Thresholding Based Segmentation

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Isolating flat parts

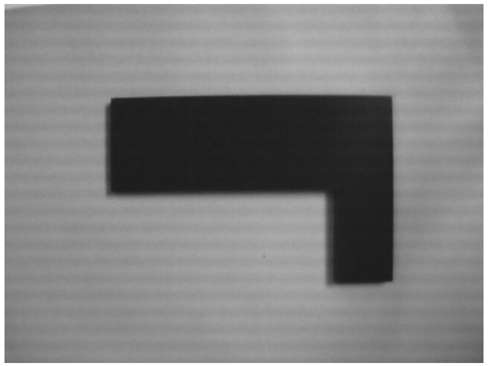
Isolate parts, then characterise later

Assume

- Dark part
- Light background
- Reasonably uniform illumination $->$ distinguishable parts

Motivating Example

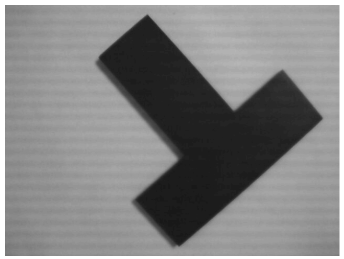
Given this image, how might we label pixels as object and background?

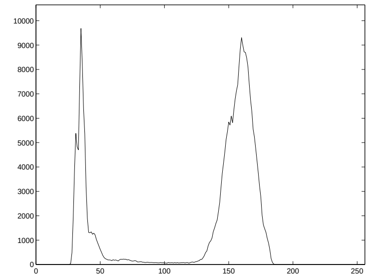


Thresholding Introduction

Key technique: thresholding
Assume pixel values are separable

Part and typical distribution





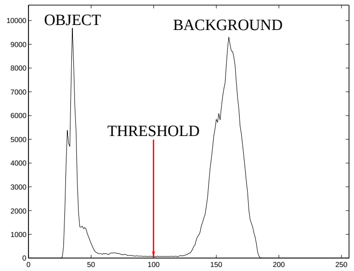
Spread: not quite uniform illumination + part color variations + sensor noise

Thresholding Algorithm

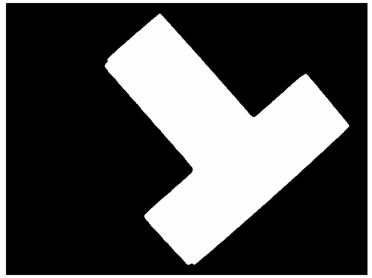
Thresholding: central technique

```
for row = 1 : height
 for col = 1 : width
  if value(row,col) < ThreshHigh % inside high bnd
  % & value(row,col) > ThreshLow % optional low bnd
      output(row,col) = 1;
  else
      output(row,col) = 0;
  end
```


Thresholding Example 1



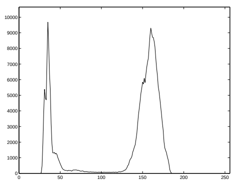
Histogram



Thresholded Image

Threshold Selection 1

Exploit bimodal distribution



But:

- Distributions broad and some overlap $->$ misclassified pixels
- Shadows dark so might be classified with object
- Distribution has more than 2 peaks

So: smooth histogram to improve shape for selection

Convolution

General purpose image (and signal) processing function

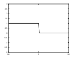
Computed by a weighted sum of image data and a fixed mask

Linear operator: conv(a*B,C) = a*conv(B,C)

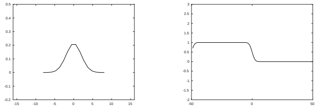
Used in different processes: noise removal, smoothing, feature detection, differentiation, ...

Convolution in 1D

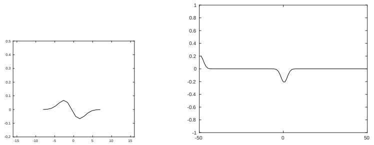
$$Output(x) = \sum_{i=-N}^{N} weight(i) * input(x - i)$$

Input: 

Gaussian Mask and Output:



Derivative of Gaussian Mask and Output:

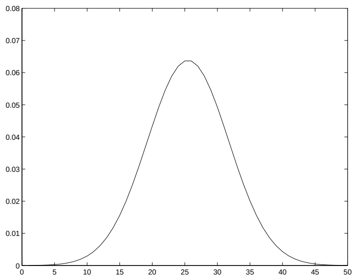


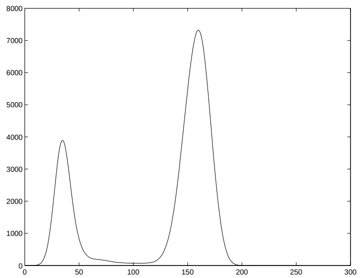
Histogram Smoothing for Threshold Selection

Histogram Smoothing (in `findthresh.m`)
Convolve with a Gaussian smoothing window

```
filterlen = 50;                              % filter length
thefilter = gausswin(filterlen,sizeparam); % size=4
thefilter = thefilter/sum(thefilter); % unit norm
tmp2=conv(thefilter,thehist); % makes longer output
% select corresponding portion
offset = floor((filterlen+1)/2);
tmp1=tmp2(offset:len+offset-1);
```


Convolved Histogram Example



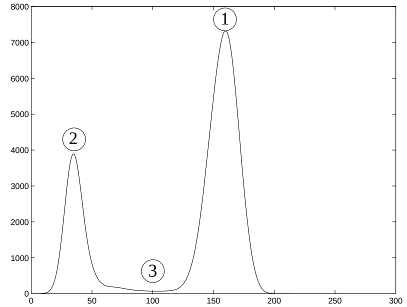


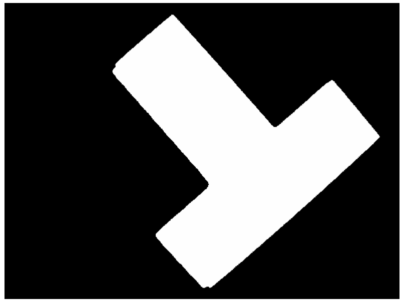
FILTER SHAPE SMOOTHED HISTOGRAM

Threshold Selection 2

Assume 2 big peaks, brighter background is higher:

1. Find biggest peak (background)
2. Find next biggest peak in darker direction
3. Find lowest point in trough between peaks





Peak Pick Code

Omit special cases for ends of array and closing 'end's.

```
peak = find(tmp1 == max(tmp1));   % find largest peak

% find highest peak to left
xmaxl = -1;
for i = 2 : peak-1
  if tmp1(i-1) < tmp1(i) & tmp1(i) >= tmp1(i+1) ...
  & tmp1(i)>xmaxl
      xmaxl = tmp1(i);
      pkl = i;

% find deepest valley between peaks
```

 Slide credit: Bob Fisher

```
xminl = max(tmp1)+1;
for i = pkl+1 : peak-1
  if tmp1(i-1) > tmp1(i) & tmp1(i) <= tmp1(i+1) ...
  & tmp1(i)<xminl
      xminl = tmp1(i);
      thresh = i;
```

 Slide credit: Bob Fisher

Lecture Overview

1. Thresholding to differentiate object from a constant and simple background (not just white backgrounds: see also *bluescreening* or *chroma keying*)
2. 1D Convolution
3. Histogram smoothing & threshold selection

 Slide credit: Bob Fisher