Neural Modeling of Flow Rendering Effectiveness

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It has been previously proposed that understanding the mechanisms of contour perception can provide a theory for why some flow-rendering methods allow for better judgments of advection pathways than others. In the present article, we develop this theory through a numerical model of the primary visual cortex of the brain (Visual Area 1) where contour enhancement is understood to occur according to most neurological theories. We apply a two-stage model of contour perception to various visual representations of flow fields evaluated using the advection task of Laidlaw et al. [2001]. In the first stage, contour enhancement is modeled based on Li's cortical model [Li 1998]. In the second stage, a model of streamline tracing is proposed, designed to support the advection task. We examine the predictive power of the model by comparing its performance to that of human subjects on the advection task with four different visualizations. The results show the same overall pattern for humans and the model. In both cases, the best performance was obtained with an aligned streamline-based method, which tied with a LIC-based method. Using a regular or jittered grid of arrows produced worse results. The model yields insights into the relative strengths of different flow visualization methods for the task of visualizing advection pathways.

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