenging problem that can improve the quality of computer graphics applications. During the recent years, a novel hybrid method for dynamic colour textures modelling was developed.

Dynamic textures (DT), or temporal textures, can be defined as spatially repetitive motion patterns exhibiting stationary temporal properties and having indeterminable spatial and temporal contents. The surface of water, fire and straw in the wind are typical DT examples. As a basic representation of DTs, a video sequence has finite duration. This limits the use of DTs in virtual reality systems of any kind, making temporally unconstrained modelling of DT a challenging problem for research areas such as computer vision, pattern recognition and computer graphics. Previous DT modelling approaches were based either on video editing techniques or time-consuming mathematical models, which were generally restricted to greyscale DT modelling.

The newly proposed method shows good performance for most of the tested DTs. This depends mainly on the properties of the original sequence. Moreover, this method significantly compresses the original data and enables high-speed synthesis of unlimited artificial sequences, which is easily performed by means of contemporary graphics hardware.

The method is based on a combination of input data dimensionality reduction using the eigen-analysis, and the subsequent modelling of resulting temporal coefficients by means of a causal simultaneous autoregressive random field model (CAR).

The model passes the stage of learning from really measured DTs (typically 250-frame video sequences). Measured data often show spatial discontinuity between successive images in DT sequences of very fast processes. Furthermore, available sequences are usually too short for robust statistical estimation of model parameters. We therefore performed the interpolation of individual temporal coefficients by means of cubic splines. This pre-processing step generates additional frames between each pair of original frames and improves the learning quality of the underlying random field model. The major advantage of the CAR model is that the problem can be solved analytically under several additional and acceptable assumptions.

The CAR model of synthesis is very simple. New temporal mixing coefficients of individual eigen-images can be directly generated from the model equation using the estimated model parametric matrix and a multivariate Gaussian generator with estimated noise variance. Both the synthesis of new temporal coefficients and the following interpolation of eigen-images can be performed at even faster rates using contemporary graphics hardware programming. This technique enables significant compression of the original DT data, typically at a ratio of between 1:5 and 1:10 depending on the length and the character of the DT sequence.