1: Introduction

Texture flow (or orientation-defined texture) is a dense visual percept characterized by local (almost) parallelism and (typically) varying dominant local orientation. Its organization into coherent parts is fundamental to perceptual organization, shape interpretation, and shading analysis.

2: Geometry and Representation

Any texture flow can be represented as a scalar function \( f(x,y) \) over the image. Its 3D surface representation (where height/orientation) makes explicit the discontinuity (depicted as abrupt height change) and support the importance of the gradient. However, it provides no insight into the intrinsic geometry. For that, we utilize the frame field representation (O'Neill 1966) which leads to the texture flow connection equation and its curvature covariants:

\[
\begin{align*}
\frac{\partial f}{\partial x} & = v_x, \\
\frac{\partial f}{\partial y} & = v_y, \\
\frac{\partial^2 f}{\partial x \partial y} & = 0, \\
\frac{\partial^2 f}{\partial y \partial x} & = 0,
\end{align*}
\]

Which aspects of the orientation content influence orientation-based segmentation? Following texture theory and research into orientation gradients [e.g., Nothdurft 1985, Landy & Bergen 1991], current models for orientation-based segmentation depend only on the relationship between two scalars - the change of orientation between regions \( \Delta \theta \) and the change of orientation within regions \( \Delta \theta \) [e.g., Nothdurft 1991, Mussap & Lew 1998].

3: Methods

Stimuli: Figure-ground style textures with two possible configurations (for the figure)

- constant orientation gradient \( \Delta \theta \) at \( \Delta \theta \), either 5, 10, 15, 20, 25, 30 degrees.
- constant orientation discontinuity \( \Delta \theta \) at \( \Delta \theta \), either 5, 10, 15, 20, 25, 30 degrees.
- constant curvature discontinuities \( \Delta \kappa \) and \( \Delta \kappa \), one of them 30 degrees.

Note: Given \( \Delta \theta \), \( \Delta \theta \), and one \( \Delta \kappa \), the other \( \Delta \kappa \) is determined through Eq. (1).

4: Results

Select a subject. Average of 6 subjects.

For \( \Delta \theta \) higher than 25 degrees (graphs omitted here), no type of discontinuity surpasses the others, and at all, on average, lie around chance level.

5: Implications

- Contrary to existing models, performance in orientation-based segmentation depends on more than the relationship between the (scalar values of the) rate of change of orientation within regions \( \Delta \theta \) and between regions \( \Delta \theta \). Since these notions are fundamental to preattentive vision in general, our findings justify a reexamination of the role of features, and feature gradients, in preattentive vision.

- Performance in orientation-based segmentation depends on discontinuities in flow curvatures.

- Psychophysiology suggests the existence of a representation for curvatures in the human visual system. In particular, these experiments imply, for the first time, that the human visual system maintains a representation for a normal curvature, which demands an extension of current “association field” models to quantify the integration of curves, among other regions (Hayes, 1993).

- Since flow curvatures are basic geometrical properties, an inquiry into the role of intrinsic geometry of other perceptual features (e.g., shading, color, motion) may be in place.

- Epilogue: Differences in curvature discontinuities explain the asymmetry in the saliency of the top and bottom edges of the Nothdurft square in the introduction.