

IMAGE BASED Tensor Visualization



SURF-IT

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Abstract

We suggest a new method of visualizing two-dimensional symmetric tensor fields. Our algorithm utilizes Image Based Flow Visualization (IBFV) [1] to create images reminiscent of HyperLIC [2]. The algorithm produces an animation of two-dimensional textures, where each frame is generated by morphing the result of blending between the previous frame and a white noise texture. This method can be used to visualize both static and non-static tensor fields. Also, it can easily be extended to visualize tensor fields on surfaces.

Tensors

A second order 2D tensor is a 2x2 matrix with four unique quantities, or three for a real symmetric tensor. We take a 2D tensor field as input and calculate the eigenvectors and eigenvalues for each tensor. We determine the major and minor eigenvectors based on the corresponding eigenvalues, and normalize them so that the magnitude of the major eigenvector equals to one.

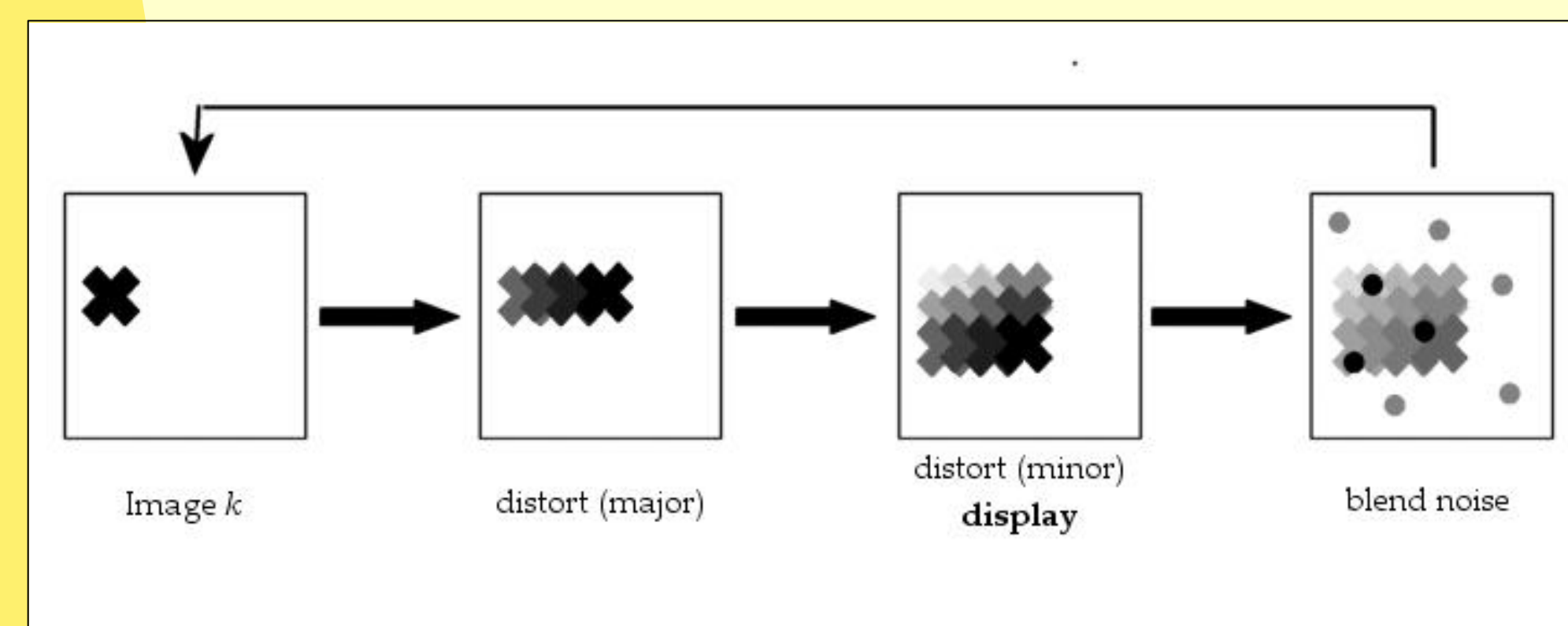


Figure 1. Pipeline of image based tensor visualization

Algorithm

Each frame of the animation is created by blending previous frame with a noise texture and morphing the result. The morphing is done in two steps. First, we warp the image in the direction of the major eigenvectors, and blend the warped version with the previous one. We repeat the process for a specified number of times. Second, we warp the result of the first process in the direction of the minor eigenvectors (Figure 1). This two-pass algorithm tries to simulate the effect of applying a filter, creating images reminiscent of HyperLIC [2].

Results

Our algorithm was able to visualize tensor fields (Figure 2). Producing an animation, this program makes it easy to visualize the underlying tensor field. One problem we encountered was the boundary effect (Figure 3). We fixed the problem by mapping texture from an offset. The boundary effects are far less apparent when texture mapping is used.

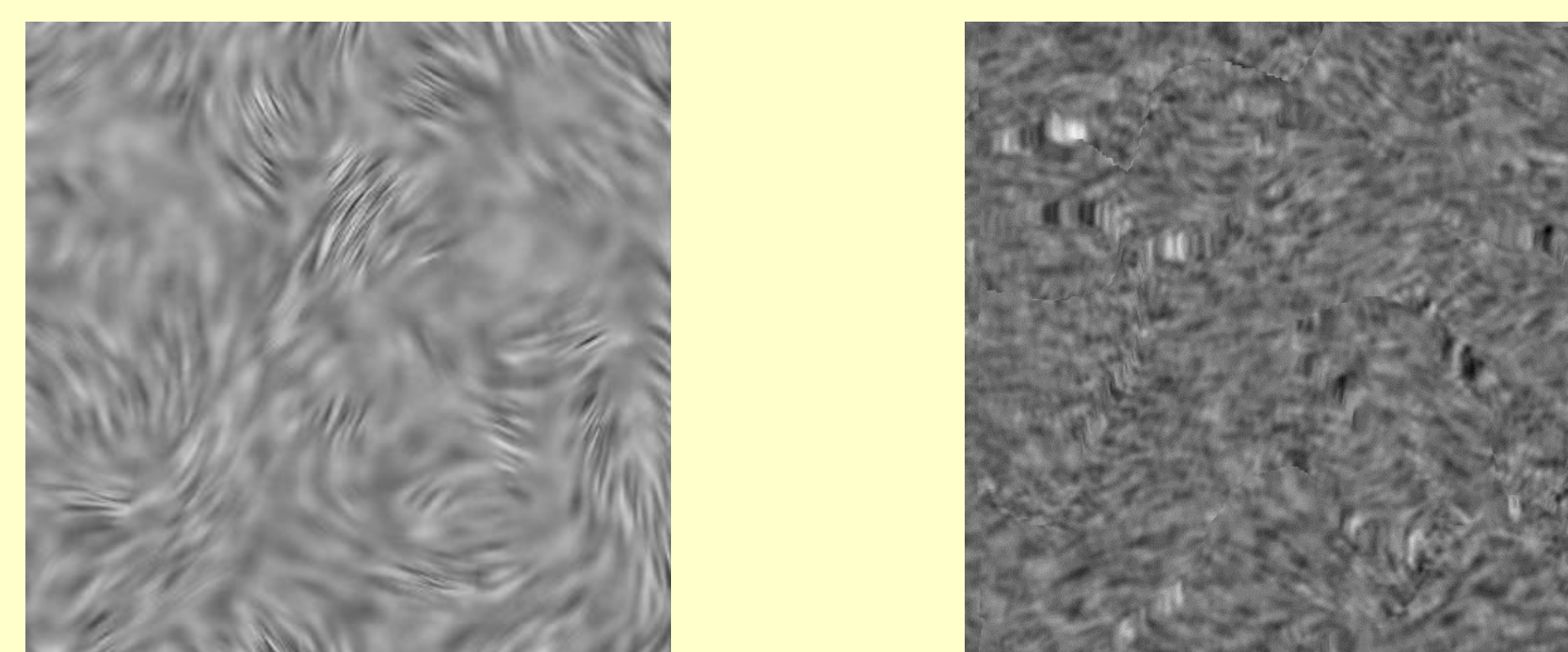


Figure 2. Tensor visualization by HyperLIC (left) and the visualization by Image Based Tensor Visualization (right).

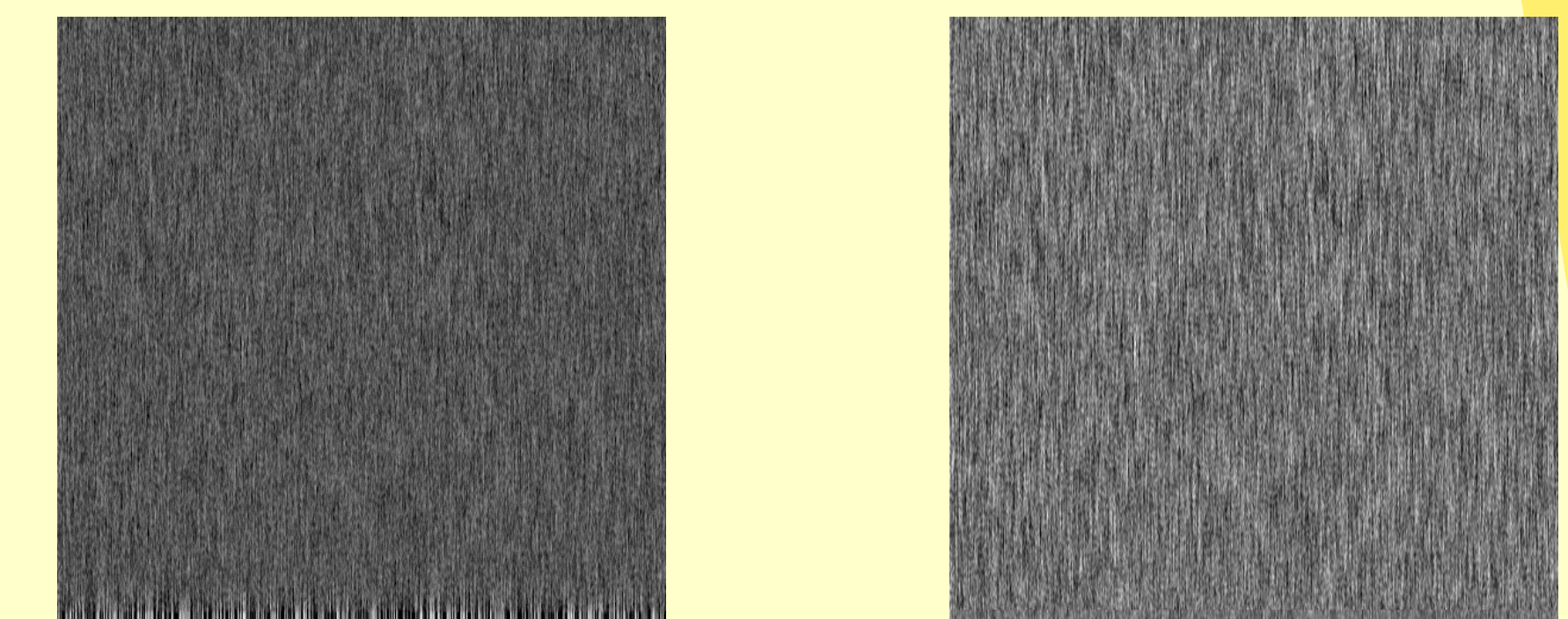


Figure 3. Boundary effects at the 60th frame without texture mapping (left) and with mapping (right).

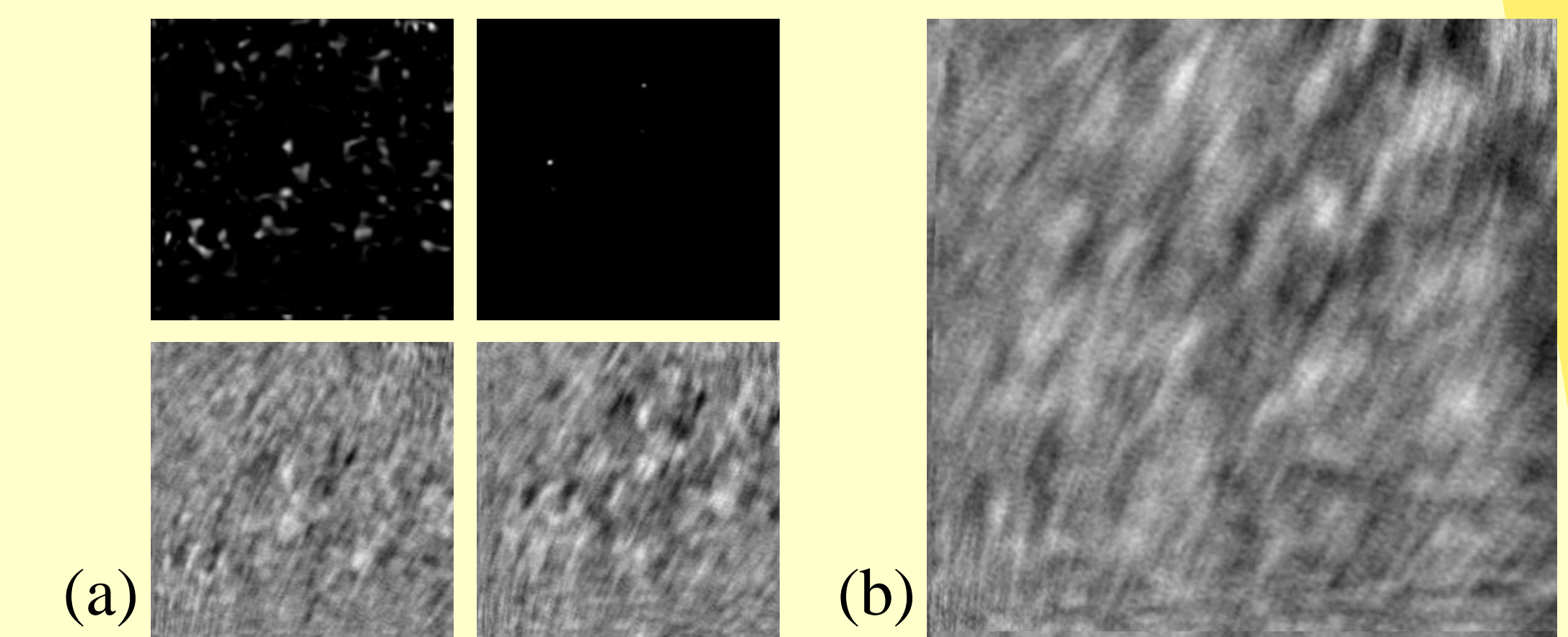


Figure 4. (a) The 15th and 30th frames without added noise (top) and with noise (bottom). (b) Image with noise after 200 frames

Future Works

- Enhance the image quality
- Minimize the boundary effects
- Visualize tensor fields on surfaces

References

- [1] J. J. van Wijk, Image Based Flow Visualization. *ACM Transactions on Graphics*, 21(3): 745-754, 2002.
- [2] X. Zheng and A. Pang, HyperLIC. *Proceedings of IEEE Visualization 2003*, October 19-24, 2003, IEEE Press, p. 249-256.