Segmentation and classification of fine art paintings from photographs

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PROBLEM

Text based Image search (90's)

Content based image retrieval systems (2000)

Semantic gap

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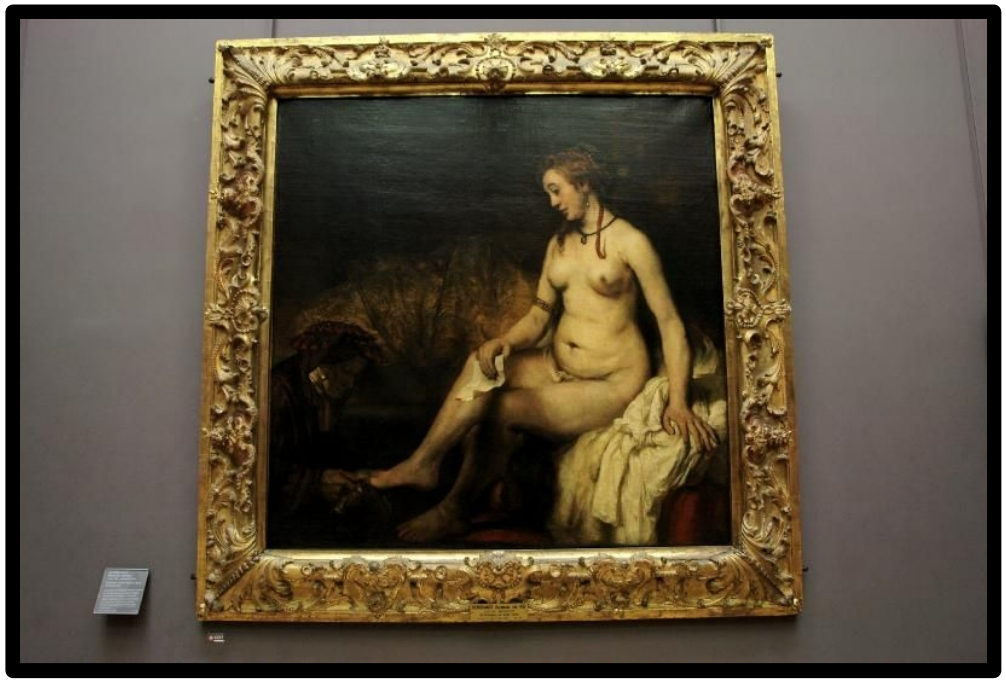
MOTIVATION

Great amount of art galleries on the Internet

Text based or no image retrieval

Different problem => we have an image and search for the name.



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APPROACH

Create a tool for classifying the photographs of paintings

Segment the painting from photograph

Match the painting with the database of paintings

Classify painting

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DATABASE

15 Original Rembrandt's paintings (Vienna, New York, Amsterdam)

100 Photographs taken by tourists in same galleries

Photograph contains:

- Wall
- Frame
- Painting
- and some
- other elements

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PIPELINE

Original Photograph

↓

Segmented Painting (3 different segmentation methods)

↓

Descriptor File (2 different classification methods)

↓

Name of the best matching painting (and the number of matches)

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SEGMENTATION

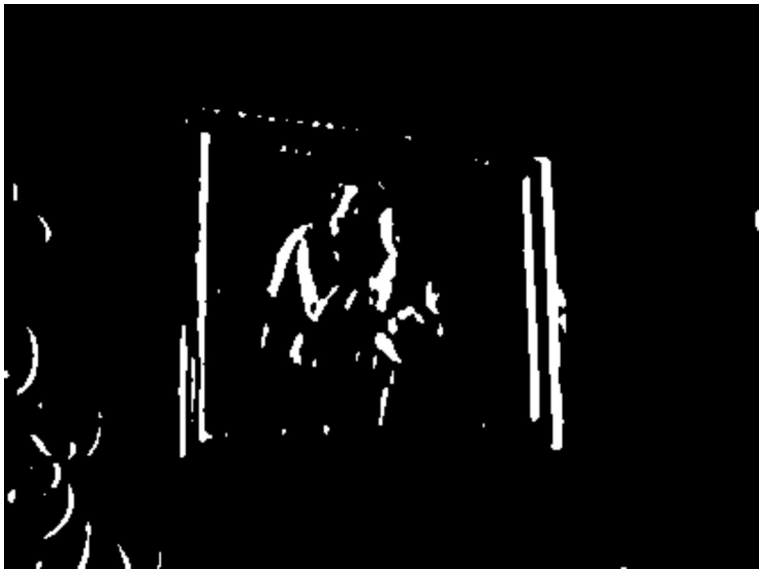
1. Gauss gradient
2. Anisotropic diffusion
3. Watershed

GAUSS GRADIENT

1. Convert image to grey scale and equalize the histogram

2. Use Gauss gradient(computes Gx, Gy gradient

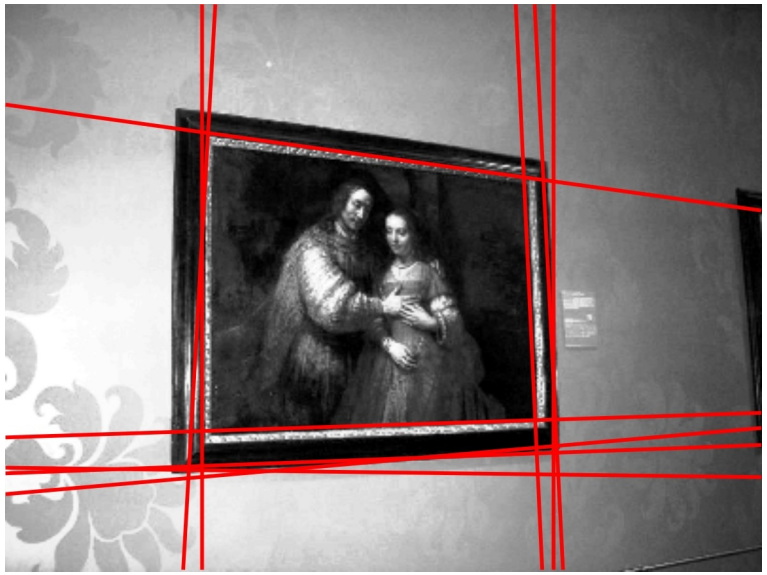
images using the first order derivative of the Gaussian).



GAUSS GRADIENT

3. Find lines with Hough transform in Gx,Gy images and connect or trim them based on their length.

4. Divide lines into upper, lower, left and right edges. Segment the painting as the smallest quadrilateral created from these lines.



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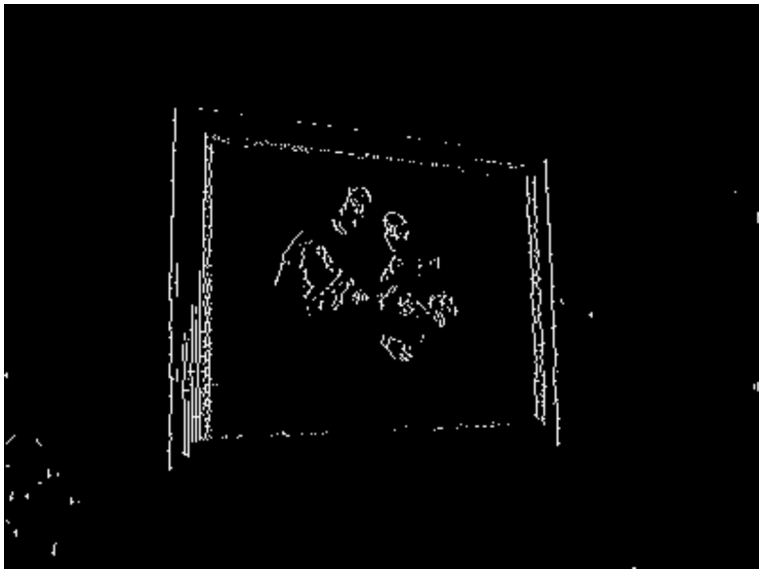
ANISOTROPIC DIFFUSION

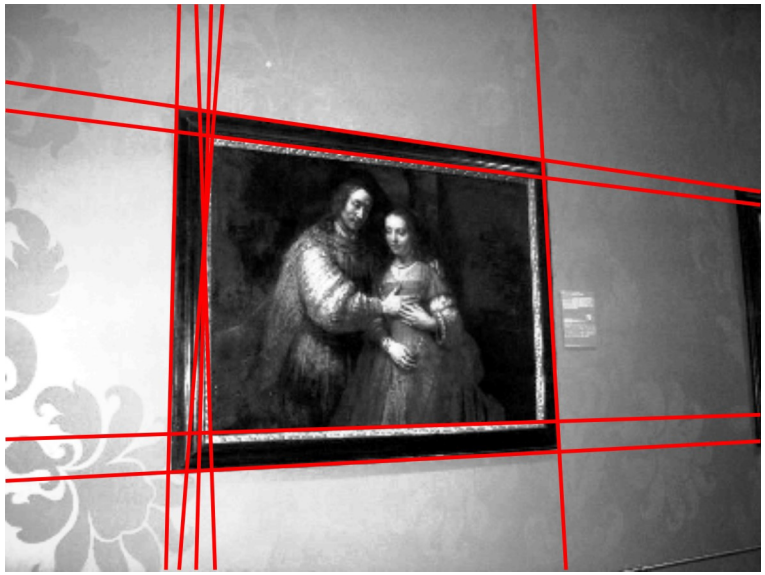
1. Convert image to grey scale and equalize the histogram
2. Filter the image with Anisotropic diffusion and convolve with Sobel filter to find edges.



ANISOTROPIC DIFFUSION

3. Find lines with Hough transform in Sx, Sy Sobel images.

4. Divide lines into upper, lower, left and right edges. Segment the painting as the smallest quadrilateral created from these lines.



WATERSHED

1. Convert image to grey scale and equalize the histogram
2. Create top and bottom hat of the image
3. Create image Im2= (I+ tophat) -bottomhat
4. Create Im3 as extended minima (regional minima of the H-minima transform) of Im2.

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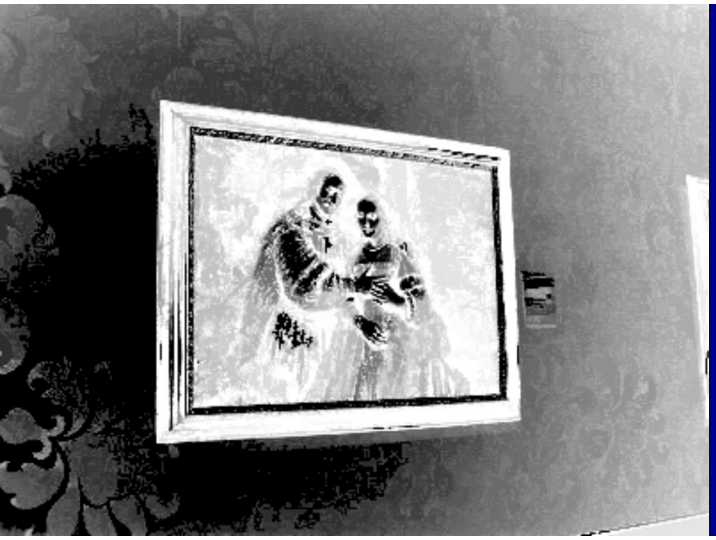
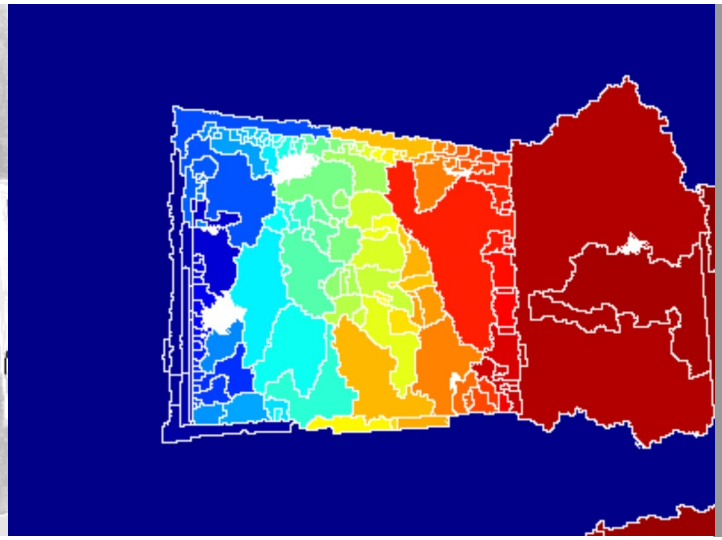
WATERSHED

5. Make minima imposition from the complement of Im2 with the marker Im3.
6. Create clusters with watershed.
7. Final segmentation: grow the background from the corners.





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CLASSIFICATION

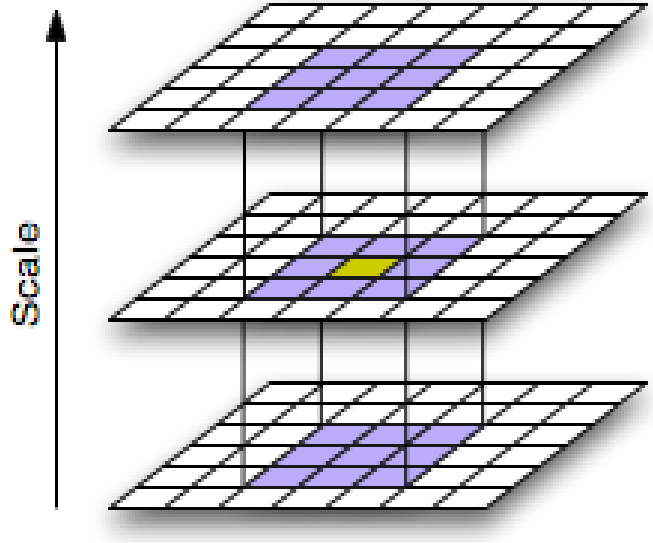
1. SIFT
2. SURF

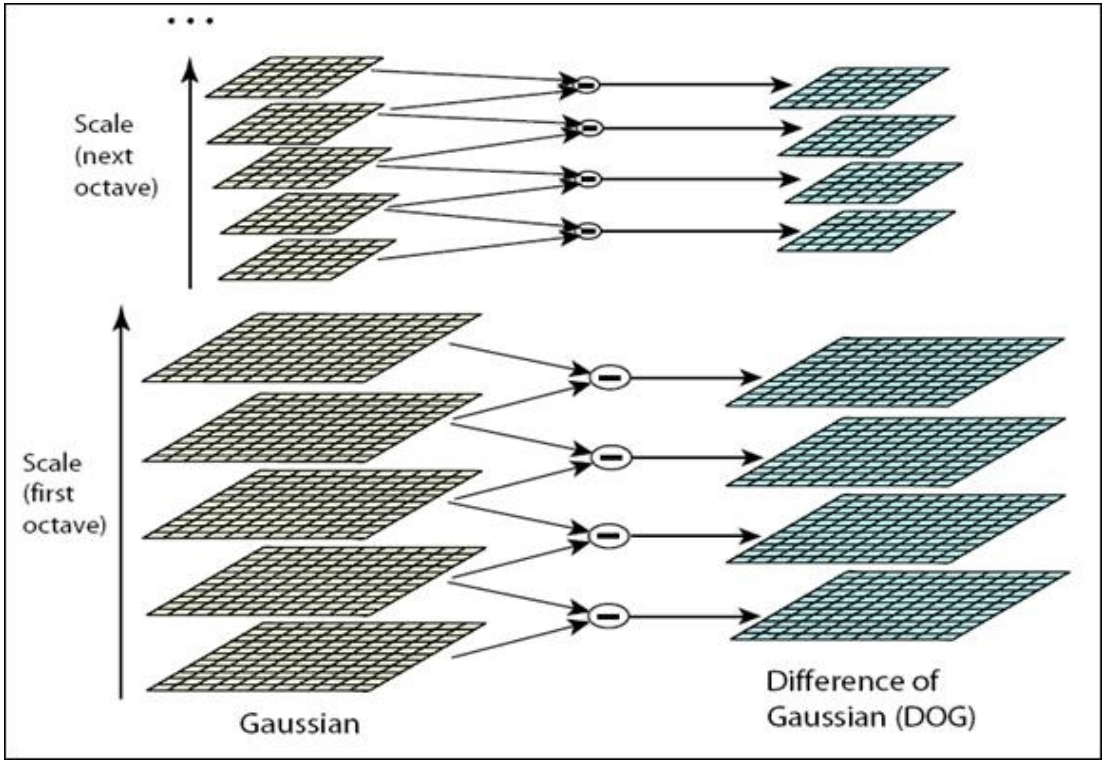
SIFT

detector and a **descriptor** of features invariant to affine transformations

detector identify IPs in the scale space (Difference of Gaussians)

IPs are the local extremes in the 3x3x3 neighbourhood

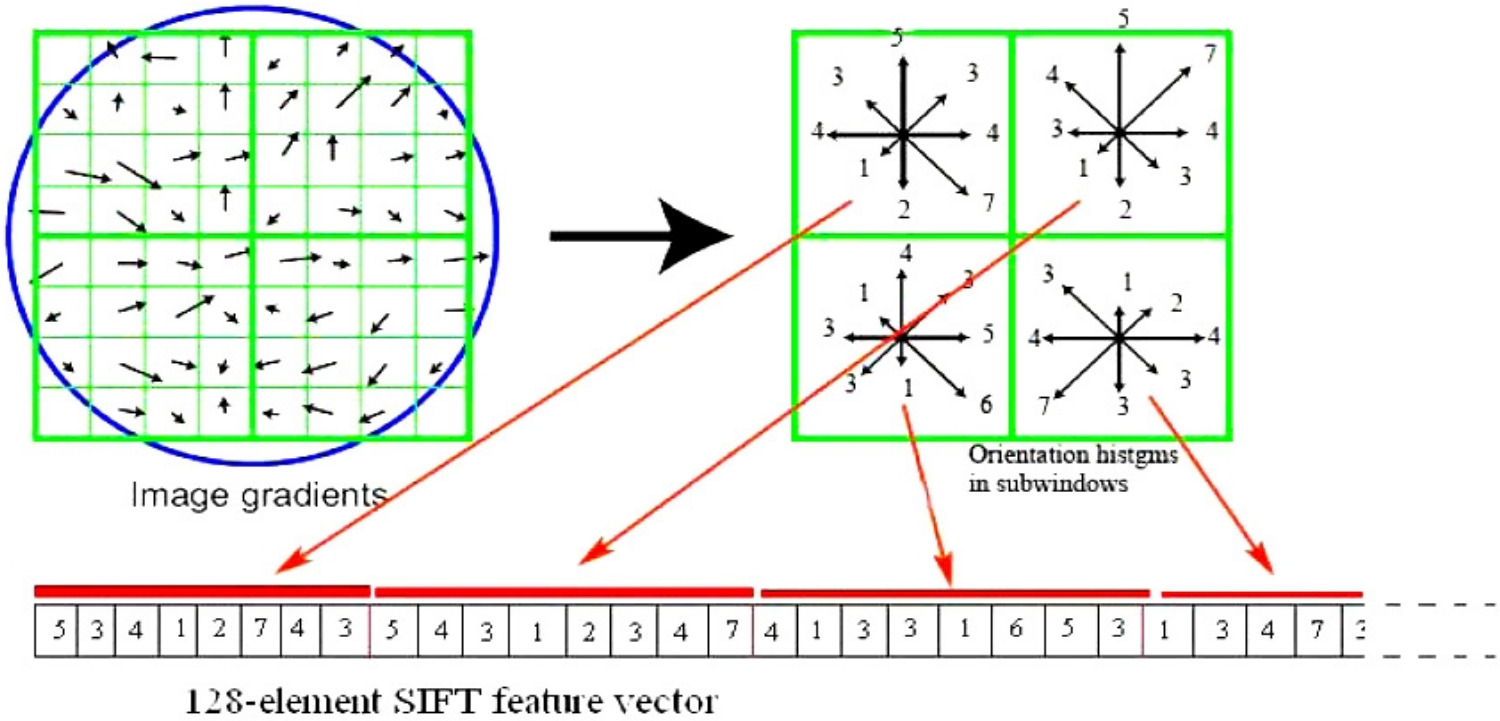




SIFT

for each **IP:** sample points are identified in the 16 neighbouring subregions and the size and the orientation of their gradient is computed and weighted by the Gaussian window. Orientation histogram is created from these values.

descriptor for each **IP:** 8 values of orientation histogram for all 16 subregions (128 values)



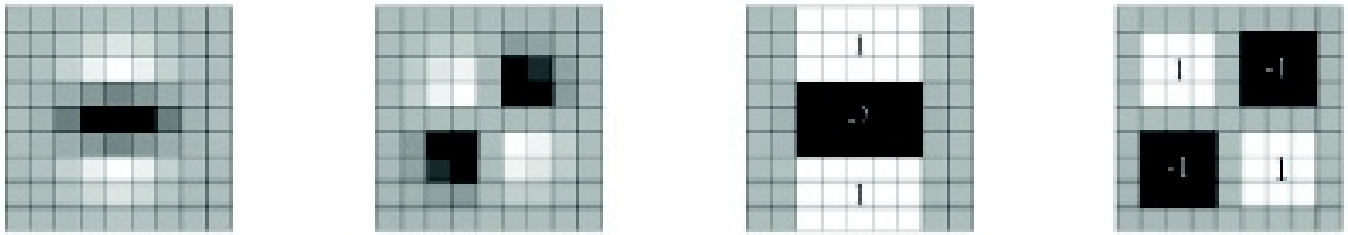
SURF

detector and a **descriptor** of features invariant to affine transformations

detector identify IPs in the scale space (convolve the original image

with the different scales of the box filters)

IPs are localised by a non maximum suppression in the 3x3x3 neighbourhood



SURF

dominant orientation of the IP is extracted from the circular neighborhood as the longest vector estimated as the sum of all Haar-wavelet responses

Square region around the IP is created and oriented along the **dominant orientation** and divided into 4x4 **subregions**

In every **subregion** Σdx, Σdy, Σ|dx|, Σ|dy| features are counted from 5x5 points

descriptor for each IP have 4 values from 16 subregions (64) values

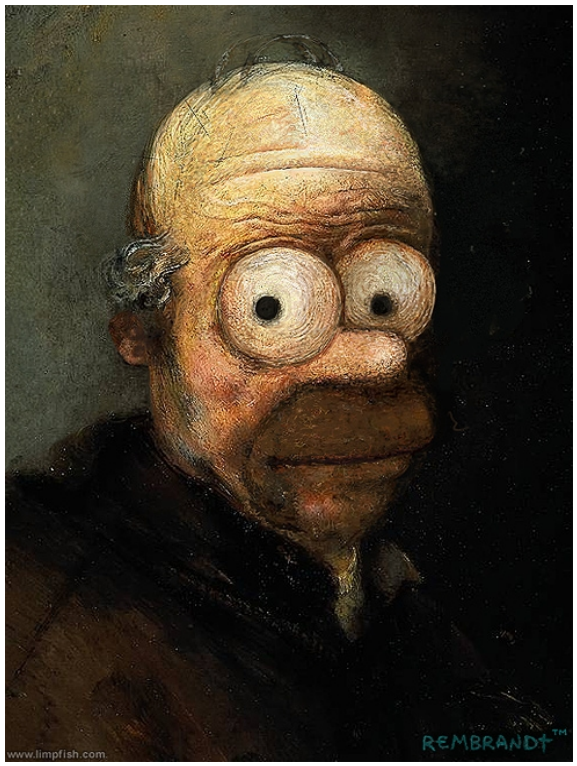
MATCHING

For image (D1) we count best matching original (D2)

The matching value is the sum of rows of descriptor file D1 which has the value of the nearest neighbour from D2 < 0.6 * second nearest neighbour

Classification to 16 classes: 15 originals + others

Threshold for minimal matching value



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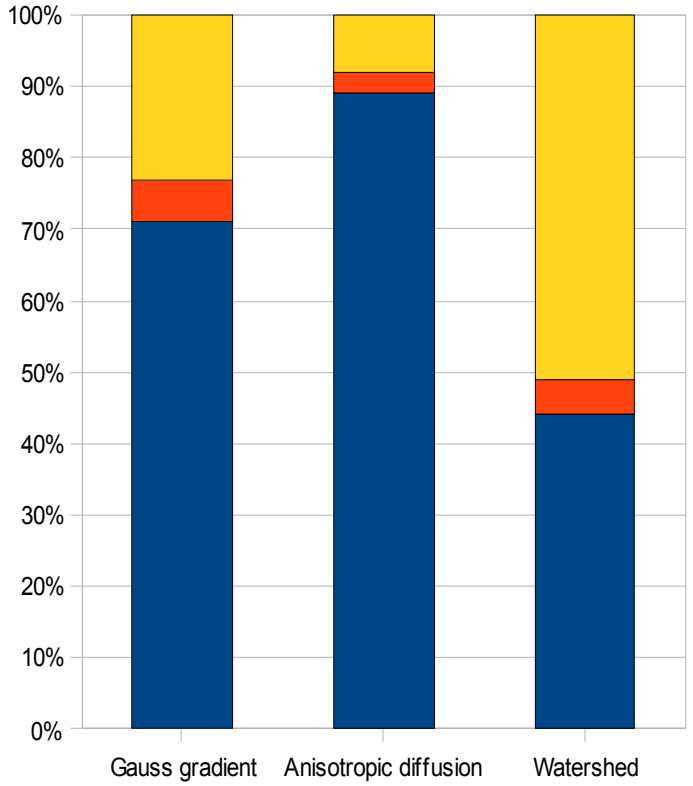
RESULTS (SEGMENTATION)

Method	Gauss gradient	Anisotr. Diffusion	Watershed
Correct segmentation	73%	89%	49%
Over segmentation	6%	3%	1%
Under segmentation	21%	8%	50%

Best results: Anisotropic diffusion



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PROBLEMS

RESULTS (CLASSIFICATION)

Method	SIFT	SURF
threshold = 0	75%	73%
threshold = 6	88%	90%
threshold = 8	89%	88%
threshold = 12	90%	82%

Method	SIFT	SURF
time of the computation of one descriptor file	0,8125 s	0,32025 s

Best results: SURF

FUTURE WORK

Extension of the database of the originals

Implementation in OpenCV

Cooperation with the Olga's gallery

REFERENCIES

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Thank you for your attention