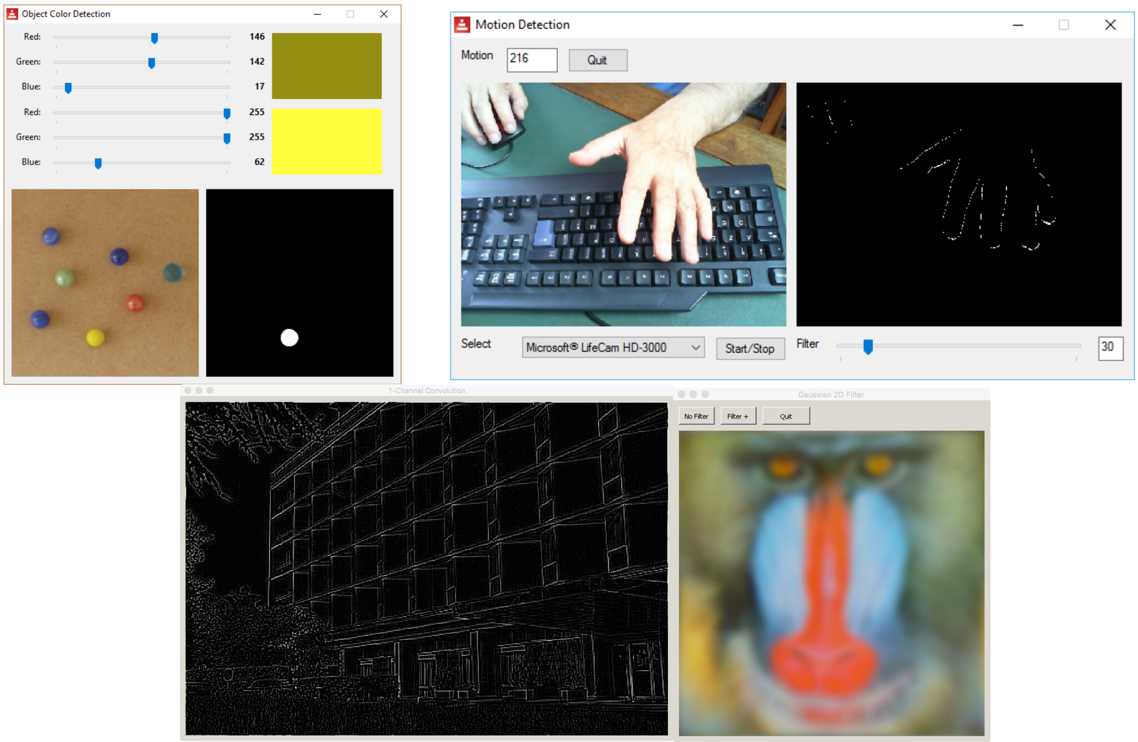
RedCV Open Source Computer Vision Library



What is RedCV

RedCV means Red Language Open Source Computer Vision Library. It is a collection of Red functions and routines that give access to many popular Image Processing algorithms.

The key features

RedCV provides cross-platform high level API that includes about 150 functions. RedCV has no strict dependencies on external libraries. RedCV is free for both non-commercial and commercial use.

Who created it

The list of authors and major contributors:
François Jouen for the library development.
Thanks to Tarek Hamouda for the library optimization.
Thanks to Nénad Rakocevic and Qingtian Xie for developing Red and their constant help.
Thanks to Didier Cadieu for samples optimization.

Where to get RedCV

Go https://github.com/ldci/redCV.

Using RedCV Library

Most of functions are calling Red/System routines for faster image rendering. All redCV routines can be directly called from a red program (not for newbies). For a more convenient access, Red/System routines are exported as red functions. All red routines are prefixed with underscore (e.g. _rcvCopy). Only red functions are documented.

All includes to redCV libraries are declared in a single file (/libs/redcv.red). You just need including *redcv.red* file in your Red programs.

```
[
#include %core/rcvCore.red              ; Basic image creating and processing functions
#include %highgui/rcvHighGui.red        ; Fast Highgui functions
#include %matrix/rcvMatrix.red          ; Matrices functions
#include %imgproc/rcvImgProc.red        ; Image processing functions
#include %math/rcvRandom.red            ; Random laws for generating random images
#include %math/rcvStats.red             ; Statistical functions for images
]
```

```
; all we need for computer vision with Red
#include %../../libs/redcv.red ; for red functions
```

Some lectures
Image Processing in C, by Dwayne Phillips. The first edition of Image Processing in C (Copyright 1994, ISBN 0-13-104548-2) was published by R & D Publications
1601 West 23rd Street, Suite 200
Lawrence, Kansas 66046-0127
Algorithms for Image Processing and Computer Vision (2011) by J.R. Parker, published by Wiley Publishing, Inc.
10475 Crosspoint Boulevard
Indianapolis, IN 46256

RedCV Reference Manual

- Using RedCV library
- Basic structures
- Operations on arrays
- Logical operators on arrays
- Mathematical operators on arrays
- Statistical operators on arrays
- Morphological operators on arrays
- Random generator
- Arrays conversions
- Filters
- Color conversions
- Operations on sub-arrays
- Image transformations
- Highgui functions

Basic Structures

Image

RedCV directly uses Red image! datatype. Loaded images by Red are in ARGB format (a tuple). Images are 8-bit and internally uses bytes [0..255] as a binary string. Images are 4-channels and actually Red can't create 1, 2 or 3-channels images. Similarly Red can't create 16-bit (0..65536) 32-bit or 64-bit (0.0..1.0) images.

Channels can be easily accessed by a pointer

pixel >>> 24	: Alpha (transparency) channel
pixel and FF0000h >> 16	: Red channel
pixel and FF00h >> 8	: Green channel
pixel and FFh	: Blue channel

Matrix

Matrix! Datatype is not yet implemented by Red. We simulate matrices with Red vector! datatype. Work under progress. Matrices are 2-D with n lines *m columns. Matrix element can be Char!, Integer! or Float!

Operations on Arrays

Images

rcvCreateImage

Creates and returns empty (black) image

rcvCreateImage: function [size [pair!] return: [image!]
size : image size width and height as a pair

```
dst: rcvCreateImage 512x512
```

rcvReleaseImage

Releases image data

rcvReleaseImage: function [src [image!]]
src : image to remove

> This function will be probably removed with Red garbage collector development.

rcvLoadImage

Loads image from file

rcvLoadImage: function [fileName [file!] return: [image!] /grayscale]
filename: name of the file to load as a Red file datatype
/grayscale: loads image as grayscale

```
tmp: request-file
if not none? tmp [ img1:  rcvLoadImage  tmp img2: rcvLoadImage  /grayscale]
```

rcvLoadImageB

Load image from file and return image as binary

rcvLoadImageB: function [fileName [file!] return: [binary!] /alpha]
filename: name of the file to load as a Red file datatype
/ alpha: loads image as 4 channels image including alpha channel

rcvSaveImage

Save image to file

rcvSaveImage: function [src [image!] fileName [file!]]
src: image to save
filename: name of the file to save as a Red file datatype

rcvCloneImage

Returns a copy of source image

rcvCloneImage: function [src [image!] return: [image!]]
src: image to be cloned

```
img: recCreateImage 512x512
hsv: rcvCloneImage img
```

rcvCopyImage

Copies source image to destination image

Source and destination image must have the same size!
rcvCopyImage: function [src [image!] dst [image!]]
src: image to be copied
dst: destination

```
img: hsv : recCreateImage 512x512
hsv: rcvCopy img hsv
```

rcvZeroImage

All image pixels to 0

rcvZeroImage: function [src [image!]]
src: image to clear

rcvRandomImage

Creates a random uniform color or pixel random image

rcvRandomImage: function [size [pair!] value [tuple!] /uniform /alea return: [image!]]
size: size of image as pair!
Value: random value as tuple!
/uniform : random uniform color
/alea : random pixels

rcvSetAlpha

Sets image transparency

rcvSetAlpha: function [src [image!] dst [image!] alpha [integer!]]
src: image remains unchanged and transparency is modified for destination image
alpha : transparency value [0..255]
sl: slider 256 [t: 255 - (to integer! sl/data * 255) rcvSetAlpha img1 img2 t]

Matrices

rcvCreateMat

Creates 2D matrix

rcvCreateMat: function [type [word!] bitSize [integer!] mSize [pair!] return: [vector!]]
type: name of accepted datatype: char! | integer! | float!
bitSize: 8 for char!, 8 | 16 | 32 for integer!, 32 | 64 for float!
mSize: matrix size as pair

```
msize: 128x128
mat1: rcvCreateMat 'integer! 8 msize
mat2: rcvCreateMat 'integer! 16 msize
mat3: rcvCreateMat 'integer! 32 msize
```

rcvReleaseMat

Releases Matrix

rcvReleaseMat: function [mat [vector!]]
mat: matrix to be released

rcvCloneMat

Returns a copy of source matrix

rcvCloneMat: function [src [vector!] return: [vector!]
src: matrice to be cloned

rcvCopyMat

Copy source matrix to destination matrix

rcvCopyMat: function [src [vector!] dst [vector!]]
src: matrice to be copied
dst: destination matrix

rcvRandomMat

Randomize matrix

rcvRandomMat: function [mat [vector!] value [integer!]]
mat: destinatiobn matrix
value: random value as integer!

```
mat1: rcvCreateMat 'integer! 8 msize
mat2: rcvCreateMat 'integer! 16 msize
mat3: rcvCreateMat 'integer! 32 msize
rcvRandomMat mat1 FFh
rcvRandomMat mat2 FFFFh
rcvRandomMat mat3 FFFFFFh
```

rcvColorMat

Set matrix color

rcvColorMat: function [mat [vector!] value [integer!]]
mat: destination matrix
value: color value as integer

```
mat1: rcvCreateMat 'integer! 8 msize
rcvColorMat mat1 0 ;
```

Logical Operators on Arrays

Images

rcvAND

dst: src1 AND src2

rcvAND: function [src1 [image!] src2 [image!] dst [image!]]
src1: first image
src2: second image
dst: src1 and src2

rcvOR

dst: src1 OR src2

rcvOR: function [src1 [image!] src2 [image!] dst [image!]]
src1: first image
src2: second image
dst: src1 or src2

rcvXOR

dst: src1 XOR src2

rcvXOR: function [src1 [image!] src2 [image!] dst [image!]]
src1: first image
src2: second image
dst: src1 xor src2

rcvNAND

dst: src1 NAND src2

rcvNAND: function [src1 [image!] src2 [image!] dst [image!]]
src1: first image
src2: second image
dst: src1 nand src2

rcvNOR

dst: src1 NOR src2

rcvNOR: function [src1 [image!] src2 [image!] dst [image!]]
src1: first image
src2: second image
dst: src1 nor src2

rcvNXOR

dst: src1 NXOR src2

rcvNOR: function [src1 [image!] src2 [image!] dst [image!]]

src1: first image
src2: second image
dst: src1 nxor src2

rcvNOT

dst: src1 NOT src2
rcvNOR: function [src1 [image!] src2 [image!] dst [image!]]
src1: first image
src2: second image
dst: src1 not src2

rcvANDS

Tuple value is use to create a colored image which is ANDed to source image. Result is copied to destination
rcvANDS: function [src [image!] dst [image!] value [tuple!]
src: source image
dst: image
value: tuple!

rcvANDS img1 dst 255.0.0.0; dst: add red color to img1

rcvORS

Tuple value is use to create a colored image which is ORed to source image. Result is copied to destination
rcvORS: function [src [image!] dst [image!] value [tuple!]
src: source image
dst: image
value: tuple!

rcvXORS

Tuple value is use to create a colored image which is XORed to source image. Result is copied to destination
rcvXORS: function [src [image!] dst [image!] value [tuple!]
src: source image
dst: image
value: tuple!

Matrices

rcvANDMat

Returns source1 AND source2
rcvAndMat: function [src1 [vector!] src2 [vector!] return: [vector!]
src1: first matrice
src2: second matrice

rcvORMat

Returns source1 OR source2

rcvORMat: function [src1 [vector!] src2 [vector!] return: [vector!]
src1: first matrice
src2: second matrice

rcvXORMat

Returns source1 XOR source2

rcvORMat: function [src1 [vector!] src2 [vector!] return: [vector!]
src1: first matrice
src2: second matrice

rcvANDSMat

And integer value to all element in source matrix

rcvANDSMat: function [src [vector!] value [integer!]
src: matrice
value: integer!

rcvORSMat

OR integer value to all element in source matrix

rcvANDSMat: function [src [vector!] value [integer!]
src: matrice
value: integer!

rcvXORSMat

XOR integer value to all element in source matrix

rcvANDSMat: function [src [vector!] value [integer!]
src: matrice
value: integer!

Mathematical Operators on Arrays

Images

rcvAdd

dst: src1 + src2
rcvAdd: function [src1 [image!] src2 [image!] dst [image!]]
src1: image
src2: image
dst: image

rcvSub

dst: src1 - src2
rcvSub: function [src1 [image!] src2 [image!] dst [image!]]
src1: image
src2: image
dst: image

rcvMul

dst: src1 * src2
rcvMul: function [src1 [image!] src2 [image!] dst [image!]]
src1: image
src2: image
dst: image

rcvDiv

dst: src1 / src2
rcvDiv: function [src1 [image!] src2 [image!] dst [image!]]
src1: image
src2: image
dst: image

rcvMod

dst: src1 // src2 (modulo)
rcvMod: function [src1 [image!] src2 [image!] dst [image!]]
src1: image
src2: image
dst: image

rcvRem

dst: src1 % src2 (remainder)
rcvRem: function [src1 [image!] src2 [image!] dst [image!]]
src1: image
src2: image

dst: image

rcvAbsDiff

dst: absolute difference src1 src2
rcvAbsDiff: function [src1 [image!] src2 [image!] dst [image!]]
src1: image
src2: image
dst: image

rcvMIN

dst: minimum src1 src2
rcvMIN: function [src1 [image!] src2 [image!] dst [image!]]
src1: image
src2: image
dst: image

rcvMAX

dst: maximun src1 src2
rcvMax: function [src1 [image!] src2 [image!] dst [image!]]
src1: image
src2: image
dst: image

rcvAddS

dst: src + integer! value
rcvAddS: function [src [image!] dst [image!] val [integer!]]
src: image
dst: image
val: integer

rcvSubS

dst: src - integer! value
rcvSubS: function [src [image!] dst [image!] val [integer!]]
src: image
dst: image
val: integer

rcvMulS

dst: src * integer! value
rcvMulS: function [src [image!] dst [image!] val [integer!]]
src: image
dst: image
val: integer

rcvDivS

dst: src / integer! value

rcvDivS: function [src [image!] dst [image!] val [integer!]]
src: image
dst: image
val: integer

rcvModS

dst: src // integer! Value (modulo)

rcvModS: function [src [image!] dst [image!] val [integer!]]
src: image
dst: image
val: integer

rcvRemS

dst: src % integer! Value (remainder)

rcvRemS: function [src [image!] dst [image!] val [integer!]]
src: image
dst: image
val: integer

rcvLSH

Left shift image by value

rcvLSH: function [src [image!] dst [image!] val [integer!]]
src: image
dst: image
val: integer

rcvRSH

Right shift image by value

rcvLSH: function [src [image!] dst [image!] val [integer!]]
src: image
dst: image
val: integer

rcvPow

dst: src ^integer! Value

rcvPow: function [src [image!] dst [image!] val [integer!]]
src: image
dst: image
val: integer

rcvSqr

Image square root

rcvSqr: function [src [image!] dst [image!] val [integer!]]

src: image
dst: image
val: integer

rcvAddT

dst: src + tuple! value
rcvAddT: function [src [image!] dst [image!] val [tuple!]]

rcvSubT

dst: src - tuple! value
rcvSubT: function [src [image!] dst [image!] val [tuple!]]

rcvMulT

dst: src * tuple! value
rcvMulT: function [src [image!] dst [image!] val [tuple!]]

rcvDivT

dst: src / tuple! value
rcvDivT: function [src [image!] dst [image!] val [tuple!]]

rcvModT

dst: src // tuple! Value (modulo)
rcvModT: function [src [image!] dst [image!] val [tuple!]]

rcvRemT

dst: src % tuple! Value (remainder)
rcvRemT: function [src [image!] dst [image!] val [tuple!]]

Matrices

rcvAddMat

dst: src1 + src2
rcvAddMat: function [src1 [vector!] src2 [vector!] return: [vector!]]
src1: first matrix
src2: second matrix

rcvSubMat

dst: src1 - src2
rcvSubMat: function [src1 [vector!] src2 [vector!] return: [vector!]]
src1: first matrix
src2: second matrix

rcvMulMat

dst: src1 * src2

rcvMulMat: function [src1 [vector!] src2 [vector!] return: [vector!]]
src1: first matrix
src2: second matrix

rcvDivMat

dst: src1 / src2

rcvDivMat: function [src1 [vector!] src2 [vector!] return: [vector!]]
src1: first matrix
src2: second matrix

rcvRemMat

dst: src1 % src2

rcvRemMat: function [src1 [vector!] src2 [vector!] return: [vector!]]
src1: first matrix
src2: second matrix

rcvAddSMat

src + value

rcvAddSMat: function [src [vector!] value [integer!]]
src: matrix
value: integer

rcvSubSMat

src - value

rcvSubSMat: function [src [vector!] value [integer!]]
src: matrix
value: integer

rcvDivSMat

src / value

rcvDivSMat: function [src [vector!] value [integer!]]
src: matrix
value: integer

rcvRemSMat

src % value (remainder)

rcvRemSMat: function [src [vector!] value [integer!]]
src: matrix
value: integer

Statistical Operators on Arrays

Images and Matrices

rcvCountNonZero

Returns number of non zero values in image or matrix
rcvCountNonZero: function [arr [image! vector!] return: [integer!]]
arr: image or vector

rcvSum

Returns sum value of image or matrix as a block of rgb values
rcvSum: function [arr [image! vector!] return: [block!] /argb]
arr: image or vector
/argb: includes alpha channel

rcvMean

Returns mean value of image or matrix as a tuple of rgb values
rcvMean: function [arr [image! vector!] return: [tuple!] /argb]
arr: image or vector
/argb: includes alpha channel

rcvSTD

Returns standard deviation value of image or matrix as a block of rgb values
rcvSTD: function [arr [image! vector!] return: [tuple!] /argb]
arr: image or vector
/argb: includes alpha channel

rcvMedian

Returns median value of image or matrix as a block of rgb values
rcvMedian: function [arr [image! vector!] return: [tuple!] /argb]
arr: image or vector
/argb: includes alpha channel

rcvMinValue

Returns minimal value of image or matrix as a block of rgb values
rcvMinValue: function [arr [image! vector!] return: [tuple!]]
arr: image or vector

rcvMaxValue

Returns maximum value of image or matrix as a block of rgb values

rcvMaxValue: function [arr [image! vector!] return: [tuple!]]
arr: image or vector

rcvMinLoc

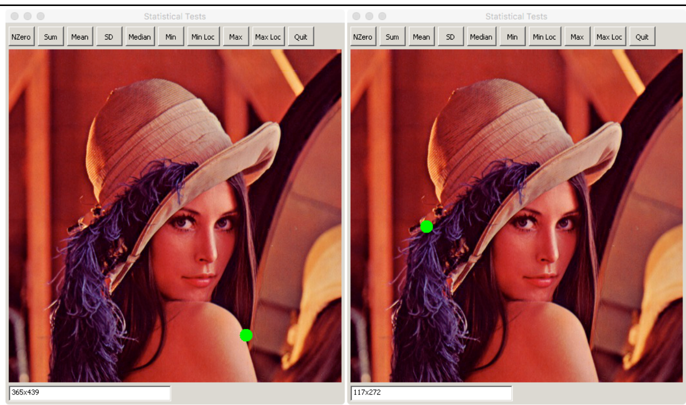
Finds global minimum location in array

rcvMinLoc: function [arr [image! vector!] arrSize [pair!] return: [pair!]]
arr: image or vector
arrSize: array size as pair

rcvMaxLoc

Finds global maximum location in array

rcvMaxLoc: function [arr [image! vector!] arrSize [pair!] return: [pair!]]
arr: image or vector
arrSize: array size as pair



Min Location Max Location

rcvHistogram

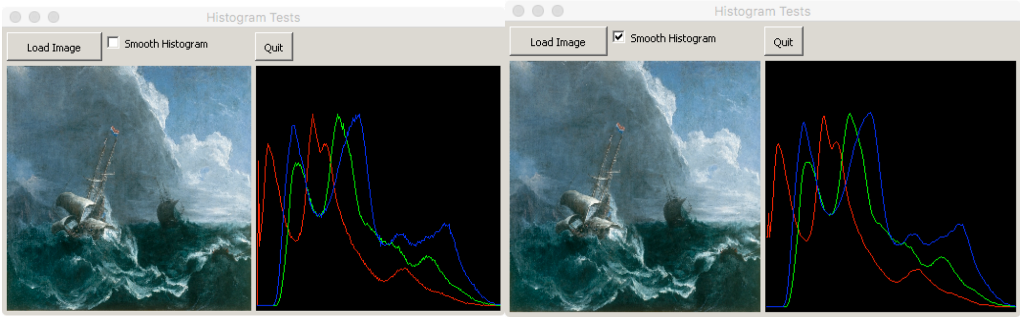
Calculates array histogram

rcvHistogram: function [arr [image! vector!] return: [vector!] /red /green /blue]
arr: image or vector
/red: histogram for red channel
/green: histogram for green channel
/blue: histogram for blue channel

rcvSmoothHistogram

This function smoothes the input histogram by a 3 points mean moving average

rcvSmoothHistogram: function [arr [vector!] return: [vector!]]
arr: input histogram as vector!



rcvHistogramEqualization

This function performs histogram equalization on the input image array

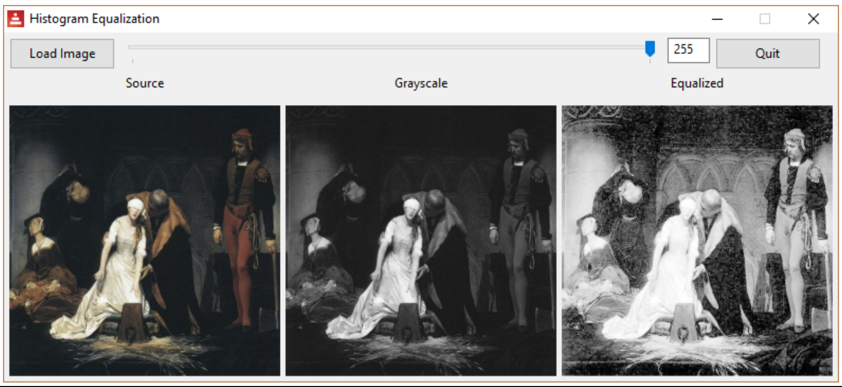
rcvHistogramEqualization: function [image [vector!] gLevels [integer!]]
image: a 8-bit matrice
gLevels: number of gray levels in the new image

This algorithm performs first the histogram of the source image and then calculates the probability-density function of a pixel value n: $p_1(n)$ is the probability of finding a pixel with the value n in the image. Then the following equation is applied

$$f(a) = D_m \frac{1}{Area_1} \sum_{i=0}^{a} H_c(a)$$

$H_c(a)$ is the histogram of the original image c and D_m is the number of gray levels in the new image b. Area is the size of the image. f(a) simply takes the probability density function for the values in image b and multiplies this by the cumulative density function of the values in image c.

This function is useful for improving contrast in low-contrasted images or simply modifying the contrast of image.



rcvMakeTranscodageTable

Creates a transcoding 256 table for affine enhancement

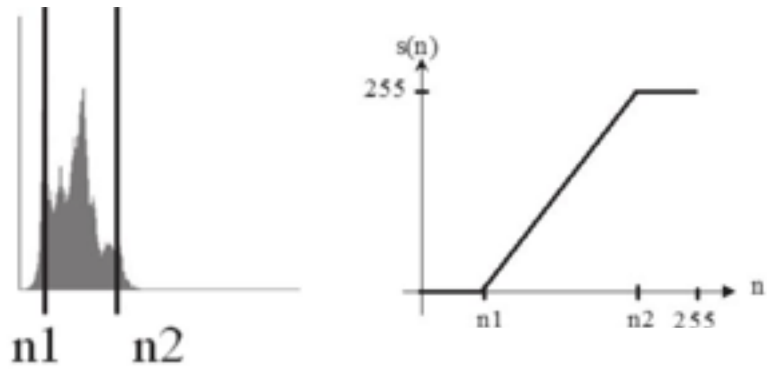
rcvMakeTranscodageTable: function [n [percent!] return: [vector!]]
n: percent of values to exclude

This function is used by rcvContrastAffine method. See below.

rcvContrastAffine

Enhances image contrast with affine function

rcvContrastAffine: function [image [vector!] n [percent!]]
image: a 8-bit matrice
n: percent of values to exclude



S(n)= 0 if n<=n1, s(n)= 255 * (n-n1)/(n2-n1) if n1<n<n2 and s(n)=255 if n >= n2

rcvRangeImage

Gives range value in Image as a tuple

rcvRangeImage: function [source [image!] return: [tuple!]]
source: image

rcvSortImage

Ascending image sorting

rcvSortImage: function [source [image!] dst [image!]]
source: image
dst: image

Morphological Operators on Arrays

rcvCreateStructuringElement

The function allocates and fills a block, which can be used as a structuring element in the morphological operations

cvCreateStructuringElement: function [kSize [pair!] return: [block!]
/rectangle /cross]
kSize: Kernel size (e.g. 3x3)

Refinement is used to create a cross-shaped element or a rectangular element

rcvErode

Erodes image by using structuring element

rcvErode: function [src [image!] dst [image!] kSize [pair!] kernel [block!]]
src: image
dst: image
kSize: kenel size as pair!
Kernel: block generated by cvCreateStructuringElement or customed structuring element

The function rcvErode erodes the source image using the specified structuring element that determines the shape of a pixel neighborhood over which the minimum is taken:

$$\texttt{dst=erode(src,element)}: \quad \texttt{dst(x,y)=min}_{\texttt{((x',y') in element)}}\texttt{)src(x+x',y+y')}$$

rcvDilate

Dilates image by using structuring element

rcvDilate: function [src [image!] dst [image!] kSize [pair!] kernel [block!]]
src: image
dst: image
kSize: kenel size as pair!
kernel: block generated by cvCreateStructuringElement or customed structuring element

The function rcvDilate dilates the source image using the specified structuring element that determines the shape of a pixel neighborhood over which the maximum is taken:

$$\texttt{dst=dilate(src,element)}: \quad \texttt{dst(x,y)=max}_{\texttt{((x',y') in element)}}\texttt{)src(x+x',y+y')}$$

rcvOpen

Erodes and Dilates image by using structuring element

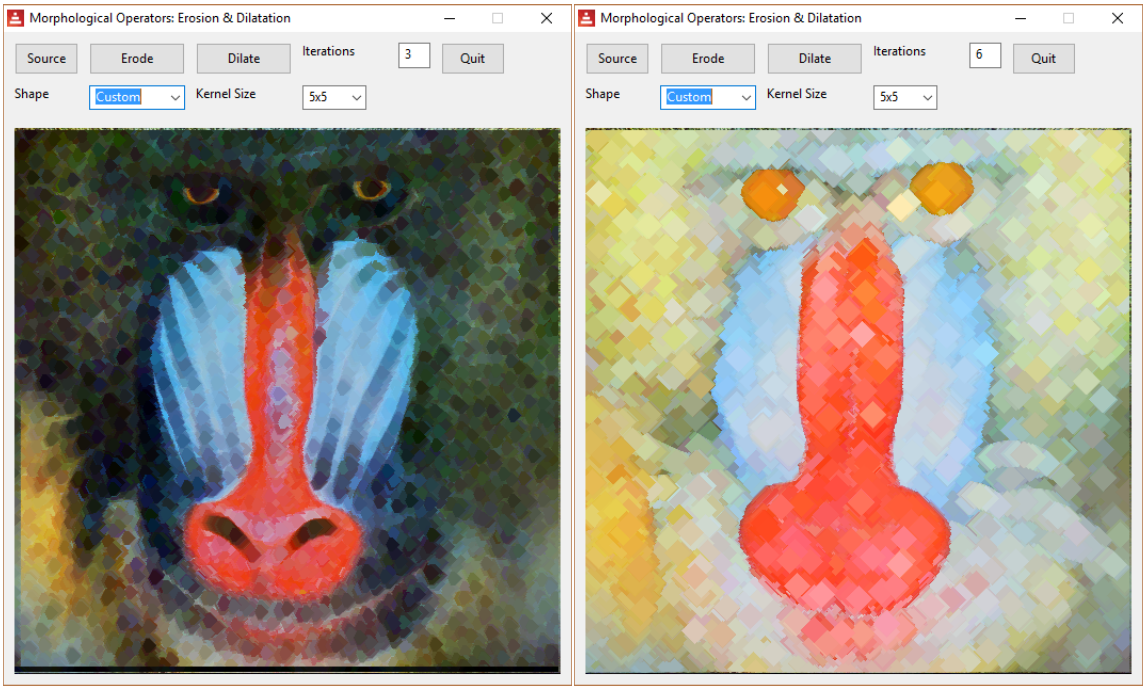
rcvOpen: function [src [image!] dst [image!] kSize [pair!] kernel [block!]]
src: image
dst: image
kSize: kenel size as pair!

kernel: block generated by cvCreateStructuringElement or customed structuring element

rcvClose

Dilates and Erodes image by using structuring element

rcvClose: function [src [image!] dst [image!] kSize [pair!] kernel [block!]]
src: image
dst: image
kSize: kenel size as pair!
kernel: block generated by cvCreateStructuringElement or customed structuring element



Erosion Dilatation

rcvMGradient

Performs advanced morphological transformations using erosion and dilatation as basic operations

rcvMGradient: function [src [image!] dst [image!] kSize [pair!] kernel [block!] /reverse]
src: image
dst: image
kSize: kenel size as pair!
kernel: block generated by cvCreateStructuringElement or customed structuring element

```
dst=dilate src – erode src
/reverse : dst=erode src – dilate src
```

rcvTopHat

Performs advanced morphological transformations

rcvTopHat: function [src [image!] dst [image!] kSize [pair!] kernel [block!]]
src: image
dst: image
kSize: kenel size as pair!
kernel: block generated by cvCreateStructuringElement or customed structuring element

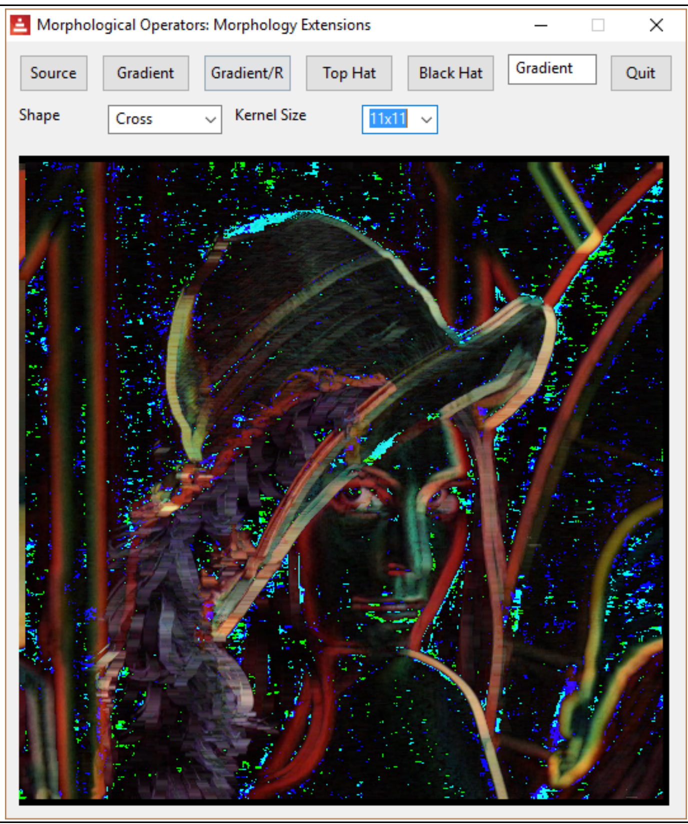
```
dst =src – open src dst
```

rcvBlackHat

Performs advanced morphological transformations

rcvTopHat: function [src [image!] dst [image!] kSize [pair!] kernel [block!]]
src: image
dst: image
kSize: kenel size as pair!
kernel: block generated by cvCreateStructuringElement or customed structuring element

```
dst = open src dst - src
```



Random Generator

Continuous Laws

randFloat

Returns a decimal value beween 0 and 1. Base 16 bit
randFloat: function[]

randUnif

Uniform law
randUnif: function [i [float!] j [float!]]
i: float value

randExp

Exponential law
randExp: function []

randExpm

Exponential law with a l degree
randExpm: function [l [float!]]
l: float value (e.g. 1.0)

randNorm

Normal law
randNorm : function [A [float!]]
A: float value (e.g. 1.0)

randLognorm

Lognormal law
randLognorm: function [a [float!] b [float!] z [float!]]
a: float value
b: float value
z: float value

randGamma

Gamma law
randGamma: func [k [integer!] l [float!] i]
k: integer value
l: float value

randDisc

Geometric law in a disc
randDisc: function []

randRect

Geometric law in a rectangle
randRect: function [a [float!] b [float!] c [float!] d [float!]]
a: float value
b: float value
c: float value
d: float value

randChi2

Chi square law
randChi2: function [v [integer!]]
v: integer value (e.g. 2)

randErlang

Erlang law
randErlang: function [n [integer!]]
n: integer value (e.g. 2)

randStudent

Student law
randStudent: function [n [integer!] z [float!]]
n: integer value (e.g. 3)
z: float value (e.g. 1.0)

randFischer

Fisher law (e.g 1 1)
randFischer: function [n [integer!] m [integer!]]
n: integer value (e.g. 1)
m: integer value (e.g. 1)

randLaplace

Laplace law
randLaplace: function [a [float!] /local u1 u2]
a: float value (e.g. 1.0)

randBeta

Beta law
randBeta: function [a [integer!] b [integer!]]
a: integer value (e.g. 1)
b: integer value (e.g. 1)

randWeibull

Weibull law
randWeibull: function [a [float!] l [float!]]
a: float value (e.g. 1.0)
l: float value (e.g. 1.0)

randRayleigh

Rayleigh law
randRayleigh: function []

Discrete Laws

randBernouilli

Bernouilli law
randBernouilli: function [p [float!]]
p: float value (e.g. 0.5)

randBinomial

Binomial law
randBinomial: function [n [integer!] p [float!]]
n: integer value (e.g. 1)
p: float value (e.g. 0.5)

randBinomialneg

Binomial negative law (e.g. 1 0.5)
randBinomialneg: function [n [integer!] p [float!]]
n: integer value (e.g. 1)
p: float value (e.g. 0.5)

randGeo

Geometric law
randGeo: func [p [float!]]
p: float value (e.g. 0.25)

randPoisson

Poisson law
randPoisson: function [l [float!]]
l: float value (e.g. 1.5)

Arrays Conversions

Images

rcv2BW

Convert RGB image to Black[0] and White [255]
rcv2BW: function [src [image!] dst [image!]]
src: source image
dst: destination image

Treshold value is equal to 128. For an accurate thresholding see rcv2BWFilter function.

rcv2Gray

Convert RGB image to Grayscale according to refinement
rcv2Gray: function [src [image!] dst [image!] /average /luminosity /lightness return: [image!]]
src: source image
dst: destination image

The average method simply averages the values: (R + G + B) / 3.
The lightness method averages the most prominent and least prominent colors: (max(R, G, B) + min(R, G, B)) / 2.
The luminosity method is a more sophisticated version of the average method. It also averages the values, but it forms a weighted average to account for human perception. The formula for luminosity is 0.21 R + 0.72 G + 0.07 B.

rcv2BGRA

Converts RGBA to BGRA
rcv2BGRA: function [src [image!] dst [image!]]
src: source image
dst: destination image

rcv2RGBA

Converts BGRA to RGBA
rcv2RGBA: function [src [image!] dst [image!]]
src: source image
dst: destination image

rcvInvert

Destination image: inverted source image (Similar to NOT image)
rcvInvert: function [source [image!] dst [image!]]
src: source image
dst: destination image

rcvImage2Mat

Converts Red Image to 8-bit 2-D Matrix

rcvImage2Mat: function [src [image!] mat [vector!]]
src: image
mat: vector
Grayscale

Matrices

rcvMat82Image

8-bit Matrix to Red Image

rcvMat82Image: function [mat [vector!] dst [image!]]
mat: vector
dst: image

rcvMat162Image

16-bit Matrix to Red Image

rcvMat162Image: function [mat [vector!] dst [image!]]
mat: vector
dst: image

rcvMat322Image

32-bit Matrix to Red Image

rcvMat322Image: function [mat [vector!] dst [image!]]
mat: vector
dst: image

rcvConvertMatScale

Converts Matrix Scaleto another bit size

rcvConvertMatScale: function [src [vector!] dst [vector!] srcScale [number!] dstScale [number!] /fast /normal]
src: vector
dst: vector
srcScale: source range e.g 255
dstScale : destination range e.g 65535
/normal : uses a general function
/fast: uses a faster routine

```
msize: 256x256
mat1: rcvCreateMat 'integer! 8 msize
mat2: rcvCreateMat 'integer! 16 msize
mat3: rcvCreateMat 'integer! 32 msize
rcvConvertMatScale/normal mat1 mat2 FFh FFFFh
rcvConvertMatScale/normal mat1 mat3 FFh FFFFFFh
```

rcvMatInt2Float

Converts Integer Matrix to Float [0..1] matrix

rcvMatInt2Float: function [src [vector!] dst [vector!] srcScale [float!]]
src: source matrix
dst: destination matrix
srcScale: source range as a float!

Filters

Many filters are based on 2-D convolution. The 2-D convolution operation isn't extremely fast, unless you use small (3x3 or 5x5) filters. There are a few rules about the filter. Its size has to be generally uneven, so that it has a center, for example 3x3, 5x5, 7x7 or 9x9 are ok. Apart from using a kernel matrix, convolution operation also has a multiplier factor and a bias. After applying the filter, the factor will be multiplied with the result, and the bias added to it. So if you have a filter with an element 0.25 in it, but the factor is set to 2, all elements of the filter are multiplied by two so that element 0.25 is actually 0.5. The bias can be used if you want to make the resulting image brighter.

General functions

rcvMakeGaussian

Creates a Gaussian uneven kernel

rcvMakeGaussian: function [kSize [pair!] return: [block!]]
kSize: uneven pair for kernel e.g 3x3

Creates a Gaussian uneven kernel with the following equation

$$G(x, y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

Where, x is the distance along horizontal axis measured from the origin, y is the distance along vertical axis measured from the origin and σ is the standard deviation of the distribution.

rcvConvolve

Convolves an image with the kernel

rcvConvolve: function [src [image!] dst [image!] kernel [block!] factor [float!] delta [float!]]
src: source image
dst: destination image
kernel: kernel matrix as block!
factor: multiplier factor as float!
delta: bias for image brightness

```
img1: rcvLoadImage %../../images/lena.jpg
dst:  rcvCreateImage img1/size
gaussian: [0.0 0.2 0.0
           0.2 0.2 0.2
           0.0 0.2 0.0]
rcvConvolve img1 dst gaussian 2.0 0.0
```

rcvConvolveMat

Convolves a 2-D matrix with the kernel

rcvConvolveMat: function [src [vector!] dst [vector!] mSize[pair!] kernel [block!] factor [float!] delta [float!]]
src: source matrix
dst: destination matrix
mSize: matrix size as a pair!
kernel: kernel matrix as block!
factor: multiplier factor as float!
delta: bias for image brightness

rcvFastConvolve

Convolves 8-bit and 1-channel image with the kernel

rcvFastConvolve: function [src [image!] dst [image!] channel [integer!] kernel [block!] factor [float!] delta [float!]]
src: source image
dst: destination image
channel: image channel to process (RGB)
kernel: kernel matrix as block!
factor: multiplier factor as float!
delta: bias for image brightness

Images and matrices Filters

rcv2BWFilter

Binarization of RGB image image according to threshold

rcv2BWFilter: function [src [image!] dst [image!] thresh [integer!]]
src: image
dst: image
thresh: threshold integer value

rcvFilter2D

Basic convolution filter

rcvFilter2D: function [src [image!] dst [image!] kernel [block!] delta [integer!]]
src: image
dst: image
kernel: kernel matrix as block!
delta: bias for image brightness

Similar to convolution but the sum of the weights is computed during the summation, and used to scale the result.

rcvFastFilter2D

Fast convolution filter

rcvFastFilter2D: function [src [image!] dst [image!] kernel [block!]]
src: image
dst: image
kernel: kernel matrix as block!

A faster version without controls on pixel value! Basically for 1 channel gray scaled image.
The sum of the weights is computed during the summation, and used to scale the result

rcvGaussianFilter

Fast Gaussian 2D filter

rcvGaussianFilter: function [src [image!] dst [image!]]
src: image
dst: image

Kernel is 3x3 and bias is equal to zero. For larger kernel please use rcvFilter2D.
knl: rcvMakeGaussian 11x11 rcvFilter2D src dst

rcvSobel

Direct Sobel edges detection for image or matrix

rcvSobel: function [src [image! vector!] dst [image! vector!] iSize [pair!]]
src: image or matrix as vector
dst: image or matrix as vector
iSize: image or matrix size as pair

```
img1: rcvLoadImage %../../images/lena.jpg
img2: rcvCreateImage img1/size
img3: rcvCreateImage img1/size
rcv2Gray/average img1 img2                ; Grayscaled image
rcvSobel img2 img3 img1/size              ; Direct Sobel on image
```

```
img1: rcvLoadImage %../../images/lena.jpg
img2: rcvCreateImage img1/size
mat1: rcvCreateMat 'integer! intSize img1/size
mat2: rcvCreateMat 'integer! intSize img1/size
rcvImage2Mat img1 mat1        ; Converts image to 1 Channel matrix [0..255]
rcvSobel mat1 mat2 img1/size; Sobel detector on Matrix
```

rcvRobert

Robert's cross edges detection for image or matrix

rcvRobert: function [src [image! vector!] dst [image! vector!] iSize [pair!] factor [float!] delta [float!]]
src: image or matrix as vector
dst: image or matrix as vector

iSize: image or matrix size as pair
factor: multiplier factor as float!
delta: bias for image brightness

Color Conversions

Images

rcvRGB2HSV

RBG color to HSV conversion
rcvRGB2HSV: function [src [image!] dst [image!]]
src: image
dst: image

rcvBGR2HSV

BGR color to HSV conversion
rcvBGR2HSV: function [src [image!] dst [image!]]
src: image
dst: image

The Hue/Saturation/Value model was created by A. R. Smith in 1978. The coordinate system is cylindrical. The hue value H runs from 0 to 360º. The saturation S is the degree of purity and is from 0 to 1. Purity is how much white is added to the color. S=1 makes the purest color (no white). Brightness V also ranges from 0 to 1, where 0 is the black. There is no transformation matrix for RGB or BGR to HSV conversion, but R, G and B are converted to floating-point format and scaled to fit 0..1 range.

rcvRGB2HLS

RBG color to HLS conversion
rcvRGB2HLS: function [src [image!] dst [image!]]
src: image
dst: image

rcvBGR2HLS

RBG color to HLS conversion
rcvBGR2HLS: function [src [image!] dst [image!]]
src: image
dst: image

Also a cylindrical coordinates system. There is no transformation matrix for RGB or BGR to HLS conversion, but R, G and B are converted to floating-point format and scaled to fit 0..1 range.

rcvRGB2YCrCb

RBG color to YCrCb conversion

rcvRGB2YCrCb: function [src [image!] dst [image!]]
src: image
dst: image

rcvBGR2YCrCb

RBG color to YCrCb conversion

rcvBGR2YCrCb: function [src [image!] dst [image!]]
src: image
dst: image

There is no transformation matrix.
Y <- 0.299*R + 0.587*G + 0.114*B
Cr <- (R-Y)*0.713 + delta
Cb <- (B-Y)*0.564 + delta

rcvRGB2XYZ

RGB to CIE XYZ color conversion

rcvRGB2XYZ: function [src [image!] dst [image!]]
src: image
dst: image

rcvBGR2XYZ

BGR to CIE XYZ color conversion

rcvBGR2XYZ: function [src [image!] dst [image!]]
src: image
dst: image

To transform from XYZ to RGB the matrix transform used is :

$$\begin{bmatrix} X \\ Y \\ Z \end{bmatrix} = \begin{bmatrix} 0.412453 & 0.357580 & 0.180423 \\ 0.212671 & 0.715160 & 0.072169 \\ 0.019334 & 0.119193 & 0.950227 \end{bmatrix} * \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

rcvRGB2Lab

RBG color to CIE L*a*b conversion

rcvRGB2Lab: function [src [image!] dst [image!]]
src: image
dst: image

rcvRGB2Lab

RBG color to CIE L*a*b conversion

rcvBGR2Lab: function [src [image!] dst [image!]]
src: image
dst: image

R, G and B are converted to floating-point format and scaled to fit 0..1 range. R, G and B are first converted to CIE XYZ before processing. On output 0≤L≤100, -127≤a≤127, -127≤b≤127. The values are then converted to 8-bit images: L <- L*255/100, a <- a + 128, b <- b + 128.

rcvRGB2Luv

RBG color to CIE L*u*v conversionconversion

rcvRGB2Luv: function [src [image!] dst [image!]]
src: image
dst: image

rcvRGB2Luv

RBG color to CIE L*u*v conversion

rcvBGR2Luv: function [src [image!] dst [image!]]
src: image
dst: image

R, G and B are converted to floating-point format and scaled to fit 0..1 range. R, G and B are first converted to CIE XYZ before processing. On output 0≤L≤100, -134≤u≤220, -140≤v≤122. The values are then converted to 8-bit images: L <- L*255/100, u <- (u + 134)*255/354, v <- (v + 140)*255/256.

Operations on Sub-Arrays

Images and Matrices

rcvSplit

Separates source image in RGBA channels. Destination contains selected source channel.

rcvSplit: function [src [image!] dst [image!]/red /green /blue /alpha]
src: source image
dst: destination image
/red: red channel
/green: green channel
/blue: blue channel
/alpha: alpha channel

rcvSplit2Mat

Separates image channels to 4 8-bit matrices

rcvSplit2Mat: function [src [image!] mat0 [vector!] mat1 [vector!] mat2 [vector!] mat3 [vector!]]
src: image
mat0: image alpha channel
mat1: image red channel
mat2: image green channel
mat3: image blue channel

if source image is grayscale then mat1 = mat2 = mat3.

rcvMerge2Image

Merges 4 8-bit matrices to Red image

rcvMerge2Image: function [mat0 [vector!] mat1 [vector!] mat2 [vector!] mat3 [vector!] dst [image!]]
mat0: image alpha channel
mat1: image red channel
mat2: image green channel
mat3: image blue channel
dst: image

rcvInRange

Extracts sub array from image according to lower and upper rgb values

rcvInRange: function [src [image!] dst [image!] lower [tuple!] upper [tuple!]]
src: source image
dst: destination image
lower: lower tuple
upper: lower tuple

Image Transformations

rcvFlip

Left/Right, Up/Down or both directions image flip

rcvFlip: function [src [image!] dst [image!] /horizontal /vertical /both return: [image!]]
src: source image
dst: destination image
refinement for direction

source Left/Right Up/Down Both

rcvResizeImage

Resizes image and applies filter for Gaussian pyramidal up or downsizing if required

rcvResizeImage: function [src [image!] canvas iSize [pair!]/Gaussian return: [pair!]]
src: destination image
canvas: Red base face containing the image
iSize: New size of the image as pair
/Gaussian: applies a 5x5 kernel Gaussian filter on image

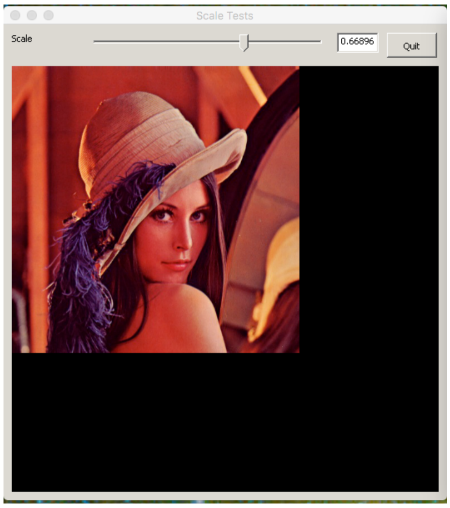
```
img1: rcvLoadImage %../../images/lena.jpg
dst:  rcvCreateImage img1/size
iSize: 256x256
canvas: base iSize dst
nSize: 512x512
rcvResizeImage dst canvas nSize
```

rcvScaleImage

Sets the scale factors: Returns a Draw block

rcvScaleImage: function [factor [float!] return: [block!]]
factor: scale factor as float! Default value : 1.0 original size

```
This function uses Draw Dialect and you
have to add the image instance to the draw
block.
img1: rcvLoadImage %../../images/lena.jpg
factor: 1.0
drawBlk: rcvScaleImage factor
append drawBlk [img1]
...
```



rcvTranslateImage

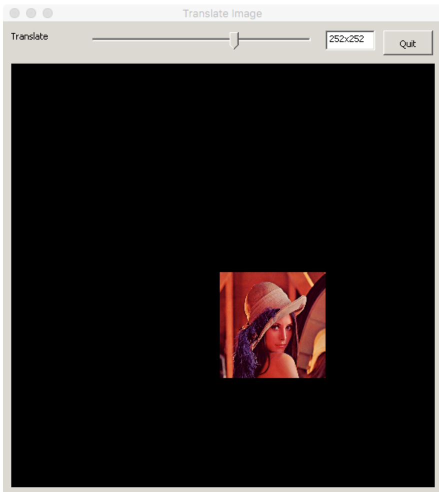
Sets the origin for drawing commands : Returns a Draw block

rcvTranslateImage: function [scaleValue [float!] translateValue [pair!] return: [block!]]

scaleValue: float! value to reduce or increase image size

translateValue : pair to translate image in X and Y direction

```
This function uses Draw Dialect and
you have to add the image instance to
the draw block.
img1: rcvLoadImage
%../../images/lena.jpg
factor: 0x0
drawBlk: rcvTranslateImage 0.25
factor
append drawBlk [img1]
...
```

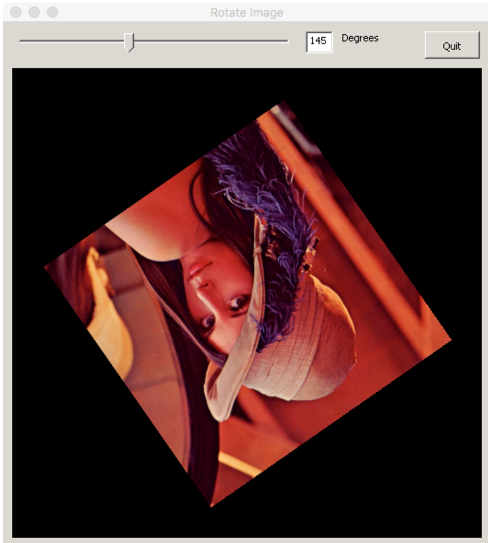


rcvRotateImage

Sets the clockwise rotation about a given point, in degrees : Returns a Draw

rcvRotateImage: function [scaleValue [float!] translateValue [pair!] angle [float!] center [pair!] return: [block!]]
scaleValue: float! value to reduce or increase image size
translateValue : pair to translate image in X and Y direction
angle: rotation of image in degrees
center: center of image rotation as pair! Default value 0x0

```
This function uses Draw Dialect and
you have to add the image instance
to the draw block.
img1: rcvLoadImage
%../../images/lena.jpg
iSize: img1/size
centerXY: iSize / 2
rot: 0.0
drawBlk: rcvRotateImage 0.625
96x96 rot centerXY
append drawBlk [img1]
...
```

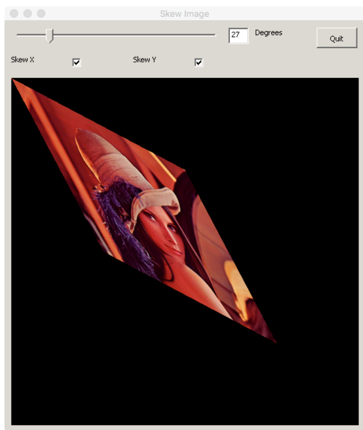


rcvSkewImage

Sets a coordinate system skewed from the original by the given number of degrees

rcvSkewImage: function [scaleValue [float!] translateValue [pair!] x [number!] y [number!] return: [block!]]
scaleValue: float! value to reduce or increase image size
translateValue : pair to translate image in X and Y direction
x: skew along the x-axis in degrees (integer! float!).
y: skew along the y-axis in degrees (integer! float!).

```
This function uses Draw Dialect and
you have to add the image instance to
the draw block.
img1: rcvLoadImage
%../../images/lena.jpg
x: 0
y: 0
drawBlk: rcvSkewImage 0.5 0x0 x y
append drawBlk [img1]
```



Highgui Functions

Some highgui functions for RedCV quick test. Functions are pure Red code. Routines are not required. These functions can also be used for displaying temporary images.

rcvNamedWindow

Creates a window

rcvNamedWindow: function [title [string!] return: [window!]]
title: Windows title as a string
window is returned a face datatype!

rcvDestroyWindow

Destroys a created window

rcvDestroyWindow: function [window [face!]]
window: Points to a window created by rcvNamedWindow

rcvDestroyAllWindows

Destroys all windows

rcvDestroyAllWindows: function []

rcvResizeWindow

Sets window size

rcvResizeWindow: function [window [face!] wSize [pair!]]

rcvMoveWindow

Sets window position

rcvMoveWindow: function [window [face!] position [pair!]]

rcvShowImage

Shows image in window

rcvShowImage: function [window [face!] image [image!]]

```
#include %../../libs/redcv.red
img1: rcvLoadImage %../../images/lena.jpg
s1: rcvNamedWindow "Source"
rcvShowImage s1 img1 wait 2
rcvMoveWindow s1 20x60 wait 2
rcvResizeWindow s1 512x512 wait 2
rcvDestroyWindow s1
do-events
```