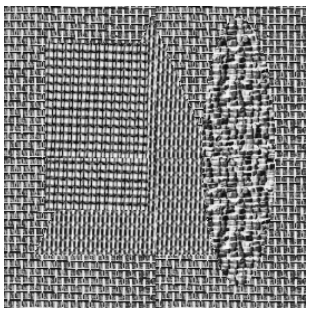
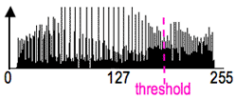
# Texture Segmentation

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

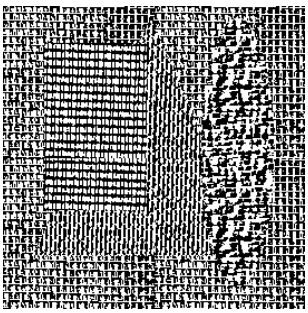


Collage of various textures




Grey level histogram

Segmentation by thresholding

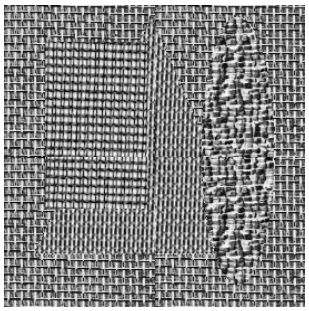


Meaningless regions obtained by simple thresholding



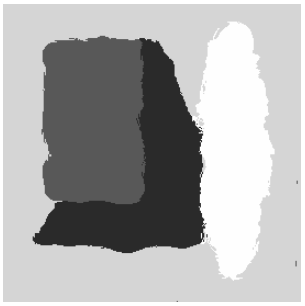
# Texture Segmentation

- 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



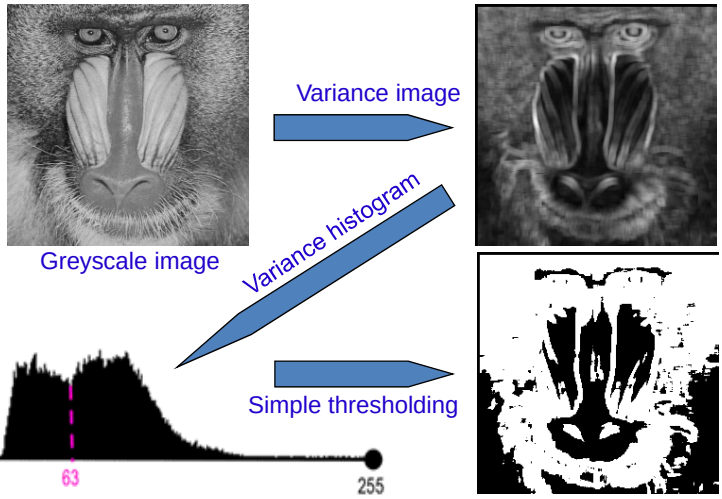
# Variance as a Texture Feature

- The simplest statistical measure is the *variance* $\sigma^2$ 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 $\sigma$ 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






# 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:

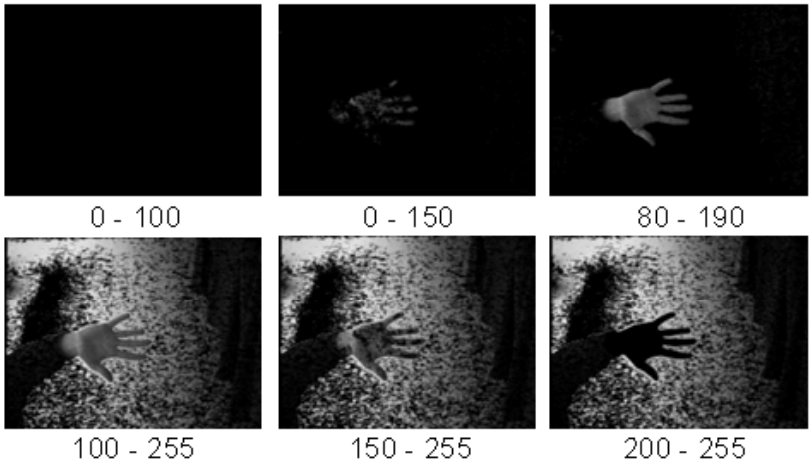
    **H = 256 G/R** if **G < R** and **H = 255** if **G ≥ R**

Intensity **I**

Hue **H**

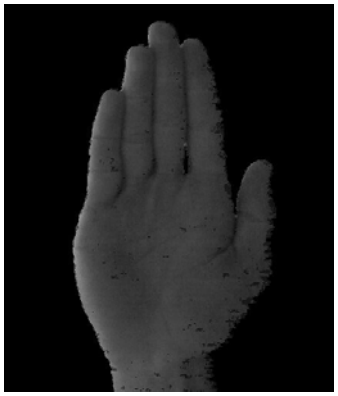


# Segmentation with Different Ranges of the Hue



# Hue Thresholding

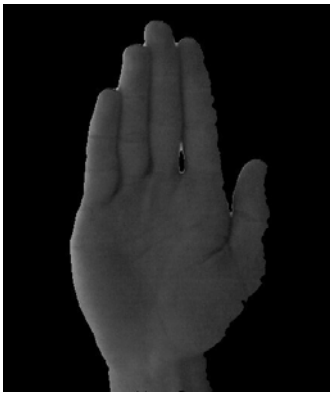
- Raw hue-based segmentation





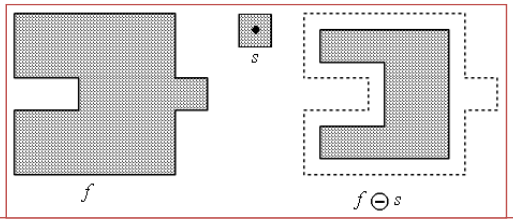

# Post-processing

- 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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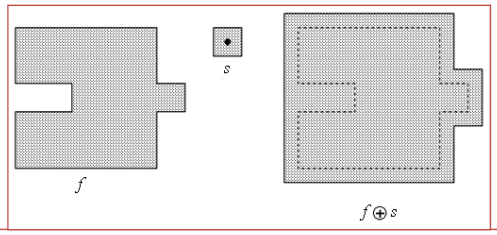
# Fundamental Operation: Dilation

- **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

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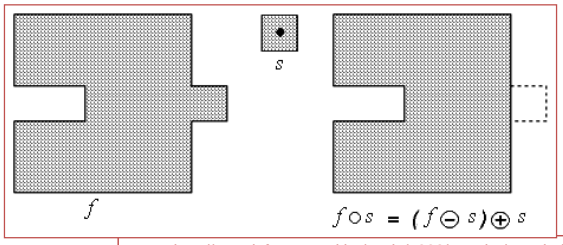
# Opening

- **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

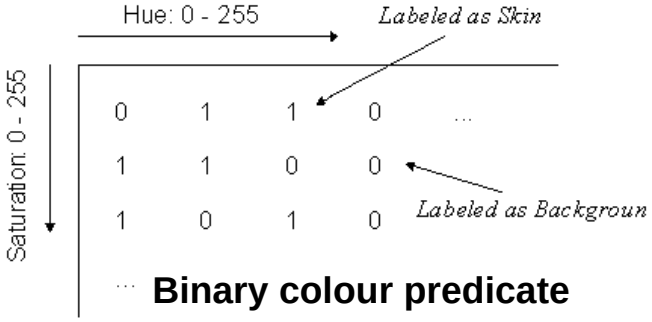
| | | | | | |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 30 | 30 | 30 |
| 0 | 0 | 0 | 30 | 30 | 30 |
| 0 | 0 | 0 | 30 | 30 | 30 |
| 10 | 10 | 10 | 20 | 20 | 20 |
| 10 | 10 | 10 | 20 | 20 | 20 |
| 10 | 10 | 10 | 20 | 20 | 20 |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | |
| | 0 | 0 | 30 | 30 | |
| | 0 | 10 | 30 | 30 | |
| | 10 | 10 | 20 | 20 | |
| | 10 | 10 | 20 | 20 | |
| | | | | | |

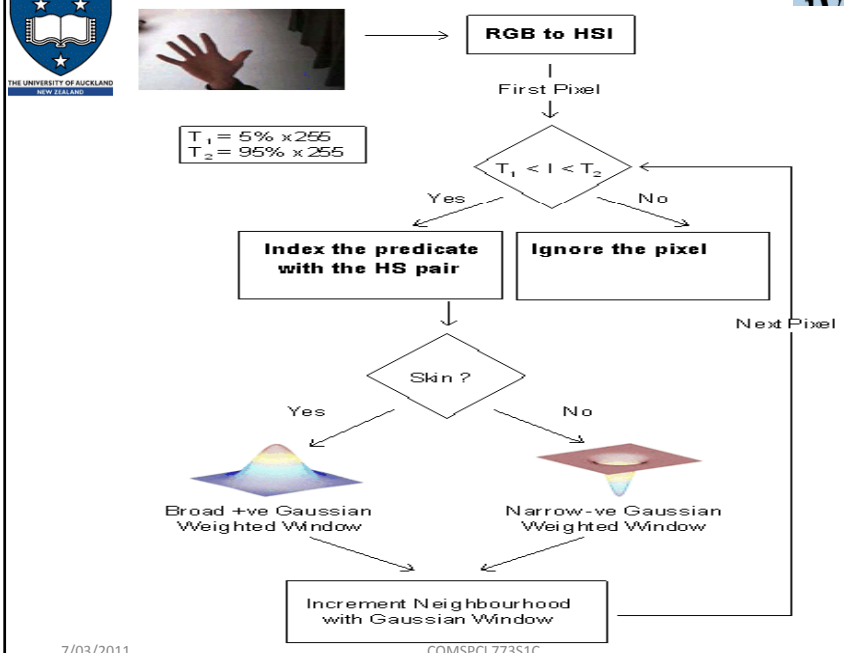
The median is calculated by first sorting all the pixel values from the window into numerical order, and then replacing the pixel being considered with the middle (median) pixel value.

# Predicate Training

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





# The Use of the Predicate