Adaptive Matrices for Color Texture Classification
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Contribution
Traditional texture analysis methods mostly concern gray scale images and their adaptation to the color domain is not always straightforward. We introduce a novel method for color texture classification and recognition based on Gabor filters that incorporates a data-driven adaptation of the system. Given a set of labeled color images and a bank of Gabor filters the goal is to learn a transformation of a color image to a single channel (intensity) image, such that the Gabor responses of the transformed images will yield the best possible classification.

Method
We propose the Color Image Analysis LVQ (CIA-LVQ) extending the GMLVQ [3] scheme. This enables the learning of color texture.

Original Image
Define a Gabor filter bank G
G¹ ... G¹
Extract patches of size p x p
Use the Fourier representation of the 3 channels
x' = [F(R), F(G), F(B)] ∈ C^p x 3
with label y'
Color Image Analysis LVQ
CIA-LVQ
Initialize:
1. prototypes w^k ∈ C^p x 3 and labels c(w^k)
2. transformation matrices Ω^k ∈ C^p x 3 x p 
Define:
1. image descriptor:
f_v(G) : v → r_v(G) = Σ vΩ^k * G^i
2. distance: d(x',w^k) = ||r_v(x') - r_v(w^k)||2
Optimize:
the cost function
f_L(d) = Σ d(x',w^k) - d(x',w^j)
where
w^j = arg min (d(x',w^j)) with y' = c(w^j)
w^k = arg min (d(x',w^k)) with y' ≠ c(w^k)
subject to w^k and Ω^k with L ∈ {J,K}

Results
- Dataset: VisTex [1], 128 x 128 px images from the groups Bark, Brick, Tile, Fabric and Food.
- Experimental Setup: 15 x 15 px patches are randomly drawn from each image.
- The images in Fig. 1 (left) were used for the training and test sets.
- The training error is 10.6% and the error on the test set 28%.

Evaluation set: Images in Fig. 1 (right), never presented during the training process.
CIA-LVQ has an evaluation error of 28.8%.
We compare with: Opponent Color Features [2] (OCF) and the common approach of deriving textural information only from the luminance plane of images (RGB2GRAY) using a Nearest Neighbor (NN) classifier.
The OCF/NN error is 43.1% and the RGB2GRAY/NN error 61.9%.

References
VisionTexture/visindex.html.

Fig. 1: Images used in the training, test (left) and the evaluation (right) sets.

Fig. 2: Descriptors of prototypes used for classification (top), alongside examples of correctly (middle) and wrongly (bottom) classified image patches and their descriptors.

Fig. 3: Classwise and individual image accuracies