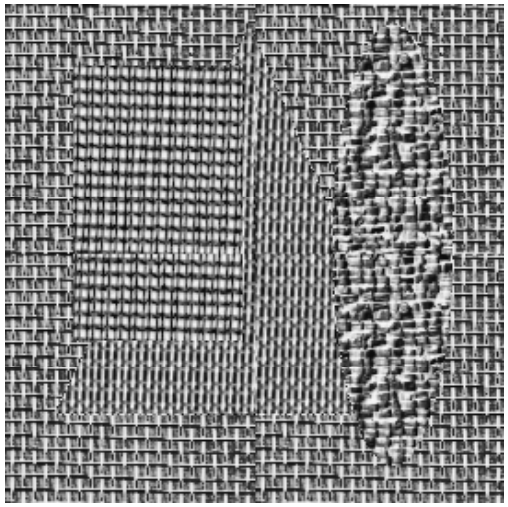
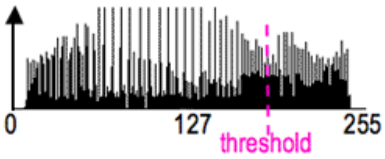
Texture Segmentation

- Grey level or colour pixel values by themselves are not sufficient for segmenting natural highly-textured images:

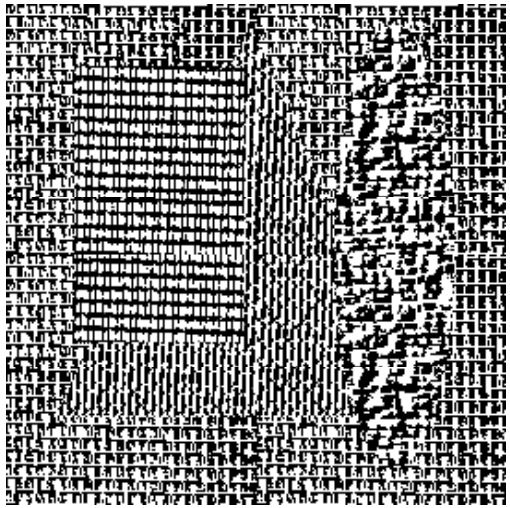


Collage of various textures



Grey level histogram

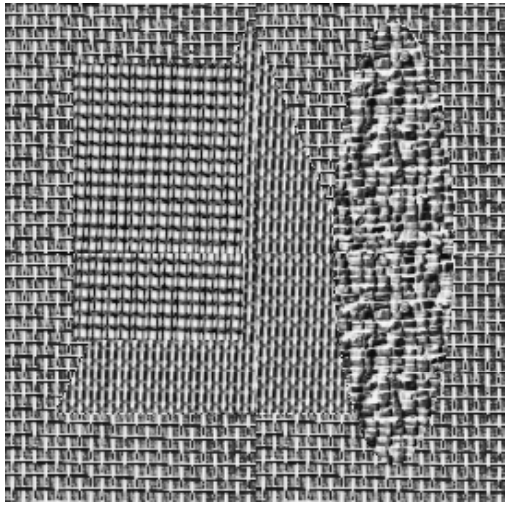
Segmentation by thresholding



Meaningless regions obtained by simple thresholding

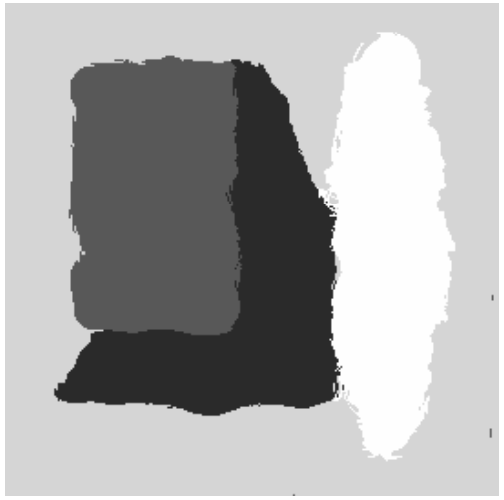
Texture Segmentation

- Specific texture measures (features) describing local spatial signal patterns have to be used



Collage of various textures

Segmentation by separation of local signal features



Meaningful texture

From: http://www.sztaki.hu/~sziranyi/textu-iu.html

Texture Segmentation

From: http://www.ercim.org/publication/Ercim_News/enw64/mikes.html

- Texture is a spatial property that characterises groups of pixels
- A local measure of texture is computed over a pixel neighbourhood

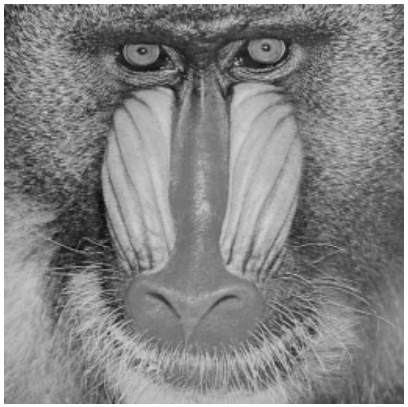
Variance as a Texture Feature

- The simplest statistical measure is the *variance* σ^2 of grey levels in a square $n \times n$ neighbourhood centred on a pixel:

$$\sigma^2 = \frac{1}{n^2} \sum_{\xi=-n/2}^{n/2} \sum_{\eta=-n/2}^{n/2} \left(f(x+\xi, y+\eta) - \mu \right)^2; \quad \mu = \frac{1}{n^2} \sum_{\xi=-n/2}^{n/2} \sum_{\eta=-n/2}^{n/2} f(x+\xi, y+\eta)$$

- **"Variance" image**: scaled standard deviations σ for each pixel
  - Bright regions in the variance image: high local variance of grey levels
- For most of simple statistical measures are of little use
- If two textures of interest are periodic, they might be separated in the frequency domain by comparing the spectra of small samples taken from the two patterns

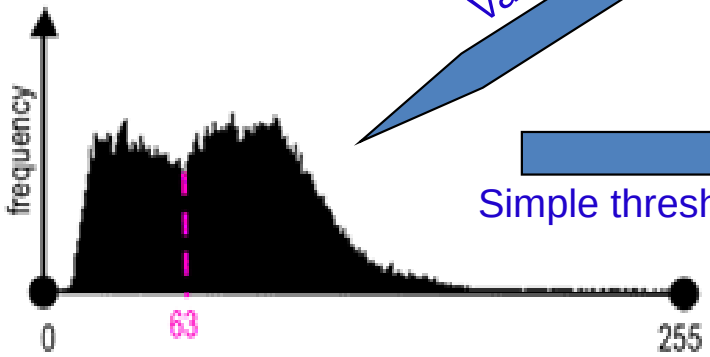
Variance as a Texture Feature



Greyscale image

Variance image

Variance histogram



Simple thresholding

Image Segmentation for Skin Detection: Colour predicate

Colour Segmentation

- Region-of-interest in a training image - look-up table of skin colours
  - **Drawback**: incorrect classification of skin pixels absent in the training sample and background pixels
- Edge-based segmentation - regions with closed boundaries formed by edge strokes

Colour Predicate

- The use of many training images
- Automatic segmentation of each training image into skin and background regions
- Can use any colour space (RGB, rgb, YCrCb, HSI, YCM)
- RGB non discriminative for skin
- Look at Hue images
  - Thresholding the hue images

Logarithmic hue

- CCD micro-camera
  - poor results with angular transform (classic ***HIS***)
- **Logarithmic hue** difference between ***G***reen and ***R***ed
  - independence from lighting conditions
  - ***Logarithmic hue*** values: R - G components only because red prevails in skin; the ratio G/R is robust to intensity changes:

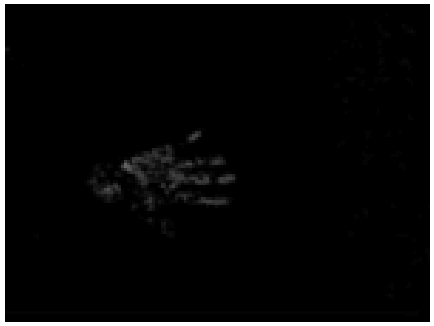
    H = 256 G/R if **G < R** and **H = 255** if **G ≥ R**

Intensity **I**

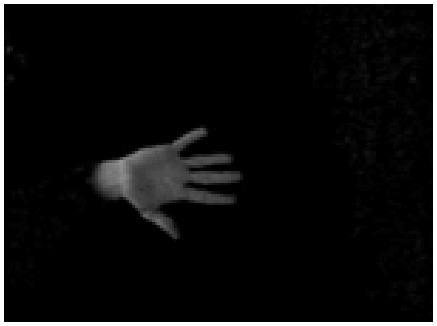
Hue **H**

Segmentation with Different Ranges of the Hue

0 - 100



0 - 150



80 - 190

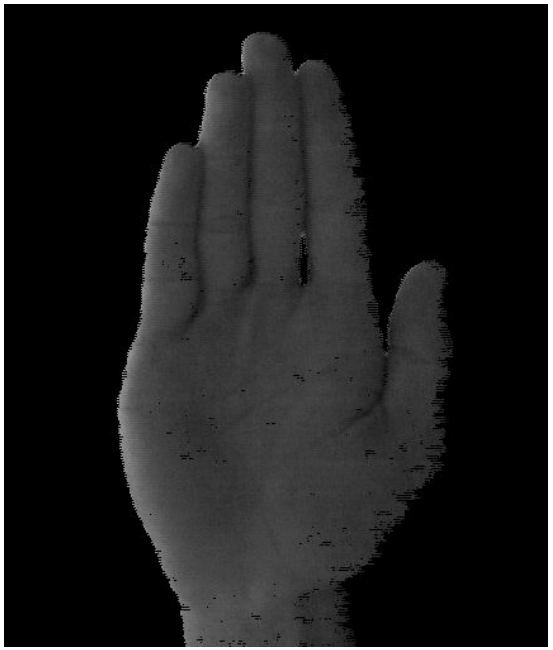
100 - 255

150 - 255

200 - 255

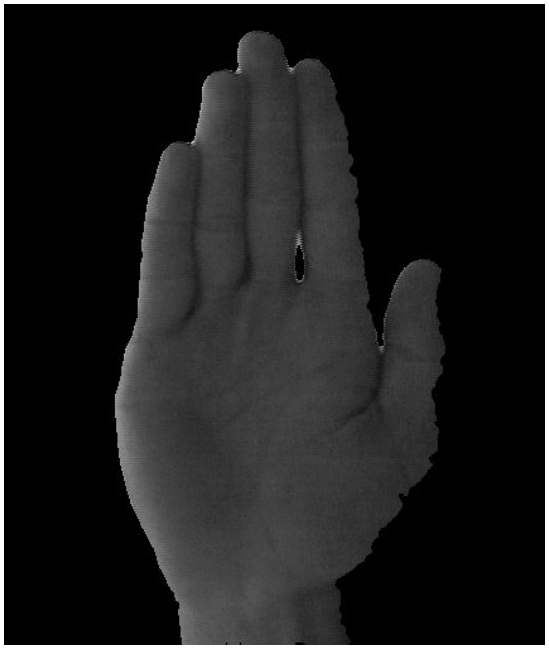
Hue Thresholding

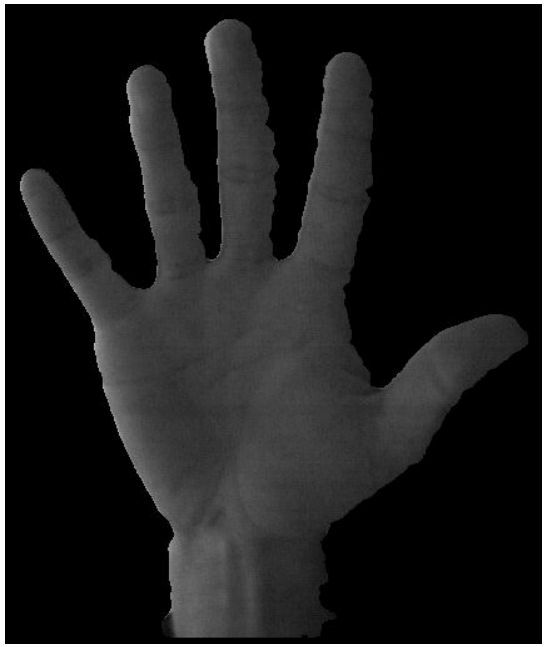
- Raw hue-based segmentation



Post-processing

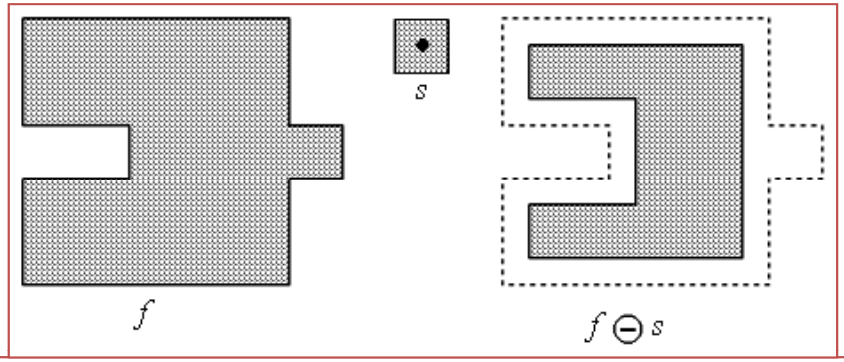
- morphological opening + median filtering





Fundamental Operation: Erosion

- **Erosion** $f \ominus s$ of a binary image f by a structuring element s produces a new binary image $g = f \ominus s$
  - The eroded image has ones in all locations (x,y) of an origin of the structuring element s at which s fits the input image f
    - For all pixel coordinates (x,y), $g(x,y) = 1$ if s fits f and 0 otherwise



From: http://www.inf.u-szeged.hu/~ssip/1996/morpho/morphology.html

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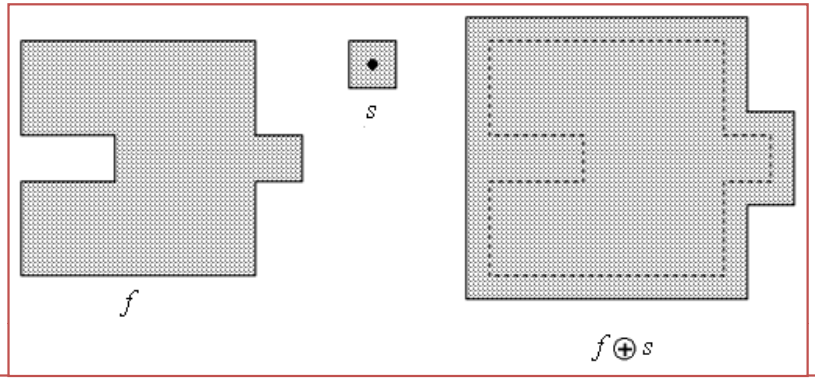
Fundamental Operation: Dilation

- **Dilation** $f \oplus s$ of a binary image f by a structuring element s produces a new binary image $g = f \oplus s$
  - The dilated image has ones in all locations (x,y) of an origin of the structuring element s at which s hits the input image f
    - For all pixel coordinates (x,y), $g(x,y) = 1$ if s hits f and 0 otherwise

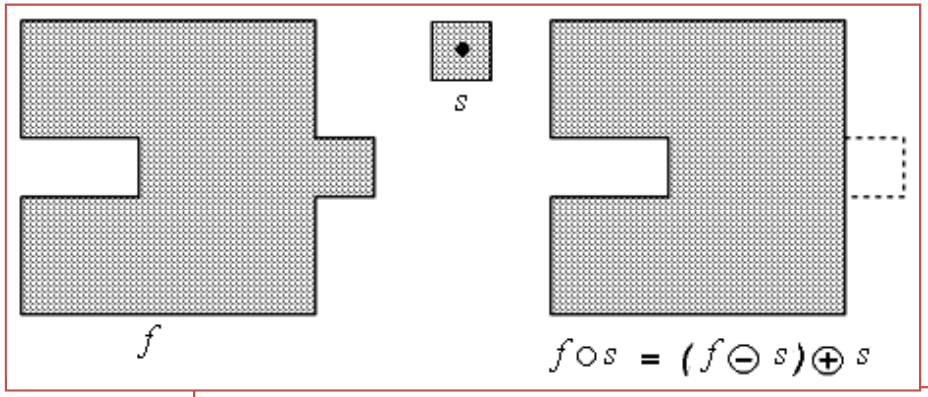


From: http://www.inf.u-szeged.hu/~ssip/1996/morpho/morphology.html

Opening

- **Opening** $f \circ s$ of an image f by a structuring element s is an *erosion* followed by a *dilation*:

$$f \circ s = (f \ominus s) \oplus s$$



From: http://www.inf.u-szeged.hu/~ssip/1996/morpho/morphology.html

Median filter

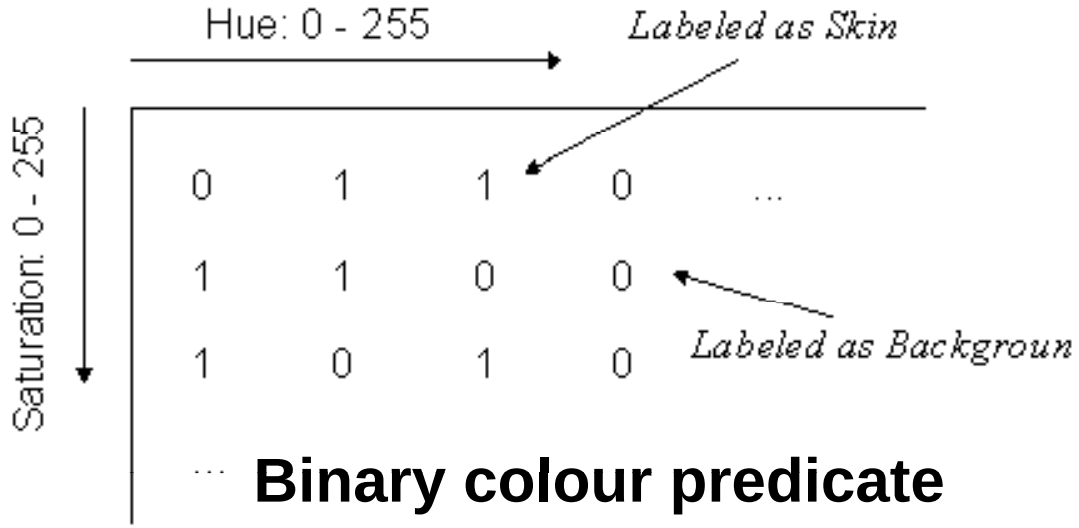
0	0	0	30	30	30
0	0	0	30	30	30
0	0	0	30	30	30
10	10	10	20	20	20
10	10	10	20	20	20
10	10	10	20	20	20

	0	0	30	30	
	0	10	30	30	
	10	10	20	20	
	10	10	20	20	

The median is calculated by first sorting all the pixel values from the window into numerical order, and then replacing the pixel being considered with the middle (median) pixel value.

Predicate Training

- Largest connected region of skin-coloured pixels: connected component algorithm of Haralick-Shapiro



RGB to HSI

First Pixel

$T_1 = 5\% \times 255$
$T_2 = 95\% \times 255$

$T_1 < I < T_2$

Yes

No

Index the predicate with the HS pair

Ignore the pixel

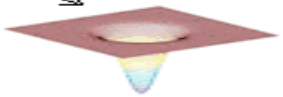
Next Pixel

Skin ?

Yes

No

Broad +ve Gaussian Weighted Window



Narrow-ve Gaussian Weighted Window

Increment Neighbourhood with Gaussian Window

The Use of the Predicate