Textures and their usage in Image Segmentation

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Textures

Texture features - colorspaces

- Several colospaces
  - RGB - acquisition colorspace
  - HSV - perceptual colorspace
  - L*A*B* - based on human vision

Texture features - CM

- Co-occurence matrix
  - Which colors occur in texture together?
  - Quantization
  - RSCCM - Reduced Size Chromatic Co-occurence Matrix
  - Haralick Features

Texture features - Haralick Features

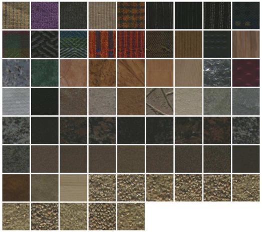
- Co-occurence matrix features
  - Angular second moment
  - Contrast
  - Correlation
  - Sum of squares: variance
  - Inverse difference momewnt
  - Sum average
  - Sum variance
  - Sum entropy
  - Entropy
  - Difference variance
  - Difference entropy
  - Information measures of correlation
  - Maximal correlation coefficient

Training

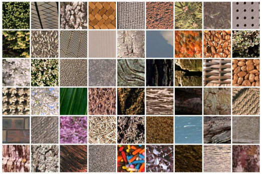
- Classify images into categories
  - Tedious
- Classify several image pairs
  - Must-link or cannot-link constraints (Same or different class)
- Selection of most relevant texture features
  - based on Laplacian score
    - projections of same classes should be together
  - based on constraint score
    - relevance with must-links and cannot-link constraints

Results

- Constraint score is better



100 %

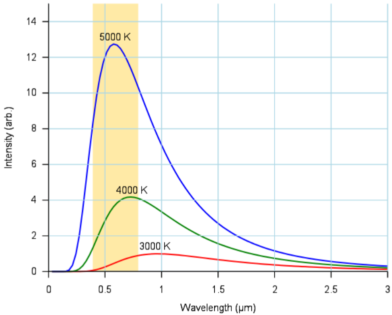


92 %

89 %

Illumination invariance

- Different light sources, different spectral characteristics
- Black body radiation, different temperatures
- Light sources with narrow spectrum
- Human eye can adapt
- Metameres



Illumination models

- Illumination models
  - Diagonal
  - Diagonal-Offset
  - Affine

$$R' = R \times \alpha_r + \beta_r$$
$$G' = G \times \alpha_g + \beta_g$$
$$B' = B \times \alpha_b + \beta_b$$

$$R' = R \times \alpha_{rr} + G \times \alpha_{rg} + B \times \alpha_{rb} + \beta_r$$
$$G' = R \times \alpha_{gr} + G \times \alpha_{gg} + B \times \alpha_{gb} + \beta_g$$
$$B' = R \times \alpha_{br} + G \times \alpha_{bg} + B \times \alpha_{bb} + \beta_b$$

Illumination invariance - solution

- Normalize colors before computing features
- Assume diagonal model
- Normalize using FFT
- Use Gabor filtering or Local linear transform on result

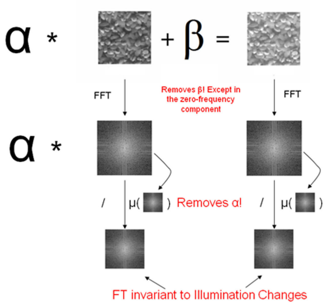


Image Segmentation

Training data

- We need to obtain training data
- Manually tracing examples is tedious

Alternate approach

- Manually pick a bounding box around object
- Inside: object and some parts of background
- Outside: only background
- Less precise
- Much faster, more images in training set

Algorithm

- Split images into superpixels - patches of same texture
- Use patches to learn the system
- Learn using texture features from patches

Algorithm

- Fully segmented data
  - Markov Random Fields
  - Conditional Random Fields
  - Boosting
  - SVM
- Partially segmented data
  - Multiple Instance Learning
    - 1. Identify positive in training data
    - 2. Learn to distinguish positive and negative

Active learning

- Find out images with patches close to decision boundary
- Get user help with classifying these patches

Improvement - Background

- Use background information to improve accuracy
- Cow is more likely to be on grass
- Car is more likely to be on road

Literature

- Rahat Khan, Damien Muselet and Alain Trémeau, Classical texture features and illumination color variations
- M. Kalakech, A. Porebski, P. Biela, D. Hamad and L. Macaire, Constraint score for semi-supervised selection of color texture features
- Jaume Amores, David Gerónimo, Antonio López, Multiple Instance and Active Learning for weakly-supervised object-class segmentation
- R. Haralick, K. Shanmugan and I. Dinstein, Textural features for image classification

Summary

Questions?