



Computer Vision

Image math and geometric operators

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Noordelijke Hogeschool Leeuwarden and Van de Loosdrecht Machine Vision
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Image math and geometric operators

- Image math
- Geometric operators
 - Rotate and translate
 - Mirror
 - Zoom
 - Warping, morphing and tweening
- Miscellaneous
 - Copy
 - Convert
 - Insert (*)
 - ROI
 - ROIR (*)
 - SumColumns, SumRows
 - TransitionsColumns and TransitionsRows (*)

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Image math

- **Add (subtract) constant value to all pixels**
 - Adjust brightness
- **Add images**
 - Extends exposure time (no Schwarzschild effect)
 - Average out distortions and noise
- **Subtract images**
 - Background elimination (logarithmic sensor)
 - Motion detection
- **Multiply (divide) image with constant value**
 - Adjust brightness
- **Multiply images**
 - Selection with use of mask image
- **Divide images**
 - Background elimination (linear sensor)

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Demonstration Image math

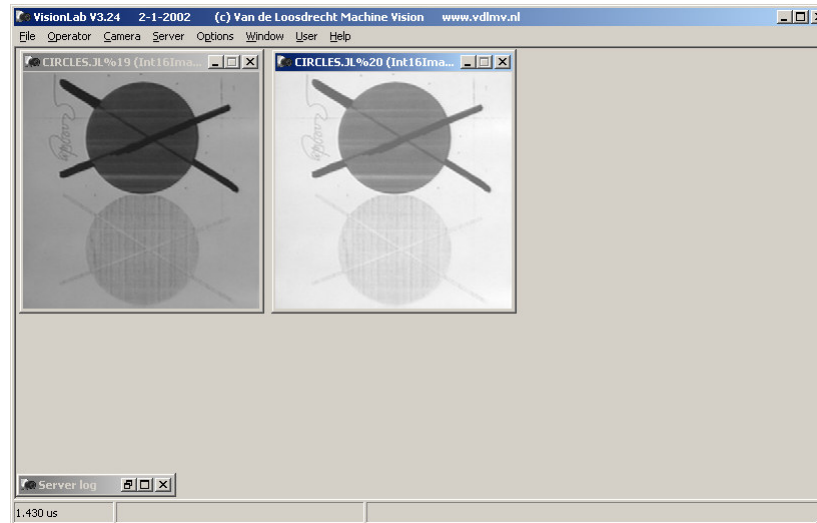
- Open image circles.jl
- Demo add pixel 80, use LUT = clip
- Close circles.jl
- Demo subtract images: motion detection of people in the audience
note: camera is necessary !

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Add Pixel 80



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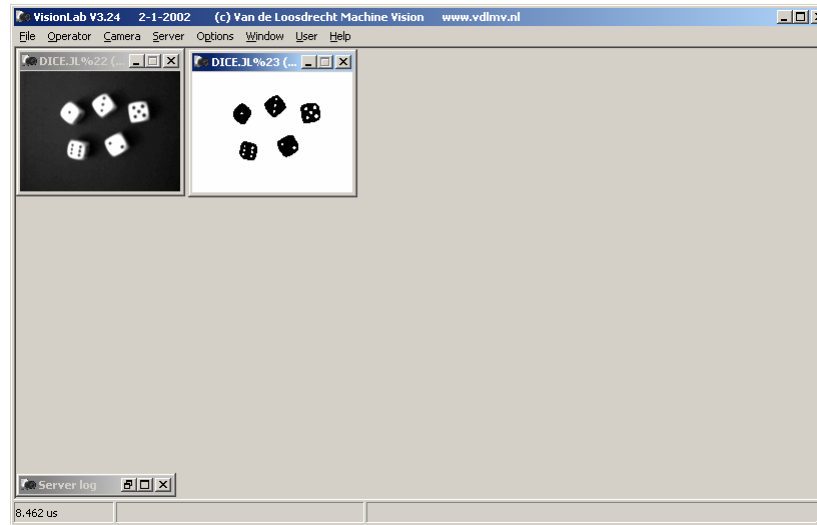
Demonstration Image math usage of mask

- Demo selection with use of mask image, get grey values of 'dice 6'
 - open image dice.jl
 - threshold 180 255
 - labels blobs, analyse pixels -> the six has labelNr 5
 - threshold 5 5
 - Fillholes (from segmentation menu)
 - multiply with original image:
 - everything is zero
 - the six has its original values
- **Do not close images, they are needed for a next example**

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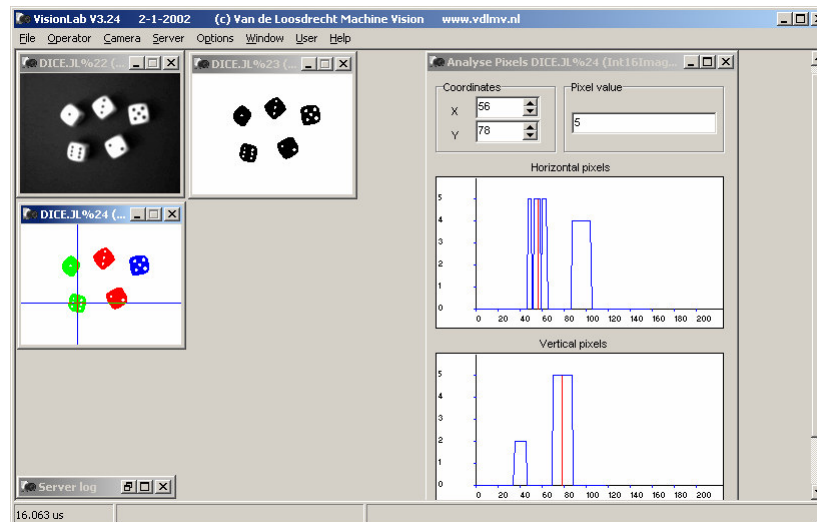
6

Threshold 180 255

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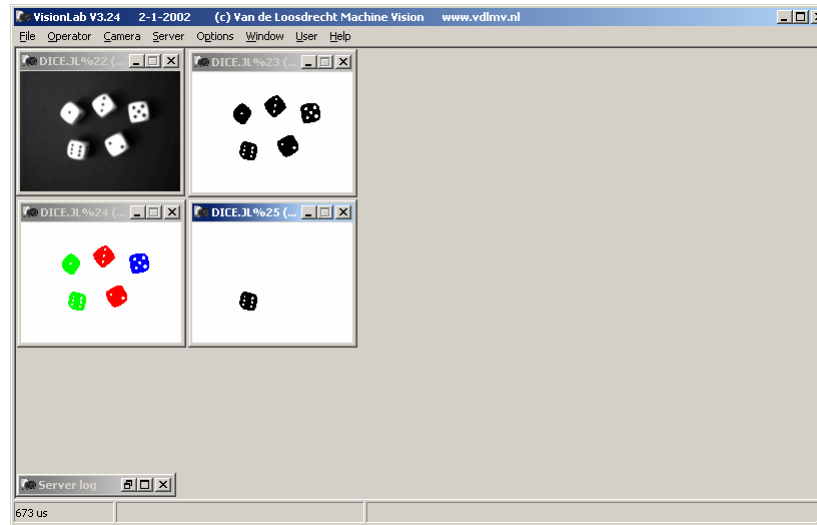
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Labels blobs, analyse pixels -> the six has labelNr 5

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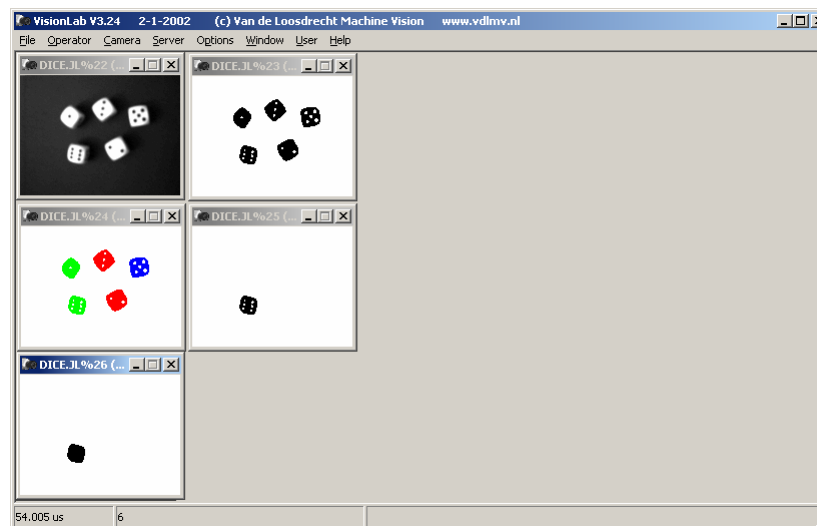
8

Threshold 5 5

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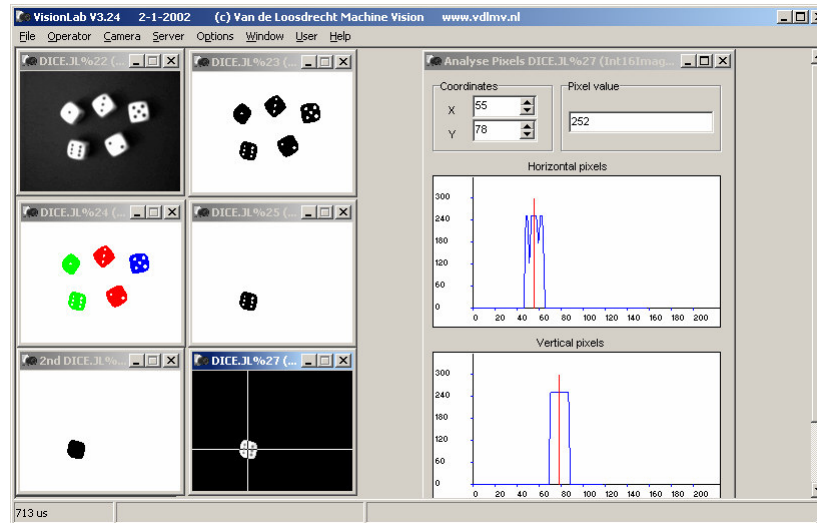
Fill holes

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Multiply with original image



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Image math for binary images

Binary images:

- Background = 0
- Object = 1

Used for masking operations:

- And
- Or
- Exor
- Not

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Demonstration Or operator

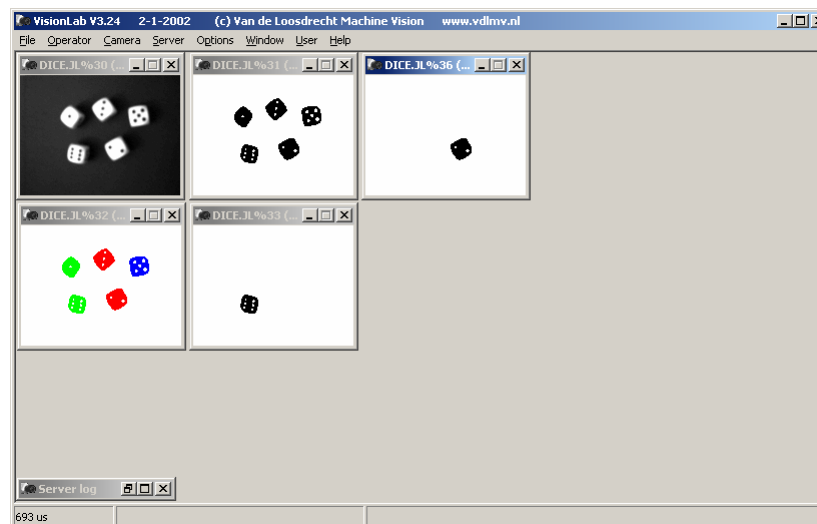
- Demo or:
 - threshold 4 4 on labelled image, in order to select dice 'two'
 - or this image with binary image of the six
 - Note: adding has the same result if blobs do not overlap

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Threshold 4 4 on labelled image

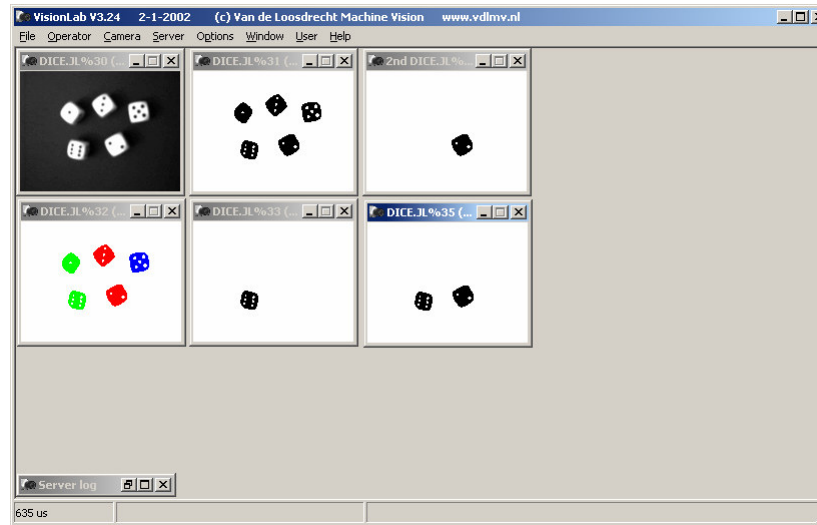


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'Or' this image with binary image of the six



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Image math

- Invert image
- Remainder images
- Min images
- Max images
- Mean images

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Demonstration Image math

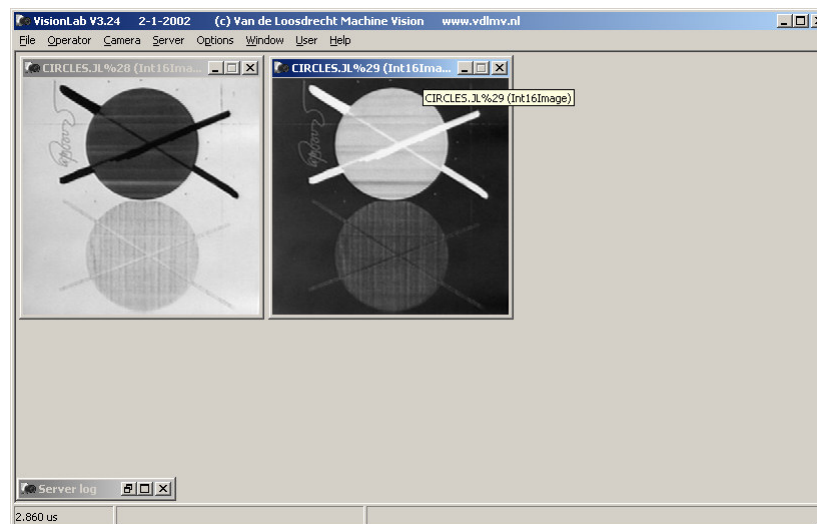
- Demo invert image on circles.jl

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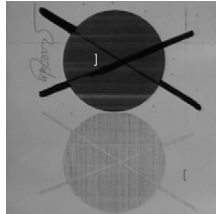
Invert image



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Exercise using masks**Image h1.jl**

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Exercise using masks**Use Int16Image h1.jl with has values in range [0..255]**

- a) write a script which changes all pixel with value 255 to 0, all other pixels are not changed
- b) write a script which changes all pixel with value 100 to 0, all other pixels are not changed
- c) write a script which changes all pixel with value 100 to 10, all other pixels are not changed
- d (*)) as c) write a script which replaces all pixels with a specified mask value by a specified new value and add this script as a new operator to VisionLab, the value of the maskpixel and the value of the new pixel value must be supplied as a parameter to the script
- e (*)) make your own c++ operator with functionality of d) and add it to VisionLab

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Exercise using masks

see for answers:

- h1a.jls
- h1b.jls
- h1c.jls
- h1d.jls + h1d.ini (note: script h1d.jls should be in current directory)
- e) to be done

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Background subtract versus division

Purpose: to correct an inhomogeneous illumination

Strategies:

- **Logarithmic sensor:** subtract images
- **Linear sensor:** divide images

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Demonstration background subtract versus division

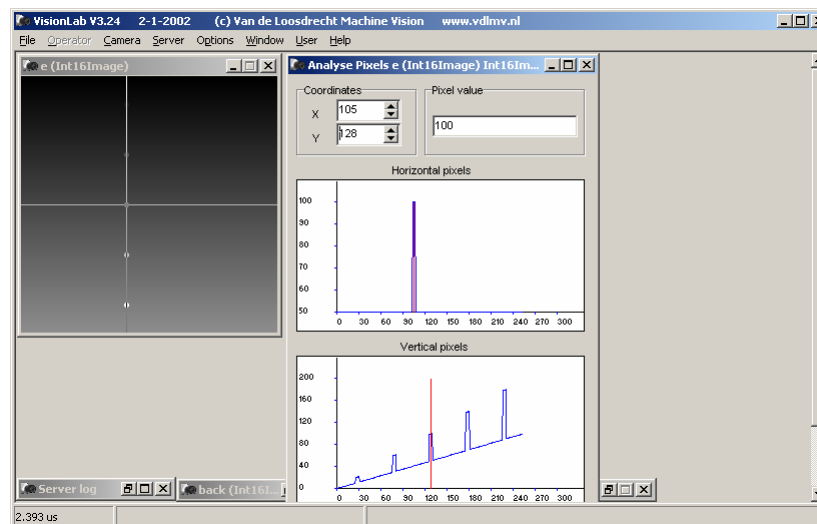
- **Note:** MaximumFilter and MinimumFilter operations are explained later
- Open image backsubdiv.jl (or use script backsubdiv.jls)
- Demonstrate that thresholding is impossible, threshold 100 255
- **subtract:**
 - read e backsubdiv.jl
 - minimumfilter e em EdgeExtend octagon7x7
 - maximumfilter em back EdgeExtend octagon7x7
 - copy e sub
 - subtract sub back
 - see result with analyse pixels
 - Threshold 10 255 finds the dots
- **divide:**
 - convert e ef FloatImage
 - convert back backf FloatImage
 - // to avoid dividing zero and dividing by zero
 - addpixel ef 0.1 // note: use . and not ,
 - addpixel backf 0.1
 - copy ef divf
 - divide divf backf
 - see result with edit pixels

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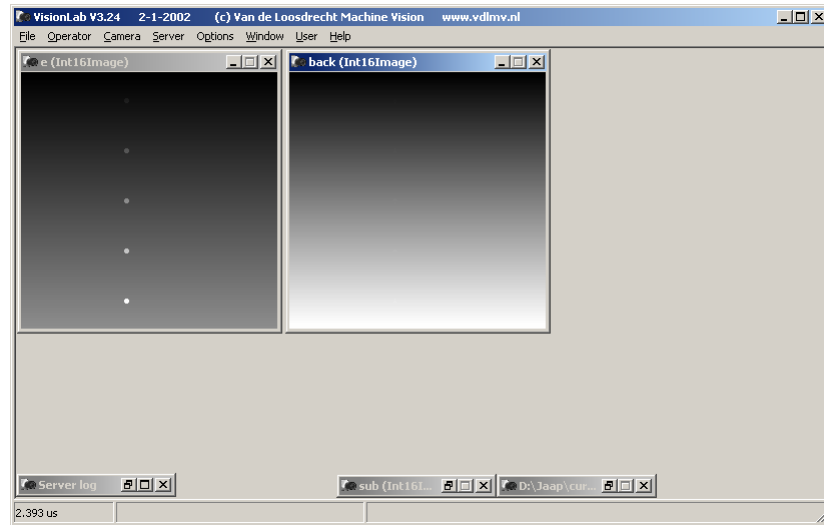
Analyse test image



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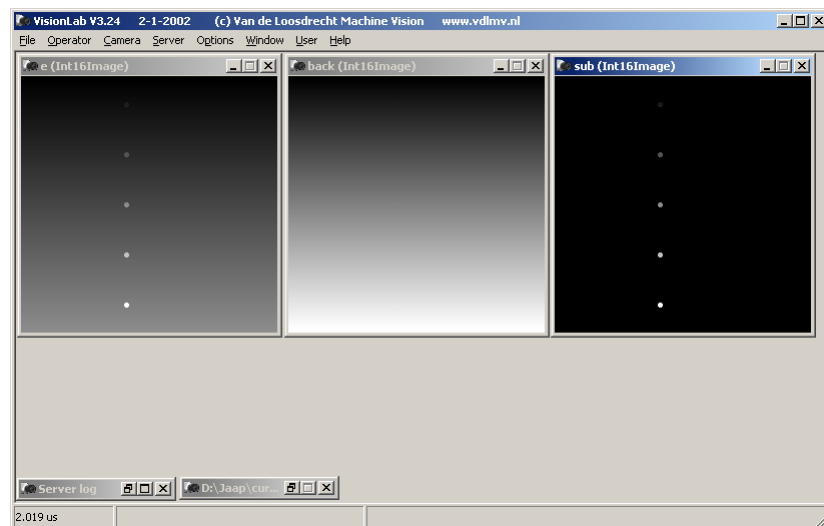
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Generate background

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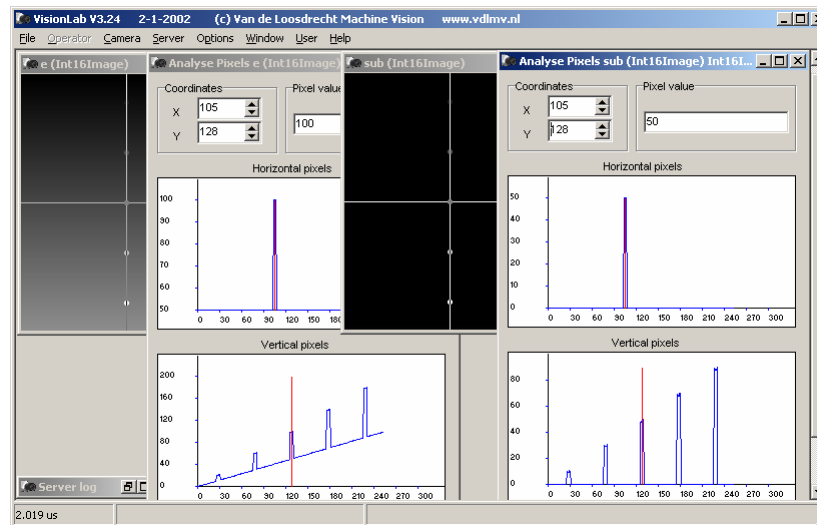
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Subtract background

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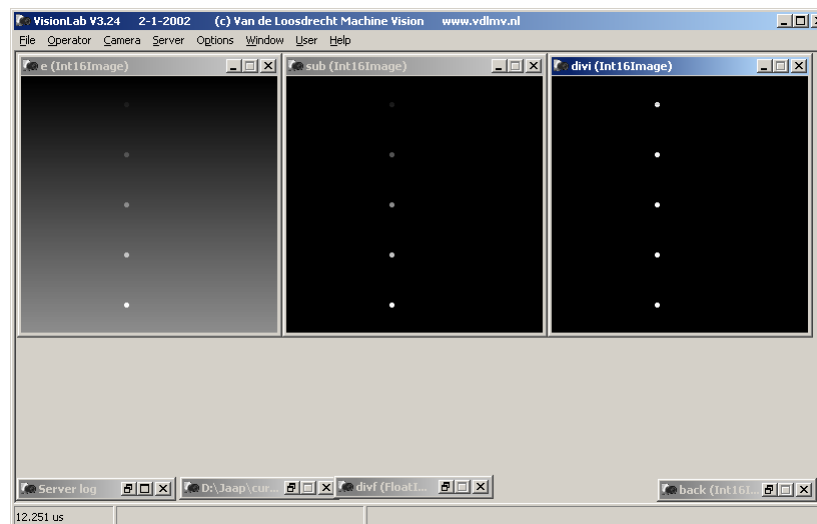
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Analyse result subtraction

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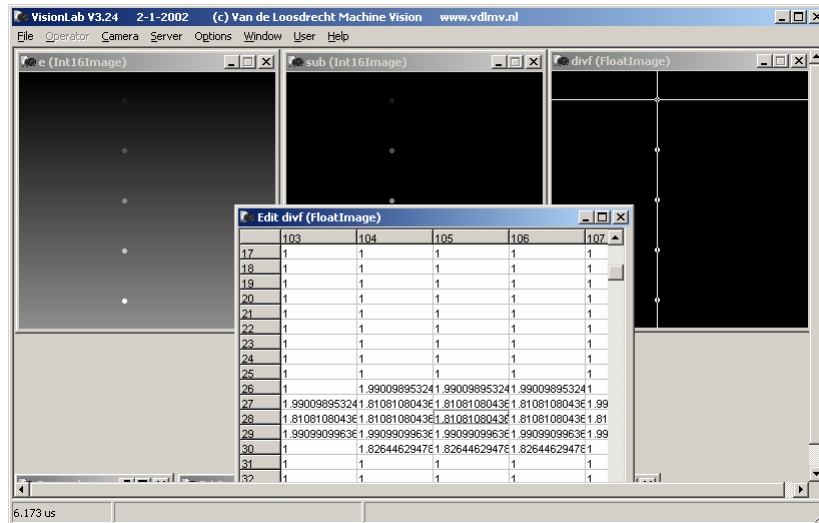
Divide with background

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Analyse result division



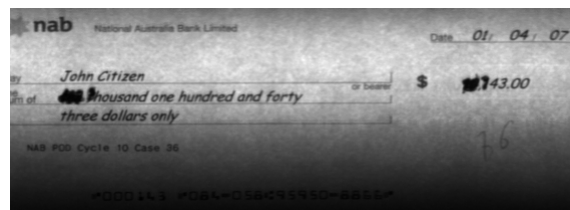
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Exercise: background subtract versus division

Image cheque.jl taken with a line scan camera



Correct the background using a subtract and a divide
 Hint: Use ROI and ExtendBorder to generate a background image

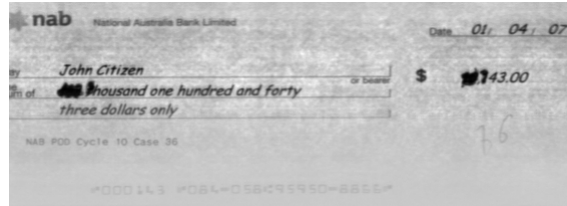
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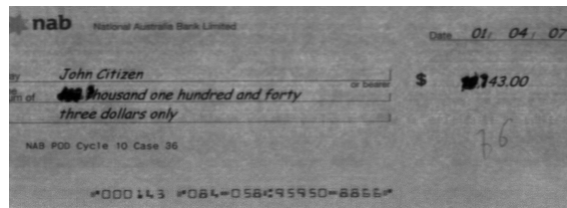
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Solution: background subtract versus division

Subtract:
Cheque_subtract.jl



Divide:
Cheque_divide.jl



Answer: cheque_bg.jls

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Geometric operations

Translation:

$$x' = x + x_t$$

$$y' = y + y_t$$

Rotation:

$$x' = (x+x_c) * \cos(\beta) - (y+y_c) * \sin(\beta)$$

$$y' = (x+x_c) * \sin(\beta) + (y+y_c) * \cos(\beta)$$

Problems

- Image is rotated (translated) off the view area
- Pixel interpolation
 - Nearest pixel
 - Bilinear interpolation

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Geometric operations

Mirror:

- In centre
- In X-axis
- In Y-axis

Zoom (Scaling):

- Zoom (height,width)
- ZoomXY (factorX,factorY)
- Reduce2 (Used for speeding up calculations)
- Enlarge2
- Binning (summing or averaging)

Polar stretch:

- This operator stretches and bends a part of a circle to a rectangular shape.

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Geometric operations

Warping:

- Rubber band stretching

Morphing:

- Repeatedly applying of warping
- Used mainly in computer graphics

Tweening:

- Calculate images between a start and stop image giving a smooth transformation
- Used mainly in video editing

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Demonstration geometric operations

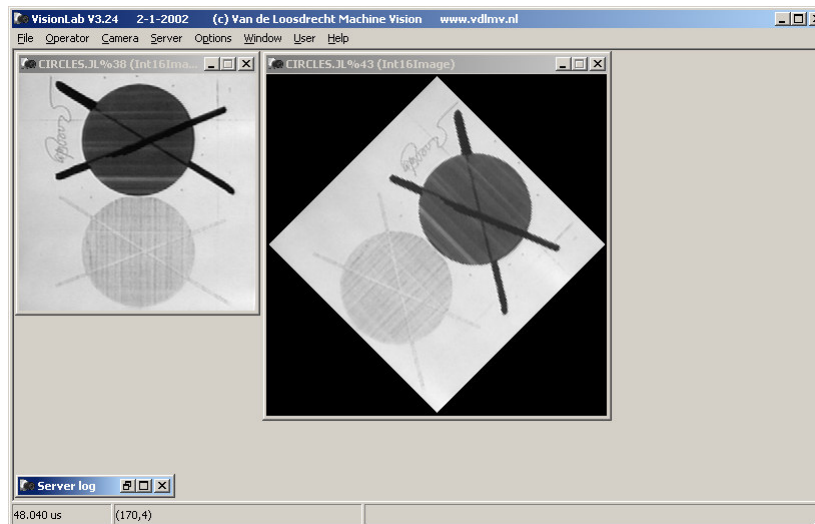
- use image circles.jl
- demonstrate Rotate and RotateFull
- demonstrate difference between Nearest Pixel and Bilinear
- explain 'backwards' implementation
- demonstrate Mirror, Reduce2, Enlarge2, Zoom and ZoomXY
- Note: Enlarge2 is much faster then Zoom(2)
- Demonstrate Polar stretch on image polartest.jl, with params 109 109 0 0 200 150 0 BilinearPixelInterpolation
- Demonstrate Warp with warp_demo.jls

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Rotate Full with nearest pixel interpolation

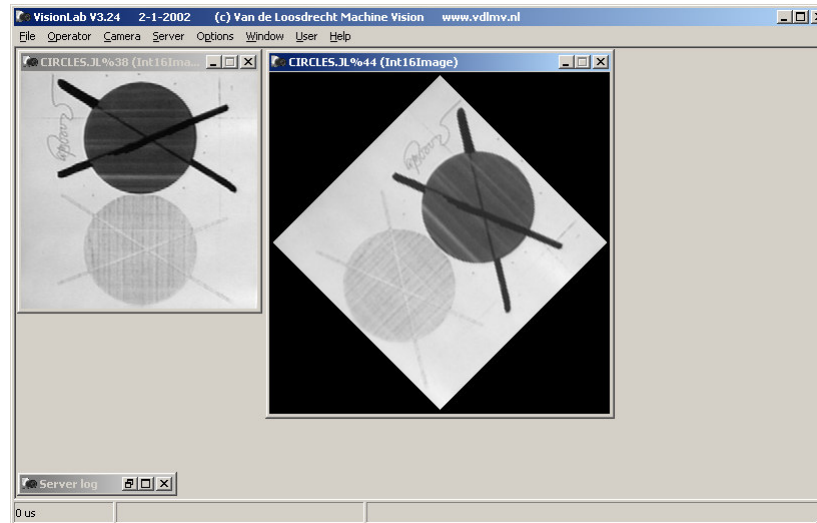


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Rotate Full with bilinear pixel interpolation

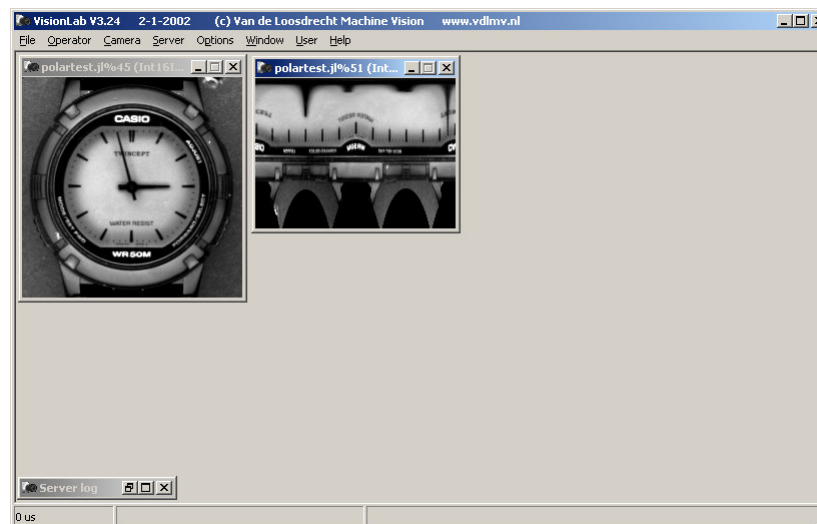


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Polar Stretch

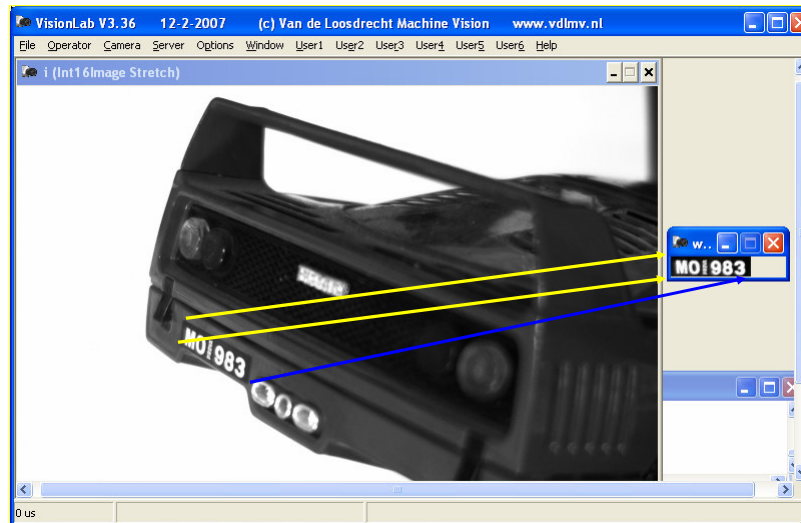


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Warp forward

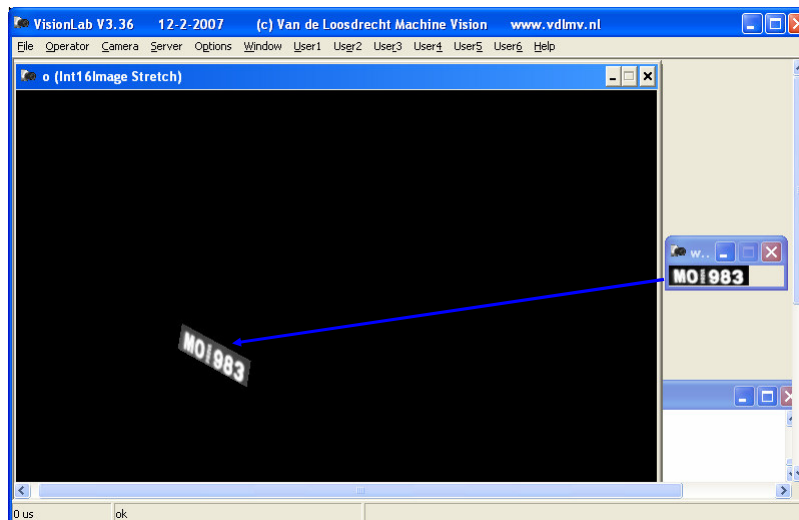


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Warp Reverse



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Miscellaneous

Copy:

- **Make a copy of image**

Convert

- **Convert image to another type:**

ByteImage, ComplexFloatImage, ComplexDoubleImage, DoubleImage, FloatImage, HSV888Image, HSV161616Image, Int8Image, Int16Image, Int32Image, RGB888Image, RGB161616Image, YUV888Image and YUV161616Image.

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Miscellaneous

ROI:

- **Region Of Interest**
- **copy aligned rectangle from image**

ROIR:

- **Region Of Interest Rotated**
- **copy arbitrary rotated rectangle from image**

SumColumns and SumRows:

- **The columns or rows of the image are summed**

Insert:

- **Insert image in another image**

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Demonstration Convert and ROI

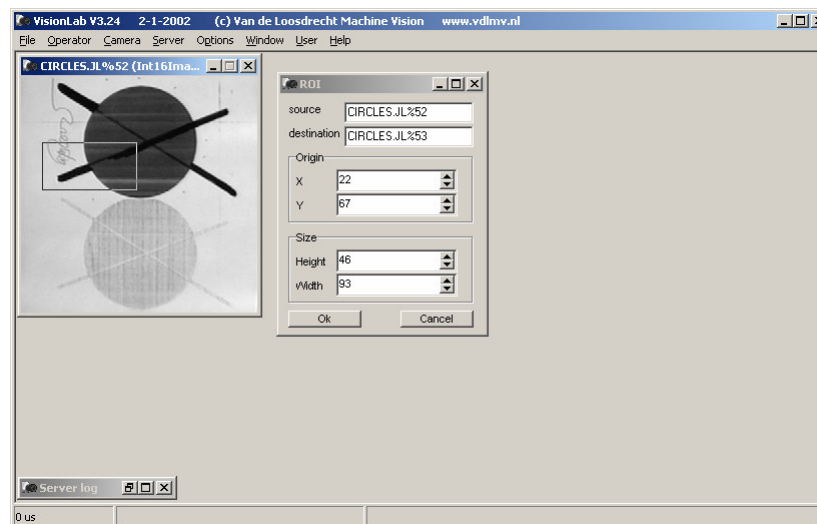
- Use image circles.jl
- Demonstrate Convert (no slides)
- Demonstrate ROI

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Demonstration of ROI

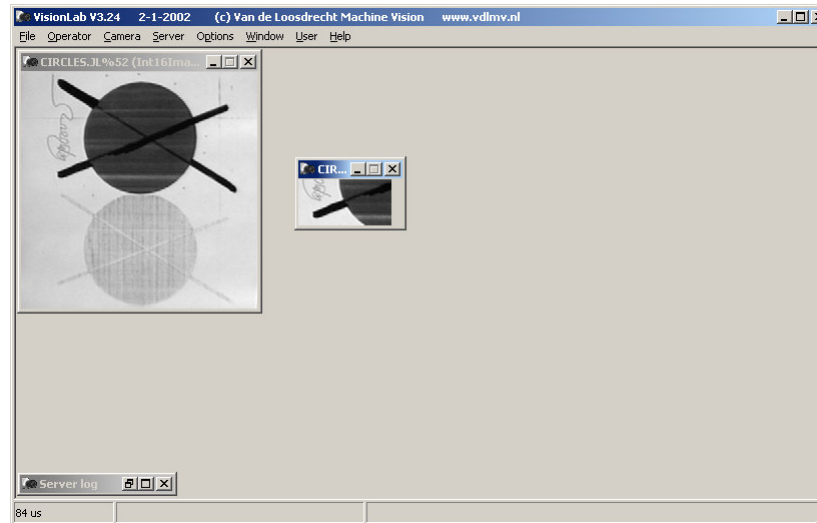


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Demonstration of ROI



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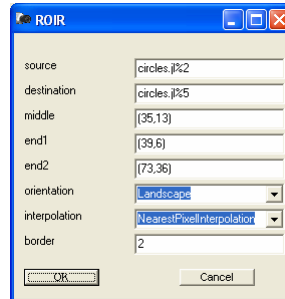
Demonstration ROIR and Insert (*)

- Use image circles.jl
- Demonstrate ROIR
 - ROIR (35,13) (39,6) (73,36) Landscape BilinearPixelInterpolation 2
- Demonstrate Insert, insert result of ROIR somewhere in circles

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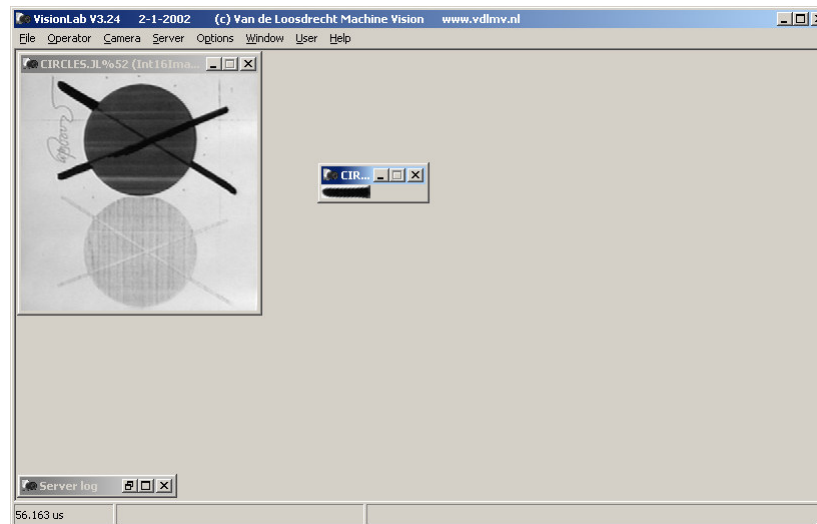
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ROIR parameters (*)

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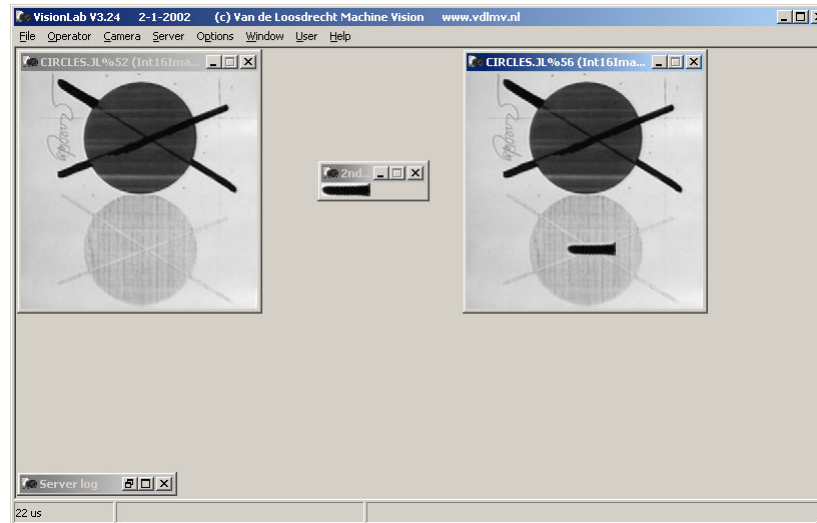
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ROIR (*)

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Insert (*)

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SumColumns and SumRows**SumColumns and SumRows:**

- The columns or rows of the image are summed into an image with height or width of 1 pixel

Usage:

- For creating “thickness profiles”

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Demonstration SumColumns

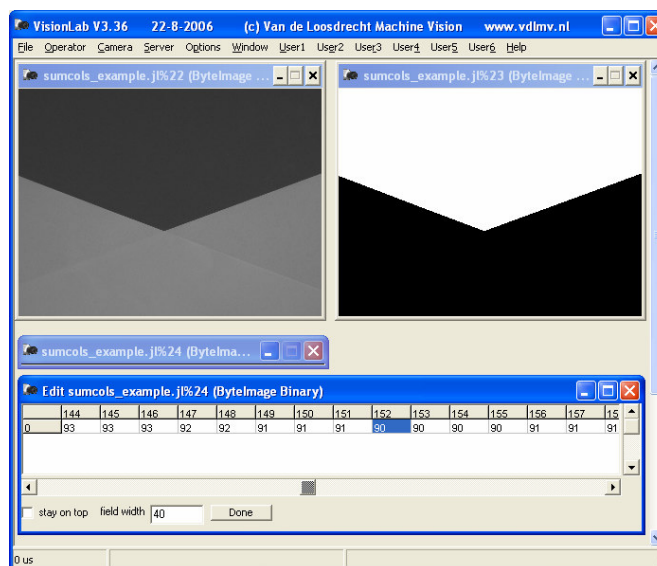
- Open `sumcols_example.jl`
- `ThresholdIsoData BrightObject`
- `SumColumns` (from Point menu)
- Set LUT to Stretch
- Show result of `SumColumns` with Edit

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Demonstration SumColumns



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TransitionsColumns and TransitionsRows

TransitionsColumns src destination threshold

TransitionsRows src destination threshold

The columns or rows of the src image are scanned for transitions. The number of transitions are stored in the destination image.

A transition is defined as:

- a pixel has value lower then threshold and its neighbour column or row pixel has a value greater or equal threshold
- or
- a pixel has value greater or equal then threshold and its neighbour column or row pixel has a value lower threshold

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Demonstration TransitionsColumns/Rows (*)

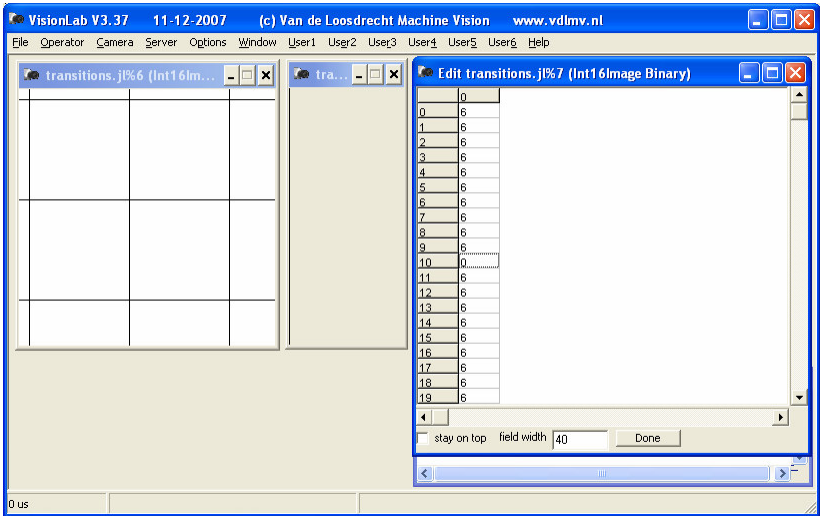
- Open transitions.jl
- TransitionsRows 1
- Examine result with Edit image
- TransitionsColumns 1
- Examine result with Edit image

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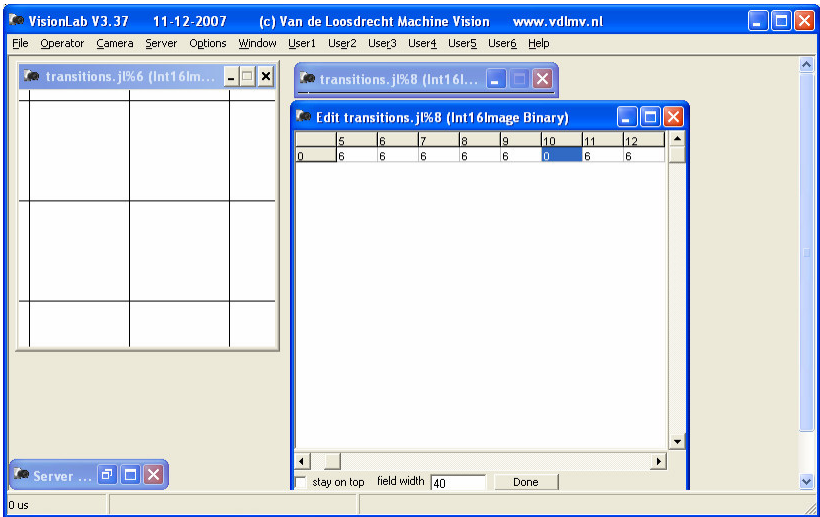
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TransitionsRows (*)



TransitionsColumns (*)



Exercise

- **Experiment with the basic operators**
- **The basic operators will be needed in other exercises**

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