Morphological Image Filtering and Analysis
From Algae to Galaxies

Erik R. Urbach

Institute for Mathematics and Computing Science
University of Groningen
The Netherlands

April 6-7, 2006
Overview

- Describing objects using scalars
- Automatic identification of diatoms
- Describing shape using vectors
- Image analysis using vector attributes
- Traffic signs
- Astronomy
- Possible other applications
- Future
- Conclusions
Describing objects using scalars

The shape of objects can be described using scalar attributes, such as: area, perimeter, elongation, number of holes.

A method based on pattern spectra to classify diatoms using two attributes, elongation (shape) and area (size) of the patterns, achieved a 91% classification performance on a set of 781 images. It was the fastest and among the best of all methods we used for this purpose.
Automatic identification of diatoms
Describing shape using vectors

Removing objects that are similar enough ($\epsilon$) to a given reference shape.

Original image

$\epsilon = 0.01$

$\epsilon = 0.10$

$\epsilon = 0.15$

Original image

A’s removed

B’s removed

C’s removed

BCN Retreat 2006, Odoorn, NL
Image analysis using vector attributes

Original image

Pattern spectrum

Shape histogram

A’s removed

B’s removed

C’s removed
Traffic signs

Reference shapes:

Input images:

Output images:
We are working on trainable vector-attribute filters for the automatic detection and classification of the different types of galaxies in wide-field astronomical images (Kapteyn Astronomical Institute).
Possible other applications

- Texture segmentation/classification

- Analysis of butterfly eyes (Neurobiofysica, RuG)

- Segmenting veins in chorioallantois membrane of eggs (KU Leuven)

- Human tissue analysis such as detection of skin diseases and breast cancer
A project proposal was submitted to NWO Focus for a 2-year study by three postdocs to develop trainable shape recognition algorithms by combining:

1. Vector-attribute filters
2. Contour-based shape descriptors
3. Prototype-based classifiers (LVQ, Neural Networks, etc.)
Conclusions

An efficient method was developed for pattern-based image classification.

This was successfully used for the classification of diatom images (91%) based on the ornamental patterns on their valves.

A new class of filters was developed that can learn by example to remove or preserve the desired objects in images.

Two test applications (letter and traffic sign recognition) proved that these adaptive shape filters are suitable for detection and classification of objects in images.

Recently, work has started to investigate the use of these shape filters for the classification of galaxies.

For most (larger) applications both the attributes used and more advanced learning strategies need to be investigated (proposal to NWO FOCUS).
Questions