Motivation

We aim to capture four features of a texture: the orientation, scale, contrast, and bias. In natural textures, each of these features can change due to the underlying geometric shape of the object or a physical change in the texture. We attempt to measure these features and impose a smooth Markov random field (MRF) to capture the spatial correlation of slowly varying textures.

Steerable Pyramids

The Steerable Pyramid [1] is a multi-scale multi-orientation decomposition of an image similar to the conventional wavelet transform. The red dot is recursively replaced with the gray box. The advantage of the Steerable Pyramid is that the output at any orientation can be interpolated from the basis. An example output is shown below.

Texture Descriptors

For the interpolated filter output, \( y_{x,s}^I \) at pixel \( i \), scale \( s \), and orientation \( \theta \), we define the energy as:

\[
E_i(\theta) = \frac{1}{|R|} \sum_{j \in R} y_{x,s}^I
\]

We also define the bias of the texture as:

\[
\mu_i = \frac{1}{|R|} \sum_{j \in R} \theta_j
\]

Smooth Fields

For each feature, we impose a smooth, additive MRF. In the orientation case, this is represented as:

\[
\phi, \phi' \in \theta
\]

where \( \phi \) is the smooth field and \( \phi' \) is the intrinsic orientation. Once these fields are found, we can find the traditional intrinsic image and the intrinsic texture image (equal contrast, bias, orientation, and scale).

Segmentation

We use our feature set in the segmentation algorithm presented in [2], treating each feature as statistically independent. We incorporate the multi-region segmentation algorithm used in [3].

Nonlinear Camera Estimation

Our model also allows us to easily estimate a one parameter camera radiometric function. We take advantage of the similar structure between the camera model and our texture model.

Shape from Shading

Once the nonlinear camera model has been estimated with our model, we also estimate a shading image. We use a common shape from shading algorithm [4] to infer the shape.


