Digital Image Processing

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Object recognition
Introduction to object recognition

Object recognition often starts with
• Feature extraction
  → Possibly followed by dimensionality reduction (PCA)
• Clustering
• Decision boundary making

In some applications this process is “semi-blind” and in others it is based on template matching. In template matching applications a crucial part is definition of degradation invariant features.

Some object recognition techniques are based on simple concepts while others employ complex systems such as neural networks. Object recognition based on these complex systems is out of the scope of this course.

1D example: recognition of ECG peaks

In this application, problem is to discriminate between normal types of peaks (N-peaks) and two types of abnormal peaks (S-peaks) and (V-peaks).

Application: intelligent pacemakers
For feature extraction, in this example non-decimated wavelet transform is used with quadratic spline wavelet.

Examined features:

- Modulus maxima at different scales
- Average Cone Ratio (ACR)
- Coefficient energy within the cone of influence
- A wavelet response shape factor
- A time domain feature (time to previous peak – so called RR\textsubscript{time})

Example of feature distributions:

- ACR
- RR\textsubscript{time}
- Wavelet response factor

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...1D example: recognition of ECG peaks...
1D example: recognition of ECG peak

Feature clustering

Cone energies after SVD from 5 scales

Polynomial fit of cone energies

polynomial fit of maxima

Classification

Classification can be made based on the distance of the pattern under study and the centroids of each cluster

Different distance measures can be defined:

- Euclidian distance
- Mahalanobis distance (takes into account the covariances of different clusters)

Some of the well-known classifiers:

- K-means clustering
- Fuzzy C-means clustering
- Bayesian classifiers

Bayesian classifiers often model data clusters by multivariate Gaussians (for simplicity reasons)
Hierarchical classification

Classification example

speckle-reduced polarimetric SAR image

classification result with spatial regularization

different classes of the terrain