Fire and Flame Detection
Face Recognition
Vehicle Tracking Classification

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Fire and Flame Detection
• Typical Steps
  – Detection of the moving regions by estimating the background
  – Detection of fire-colored pixels by using the learned information from sufficient training images
  – Temporal wavelet analysis
  – Spatial wavelet analysis
  – Decision fusion by combining the above results

Face Recognition
• Typical Steps
  – Face detection by using color model and morphological operations
  – Feature extraction
  – Classification techniques (Need to have sufficient training data to learn)

Step 1: Face Detection
• Different Color Spaces
  – RGB
  – YCbCr
  – HSI
  – UCS (Perceptually uniform color system)

  • Histogram-based Approaches
    – Skin color distribution model
    – Hair color distribution model

  • Morphological Operations

Step 2: Feature Extraction
• Edge Detectors
• Wavelet and wavelet packets
• Discrete Cosine transformation
• Gabor filters
• Several Important Statistics: Moments
• Shape/color features
• Fuzzified features

Face color distributions are normally modeled as Gaussian mixtures.
Gabor Wavelet-based Features (Cont.)

(b) The Gabor wavelet responses at 3 spatial frequencies and 4 orientations (0, 45, 90, 135).

Step 3: Face Recognition (Cont.)

- **Classification Techniques**
  - PCA (Principal Component Analysis)
    - Kernel PCA
    - GA-PCA
    - Incremental PCA
  - LDA (Linear Discriminant Analysis)
  - ICA (Independent Component Analysis)
  - Locality Preserving Projections (LPP)
  - SVMs (Support Vector Machines)
  - NN (Neural Network)
    - RBF (Radial Basis Function) NN
    - SOM (Self-Organizing Map)

Step 3: Face Recognition (Cont.)

- **Statistical Modeling**
  - Bayes classifier

- **Distance/Similarity Measures**
  - Euclidean Distance
  - Bhattacharrya Distance
  - Manhattan Distance

Some examples of eigenfaces (the number indicates the principal component number, ordered according to eigenvalues)

Common Face Databases

- FERET: Face Recognition Technology
- AR Face Database
  [http://rvl1.ecn.purdue.edu/~aleix/aleix_face_DB.html](http://rvl1.ecn.purdue.edu/~aleix/aleix_face_DB.html)
- Yale B
- CMU PIE: Carnegie Mellon University Pose, Illumination, and Expression

Vehicle Tracking and Classification

- **Typical Steps**
  - Segmentation by estimating the background
  - Region tracking
  - Recovery of vehicle parameters (location, length, width, and velocity of the regions, which correspond to vehicle fragments)
  - Vehicle identification
  - Vehicle tracking
  - Vehicle classification