



# Computer Vision

## Segmentation

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## Segmentation

**Overview:**

- **Threshold**
  - **Manual**
  - **Automatic**

## Threshold Manual

- **Threshold**
- **Threshold Tool**
- **Threshold Local (*)**
- **Threshold Hysteresis (*)**

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## Threshold (manual)

**Threshold (image, low, high)**

**The threshold operator takes a greyscale image and produces a binary image.**

**If low <= high then all pixel values in the range [low..high] are converted to the value Object (=1) and all other pixel values are converted to the value Background (=0).**

**If low > high then all pixel values not in the range (high..low) are converted to the value Object and all other pixel values are converted to the value Background.**

**Usage: information reduction**

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## Demonstration Threshold (manual) (*)

- **Open image circles.jl**
- **Threshold image 0 120**
- **Threshold image 120 0**
- **Invert (Threshold 120 0) != Threshold 0 120, demonstrate with Difference operator**
- **Invert (Threshold 121 -1) = Threshold 0 120, idea: border belongs to object**

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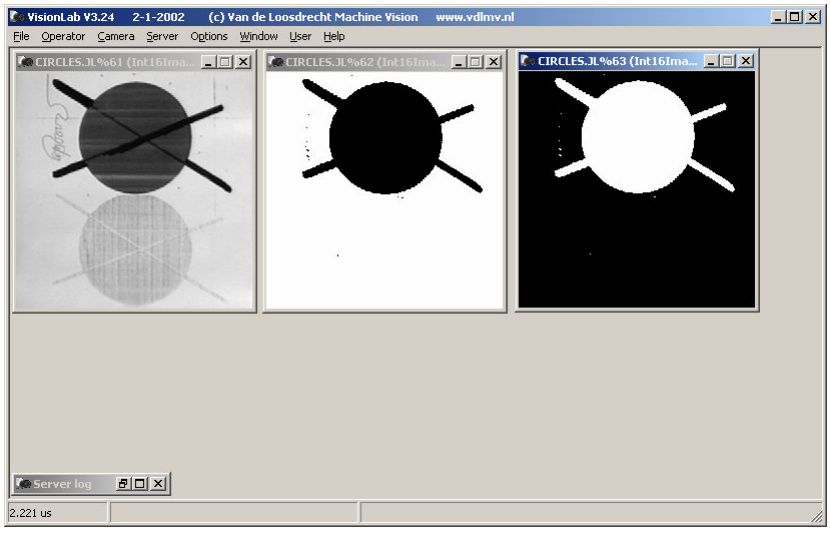
## Threshold image 0 120 Threshold image 120 0 (*)

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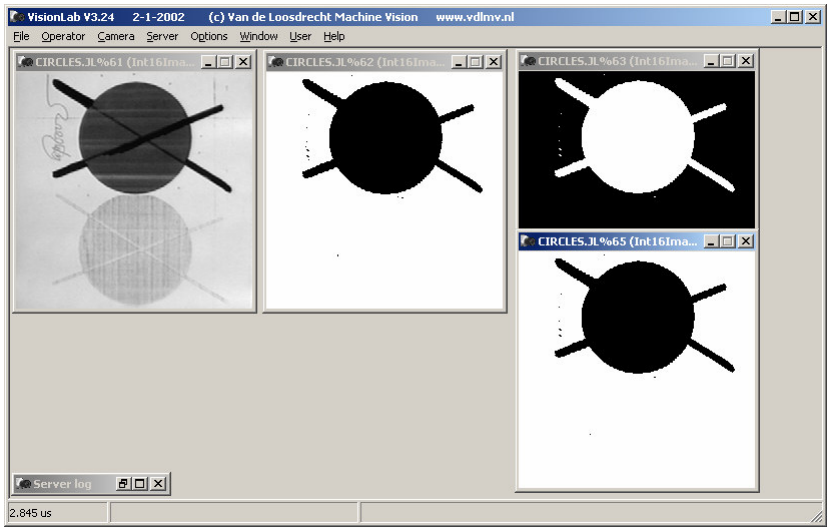
**Threshold image 0 120 != Invert(Threshold image 120 0) (*)**

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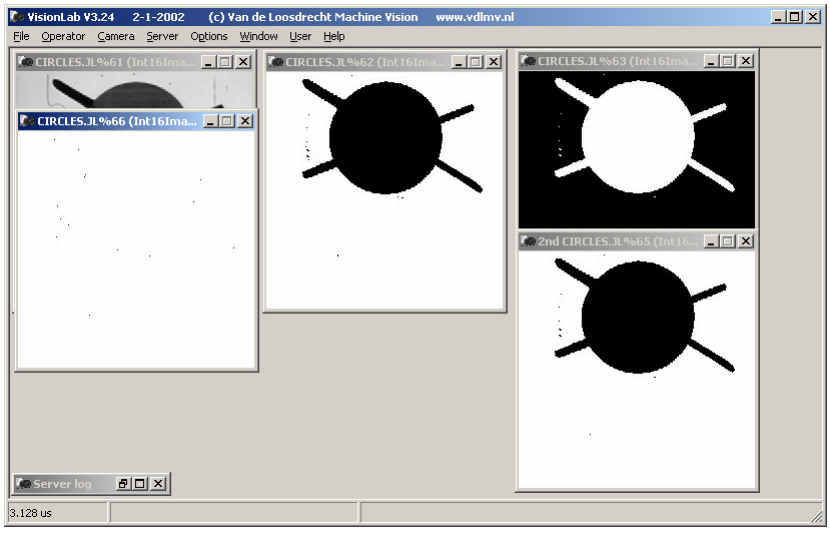
**Threshold image 0 120 != Invert(Threshold image 120 0) (*)**

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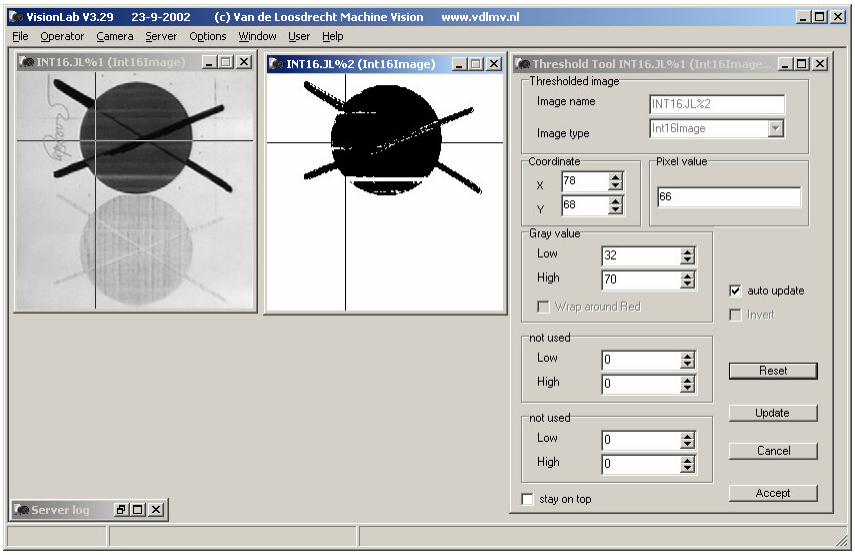
## Threshold Tool

**With this tool you can threshold interactively an image by selecting the object pixels with the mouse cursor**



## Demonstration Threshold Tool



## Special manual threshold operators

- **ThresholdSimple (image, thres, bright|dark)**
- **ThresholdFast (image, low, high, min, max)**
- **ThresholdMulti (image, $th_1$, $th_2$, … ,$th_n$)**
- **ThresholdOnHighest (image)**
- **ThresholdOnLowest (image)**
- **ThresholdOnLowestButZero (image)**

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## Demonstration Threshold (manual) (*)

- **Open image circles.jl (no slides for example)**
- **ThresholdSimple 120 DarkObject**
- **ThresholdFast 0 120 0 255, uses LUT, is faster then normal threshold**

- **Open image circles.jl**
- **Threshold 0 120**
- **LabelBlobs EightConnected**
- **BlobAnalysis Area Height TopLeft Width**
- **ThresholdMulti 2 7 8, in order to select the 3 biggest objects**

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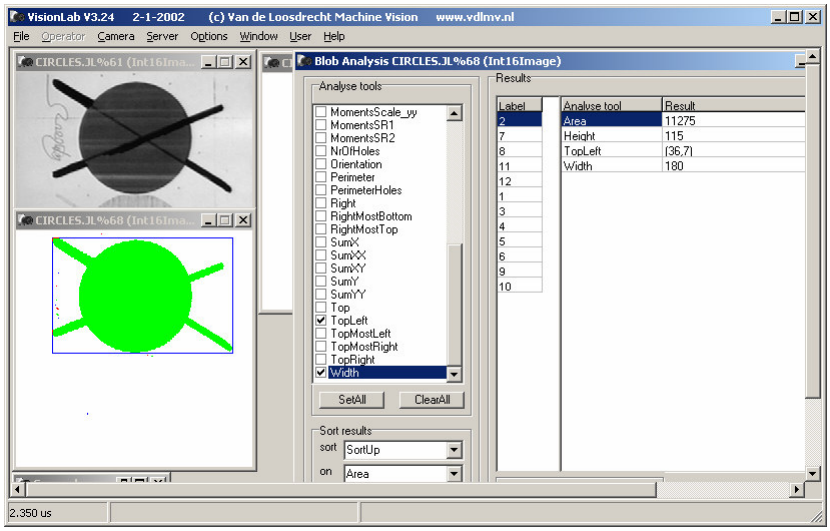
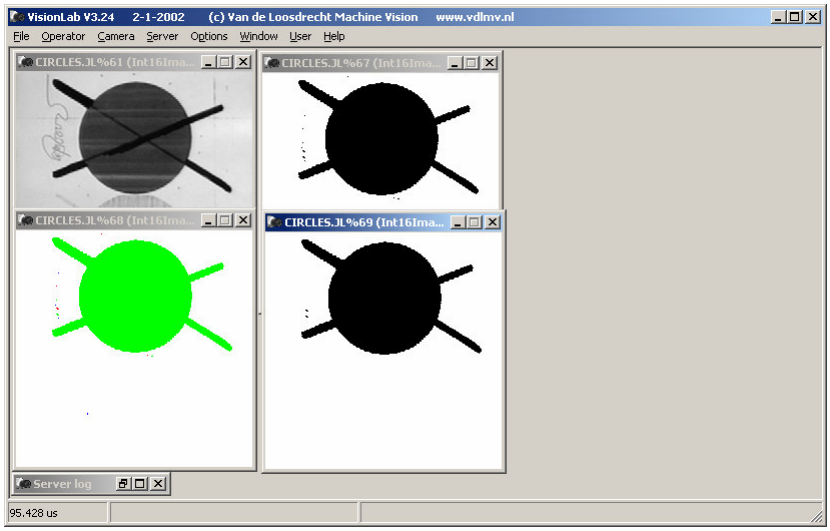
## After BlobAnalysis (*)






## ThresholdMulti 2 7 8 (*)



## Demonstration Threshold (manual) (*)

- **Open image circles.jl**
- **Threshold 0 120**
- **LabelBlobs EightConnected**
- **BlobMeasure Area 100 UseX, label number is replaced by area of blob**
- **ThresholdOnHigest, selects largest object**
- **ThresholdOnLowestButZero, selects smallest object**

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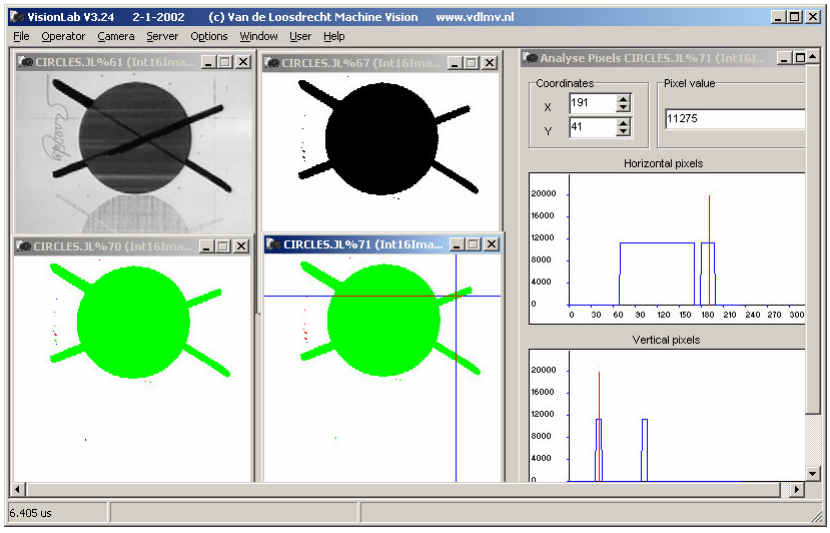
## BlobMeasure Area (*)

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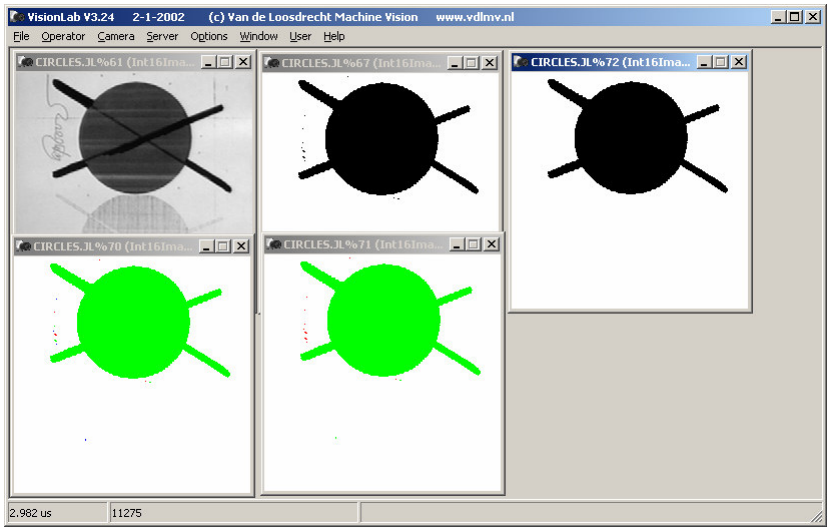
**ThresholdOnHigest (*)**

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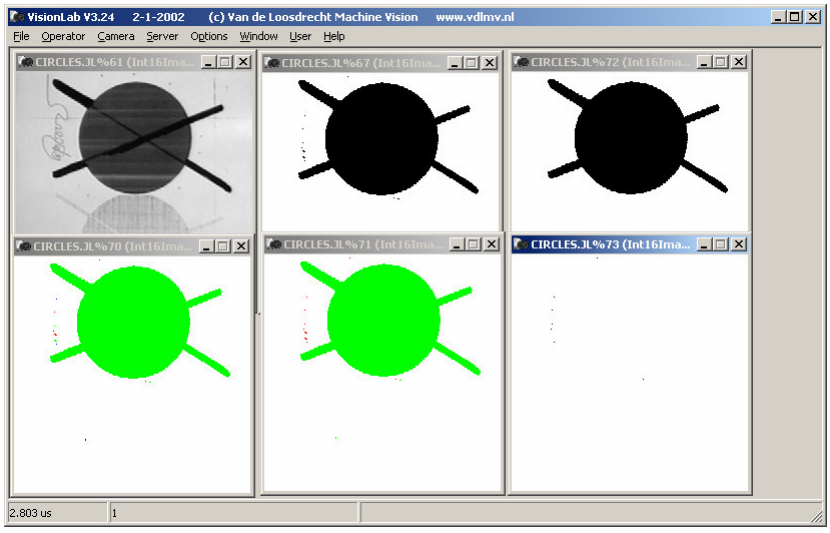
**ThresholdOnLowestButZero (*)**

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## Threshold Local (*)

**ThresholdLocal (image, mask, bright|dark)**

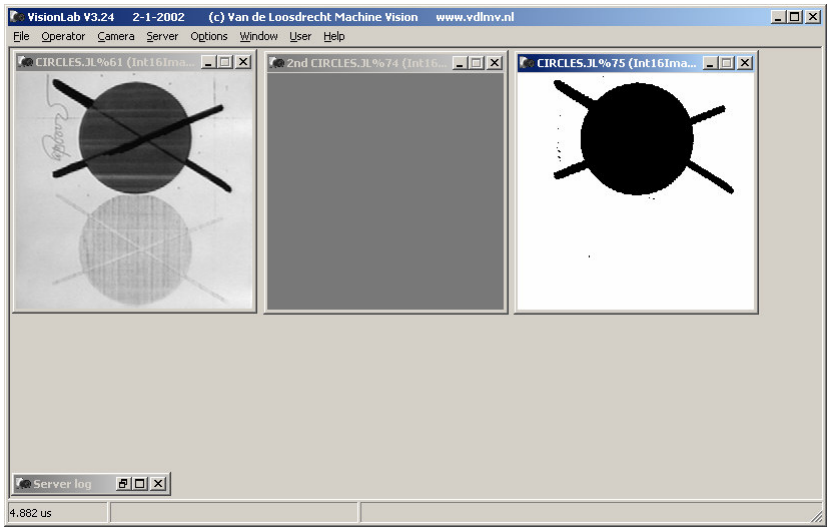
**This operator uses the pixel values in the mask image as an individual threshold value for each pixel the image.**



## Demonstration Threshold Local (*)

- **Open image circles.jl**
- **SetAllPixels 120**
- **Select as 2nd image**
- **ThresholdLocal circles.jl 2ndImage, used later for dynamic thresholds**

**ThresholdLocal with mask image with value 120 everywhere (*)**

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**Exercise Threshold local (*)**

- **Use image backsubdiv.jl in the images directory**
- **Use analyse pixel to analyse image**
- **Generate a suitable mask image using ramppattern in Operator|Synthetic menu**

- **See threslocal.jls for answer**

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## Threshold Hysteresis (*)

**ThresholdHysteresis (image low high connected)**

**The thresholdhysteresis operator takes a greyscale image and produces a binary Image.**

**If high >= low then all pixels with a value greater than high are selected as object pixels. These object pixels are used as seeds. All connected neighbours of the seeds with a pixel value greater than low are added to the object pixels. This growing process is repeated until no pixels are added.**

**If high < low then all pixels with a value smaller than high are selected as object pixels. These object pixels are used as seeds. All connected neighbours of the seeds with a pixel value smaller than low are added to the object pixels. This growing process is repeated until no pixels are added.**

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## Demonstration Threshold Hysteresis (*)

- **Open image thres_hyst.jl**
- **Analyse image with analyze pixels:**
  - **background = 25**
  - **left disk = 50**
  - **right disk = [40 .. 125]**
- **Problem: select complete right disk only**
- **Threshold image 40 255, gives both disks**
- **Threshold image 100 255, gives right disk but it is to small**
- **ThresholdHysteresis 40 100 EightConnected**

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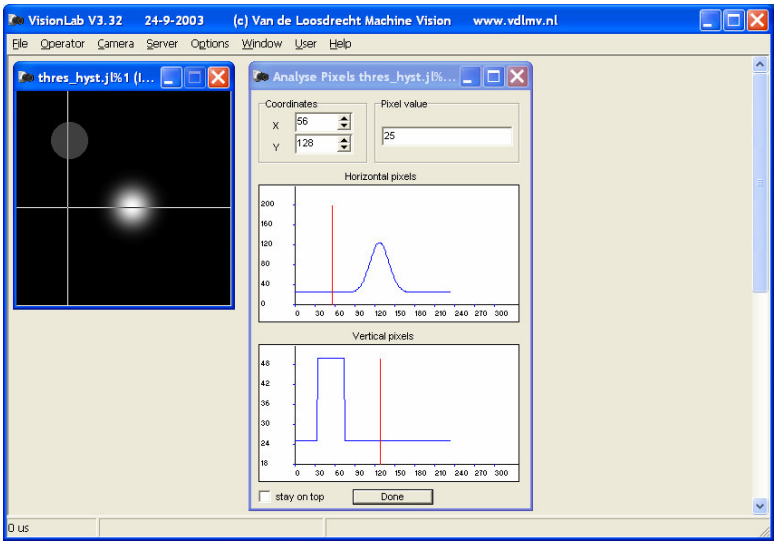
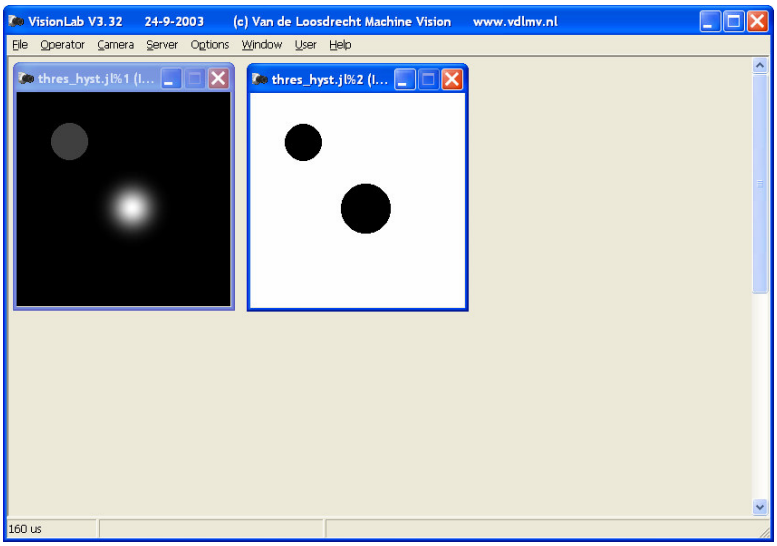
**Analyse image (*)**

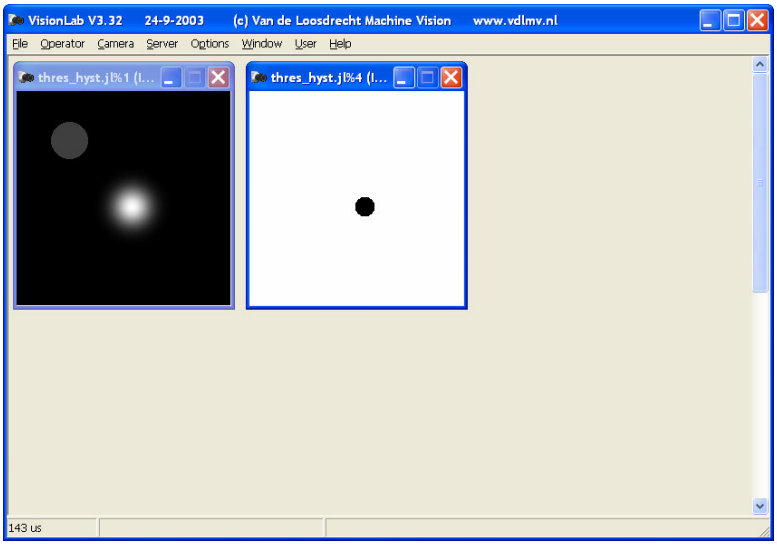





**Threshold 40 255 (*)**



**Threshold 100 255 (*)**

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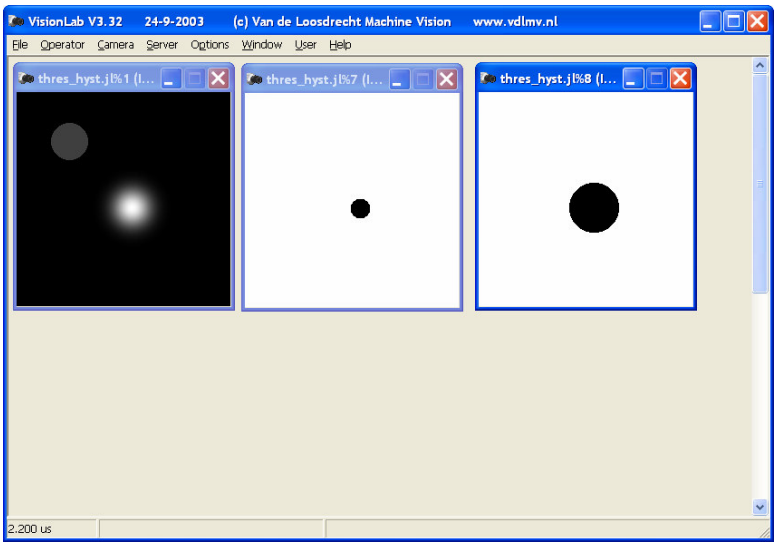
**ThresholdHysteresis 40 100 EightConnected (*)**

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## Automatic Thresholding

- **Threshold Iso Data**
- **Robust Automatic Threshold Selection (RATS) ***
- **Local RATS ***



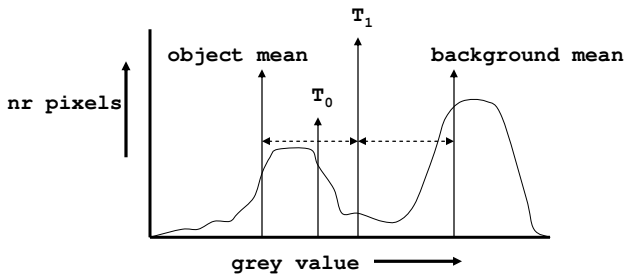
## Threshold Iso Data

**ThresholdIsoData (image, bright|dark)**

**idea:**

- **works good if histogram has a bi-modal distribution**
- **try to find the middle between the bumps**

## Threshold Iso Data




**Algorithm "2-means method":**

- choose any threshold $T_0$
- calculate average grey value left of $T_0$
- calculate average grey value right of $T_0$
- new $T_1$ = average of left and right averages
- iterate until $T_n$ stabilises

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## Threshold Iso Data

**Algorithm:**

- **Converges always**
- **Fast method because it operates on the histogram and not on the image**

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## Demonstration Threshold Iso Data

- **Open image circles.jl**
- **Show frequency histogram, show binomial distribution**
- **ThresholdIsoData DarkObject, note chosen threshold is returned**

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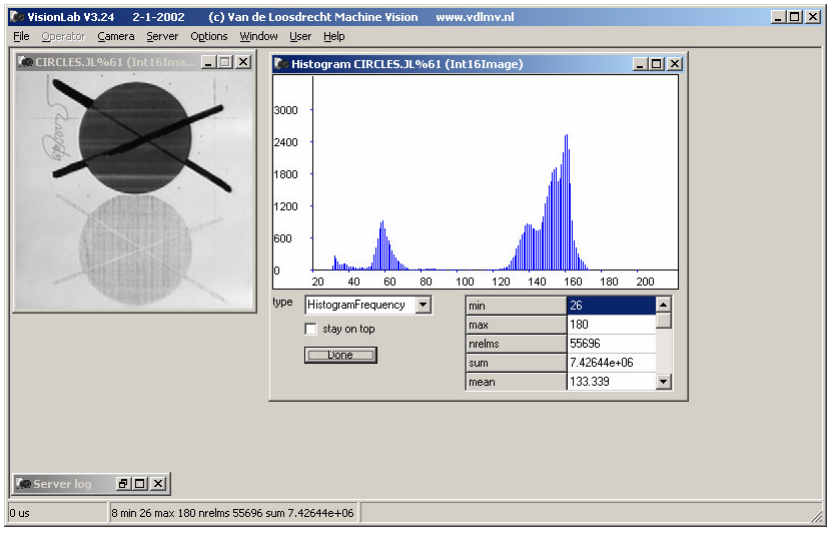
## Frequency histogram, bi-modal distribution

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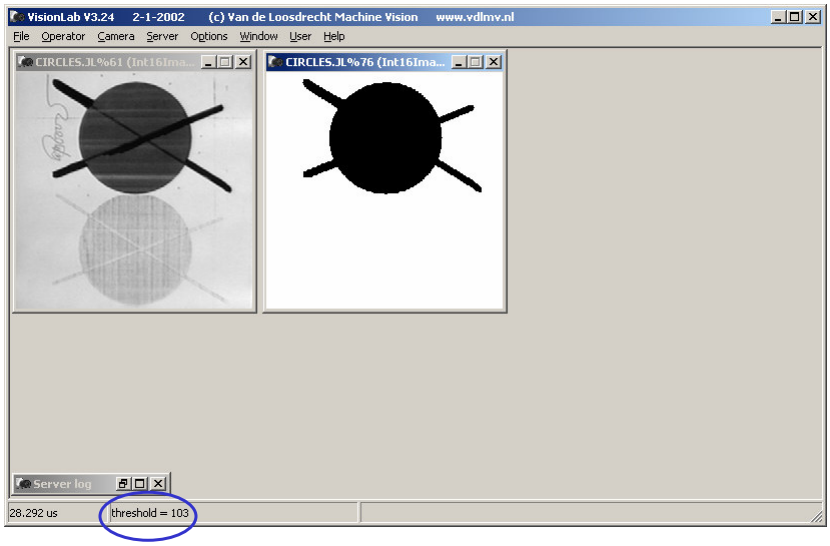
## ThresholdIsoData DarkObject

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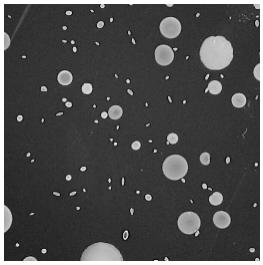
## Exercise Threshold operators



- **Experiment with Threshold, ThresholdTool, ThresholdIsoData on images dice.jl and cells.jl**

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## Robust Automatic Threshold Selection (*)

**Robust Automatic Threshold Selection**

- **RATS (image, minEdge)**
- **ThresholdRATS (image, minEdge, bright|dark)**

**Idea:**

- **Find the strong edges in the image**
- **Chosen threshold value is the weighted mean value of the positions with the strong edges**
- **"How stronger the edge, the more the pixel value contributes to the calculated value"**

  **threshold = sum(image*highEdges) / sum(highEdges)**

**NOTE: because of the internal calculations that are performed at least Int32Images are necessary to avoid overflow**

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## Demonstration RATS (*)

- ***Convert circles.jl to Int32Image***
- **First some explanation about edge detection:**
  - **There will be later a full lecture about edge detection**
  - **Sobel GradientMagnitude 10000 0, analyse pixels result**
  - **Threshold 100 10000, to find the strong edges**
- **RATS circles32.jl 100,**
  **returns optimal threshold value**
- **ThresholdRats circles32.jl 100 DarkObject,**
  **executes the threshold operation also.**
  **Almost the same result as ThresholdIsoData for this image, but based on a different method (no bi-modale distribution needed).**

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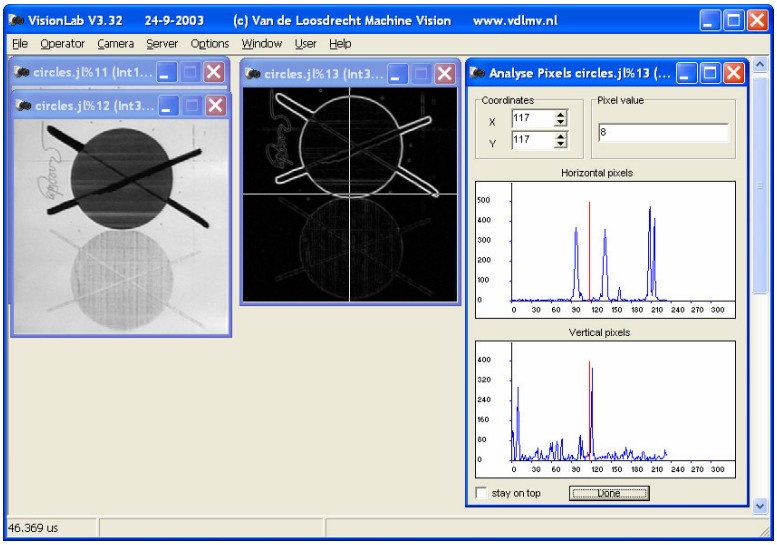
**Sobel GradientMagnitude 10000 0 (*)**

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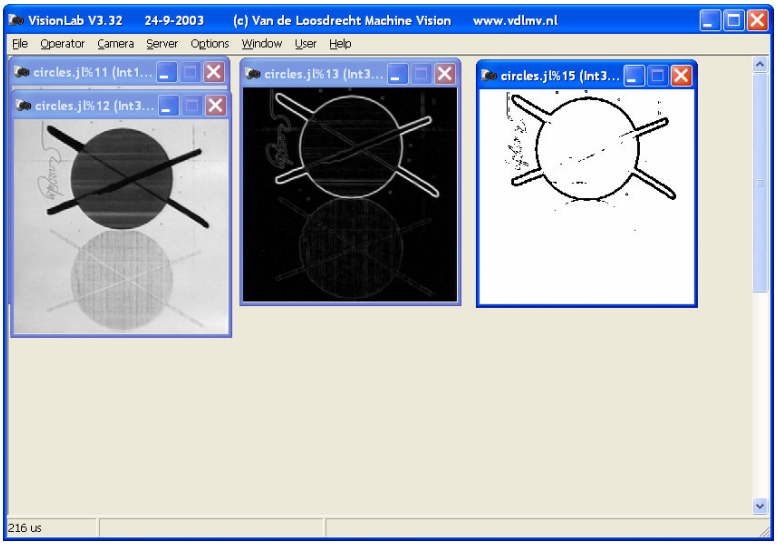
**Threshold 100 10000, to find the strong edges (*)**

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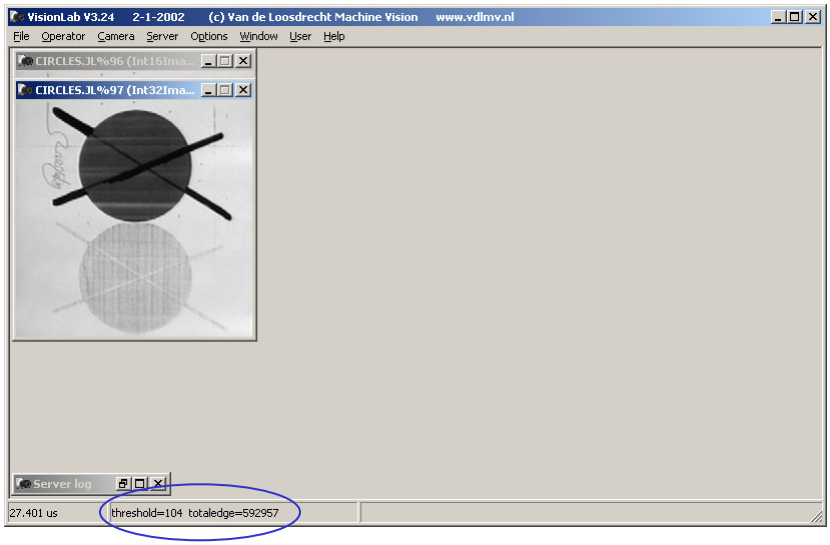
**RATS circles32.jl 100 (after conversion to Int32Image) (*)**

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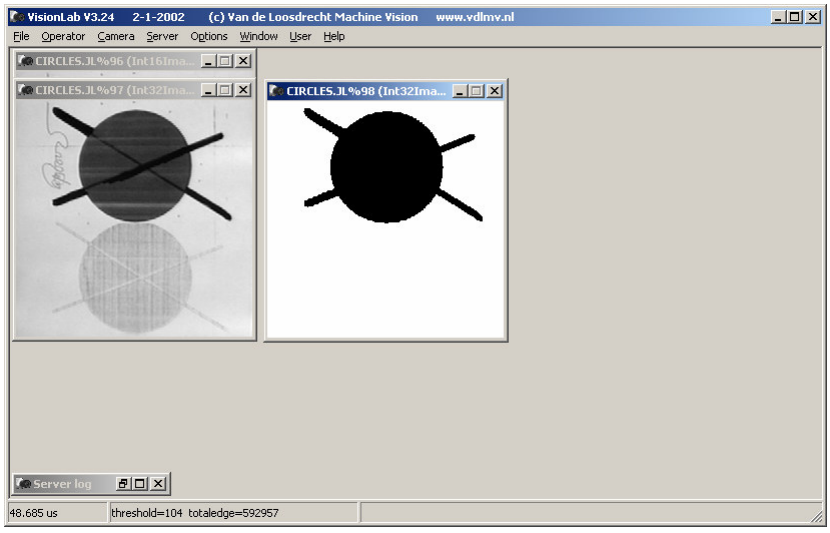
**ThresholdRats circles32.jl 100 DarkObject (*)**

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## Threshold RATSLocal (*)

**Local Robust Automatic Threshold Selection**

- **RATSLocal (image, mask, minEdge, minAvgEdges, nrLevels)**
- **ThresholdRATSLocal (image, minEdge , minAvgEdges, nrLevels, bright|dark)**

**Idea:**

- **The image is subdivided in small squares, nrLevels deep making a quad tree**
- **For each square a local threshold is calculated using RATS, If the average edge value in a square is below minAvgEdges, the square inherits the local threshold value of the next higher square in the quad tree.**
- **With the local threshold values a mask image is build.**

**NOTE: because of the internal calculations that are performed at least Int32Images are necessary to avoid overflow**

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## Demonstration RATSLocal (*)

- **Open image circles.jl and *convert to Int32Image***
- **Zoom circles32.jl 256 256 BilinearPixelInterpolation, size restrictions for RATSLocal, see on-line help**
- **RATSLocal circles32.jl 50 5 5, creates maskImage**
- **ThresholdLocal circles32.jl maskImage DarkObject, explain result, explain holes**
- **ThresholdRATSLocal circles32.jl 50 5 5 DarkObject**

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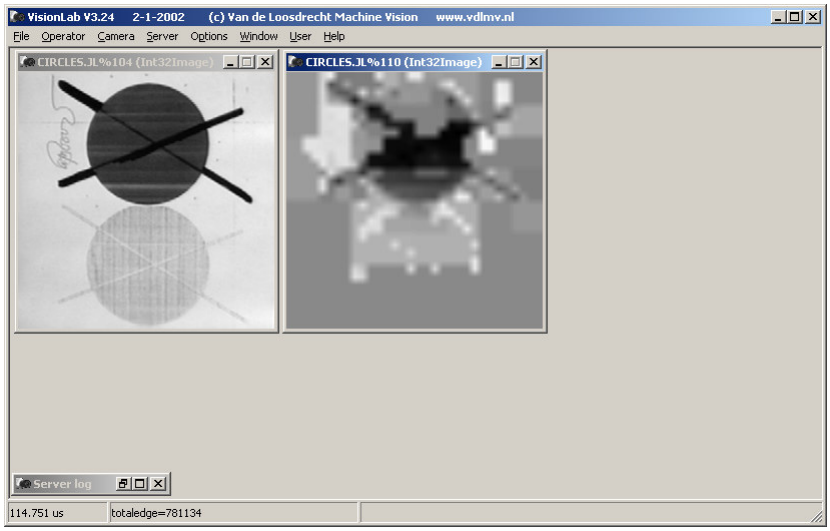
**RATSLocal 50 5 5, creates maskImage (*)**

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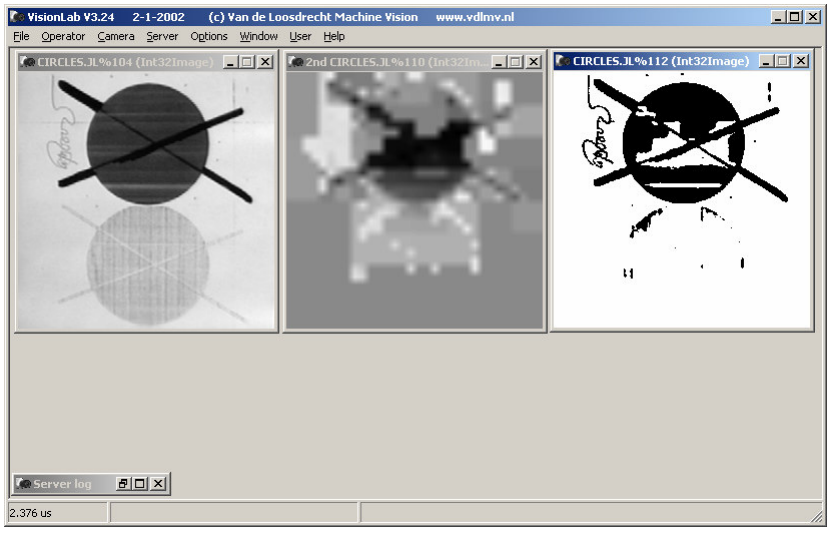
**ThresholdLocal circles.jl maskImage DarkObject (*)**

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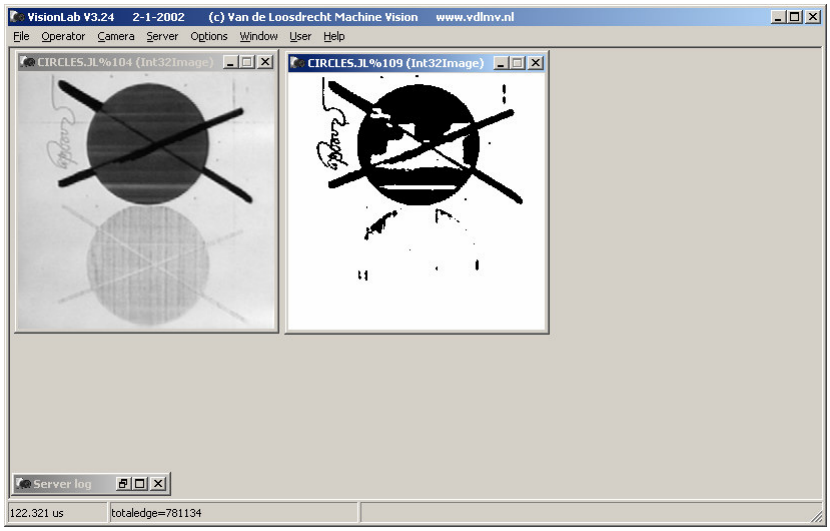
**ThresholdRATSLocal circles.jl 50 5 5 DarkObject (*)**

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**Explanation ThresholdLocal results (*)**

**NrLevels determines the size of the smallest 'square' in the quadtree. Rule of thumb is that this square should be in the same order of size as the objects which are to be found**

**In the previous example the complete dark bal with his legs are found with NrLevels = 2**

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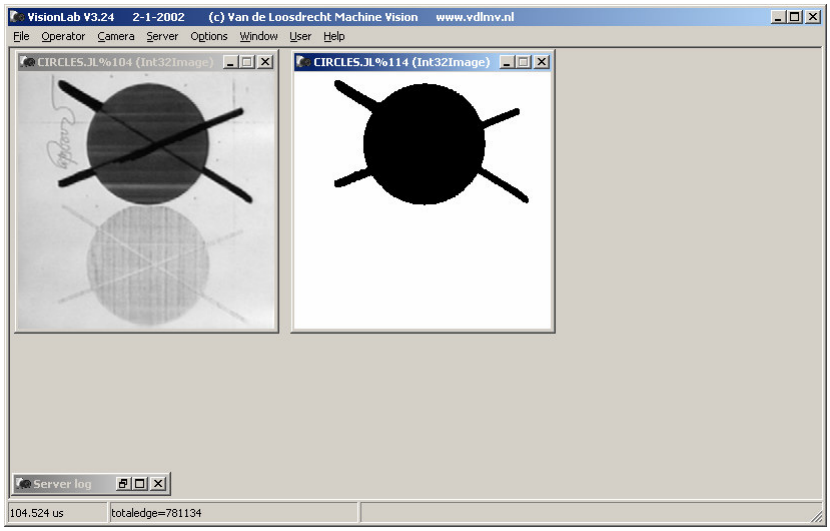
## ThresholdLocal with NrLevels = 2 (*)

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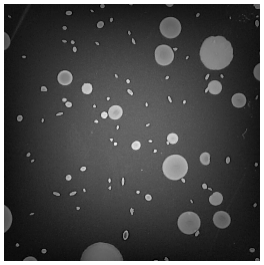
## Exercise Thresholding (*)



- **Use image shading_c.jl in the exercise directory**
- **Use analyse pixel to analyse image**
- **Try to find a correct manual threshold**
- **Use ThresholdIsoData to threshold, what is the result and why?**
- **Use ThresholdRATSLocal and try to find good parameters.**

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## Feedback exercise Thresholding (*)

- **See shading_c.jls for answer**
- **How to find optimal value for parameter minEdge ?**
  - **Sobel GradientMagnitude**
  - **analyse pixels**
  - **try Threshold 120 10000**
  - **better result after FillHoles, but still problems if incomplete edge of object has been found**
  - **we will return to this exercise in the lecture about ranking operators**