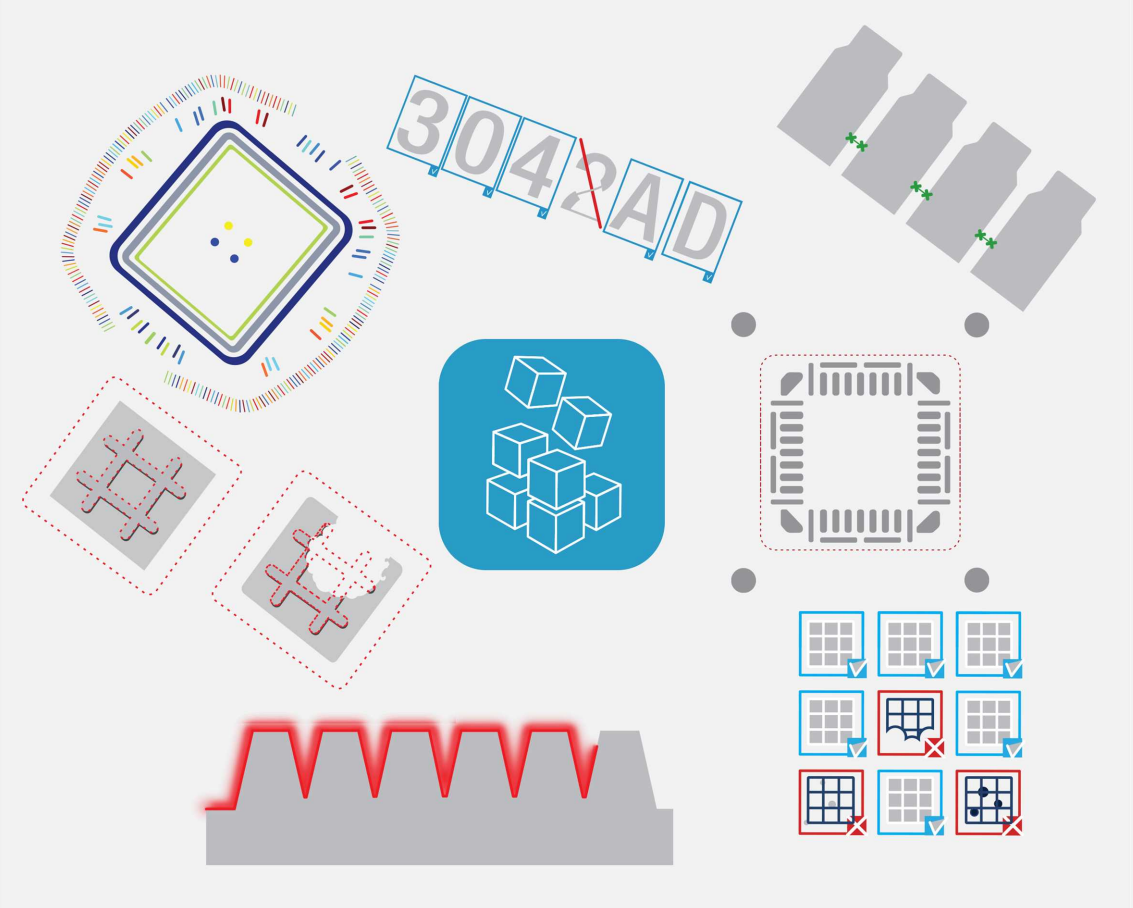
euresys
Empowering Computer Vision

CODE SNIPPETS

Open eVision



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This documentation is provided with Open eVision 2.11.1 (doc build 1125).

Contents

1. Basic Types

1.1. Loading and Saving Images

```
////////////////////////////////////////////////////////
// This code snippet shows how to load and save an image. //
////////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 srcImage= new EImageBW8();
EImageBW8 dstImage= new EImageBW8();
```

```
// Load an image file
srcImage.Load("mySourceImage.bmp");
```

```
// ...
```

```
// Save the destination image into a file
dstImage.Save("myDestImage.bmp");
```

```
// Save the destination image into a jpeg file
// The default compression quality is 75
dstImage.Save("myDestImage.jpg");
```

```
// Save the destination image into a jpeg file
// set the compression quality to 50
dstImage.SaveJpeg("myDestImage50.jpg", 50);
```

1.2. Interfacing Third-Party Images

```
////////////////////////////////////////////////////////////
// This code snippet shows how to link an Open eVision image //
// to an externally allocated buffer.                        //
////////////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// Size of the third-party image
int sizeX = bufferSizeX;
int sizeY = bufferSizeY;
```

```
//Pointer to the third-party image buffer
IntPtr imgPtr = bufferPointer;
```

```
// ...
```

```
// Link the Open eVision image to the third-party image
// Assuming the corresponding  buffer is aligned on 4 bytes
srcImage.SetImagePtr(sizeX, sizeY, imgPtr);
```

1.3. Retrieving Pixel Values

```
////////////////////////////////////////////////////////////////
// This code snippet shows the recommended method to access  //
// the pixel values in a BW8 image.                          //
////////////////////////////////////////////////////////////////
```

```
using System.RunTime.InteropServices;
```

```
IntPtr pixAddr;
byte pix;
```

```
//...
```

```
for(int y = 0; y < height; ++y)
    pixAddr = bw8Image.GetImagePtr(0,y)
    for(int x = 0; x < width; ++x)
        pix = Marshal.ReadByte(pixAddr,x)
```

1.4. ROI Placement

```
////////////////////////////////////////////////////////////////
// This code snippet shows how to attach an ROI to an image  //
// and set its placement.                                    //
////////////////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 parentImage= new EImageBW8();
```

```
// ROI constructor
EROIBW8 myROI= new EROIBW8();
```

```
// Attach the ROI to the image
myROI.Attach(parentImage);
```

```
//Set the ROI position
myROI.SetPlacement(50, 50, 200, 100);
```

1.5. Vector Management

```
////////////////////////////////////////////////////////////////
// This code snippet shows how to create a vector, fill it   //
// and retrieve the value of a given element.                //
////////////////////////////////////////////////////////////////
```

```
// EBW8Vector constructor
EBW8Vector ramp= new EBW8Vector();
EBW8 bw8 = new EBW8();
```

```
// Clear the vector
ramp.Empty();
```

```
// Fill the vector with increasing values
for(int i= 0; i < 128; i++)
{
```

```
    bw8.Value = (byte)i;
    ramp.AddElement(bw8);
}
```

```
// Retrieve the 10th element value
EBW8 value = ramp.GetElement(9);
```

1.6. Exception Management

```
//////////////////////////////////////////
// This code snippet shows how to manage  //
// Open eVision exceptions.               //
//////////////////////////////////////////
```

```
try
{
    // Image constructor
    EImageC24 srcImage= new EImageC24();
```

```
    // ...
```

```
    // Retrieve the pixel value at coordinates (56, 73)
    EC24 value= srcImage.GetPixel(56, 73);
}
```

```
catch(EException exc)
{
```

```
    // Retrieve the exception description
    string error = exc.What();
}
```

2. ERegion

See also: Arbitrary-Shaped ROI (ERegion) / example: Inspecting Pads Using Regions

2.1. Basic Usage

```
////////////////////////////////////////////////////////////
// This code snippet shows how to perform a threshold on a //
// circular region in an image.                            //
////////////////////////////////////////////////////////////

// Image constructors
EImageBW8 srcImage = new EImageBW8();
EImageBW8 dstImage = new EImageBW8();

//...

// Create the region
ECircleRegion circleRegion = new ECircleRegion(center, radius);

// Threshold the image
EasyImage.Threshold(srcImage, circleRegion, dstImage);
```

2.2. Prepare Once, Use Multiple Times

```
////////////////////////////////////////////////////////////
// This code snippet shows how to perform a threshold on a //
// circular region in multiple image while preparing it    //
// only once.                                              //
////////////////////////////////////////////////////////////

// Image constructors
EImageBW8 [] srcImage = new EImageBW8[10];
EImageBW8 [] dstImage = new EImageBW8[10];

//...

// Create the region
ECircleRegion circleRegion = new ECircleRegion(center, radius);

// Prepare the region
circleRegion.Prepare(srcImage[0]);

// Threshold the images
for (int i = 0; i < 10; i++)
  EasyImage.Threshold(srcImage[i], circleRegion, dstImage[i]);
```

2.3. Combine Regions

```
////////////////////////////////////////////////////////////
// This code snippet shows how to perform a threshold on a //
// combined region in an image                             //
////////////////////////////////////////////////////////////

// Image constructors
EImageBW8 srcImage = new EImageBW8();
EImageBW8 dstImage = new EImageBW8();

//...

// Create first region
ECircleRegion circleRegion = new ECircleRegion(center, radius);

// Create second region
ERectangleRegion rectangleRegion = new ERectangleRegion(center, width, height, angle);

// Combine regions
ERegion combinedRegion = ERegion.Union(circleRegion, rectangleRegion);

// Threshold the image
EasyImage.Threshold(srcImage, combinedRegion, dstImage);
```

2.4. Tool Chain

```
////////////////////////////////////////////////////////////
// This code snippet shows how to perform a threshold on a //
// region coming for a previous EasyFind process           //
////////////////////////////////////////////////////////////

// Image constructors
EImageBW8 findImage = new EImageBW8();
EImageBW8 srcImage = new EImageBW8();
EImageBW8 dstImage = new EImageBW8();

// EPatternFinder constructor
EPatternFinder finder = new EPatternFinder();

//...

// Use EasyFind
EFoundPattern [] patterns = finder.Find(findImage);

// Create region from found pattern
ERegion foundRegion = new ERegion(patterns[0]);

// Threshold the image
EasyImage.Threshold(srcImage, foundRegion, dstImage);
```

3. EGrabberBridge

See also:EGrabberBridge - Using Images from Coaxlink

3.1. Using EGrabberBridge

```
//////////////////////////////////////////////////////////////////////
// This code snippet shows how to go from an EGrabber buffer to an //
// EGrabberImageBW8, compatible with Open eVision processing       //
//////////////////////////////////////////////////////////////////////

// Construct the EGrabber objects.
// The FormatConverter is optional and will automatically convert the EGenTL buffer to
// the chosen Open eVision image type.
// WARNING: EGrabberCallbackOnDemand and FormatConverter are using an EGenTL instance,
// you must dispose them before disposing it.
EGenTL genTL = new EGenTL();
EGrabberCallbackOnDemand grabber = new EGrabberCallbackOnDemand(genTL);

// Allocate one buffer
grabber.reallocBuffers(1);

//....

// Start the grabber acquisition of one buffer
grabber.start(1);

// Get the acquired buffer
using (ScopedBuffer buffer = new ScopedBuffer(grabber)

{
  // Convert the ScopedBuffer to an Open eVision data container
  using (EGrabberImageBW8 image = new EGrabberImageBW8(buffer.getInfo()))
  {
    // Use the EGrabberImageBW8 as an Open eVision EImage Object
    // Here an inversion to the image is performed
    EImageBW8 invertedImage = new EImageBW8(image.Width, image.Height);
    EasyImage.Oper(EArithmeticLogicOperation.Invert, image, invertedImage);
  }
}
```

3.2. Using EGrabberBridge with Format Conversion

```
//////////////////////////////////////////////////////////////////////
```

```
// This code snippet shows how to go from an EGrabber buffer to an //
// EGrabberImageBW8, compatible with Open eVision processing using //
// format conversion                                                //
//////////////////////////////////////////////////////////////////////

// Construct the EGrabber objects.
// The FormatConverter is optional and will automatically convert the EGenTL buffer to
// the chosen Open eVision image type.
// WARNING: EGrabberCallbackOnDemand and FormatConverter are using an EGenTL instance,
// you must dispose them before disposing it.
EGenTL genTL = new EGenTL();
EGrabberCallbackOnDemand grabber = new EGrabberCallbackOnDemand(genTL);
FormatConverter converter = new FormatConverter(genTL);

// Allocate one buffer
grabber.reallocBuffers(1);

//....

// Start the grabber acquisition of one buffer
grabber.start(1);

// Get the acquired buffer
using (ScopedBuffer buffer = new ScopedBuffer(grabber))
{
  // Convert the ScopedBuffer to an Open eVision data container
  using (EGrabberImageBW8 image = new EGrabberImageBW8(converter, buffer.getInfo()))
  {
    // Use the EGrabberImageBW8 as an Open eVision EImage Object
    // Here an inversion to the image is performed
    EImageBW8 invertedImage = new EImageBW8(image.Width, image.Height);
    EasyImage.Oper(EArithmeticLogicOperation.Invert, image, invertedImage);
  }
}
```

3.3. Managing EGrabber Parameters

```
//////////////////////////////////////////////////////////////////////
// This code snippet shows how to go from an EGrabber buffer to an //
// EGrabberImageBW8, compatible with Open eVision processing using //
// format conversion                                                //
//////////////////////////////////////////////////////////////////////

// Construct the EGrabber objects.
// The FormatConverter is optional and will automatically convert the EGenTL buffer to
// the chosen Open eVision image type.
// WARNING: EGrabberCallbackOnDemand and FormatConverter are using an EGenTL instance,
// you must dispose them before disposing it.
EGenTL genTL = new EGenTL();
EGrabberCallbackOnDemand grabber = new EGrabberCallbackOnDemand(genTL);
FormatConverter converter = new FormatConverter(genTL);

// Allocate one buffer
grabber.reallocBuffers(1);

// ...

// Manage EGrabber features
// Get/set camera (RemoteModule) features of various types:
// string - integer - float.
```

```
// WARNING: The features might be specific to each camera.
string pixelFormat = grabber.getStringRemoteModule("PixelFormat");
grabber.setStringRemoteModule("PixelFormat", "Mono8");

int width = grabber.getIntegerRemoteModule("Width");
grabber.setIntegerRemoteModule("Width", 1024);

float exposureTime = grabber.getFloatRemoteModule("ExposureTime");
grabber.setFloatRemoteModule("ExposureTime", 60.0f);

// ...

// Start the grabber acquisition of one buffer
grabber.start(1);

// Get the acquired buffer
using (ScopedBuffer buffer = new ScopedBuffer(grabber))
{
  // Convert the ScopedBuffer to an Open eVision data container
  using (EGrabberImageBW8 image = new EGrabberImageBW8(converter, buffer.getInfo()))
  {
    // ...
  }
}
```

4. EasyImage

4.1. Thresholding

Single Thresholding

```
////////////////////////////////////////////////////////////////
// This code snippet shows how to perform minimum residue     //
// thresholding, absolute thresholding and relative           //
// thresholding operations.                                   //
////////////////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 srcImage= new EImageBW8();
EImageBW8 dstImage= new EImageBW8();
```

```
// ...
```

```
// Source and destination images must have the same size
dstImage.SetSize(srcImage);
```

```
// Minimum residue thresholding (default method)
EasyImage.Threshold(srcImage, dstImage);
```

```
// Absolute thresholding (threshold = 110)
EasyImage.Threshold(srcImage, dstImage, 110);
```

```
// Relative thresholding (70% black, 30% white)
EasyImage.Threshold(srcImage, dstImage, (int)EThresholdMode.Relative, 0, 255, 0.7f);
```

Double Thresholding

```
////////////////////////////////////////////////////////////////
// This code snippet shows how to perform a thresholding      //
// operation based on low and high threshold values.          //
////////////////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 srcImage= new EImageBW8();
EImageBW8 dstImage= new EImageBW8();
```

```
// ...
```

```
// Source and destination images must have the same size
dstImage.SetSize(srcImage);
```

```
// Double thresholding, low threshold = 50, high threshold = 150,
// pixels below 50 become black, pixels above 150 become white,
// pixels between thresholds become gray
EasyImage.DoubleThreshold(srcImage, dstImage, 50, 150, 0, 128, 255);
```

Histogram-Based Single Thresholding

```
////////////////////////////////////////////////////////////////
// This code snippet shows how to perform a minimum residue   //
// thresholding operation based on an histogram.              //
////////////////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 srcImage= new EImageBW8();
EImageBW8 dstImage= new EImageBW8();
```

```
// Histogram constructor
EBWHistogramVector histo= new EBWHistogramVector();
```

```
// Variables
int thresholdValue= (int)EThresholdMode.MinResidue;
float avgBelowThr, avgAboveThr;
```

```
// ...
```

```
// Compute the histogram
EasyImage.Histogram(srcImage, histo);
```

```
// Compute the single threshold (and the average pixel values below and above the
threshold)
EasyImage.HistogramThreshold(histo, ref thresholdValue, out avgBelowThr, out
avgAboveThr);
```

```
// Source and destination images must have the same size
dstImage.SetSize(srcImage);
```

```
// Perform the single thresholding
EasyImage.Threshold(srcImage, dstImage, thresholdValue);
```

Histogram-Based Double Thresholding

```
////////////////////////////////////////////////////////////////////
// This code snippet shows how to perform a double thresholding   //
// operation. The low and high threshold values are computed      //
// according to the minimum residue method based on an histogram. //
////////////////////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 srcImage= new EImageBW8();
EImageBW8 dstImage= new EImageBW8();
```

```
// Histogram constructor
EBWHistogramVector histo= new EBWHistogramVector();
```

```
// Variables
EBW8 lowThr= new EBW8();
EBW8 highThr= new EBW8();
float avgBelowThr, avgBetweenThr, avgAboveThr;
```

```
// ...
```

```
// Compute the histogram
EasyImage.Histogram(srcImage, histo);
```

```
// Compute the low and high threshold values automatically
// (and the average pixel values below, between and above the threshold)
EasyImage.ThreeLevelsMinResidueThreshold(histo, out lowThr, out highThr, out
avgBelowThr, out avgBetweenThr, out avgAboveThr);
```

```
// Source and destination images must have the same size
dstImage.SetSize(srcImage);
```

```
// Perform the double thresholding
EasyImage.DoubleThreshold(srcImage, dstImage, lowThr.UINT32Value ,
highThr.UINT32Value);
```

4.2. Arithmetic and Logic Operations

```
//////////////////////////////////////////////////////
// This code snippet shows how to apply miscellaneous //
// arithmetic and logic operations to images.         //
//////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 srcGray0= new EImageBW8();
EImageBW8 srcGray1= new EImageBW8();
EImageBW8 dstGray= new EImageBW8();
EImageC24 srcColor= new EImageC24();
EImageC24 dstColor= new EImageC24();
```

```
EBW8 bw8Constant = new EBW8(2);
EC24 c24Constant = new EC24(128, 64, 196);
```

```
// ...
```

```
// All images must have the same size
dstGray.SetSize(srcGray0);
dstColor.SetSize(srcColor);
```

```
// Subtract srcGray1 from srcGray0
EasyImage.Oper(EArithmeticLogicOperation.Subtract, srcGray0, srcGray1, dstGray);
```

```
// Multiply srcGray0 by a constant value
EasyImage.Oper(EArithmeticLogicOperation.Multiply, srcGray0, bw8Constant, dstGray);
```

```
// Add a constant value to srcColor
EasyImage.Oper(EArithmeticLogicOperation.Add, srcColor, c24Constant, dstColor);
```

```
// Erase (blacken) the destination image where the source image is black
bw8Constant.Value = (byte)0;
EasyImage.Oper(EArithmeticLogicOperation.SetZero, srcGray0, bw8Constant, dstGray);
```

4.3. Convolution

Pre-Defined Kernel Filtering

```
//////////////////////////////////////////////////////////
// This code snippet shows how to apply miscellaneous    //
// convolution operations based on pre-defined kernels.  //
//////////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 srcImage= new EImageBW8();
EImageBW8 dstImage= new EImageBW8();
```

```
// ...
```

```
// Source and destination images must have the same size
dstImage.SetSize(srcImage);
```

```
// Perform a Uniform filtering (5x5 kernel)
EasyImage.ConvolUniform(srcImage, dstImage, 2);
```

```
// Perform a Highpass filtering
EasyImage.ConvolHighpass1(srcImage, dstImage);
```

```
// Perform a Gradient filtering
EasyImage.ConvolGradient(srcImage, dstImage);
```

```
// Perform a Sobel filtering
EasyImage.ConvolSobel(srcImage, dstImage);
```

User-Defined Kernel Filtering

```
//////////////////////////////////////////////////////////
// This code snippet shows how to apply a convolution  //
// operation based on a user-defined kernel.           //
//////////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 srcImage= new EImageBW8();
EImageBW8 dstImage= new EImageBW8();
```

```
// ...
```

```
// Create and define a user-defined kernel
// (Frei-Chen row gradient, positive only)
EKernel kernel= new EKernel();
kernel.SetKernelData(0.2929f, 0, -0.2929f,
                     0.4142f, 0, -0.4142f,
                     0.2929f, 0, -0.2929f);
```

```
// Source and destination images must have the same size
dstImage.SetSize(srcImage);
```

```
// Apply the convolution kernel
EasyImage.ConvolKernel(srcImage, dstImage, kernel);
```

4.4. Non-Linear Filtering

Morphological Filtering

```
//////////////////////////////////////////////////////////
// This code snippet shows how to apply miscellaneous  //
// morphological filtering operations.                 //
//////////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 srcImage= new EImageBW8();
EImageBW8 dstImage= new EImageBW8();
```

```
// ...
```

```
// Source and destination images must have the same size
dstImage.SetSize(srcImage);
```

```
// Perform an erosion (3x3 square kernel)
EasyImage.ErodeBox(srcImage, dstImage, 1);
```

```
// Perform a dilation (5x3 rectangular kernel)
EasyImage.DilateBox(srcImage, dstImage, 2, 1);
```

```
// Perform an Open operation (5x5 circular kernel)
EasyImage.OpenDisk(srcImage, dstImage, 2);
```

Hit-and-Miss Transform

```
////////////////////////////////////////////////////////////
// This code snippet shows how to highlight the left corner //
// of a rhombus by means of a Hit-and-Miss operation.       //
////////////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 srcImage= new EImageBW8();
EImageBW8 dstImage= new EImageBW8();
```

```
// ...
```

```
// Create and define a Hit-and-Miss kernel
// corresponding to the left corner of a rhombus
EHitAndMissKernel leftCorner= new EHitAndMissKernel(-1, -1, 1, 1);
```

```
// Left column of the kernel
leftCorner.SetValue(-1, 0, EHitAndMissValue.Background);
```

```
// Middle column of the kernel
leftCorner.SetValue(0, -1, EHitAndMissValue.Background);
leftCorner.SetValue(0, 0, EHitAndMissValue.Foreground);
leftCorner.SetValue(0, 1, EHitAndMissValue.Background);
```

```
// Right column of the kernel
leftCorner.SetValue(1, -1, EHitAndMissValue.Foreground);
leftCorner.SetValue(1, 0, EHitAndMissValue.Foreground);
leftCorner.SetValue(1, 1, EHitAndMissValue.Foreground);
```

```
// Source and destination images must have the same size
dstImage.SetSize(srcImage);
```

```
// Apply the Hit-and-Miss kernel
EasyImage.HitAndMiss(srcImage, dstImage, leftCorner);
```

4.5. Vector Operations

Path Sampling

```
////////////////////////////////////////////////////////////
// This code snippet shows how to retrieve and store the    //
// pixel values along a given path together with the        //
// corresponding pixel coordinates.                         //
////////////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// ...
```

```
// Vector constructor
EBW8PathVector path= new EBW8PathVector();
EBW8 bw8= new EBW8(128);
```

```
// Path definition
path.Empty();
for (int i = 0; i < 100; i++)
{
  EBW8Path p;
  p.X = (short)i;
  p.Y = (short)i;
  p.Pixel = bw8;
  path.AddElement(p);
}
```

```
// Get the image data along the path
EasyImage.ImageToPath(srcImage, path);
int pixel = path.GetElement(20).Pixel.UINT32Value;
```

Profile Sampling

```
////////////////////////////////////////////////////////////
// This code snippet shows how to set, retrieve and store   //
// the pixel values along a given line segment.             //
////////////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// ...
```

```
// Vector constructor
EBW8Vector profile= new EBW8Vector();
```

```
// Get the image data along segment (10,512)-(500,40)
EasyImage.ImageToLineSegment(srcImage, profile, 10, 512, 500, 40);
```

```
// Set all these points to white (255) in the image
EBW8 white = new EBW8(255);
EasyImage.LineSegmentToImage(srcImage, white, 10, 512, 500, 40);
```

4.6. Statistics

Image Statistics

```
////////////////////////////////////////////////////////////////////
// This code snippet shows how to compute basic image statistics. //
////////////////////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// ...
```

```
// Count the number of pixels above the threshold (128)
int count;
EBW8 threshold = new EBW8(128);
EasyImage.Area(srcImage, threshold, out count);
```

```
// Compute the pixels' average and standard deviation values
float stdDev, average;
EasyImage.PixelStdDev(srcImage, out stdDev, out average);
```

```
// Compute the image gravity center (pixels above threshold)
float x, y;
EasyImage.GravityCenter(srcImage, 128, out x, out y);
```

Sliding Windows Statistics

```
//////////////////////////////////////////////////////////////////////
// This code snippet shows how to perform sliding windows statistics. //
//////////////////////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 srcImage= new EImageBW8();
EImageBW8 dstImage0= new EImageBW8();
EImageBW8 dstImage1= new EImageBW8();
```

```
// ...
```

```
// All images must have the same size
dstImage0.SetSize(srcImage);
dstImage1.SetSize(srcImage);
```

```
// Local average in a 11x11 window
EasyImage.LocalAverage(srcImage, dstImage0, 5, 5);
```

```
// Local deviation in a 11x11 window
EasyImage.LocalDeviation(srcImage, dstImage1, 5, 5);
```

Histogram-Based Statistics

```
//////////////////////////////////////////////////////////
// This code snippet shows how to compute statistics   //
// based on an histogram.                               //
//////////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// ...
```

```
// Histogram constructor
EBWHistogramVector histo= new EBWHistogramVector();
```

```
// Compute the histogram
EasyImage.Histogram(srcImage, histo);
```

```
// Compute the average gray-level value
float average = EasyImage.AnalyseHistogram(histo, EHistogramFeature.AveragePixelValue,
0, 255);
```

```
// Compute the gray-level standard deviation
float deviation = EasyImage.AnalyseHistogram(histo,
EHistogramFeature.PixelValueStdDev, 0, 255);
```

4.7. Noise Reduction by Integration

Temporal Noise Reduction

```
////////////////////////////////////////////////
// This code snippet shows how to perform noise  //
// reduction by temporal averaging.              //
////////////////////////////////////////////////
```

```
// Images constructor
EImageBW16 noisyImage= new EImageBW16();
EImageBW16 cleanImage= new EImageBW16();
```

```
// 16 bits work image used as an accumulator
EImageBW16 store= new EImageBW16();
```

```
// ...
```

```
// All images must have the same size
cleanImage.SetSize(noisyImage);
store.SetSize(noisyImage);
```

```
// Clear the accumulator image
EBW16 bw16= new EBW16(0);
EasyImage.Oper(EArithmeticLogicOperation.Copy, bw16, store);
```

```
// Accumulation loop
int n;
for (n = 0; n < 10; n++)
{
    // Acquire a new image into noisyImage
    // ...

    // Add this new noisy image into the accumulator
    EasyImage.Oper(EArithmeticLogicOperation.Add, noisyImage, store, store);
}
```

```
// Perform noise reduction
bw16.Value= (byte)n;
EasyImage.Oper(EArithmeticLogicOperation.Divide, store, bw16, cleanImage);
```

Recursive Average

```
////////////////////////////////////////////////
// This code snippet shows how to perform noise  //
// reduction by recursive averaging.             //
////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 noisyImage= new EImageBW8();
EImageBW8 cleanImage= new EImageBW8();
```

```
// 16 bits work image used as an accumulator
EImageBW16 store= new EImageBW16();
```

```
// ...
```

```
// All images must have the same size
cleanImage.SetSize(noisyImage);
store.SetSize(noisyImage);
```

```
// Clear the accumulator image
EBW16 bw16= new EBW16(0);
EasyImage.Oper(EArithmeticLogicOperation.Copy, bw16, store);
```

```
// Prepare the transfer lookup table (reduction factor = 3)
EBW16Vector lut= new EBW16Vector();
EasyImage.SetRecursiveAverageLUT(lut, 3.0f);
```

```
// Perform the noise reduction
EasyImage.RecursiveAverage(noisyImage, store, cleanImage, lut);
```

4.8. Feature Point Detectors

Harris Corner Detector

```
////////////////////////////////////////////////////////////////
// This code snippet shows how to retrieve corners' coordinates //
// by means of the Harris corner detector algorithm.            //
////////////////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// ...
```

```
// Harris corner detector
EHarrisCornerDetector harris= new EHarrisCornerDetector();
EHarrisInterestPoints interestPoints= new EHarrisInterestPoints();
harris.IntegrationScale= 2.0f;
```

```
// Perform the corner detection
harris.Apply(srcImage, interestPoints);
```

```
// Retrieve the number of corners
int index = interestPoints.PointCount;
```

```
// Retrieve the first corner coordinates
EPoint point = interestPoints.GetPoint(0);
float x = point.X;
float y = point.Y;
```

Canny Edge Detector

```
////////////////////////////////////////////////////
// This code snippet shows how to highlight edges  //
// by means of the Canny edge detector algorithm.  //
////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 srcImage= new EImageBW8();
EImageBW8 dstImage= new EImageBW8();
```

```
// ...
```

```
// Canny edge detector
ECannyEdgeDetector canny= new ECannyEdgeDetector();
```

```
// Source and destination images must have the same size
dstImage.SetSize(srcImage);
```

```
// Perform the edges detection
canny.Apply(srcImage, dstImage);
```

4.9. Using Flexible Masks

Computing Pixels Average

```
////////////////////////////////////////////////////////
// This code snippet shows how to compute statistics   //
// inside a region defined by a flexible mask.         //
////////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 srcImage= new EImageBW8();
EImageBW8 mask= new EImageBW8();
```

```
// ...
```

```
// Compute the average value of the source image pixels
// corresponding to the mask do-care areas only
float average;
EasyImage.PixelAverage(srcImage, mask, out average);
```

5. EasyColor

5.1. Colorimetric Systems Conversion

```
//////////////////////////////////////////////////////
// This code snippet shows how to convert a color image //
// from the RGB to the Lab colorimetric system.         //
//////////////////////////////////////////////////////
```

```
// Images constructor
EImageC24 srcImage= new EImageC24();
EImageC24 dstImage= new EImageC24();
```

```
// ...
```

```
// Prepare a lookup table for
// the RGB to La*b* conversion
EColorLookup lookup= new EColorLookup();
lookup.ConvertFromRgb(EColorSystem.Lab);
```

```
// Source and destination images must have the same size
dstImage.SetSize(srcImage);
```

```
// Perform the color conversion
EasyColor.Transform(srcImage, dstImage, lookup);
```

5.2. Color Components

```
//////////////////////////////////////////////////////
// This code snippet shows how to create a color image  //
// from 3 grayscale images and extract the luminance    //
// component from a color image.                        //
//////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 red= new EImageBW8();
EImageBW8 green= new EImageBW8();
EImageBW8 blue= new EImageBW8();
EImageC24 colorImage= new EImageC24();
EImageBW8 luminance= new EImageBW8();
```

```
// ...
```

```
// Source and destination images must have the same size
colorImage.SetSize(red);
```

```
// Combine the color planes into a color image
EasyColor.Compose(red, green, blue, colorImage);
```

```
// Prepare a lookup table for
// the RGB to LSH conversion
```

```
EColorLookup lookup= new EColorLookup();
lookup.ConvertFromRgb(EColorSystem.Lsh);
```

```
// Source and destination images must have the same size
luminance.SetSize(colorImage);
```

```
// Get the Luminance component
EasyColor.GetComponent(colorImage, luminance, 0, lookup);
```

5.3. White Balance

```
////////////////////////////////////////////////////////////
// This code snippet shows how to perform white balancing. //
////////////////////////////////////////////////////////////
```

```
// Images constructor
EImageC24 srcImage= new EImageC24();
EImageC24 dstImage= new EImageC24();
EImageC24 whiteRef= new EImageC24();
```

```
// ...
```

```
// Create a lookup table
EColorLookup lut= new EColorLookup();
```

```
// Measure the calibration values from a white reference image
float r, g, b;
EasyImage.PixelAverage(whiteRef, out r, out g, out b);
```

```
// Prepare the lookup table for
// a white balance operation
lut.WhiteBalance(1.00f, EasyColor.CompensateNtscGamma, r, g, b);
```

```
// Source and destination images must have the same size
dstImage.SetSize(srcImage);
```

```
// Perform the white balance operation
lut.Transform(srcImage, dstImage);
```

5.4. Pseudo-Coloring

```
////////////////////////////////////////////////////////////
// This code snippet shows how to perform pseudo-coloring. //
////////////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 srcImage= new EImageBW8();
EImageC24 dstImage= new EImageC24();
```

```
// ...
```

```
// Create a pseudo-color lookup table
EPseudoColorLookup pcLut= new EPseudoColorLookup();
```

```
// Define a shade of pure tints, from red to blue
EC24 red= new EC24(255, 0, 0);
EC24 blue= new EC24(0, 0, 255);
pcLut.SetShading(red, blue, EColorSystem.Ish);
```

```
// Source and destination images must have the same size
dstImage.SetSize(srcImage);
```

```
// Generate the pseudo-colored image
EasyColor.PseudoColor(srcImage, dstImage, pcLut);
```

5.5. Bayer Pattern Decoding

```
////////////////////////////////////////////////////////////////
// This code snippet shows how to perform Bayer pattern decoding. //
////////////////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 bayerImage= new EImageBW8();
EImageC24 dstImage= new EImageC24();
```

```
// ...
```

```
// Source and destination images must have the same size
dstImage.SetSize(bayerImage);
```

```
// Convert to true color with simple interpolation, default parity assumed
EasyColor.BayerToC24(bayerImage, dstImage);
```

6. Deep Learning Tools

6.1. Creating a Dataset and Training a Classifier

```
////////////////////////////////////////////////////////////////
// This code snippet shows how to create a dataset, train a  //
// classifier and get the best performance metrics obtained  //
// during the training.                                      //
////////////////////////////////////////////////////////////////

// Creating dataset and classifier objects
EClassificationDataset dataset= new EClassificationDataset();
EClassificationDataset trainingDataset= new EClassificationDataset();
EClassificationDataset validationDataset= new EClassificationDataset();
EClassifier classifier= new EClassifier();

// Adding images using a glob pattern
dataset.AddImages("*good*.png", "good");
dataset.AddImages("*defective*.png", "defective");

// Enabling data augmentation on the dataset
dataset.EnableDataAugmentation= true;

// Rotation of up to 90°
dataset.MaxRotationAngle= 90.0;

// Enabling horizontal flips
dataset.EnableHorizontalFlip= true;

// Splitting the dataset with 80% of images for the training dataset
// and 20% for the validation dataset
dataset.Split(trainingDataset, validationDataset, 0.8);

// Training the classifier for 50 epochs
classifier.Train(trainingDataset, validationDataset, 50);
classifier.WaitForTrainingCompletion();

// Get the best metrics obtained on the validation dataset
EClassificationMetrics bestMetrics = classifier.GetValidationMetrics
(classifier.BestEpoch);

// Dispose of objects
dataset.Dispose();
trainingDataset.Dispose();
validationDataset.Dispose();
classifier.Dispose();
```

6.2. Loading a Classifier and Classifying a New Image

```
////////////////////////////////////////////////////////////
// This code snippet shows how load a trained classifier and //
// classify a new image.                                    //
////////////////////////////////////////////////////////////

// Image and classifier constructor
EClassifier classifier= new EClassifier();
EImageBW8 srcImage= new EImageBW8();

// String and probability for the most probable result
string label;
float probability;

// Load classifier and image
classifier.Load(...);
srcImage.Load(...);

// Classify image
EClassificationResult result = classifier.Classify(srcImage);

// Get the most probable label
label = result.BestLabel;
probability = result.BestProbability;

// Dispose of objects
classifier.Dispose();
srcImage.Dispose();
```

6.3. Using Multithreading for Classification

```
////////////////////////////////////////////////////////////
// This code snippet shows how to parallelize the           //
// classification of new images on the CPU.                 //
// This code snippet requires the .NET Framework 4.0        //
////////////////////////////////////////////////////////////

using System.Collections.Generic;
using System.Collections.Concurrent;

...

static void ClassificationLoop(Object obj)
{
       BlockingCollection<EImageC24> queue = obj as BlockingCollection<EImageC24>;

    EClassifier c = new EClassifier();
    c.Load("classifier.ecl");
```

```
    while (!queue.IsCompleted)
    {
        EImageC24 image = queue.Take();

        EClassificationResult result = c.Classify(image);
        // Get the most probable label
        string label = result.BestLabel;
        float probability = result.BestProbability;

        // Perform other actions based on the result
               ...
    }
}

...

int NUM_THREADS = 2;

// Queue holding the image to classify
BlockingCollection<EImageC24> imageQueue = new BlockingCollection<EImageC24>(new
ConcurrentQueue<EImageC24>(), 2 * NUM_THREADS);

// Create and start the thread pool
Thread[] threads = new Thread[NUM_THREADS];
for (int i = 0; i < NUM_THREADS; i++)
{
    threads[i] = new Thread(ClassificationLoop);
    threads[i].Start(imageQueue);
}

bool hasImage = true;
while (hasImage)
{
       EImageC24 image = new EImageC24();

       // Load or set the data pointer of the image
       ...

       // Add the image to the queue
       imageQueue.Add(image);

       // Check that we still have an image to process and change the status
       // of "hasImage" if necessary.
       ...
}

// Tell the threads that they won't have any new image coming.
imageQueue.CompleteAdding();

// Wait for the threads to finish
for (int i = 0; i < NUM_THREADS; i++)
       threads[i].Join();
```

6.4. Loading an Unsupervised Segmenter and Segmenting an Image

```
//////////////////////////////////////////////////////////////////
```

```
// This code snippet shows how to load a trained             //
// unsupervised segmenter and how to segment a new image.    //
////////////////////////////////////////////////////////////////

// Image and segmenter constructor
EUnsupervisedSegmenter segmenter = new EUnsupervisedSegmenter();
EImageBW8 image = new EImageBW8();

// Load segmenter and image
segmenter.Load(...);
image.Load(...);

// Apply the segmenter on the image
EUnsupervisedSegmenterResult result = segmenter.Apply(image);

// Retrieve the segmentation map
EImageBW8 segmentationMap = segmenter.SegmentationMap() ;

// Dispose of objects
segmenter.Dispose();
image.Dispose();
```

7. EasyObject

7.1. Constructing the Blobs

Image Encoder

```
////////////////////////////////////////////////////////////
// This code snippet shows how to build blobs belonging to  //
// the white layer according to the minimum residue method  //
// and how to build blobs belonging to the black layer      //
// according to an absolute threshold.                      //
////////////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// Image encoder
EImageEncoder encoder= new EImageEncoder();
```

```
// Coded image
ECodedImage2 codedImage= new ECodedImage2();
```

```
// ...
```

```
// Build the blobs belonging to the white layer,
// the segmentation is based on the Minimum Residue method
encoder.Encode(srcImage, codedImage);
```

```
// Build the blobs belonging to the black layer,
// the segmentation is based on an absolute threshold (110)
Euresys.Open_eVision_1_1.Segmenters.EGrayscaleSingleThresholdSegmenter segmenter=
encoder.GrayscaleSingleThresholdSegmenter;
segmenter.BlackLayerEncoded= true;
segmenter.WhiteLayerEncoded= false;
```

```
segmenter.Mode= EGrayscaleSingleThreshold.Absolute;
segmenter.AbsoluteThreshold= 110;
```

```
encoder.Encode(srcImage, codedImage);
```

Image Segmenter

```
////////////////////////////////////////////////////////////
// This code snippet shows how to build blobs according to  //
// a user-defined image segmenter.                          //
////////////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// Image encoder
EImageEncoder encoder= new EImageEncoder();
```

```
// Coded image
ECodedImage2 codedImage= new ECodedImage2();

// ...

// Set the segmentation method to GrayscaleDoubleThreshold
encoder.SegmentationMethod= ESegmentationMethod.GrayscaleDoubleThreshold;

// Retrieve the segmenter object
Euresys.Open_eVision_1_1.Segmenters.EGrayscaleDoubleThresholdSegmenter segmenter=
encoder.GrayscaleDoubleThresholdSegmenter;

// Set the high and low threshold values
segmenter.HighThreshold= 150;
segmenter.LowThreshold= 50;

// Specify the layers to be encoded (neutral layer only)
segmenter.BlackLayerEncoded= false;
segmenter.NeutralLayerEncoded= true;
segmenter.WhiteLayerEncoded= false;

// Encode the image
encoder.Encode(srcImage, codedImage);
```

Holes Extraction

```
////////////////////////////////////////////////////////
// This code snippet shows how to retrieve blobs' holes. //
////////////////////////////////////////////////////////

// Image constructor
EImageBW8 srcImage= new EImageBW8();

// Image encoder
EImageEncoder encoder= new EImageEncoder();

// Coded image
ECodedImage2 codedImage= new ECodedImage2();

// ...

// Encode the image
encoder.Encode(srcImage, codedImage);

// Retrieve holes for all the blobs
for (int blobIndex = 0; blobIndex < codedImage.GetObjCount(); blobIndex++)
{
        EObject blob = codedImage.GetObj(blobIndex);

        // Browse the holes of the current object
        for (int holeIndex = 0; holeIndex < blob.HoleCount; holeIndex++)
        {
                // Retrieve a given hole
                EHole hole = blob.GetHole(holeIndex);
        }
}
```

Continuous Mode

```
////////////////////////////////////////////////
// This code snippet shows how to build blobs  //
// in the continuous mode context.             //
////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();

// Image encoder
EImageEncoder encoder= new EImageEncoder();

// Coded image
ECodedImage2 codedImage= new ECodedImage2();

// ...

// Enable the continuous mode
encoder.ContinuousModeEnabled= true;

// Loop to acquire 50 different chunks
for (int count = 0; count < 50 ; count++)
{
        // Store the new chunk into srcImage
        // ...

        // Encode the current chunk
        encoder.Encode(srcImage, codedImage);
}

// Flush the continuous mode
encoder.FlushContinuousMode(codedImage);
```

7.2. Computing Blobs Features

```
////////////////////////////////////////////////////////////
// This code snippet shows how to retrieve blobs' features. //
////////////////////////////////////////////////////////////

// Image constructor
EImageBW8 srcImage= new EImageBW8();

// Image encoder
EImageEncoder encoder= new EImageEncoder();

// Coded image
ECodedImage2 codedImage= new ECodedImage2();

// ...

// Encode the source image
encoder.Encode(srcImage, codedImage);

for (int index = 0; index < codedImage.GetObjCount(); index++)
{
        // Retrieve the selected blob gravity center
        EObject blob = codedImage.GetObj(index);
        float centerX = blob.GravityCenter.X;
        float centerY = blob.GravityCenter.Y;
}
```

7.3. Selecting and Sorting Blobs

```
////////////////////////////////////////////////////
// This code snippet shows how to build blobs, select  //
// some of them and sort the selected ones.            //
```

```
////////////////////////////////////////////////////////
// Image constructor
EImageBW8 srcImage= new EImageBW8();

// Image encoder
EImageEncoder encoder= new EImageEncoder();

// Coded image
ECodedImage2 codedImage= new ECodedImage2();

// ...

// Encode the source image
encoder.Encode(srcImage, codedImage);

// Create a blob selection
EObjectSelection selection= new EObjectSelection();
selection.AddObjects(codedImage);

// Remove the Small blobs
selection.RemoveUsingUnsignedIntegerFeature(EFeature.Area, 100,
ESingleThresholdMode.Less);

// Retrieve the number of remaining blobs
int numBlobs= selection.ElementCount;

// Sort the remaining blobs based on their area
selection.Sort(EFeature.Area, ESortDirection.Ascending);

// Retrieve the selected blobs
for (int index = 0; index < numBlobs; index++)
{
    float centerX= selection.GetElement(index).GravityCenterX;
    float centerY= selection.GetElement(index).GravityCenterY;
}
```

7.4. Using Flexible Masks

Constructing Blobs

```
////////////////////////////////////////////////////////
// This code snippet shows how to build blobs inside  //
// a region defined by a flexible mask.               //
////////////////////////////////////////////////////////

// Images constructor
EImageBW8 srcImage= new EImageBW8();
EImageBW8 mask = new EImageBW8();

// Image encoder
EImageEncoder encoder= new EImageEncoder();

// Coded image
ECodedImage2 codedImage= new ECodedImage2();

// ...

// Encode the source image regions
// corresponding to the mask do care areas
encoder.Encode(srcImage, mask, codedImage);
```

Generating a Flexible Mask from an Encoded Image

```
////////////////////////////////////////////////////////
// This code snippet shows how to generate a flexible  //
// mask from an encoded image.                         //
////////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 srcImage= new EImageBW8();
EImageBW8 mask= new EImageBW8();
```

```
// Image encoder
EImageEncoder encoder= new EImageEncoder();
```

```
// Coded image
ECodedImage2 codedImage= new ECodedImage2();
```

```
// ...
```

```
// Encode the source image
encoder.Encode(srcImage, codedImage);
```

```
// The source image and the mask must have the same size
mask.SetSize(srcImage);
```

```
// Create the mask based on the white layer
// of the coded image
codedImage.RenderMask(mask, 1);
```

Generating a Flexible Mask from a Blob Selection

```
////////////////////////////////////////////////////////
// This code snippet shows how to generate a flexible  //
// mask from a selection of blobs.                     //
////////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 srcImage= new EImageBW8();
EImageBW8 mask= new EImageBW8();
```

```
// Image encoder
EImageEncoder encoder= new EImageEncoder();
```

```
// Coded image
ECodedImage2 codedImage= new ECodedImage2();
```

```
// ...
```

```
// Encode the source image
encoder.Encode(srcImage, codedImage);
```

```
// The source image and the mask must have the same size
mask.SetSize(srcImage);
```

```
// Create a blob selection
EObjectSelection selection= new EObjectSelection();
selection.AddObjects(codedImage);
```

```
// Remove the Small blobs
selection.RemoveUsingUnsignedIntegerFeature(EFeature.Area, 100,
ESingleThresholdMode.Less);
```

```
// Create the mask based on the blob selection
selection.RenderMask(mask);
```

```
// Sort the remaining blobs based on their area
selection.Sort(EFeature.Area, ESortDirection.Descending);
```

```
// Create the mask corresponding to the largest blob
selection.GetElement(0).RenderMask(mask);
```

8. EasyMatch

8.1. Pattern Learning

```
////////////////////////////////////////////////
// This code snippet shows how to learn a pattern  //
// defined by a region of interest (ROI).          //
////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// ROI constructor
EROIBW8 pattern= new EROIBW8();
```

```
// EMatcher constructor
EMatcher matcher= new EMatcher();
```

```
// ...
```

```
// Attach the ROI to the source image
// and set its position
pattern.Attach(srcImage);
pattern.SetPlacement(214, 52, 200, 200);
```

```
// Learn the pattern
matcher.LearnPattern(pattern);
```

8.2. Setting Search Parameters

```
////////////////////////////////////////////////////////
// This code snippet shows how to tune pattern matching //
// search parameters and save them into a file.         //
////////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 pattern= new EImageBW8();
```

```
// EMatcher constructor
EMatcher matcher= new EMatcher();
```

```
// ...
```

```
// Learn the pattern
matcher.LearnPattern(pattern);
```

```
// Set the maximum number of occurrences
matcher.MaxPositions= 5;
```

```
// Set the rotation tolerances
matcher.MinAngle= -20.0f;
matcher.MaxAngle= 20.0f;
```

```
// Enable sub-pixel accuracy
matcher.Interpolate= true;
```

```
// Set the minimum score
matcher.MinScore= 0.70f;
```

```
// Save the matching context into a model file
matcher.Save("myModel.mch");
```

8.3. Pattern Matching and Retrieving Results

```
////////////////////////////////////////////////
// This code snippet shows how to perform pattern  //
// matching operations and retrieve the results.   //
////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// EMatcher constructor
EMatcher matcher= new EMatcher();
```

```
// ...
```

```
// Load a model file
matcher.Load("myModel.mch");
```

```
// Perform the matching
matcher.Match(srcImage);
```

```
// Retrieve the number of occurrences
int numOccurrences= matcher.NumPositions;
```

```
// Retrieve the first occurrence
EMatchPosition myOccurrence= matcher.GetPosition(0);
```

```
// Retrieve its score and position
float score= myOccurrence.Score;
float centerX= myOccurrence.CenterX;
float centerY= myOccurrence.CenterY;
```

9. EasyFind

9.1. Pattern Learning

```
////////////////////////////////////////////////
// This code snippet shows how to learn a pattern  //
// defined by a region of interest (ROI).          //
////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// ROI constructor
EROIBW8 pattern= new EROIBW8();
```

```
// EPatternFinder constructor
EPatternFinder finder= new EPatternFinder();
```

```
// ...
```

```
// Attach the ROI to the source image
// and set its position
pattern.Attach(srcImage);
pattern.SetPlacement(214, 52, 200, 200);
```

```
// Learn the pattern
finder.Learn(pattern);
```

9.2. Setting Search Parameters

```
////////////////////////////////////////////////////////
// This code snippet shows how to tune pattern finding  //
// search parameters and save them into a file.         //
////////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 pattern= new EImageBW8();
```

```
// EPatternFinder constructor
EPatternFinder finder= new EPatternFinder();
```

```
// ...
```

```
// Learn the pattern
finder.Learn(pattern);
```

```
// Set the maximum number of occurrences
finder.MaxInstances= 5;
```

```
// Set the rotation tolerances
finder.AngleTolerance= 20.0f;
```

```
// Set the minimum score
finder.MinScore= 0.70f;
```

```
// Save the finding context into a model file
finder.Save("myModel.fnd");
```

9.3. Pattern Finding and Retrieving Results

```
////////////////////////////////////////////////////
// This code snippet shows how to perform pattern  //
// finding operations and retrieve the results.    //
////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// EPatternFinder constructor
EPatternFinder finder= new EPatternFinder();
```

```
// EFoundPattern constructor
EFoundPattern[] foundPattern= null;
```

```
// ...
```

```
// Load a model file
finder.Load("myModel.fnd");
```

```
// Perform the pattern finding
foundPattern= finder.Find(srcImage);
```

```
// Retrieve the number of instances
int numInstances= foundPattern.Length;
```

```
// Retrieve the score and the
// position of the first instance
float score= foundPattern[0].Score;
float centerX= foundPattern[0].Center.X;
float centerY= foundPattern[0].Center.Y;
```

10. EasyGauge

10.1. Point Location

```
////////////////////////////////////////////////////////////////
// This code snippet shows how to create a point location tool, //
// adjust the transition parameters, set the nominal gauge      //
// position, perform the measurement and retrieve the result.   //
////////////////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// EPointGauge constructor
EPointGauge pointGauge= new EPointGauge();
```

```
// Adjust the transition parameters
pointGauge.TransitionType= ETransitionType.Wb;
pointGauge.TransitionChoice= ETransitionChoice.Closest;
```

```
// Set the gauge nominal position
pointGauge.SetCenterXY(256.0f, 256.0f);
```

```
// Set the gauge length to 10 units and the angle to 45°
pointGauge.SetTolerances(10.0f, 45.0f);
```

```
// Measure
pointGauge.Measure(srcImage);
```

```
// Get the measured point coordinates
float measuredX = pointGauge.GetMeasuredPoint().X;
float measuredY = pointGauge.GetMeasuredPoint().Y;
```

```
// Save the point gauge measurement context
pointGauge.Save("myPointGauge.gge");
```

10.2. Line Fitting

```
////////////////////////////////////////////////////////////////
// This code snippet shows how to create a line measurement tool, //
// adjust the transition parameters, set the nominal gauge        //
// position, perform the measurement and retrieve the result.     //
////////////////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// ELineGauge constructor
ELineGauge lineGauge= new ELineGauge();
```

```
// Adjust the transition parameters
lineGauge.TransitionType= ETransitionType.Bw;
```

```
lineGauge.TransitionChoice= ETransitionChoice.NthFromEnd;
lineGauge.TransitionIndex= 2;
```

```
// Set the line fitting gauge position,
// length (50 units) and orientation (20°)
EPoint center= new EPoint(256.0f, 256.0f);
ELine line= new ELine(center, 50.0f, 20.0f);
lineGauge.SetLine(line);
```

```
// Measure
lineGauge.Measure(srcImage);
```

```
// Get the origin and end point coordinates of the fitted line
EPoint originPoint = lineGauge.MeasuredLine.Org;
EPoint endPoint = lineGauge.MeasuredLine.End;
```

```
// Save the point gauge measurement context
lineGauge.Save("myLineGauge.gge");
```

10.3. Circle Fitting

```
//////////////////////////////////////////////////////////////////////
// This code snippet shows how to create a circle measurement tool, //
// adjust the transition parameters, set the nominal gauge          //
// position, perform the measurement and retrieve the result.       //
//////////////////////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// ECircleGauge constructor
ECircleGauge circleGauge= new ECircleGauge();
```

```
// Adjust the transition parameters
circleGauge.TransitionType= ETransitionType.Bw;
circleGauge.TransitionChoice= ETransitionChoice.LargestAmplitude;
```

```
// Set the Circle fitting gauge position, diameter (50 units),
// starting angle (10°), and amplitude (270°)
EPoint center= new EPoint(256.0f, 256.0f);
ECircle circle= new ECircle(center, 50.0f, 10.0f, 270.0f);
circleGauge.Circle = circle;
```

```
// Measure
circleGauge.Measure(srcImage);
```

```
// Get the center point coordinates and the radius of the fitted circle
float centerX = circleGauge.MeasuredCircle.Center.X;
float centerY = circleGauge.MeasuredCircle.Center.Y;
float radius = circleGauge.MeasuredCircle.Radius;
```

```
// Save the point gauge measurement context
circleGauge.Save("myCircleGauge.gge");
```

10.4. Rectangle Fitting

```
//////////////////////////////////////////////////////////////////////
// This code snippet shows how to create a rectangle measurement tool, //
// adjust the transition parameters, set the nominal gauge position,   //
// perform the measurement and retrieve the result.                    //
```

```
////////////////////////////////////////////////////////////////////////////
// Image constructor
EImageBW8 srcImage= new EImageBW8();

// ERectangleGauge constructor
ERectangleGauge rectangleGauge= new ERectangleGauge();

// Adjust the transition parameters
rectangleGauge.TransitionType= ETransitionType.Bw;
rectangleGauge.TransitionChoice= ETransitionChoice.LargestAmplitude;

// Set the rectangle fitting gauge position,
// size (50x30 units) and orientation (15°)
rectangleGauge.SetCenterXY(256.0f, 256.0f);
rectangleGauge.SetSize(50.0f, 30.0f);
rectangleGauge.Angle = 15.0f;

// Measure
rectangleGauge.Measure(srcImage);

// Get the size and the rotation angle of the fitted rectangle
float sizeX = rectangleGauge.MeasuredRectangle.SizeX;
float sizeY = rectangleGauge.MeasuredRectangle.SizeY;
float angle = rectangleGauge.MeasuredRectangle.Angle;

// Save the point gauge measurement context
rectangleGauge.Save("myRectangleGauge.gge");
```

10.5. Wedge Fitting

```
////////////////////////////////////////////////////////////////////////
// This code snippet shows how to create a wedge measurement tool, //
// adjust the transition parameters, set the nominal gauge         //
// position, perform the measurement and retrieve the result.      //
////////////////////////////////////////////////////////////////////////

// Image constructor
EImageBW8 srcImage= new EImageBW8();

// EWedgeGauge constructor
EWedgeGauge wedgeGauge= new EWedgeGauge();

// Adjust the transition parameters
wedgeGauge.TransitionType= ETransitionType.Bw;
wedgeGauge.TransitionChoice= ETransitionChoice.NthFromBegin;
wedgeGauge.TransitionIndex= 0;

// Set the wedge fitting gauge position, diameter (50 units),
// breadth (-25 units), starting angle (0°) and amplitude (270°)
EPoint center= new EPoint(256.0f, 256.0f);
EWedge wedge= new EWedge(center, 50.0f, -25.0f, 0.0f, 270.0f);
wedgeGauge.SetWedge(wedge);

// Measure
wedgeGauge.Measure(srcImage);

// Get the inner and outer radius of the fitted wedge
float innerRadius = wedgeGauge.MeasuredWedge.InnerRadius;
float outerRadius = wedgeGauge.MeasuredWedge.OuterRadius;

// Save the point gauge measurement context
wedgeGauge.Save("myWedgeGauge.gge");
```

10.6. Gauge Grouping

Gauge Hierarchy

```
////////////////////////////////////////////////////////////
// This code snippet shows how to create a gauge hierarchy  //
// and save it into a file.                                 //
////////////////////////////////////////////////////////////
```

```
// EWorldShape constructor
EWorldShape worldShape= new EWorldShape();
```

```
// Gauges constructor
ERectangleGauge rectangleGauge= new ERectangleGauge();
ECircleGauge circleGauge1= new ECircleGauge();
ECircleGauge circleGauge2= new ECircleGauge();
```

```
// ...
```

```
// Attach the rectangle gauge to the EWorldShape
rectangleGauge.Attach(worldShape);
```

```
// Attach the circle gauges to the rectangle gauge
circleGauge1.Attach(rectangleGauge);
circleGauge2.Attach(rectangleGauge);
```

```
// Set the first circle gauge name
circleGauge1.Name= "myCircleGauge1";
```

```
// ...
```

```
// Save worldShape together with its daughters
worldShape.Save("myWorldShape.gge", true);
```

Complex Measurement

```
////////////////////////////////////////////////////////////
// This code snippet shows how to trigger the measurement //
// of a whole gauge hierarchy and retrieve the results.   //
////////////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// EWorldShape constructor
EWorldShape worldShape= new EWorldShape();
```

```
// Load the EWorldShape together with its daughters
worldShape.Load("myWorldShape.gge", true);
```

```
// Retrieve the number of worldShape's daughters
int numDaughters= worldShape.NumDaughters;
```

```
// ...
```

```
// Trigger the measurement of all the
// gauges attached to the EWorldShape
worldShape.Process(srcImage, true);
```

```
// Retrieve the measurement result of
// the first daughter (a rectangle gauge)
```

```
ERectangleGauge rectangleGauge= (ERectangleGauge)worldShape.GetDaughter(0);
float sizeX= rectangleGauge.MeasuredRectangle.SizeX;
```

```
// Retrieve the measurement result of a
// daughter gauge called "myCircleGauge1"
ECircleGauge circleGauge= (ECircleGauge)worldShape.GetShapeNamed("myCircleGauge1");
EPoint center= circleGauge.MeasuredCircle.Center;
```

10.7. Calibration using EWorldShape

Calibration by Guesswork

```
//////////////////////////////////////////////////////
// This code snippet shows how to perform a calibration //
// by guesswork.                                        //
//////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// EWorldShape constructor
EWorldShape worldShape= new EWorldShape();
```

```
// ...
```

```
// Compute the calibration coefficients
// Field of view: 32x24 mm
worldShape.SetSensor(srcImage.Width, srcImage.Height, 32.0f, 24.0f);
```

```
// Retrieve the spatial resolution
float resolutionX= worldShape.XResolution;
float resolutionY= worldShape.YResolution;
```

Landmark-Based Calibration

```
//////////////////////////////////////////////////////
// This code snippet shows how to perform a landmark-based //
// calibration.                                         //
//////////////////////////////////////////////////////
```

```
// EWorldShape constructor
EWorldShape worldShape= new EWorldShape();
```

```
// ...
```

```
// Reset the calibration context
worldShape.EmptyLandmarks();
```

```
// Loop on the landmarks
for(int index= 0; index < numLandmarks; index++)
{
```

```
        // Get the I-th landmark as a pair of EPoint(x, y)
        EPoint sensorPoint, worldPoint;
```

```
        // Retrieve and store the relevant data into worldPoint and sensorPoint
    sensorPoint = myIthLandmark_Sensor;
    worldPoint = myIthLandmark_World;

    // Add the I-th pair
```

```
        worldShape.AddLandmark(sensorPoint, worldPoint);
}
```

```
// Perform the calibration
worldShape.Calibrate((int)ECalibrationMode.Skewed);
```

Dot Grid-Based Calibration

```
////////////////////////////////////////////////////////////
// This code snippet shows how to perform a dot grid-based //
// calibration.                                            //
////////////////////////////////////////////////////////////
```

```
// EWorldShape constructor
EWorldShape worldShape= new EWorldShape();
```

```
// ...
```

```
// Reset the calibration context
worldShape.EmptyLandmarks();
```

```
// Loop on the dots
for(int index= 0; index < numDots; index++)
{
        // Get the I-th dot as an EPoint(x, y)
        EPoint dotPoint;
```

```
        // Retrieve and store the relevant data into dotPoint
    dotPoint = myIthDot;
```

```
        // Add the I-th dot
        worldShape.AddPoint(dotPoint);
}
```

```
// Reconstruct the grid topology
// pitch X and Y = 5 units
worldShape.RebuildGrid(5, 5);
```

```
// Perform the calibration
// the calibration modes are computed automatically
worldShape.AutoCalibrate(true);
```

Coordinates Transform

```
////////////////////////////////////////////////////////////
// This code snippet shows how to convert coordinates from //
// the Sensor space to the World space and conversely.     //
////////////////////////////////////////////////////////////
```

```
// EWorldShape constructor
EWorldShape worldShape= new EWorldShape();
```

```
// EPoint constructor
EPoint sensor= new EPoint();
EPoint world= new EPoint();
```

```
// ...
```

```
// Perform the calibration
worldShape.Calibrate((int)ECalibrationMode.Scaled | (int)ECalibrationMode.Skewed);
```

```
// Retrieve the world coordinates of a point, knowing its sensor coordinates
world= worldShape.SensorToWorld(sensor);
```

```
// Retrieve the sensor coordinates of a point, knowing its world coordinates
sensor= worldShape.WorldToSensor(world);
```

Image Unwarping

```
////////////////////////////////////////////////////////
// This code snippet shows how to unwarp an image based //
// of the computed calibration coefficients.            //
////////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 srcImage= new EImageBW8();
EImageBW8 dstImage= new EImageBW8();
```

```
// EWorldShape constructor
EWorldShape worldShape= new EWorldShape();
```

```
// Lookup table constructor
EUnwarpingLut lut= new EUnwarpingLut();
```

```
// ...
```

```
// Perform the calibration
worldShape.Calibrate((int)ECalibrationMode.Tilted | (int)ECalibrationMode.Radial);
```

```
// Setup the lookup table for unwarping
worldShape.SetupUnwarp(lut, srcImage, true);
```

```
// Perform the image unwarping
worldShape.Unwarp(lut, srcImage, dstImage, true);
```

11. EasyOCR

11.1. Learning Characters

```
////////////////////////////////////////////////////
// This code snippet shows how to learn characters  //
// based on an image featuring a known text and     //
// save the corresponding font file.                //
////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// EOCR constructor
EOCR ocr= new EOCR();
```

```
// Text to be learned (all digits)
// Assuming the image contains this text
string text= "0123456789";
```

```
// ...
```

```
// Create a new font
ocr.NewFont(8, 11);
```

```
// Adjust the segmentation parameters
ocr.TextColor= EOCRColor.BlackOnWhite;
ocr.MinCharWidth= 15;
ocr.MaxCharWidth= 50;
ocr.MinCharHeight= 15;
ocr.MaxCharHeight= 75;
ocr.NoiseArea= 15;
```

```
// Segment the characters
ocr.BuildObjects(srcImage);
ocr.FindAllChars(srcImage);
```

```
// Learn the characters
ocr.LearnPatterns(srcImage, text, (int)EOCRClass.Digit);
```

```
// Save the font into a file
ocr.Save("myFont.ocr");
```

11.2. Recognizing Characters

```
////////////////////////////////////////////////////
// This code snippet shows how to load a font file,  //
// perform a default character recognition operation //
// and perform a character recognition operation     //
// using a class filter.                             //
////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// EOCR constructor
EOCR ocr= new EOCR();
```

```
// Load the font file
ocr.Load("myFont.ocr");
```

```
// ...
```

```
// Recognize the characters
string text= ocr.Recognize(srcImage, 10, (int)EOCRClass.AllClasses);
```

```
// Alternatively
// Define the character filter (2 letters and 3 digits)
int[] charFilter = new int[5];
charFilter[0] = (int)EOCRClass.UpperCase;
charFilter[1] = (int)EOCRClass.UpperCase;
charFilter[2] = (int)EOCRClass.Digit;
charFilter[3] = (int)EOCRClass.Digit;
charFilter[4] = (int)EOCRClass.Digit;
```

```
// Recognize the characters with class filtering
text = ocr.Recognize(srcImage, 10, charFilter);
```

12. EasyOCR2

12.1. Detecting Characters

```
////////////////////////////////////////////////////
// This code snippet shows how to detect characters   //
// in an image, using a few parameters and a topology //
////////////////////////////////////////////////////
```

```
// Load an Image
EImageBW8 image = new EImageBW8();
image.Load("image.tif");
```

```
// Attach a ROI to the image
EROIBW8 roi = new EROIBW8();
roi.Attach(image, 50, 224, 340, 96);
```

```
// Create an EOCR2 instance
EOCR2 ocr2 = new EOCR2();
```

```
// Set the expected character sizes
ocr2.CharsWidthRange = new EIntegerRange(25,25);
ocr2.CharsHeight = 37;
```

```
// Set the text polarity, in this case WhiteOnBlack
ocr2.TextPolarity = EasyOCR2TextPolarity.WhiteOnBlack;
```

```
// Set the topology
ocr2.Topology = ".{10}\n.{3} .{4}";
```

```
// Detect the text in the image. The output Text structure contains:
// - an individual textbox for each character
// - an individual bitmap image for each character
// - a threshold value to binarize the bitmap image for each character
// All structured in a hierarchy with Lines -> Words -> Characters
EOCR2Text text = ocr2.Detect(roi);
```

```
// Cleanup
text.Dispose();
ocr2.CharsWidthRange.Dispose();
ocr2.Dispose();
roi.Dispose();
image.Dispose();
```

The image used in this code snippet

12.2. Learning Characters

```
////////////////////////////////////////////////////
// This code snippet shows how to learn characters  //
// based on an image featuring a known text and     //
// save the corresponding character database        //
////////////////////////////////////////////////////
```

```
// Load an Image
EImageBW8 image = new EImageBW8();
image.Load("image.tif");
```

```
// Attach a ROI to the image
EROIBW8 roi = new EROIBW8();
roi.Attach(image, 50, 224, 340, 96);
```

```
// Create an EOCR2 instance
EOCR2 ocr2 = new EOCR2();
```

```
// Set the required parameters
ocr2.CharsWidthRange = new EIntegerRange(25,25);
ocr2.CharsHeight = 37;
ocr2.TextPolarity = EasyOCR2TextPolarity.WhiteOnBlack;
ocr2.Topology = ".{10}\n.{3} .{4}";
```

```
// Learn from the reference image:
//   1) Detect the text in the image
EOCR2Text text = ocr2.Detect(roi);
//   2) Set the true values of the text
text.Text = "Bt121KPJ80\n786 9512";
//   3) Add the characters to the character database
ocr2.Learn(text);
```

```
// Save the character database
ocr2.SaveCharacterDatabase("myDB.o2d");
```

```
// Alternatively, save the model file.
// This will store the character database and the parameter settings
ocr2.Save("myModel.o2m");
```

```
// Cleanup
text.Dispose();
ocr2.CharsWidthRange.Dispose();
ocr2.Dispose();
roi.Dispose();
image.Dispose();
```

The image used in this code snippet

12.3. Reading Characters

Reading using TrueType fonts

```
//////////////////////////////////////////////////////
// This code snippet shows how to                   //
// - create a character database from TrueType fonts  //
// - read the text in an image                      //
//////////////////////////////////////////////////////
```

```
// Load an image
EImageBW8 image = new EImageBW8();
image.Load("image.tif");
```

```
// Attach an ROI
EROIBW8 roi = new EROIBW8();
roi.Attach(src, 50, 224, 340, 96);
```

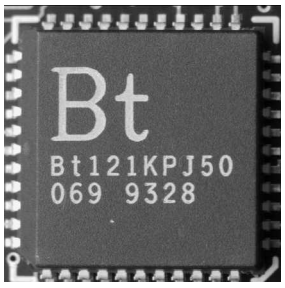
```
// Create an EOCR2 instance
EOCR2 ocr2 = new EOCR2();
```

```
// Set the required parameters
ocr2.CharsWidthRange = new EIntegerRange(25,25);
ocr2.CharsHeight = 37;
ocr2.Topology = "[LN]{10}\nN{3} N{4}";
ocr2.TextPolarity = EasyOCR2TextPolarity.WhiteOnBlack;
```

```
// Add TrueType character to the character database
ocr2.AddCharactersToDatabase("C:\\Windows\\Fonts\\calibrib.ttf");
ocr2.AddCharactersToDatabase("C:\\Windows\\Fonts\\yugothb.ttc");
```

```
// Read text from the image
string result = ocr2.Read(roi);
```

```
// Cleanup
ocr2.CharsWidthRange.Dispose();
ocr2.Dispose();
roi.Dispose();
image.Dispose();
```



The image used in this code snippet

Reading using EOCR2 Character Database

```
//////////////////////////////////////////////////////
// This code snippet shows how to                   //
// - load a pre-made character database             //
// - read the text in an image                      //
//////////////////////////////////////////////////////
```

```
// Load an image
EImageBW8 image = new EImageBW8();
image.Load("image.tif");
```

```
// Attach an ROI
EROIBW8 roi = new EROIBW8();
roi.Attach(src, 50, 224, 340, 96);
```

```
// Create an EOCR2 instance
EOCR2 ocr2 = new EOCR2();
```

```
// Set the required parameters
ocr2.CharsWidthRange = new EIntegerRange(25,25);
ocr2.CharsHeight = 37;
ocr2.Topology = "[LN]{10}\nN{3} N{4}";
ocr2.TextPolarity = EasyOCR2TextPolarity.WhiteOnBlack;
```

```
// Add a pre-made character database to the EOCR2 instance
ocr2.AddCharactersToDatabase("myDB.o2d");
```

```
// Read text from the image
string result = ocr2.Read(roi);
```

```
// Cleanup
ocr2.CharsWidthRange.Dispose();
ocr2.Dispose();
roi.Dispose();
image.Dispose();
```

Reading using EOCR2 Model file

```
//////////////////////////////////////////////////////
// This code snippet shows how to                   //
// - load a pre-made model file                     //
// - read the text in an image                      //
//////////////////////////////////////////////////////
```

```
// Load an image
EImageBW8 image = new EImageBW8();
image.Load("image.tif");
```

```
// Attach an ROI
EROIBW8 roi = new EROIBW8();
roi.Attach(src, 50, 224, 340, 96);
```

```
// Create an EOCR2 instance
EOCR2 ocr2 = new EOCR2();
```

```
// Load a pre-made model file, this will:
// - (re)set all parameters
// - add the character database in the model file to the EOCR2 instance
ocr2.Load("myModel.o2m");
```

```
// Read text from the image
string result = ocr2.Read(roi);
```

```
// Cleanup
ocr2.Dispose();
roi.Dispose();
image.Dispose();
```

12.4. View Bitmap

```
////////////////////////////////////////////////
```

```
// This code snippet shows how to inspect the //
// characters in a character database         //
////////////////////////////////////////////////

// Create an EOCR2 instance
EOCR2 ocr2 = new EOCR2();

// Load the character database
ocr2.AddCharactersToDatabase("database.o2d");

// Extract the character database
EOCR2CharacterDatabase db = ocr2.CharacterDatabase;

// Select the character that we are interested in (e.g. the third one)
EOCR2DatabaseCharacter chr = db.GetCharacter(2);

// Extract the bitmap for that character
EImageBW8 img = chr.Bitmap;
```

13. EasyBarCode

13.1. Reading a Bar Code

```
////////////////////////////////////////////////
// This code snippet shows how to read a bar code  //
////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// Bar code reader constructor
EBarCode reader= new EBarCode();
```

```
// String for the decoded bar code
string result;
```

```
// ...
```

```
// Read the source image
result = reader.Read(srcImage);
```

13.2. Reading a Bar Code Following a Given Symbology

```
////////////////////////////////////////////////////////////
// This code snippet shows how to enable a given symbology,  //
// enable the checksum verification, perform the bar code    //
// detection and retrieve the decoded string.                //
////////////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// Bar code reader constructor
EBarCode reader= new EBarCode();
```

```
// String for the decoded bar code
string result;
```

```
// ...
```

```
// Disable all standard symbologies
reader.StandardSymbologies= 0;
```

```
// Enable the Code32 symbology only
reader.AdditionalSymbologies= (int)ESymbologies.Code32;
```

```
// Enable checksum verification
reader.VerifyChecksum= true;
```

```
// Detect all possible meanings of the bar code
reader.Detect(srcImage);
```

```
// Retrieve the number of symbologies for
// which the decoding process was successful
int numDecoded = reader.NumDecodedSymbologies;
```

```
if(numDecoded > 0)
{
        // Decode the bar code according to the Code32 symbology
        result = reader.Decode(ESymbologies.Code32);
}
```

13.3. Reading a Bar Code of Known Location

```
//////////////////////////////////////////////////////
// This code snippet shows how to specify the bar code  //
// position and perform the bar code reading.           //
//////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// Bar code reader constructor
EBarCode reader= new EBarCode();
```

```
// String for the decoded bar code
string result;
```

```
// ...
```

```
// Disable automatic bar code detection
reader.KnownLocation = true;
```

```
// Set the bar code position
reader.SetCenterXY(450.0f, 400.0f);
reader.SetSize(250.0f, 110.0f);
reader.SetReadingSize(1.15f, 0.5f);
```

```
// Read the bar code at the specified location
result = reader.Read(srcImage);
```

13.4. Reading a Mail Bar Code

```
//////////////////////////////////////////////////////
// This code snippet shows how to read Mail Barcodes  //
// and retrieve the decoded data.                     //
//////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage = new EImageBW8();
```

```
// Mail barcode reader constructor
EMailBarcodeReader reader = new EMailBarcodeReader();
```

```
// Select expected symbologies and orientations (optional)
reader.ExpectedSymbologies = ...;
reader.ExpectedOrientations = ...;
```

```
// ...
```

```
// Read
EMailBarcode [] codes = reader.Read(srcImage);
```

```
// Retrieve the data included in found mail barcodes
for (int index= 0; index < codes.Length; index++)
{
    string text = codes[index].Text;
    EStringPair [] components = codes[index]. ComponentStrings;
}
```

14. EasyMatrixCode

14.1. Automatic Reading

```
////////////////////////////////////////////////////////
// This code snippet shows how to read a data matrix code  //
// and retrieve the decoded string.                        //
////////////////////////////////////////////////////////
```

```
// Image constructor
EImageBW8 srcImage= new EImageBW8();
```

```
// Matrix code reader constructor
EMatrixCodeReader reader= new EMatrixCodeReader();
```

```
// Matrix code constructor
EMatrixCode mxCode= new EMatrixCode();
```

```
// String for the decoded information
string result;
```

```
// ...
```

```
// Read the source image
mxCode = reader.Read(srcImage);
```

```
// Retrieve the decoded string
result = mxCode.DecodedString;
```

14.2. Reading with Prior Learning

```
////////////////////////////////////////////////////////////
// This code snippet shows how to learn a given data matrix //
// code type (except its flipping status), perform the      //
// reading and retrieve the decoded string.                 //
////////////////////////////////////////////////////////////
```

```
// Images constructor
EImageBW8 model= new EImageBW8();
EImageBW8 srcImage= new EImageBW8();
```

```
// Matrix code reader constructor
EMatrixCodeReader reader= new EMatrixCodeReader();
```

```
// Matrix code constructor
EMatrixCode mxCode= new EMatrixCode();
```

```
// String for the decoded information
string result;
```

```
// ...
```

```
// Tell the reader not to take the flipping into account when learning
reader.SetLearnMaskElement(ELearnParam.Flipping, false);
```

```
// Learn the model
reader.Learn(model);
```

```
// Read the source image
mxCode = reader.Read(srcImage);
```

```
// Retrieve the decoded string
result = mxCode.DecodedString;
```

14.3. Advanced Tuning of the Search Parameters

```
'////////////////////////////////////////////////////////////
'// This code snippet shows how to explicitly specify the data //
'// matrix code logical size and family, perform the reading   //
'// and retrieve the decoded string.                           //
'////////////////////////////////////////////////////////////
```

```
' Image constructor
Dim srcImage As New EImageBW8
```

```
' Matrix code reader constructor
Dim reader As New EMatrixCodeReader
```

```
' Matrix code constructor
Dim mxCode As New EMatrixCode
```

```
' String for the decoded information
Dim result As String
```

```
' ...
```

```
' Remove the default logical sizes
reader.SearchParams.ClearLogicalSize
```

```
' Add the 15x15 and 17x17 logical sizes
reader.SearchParams.AddLogicalSize ELogicalSize__15x15
reader.SearchParams.AddLogicalSize ELogicalSize__17x17
```

```
' Remove the default families
reader.SearchParams.ClearFamily
```

```
' Add the ECC050 family
reader.SearchParams.AddFamily EFamily_ECC050
```

```
' Read the source image
Set mxCode = reader.Read(srcImage)
```

```
' Retrieve the decoded string
result = mxCode.DecodedString
```

14.4. Retrieving Print Quality Grading

```
////////////////////////////////////////////////////////
// This code snippet shows how to read a data matrix code //
```

```
// and retrieve its print quality grading.                  //
////////////////////////////////////////////////////////////

// Image constructor
EImageBW8 srcImage= new EImageBW8();

// Matrix code reader constructor
EMatrixCodeReader reader= new EMatrixCodeReader();

// Matrix code constructor
EMatrixCode mxCode= new EMatrixCode();

// ...

// Enable grading computation
reader.ComputeGrading= true;

// Read the source image
mxCode = reader.Read(srcImage);

// Retrieve the print quality grading
int axialNonUniformityGrade= mxCode.AxialNonUniformityGrade;
int contrastGrade= mxCode.ContrastGrade;
int printGrowthGrade= mxCode.PrintGrowthGrade;
int unusedErrorCorrectionGrade= mxCode.UnusedErrorCorrectionGrade;
```

15. EasyMatrixCode2

15.1. Reading Matrix Codes from an Image

```
////////////////////////////////////////////////////////////
// This code snippet shows how to read data matrix codes //
// and retrieve the decoded string.                       //
////////////////////////////////////////////////////////////
```

```
using EMC2 = Euresys.Open_eVision_x_x.EasyMatrixCode2;
```

```
// Load an image
EImageBW8 image = new EImageBW8();
image.Load("image.bmp");
```

```
// Prepare a matrix code reader
EMC2.EMatrixCodeReader reader = new EMC2.EMatrixCodeReader();
```

```
// Let the reader know that there are no more than 3 codes in the image
reader.MaxNumCodes = 3;
```

```
// Read the source image
reader.Read(image);
```

```
// Retrieve the detected codes
EMC2.EMatrixCode[] codes = reader.ReadResults;
```

```
// Retrieve the decoded string for the first code
string result = codes[0].DecodedString;
```

15.2. Reading with Prior Learning

```
////////////////////////////////////////////////////////////
// This code snippet shows how to learn from a given image, //
// perform the reading and retrieve the decoded string.     //
////////////////////////////////////////////////////////////
```

```
using EMC2 = Euresys.Open_eVision_x_x.EasyMatrixCode2;
```

```
// Load an image
EImageBW8 image = new EImageBW8();
image.load("image.bmp");
```

```
// Prepare a matrix code reader
EMC2.EMatrixCodeReader reader = new EMC2.EMatrixCodeReader();
```

```
// Learn from this image
reader.Learn(image);
```

```
// Read the codes in this image
reader.Read(image);
```

```
// Retrieve the detected codes
EMC2.EMatrixCode[] codes = reader.ReadResults;
```

```
// Retrieve the decoded string of the first code
string result = codes[0].DecodedString;
```

15.3. Inspecting Print Quality Grades

```
//////////////////////////////////////////////////////////
// This code snippet shows how to read a data matrix code //
// and retrieve its print quality grades.                 //
//////////////////////////////////////////////////////////
```

```
using EMC2 = Euresys.Open_eVision_x_x.EasyMatrixCode2;
```

```
// Load an image
EImageBW8 image = new EImageBW8();
image.Load("image.bmp");
```

```
// Prepare a matrix code reader
EMC2.EMatrixCodeReader reader = new EMC2.EMatrixCodeReader();
```

```
// Tell the reader to compute grades for the read codes
reader.ComputeGrading = true;
```

```
// Read the codes in this image
reader.Read(image);
```

```
// Retrieve the detected codes
EMC2.EMatrixCode[] codes = reader.ReadResults;
```

```
// Retrieve the SemiT10 grades of the first code
EMatrixCodeSemiT10GradingParameters semiT10Grades = codes[0].SemiT10GradingParameters;
```

```
// Retrieve specific grade values
float cellDefects = semiT10Grades.CellDefects;
float symbolContrast = semiT10Grades.SymbolContrast;
float unusedErrorCorrection = semiT10Grades.UnusedErrorCorrection;
```

15.4. Asynchronous Processing

```
//////////////////////////////////////////////////////////////////////////
// This code snippet shows how to read data matrix codes asynchronously //
// from three separate images.                                          //
// The code in this snippet is valid for C++11 and newer.               //
//////////////////////////////////////////////////////////////////////////
```

```
using System.Threading;
using EMC2 = Euresys.Open_eVision_x_x.EasyMatrixCode2;
```

```
// create a subroutine that reads the codes from an image
void Read(ref EImageBW8 image, ref EMC2.EMatrixCodeReader reader, ref EMC2.EMatrixCode
[] codes, ref bool finished)
{
  // read the codes in this image
  reader.Read(image);
```

```
  // extract the results
  codes = reader.GetReadResults();

  // notify that the reader has finished
  finished = true;
}

void main()
{
  // Prepare three images
  EImageBW8 img1 = new EImageBW8();
  EImageBW8 img2 = new EImageBW8();
  EImageBW8 img3 = new EImageBW8();

  // Prepare three matrix code readers
  EMC2.EMatrixCodeReader reader1 = new EMC2.EMatrixCodeReader();
  EMC2.EMatrixCodeReader reader2 = new EMC2.EMatrixCodeReader();
  EMC2.EMatrixCodeReader reader3 = new EMC2.EMatrixCodeReader();

  // Prepare three vectors of matrix code instances
  EMC2.EMatrixCode[] codes1 = null;
  EMC2.EMatrixCode[] codes2 = null;
  EMC2.EMatrixCode[] codes3 = null;

   // Prepare three Booleans to track the thread progress
  bool finished1 = false;
  bool finished2 = false;
  bool finished3 = false;

  // load the images
  img1.Load("image1.bmp");
  img2.Load("image2.bmp");
  img3.Load("image3.bmp");

  // Launch three threads to read the codes in each image
  Thread thr1 = new Thread(() => Read(ref img1, ref reader1, ref codes1, ref
finished1));
  Thread thr2 = new Thread(() => Read(ref img2, ref reader2, ref codes2, ref
finished2));
  Thread thr3 = new Thread(() => Read(ref img3, ref reader3, ref codes3, ref
finished3));

  // Start the threads, they will run in the background.
  thr1.Join();
  thr1.Join();
  thr1.Join();

  // Wait until one of the threads has finished
  while (!(finished1 || finished2 || finished3))
    Thread.Sleep(5);

  // Here, we manually stop all code readers, they will stop processing
  // even if they have not yet found the codes in the image
  reader1.StopProcess();
  reader2.StopProcess();
  reader3.StopProcess();

  // wait for the threads to completely finish before continuing
  thr1.Join();
  thr2.Join();
  thr3.Join();
}
```

16. EasyQRCode

16.1. Automatic Reading of a QR Code

```
////////////////////////////////////////////////
// This code snippet shows how to read a QR code  //
// and retrieve the decoded data.                 //
////////////////////////////////////////////////

// Image constructor
EImageBW8 srcImage= new EImageBW8();

// QR code reader constructor
EQRCodeReader reader= new EQRCodeReader ();

// ...

// Set the source image
reader.SearchField = srcImage;

// Read
EQRCode [] qrCodes = reader.Read();
```

16.2. Retrieving Information of a QR Code

```
////////////////////////////////////////////////
// This code snippet shows how to read a QR code  //
// and retrieve the associated information.       //
////////////////////////////////////////////////

// Image constructor
EImageBW8 srcImage= new EImageBW8();

// QR code reader constructor
EQRCodeReader reader= new EQRCodeReader ();

// ...
// Set the source image
reader.SearchField = srcImage;

// Read
EQRCode [] qrCodes = reader.Read();

// Retrieve version, model and position information
// of the first QR code found, if one was found
if (qrCodes.Length > 0)
```

```
{
    uint version = qrCodes[0].Version;
    EQRCodeModel model = qrCodes[0].Model;
    EQRCodeGeometry geometry = qrCodes[0].Geometry;
}
```

16.3. Detecting QR Codes and Decoding the First One

```
//////////////////////////////////////////////////
// This code snippet shows how to decode a QR code //
// from a list of detected ones.                   //
//////////////////////////////////////////////////

// Image constructor
EImageBW8 srcImage= new EImageBW8();

// QR code reader constructor
EQRCodeReader reader= new EQRCodeReader ();

// ...

// Set the source image
reader.SearchField = srcImage;

// Detect QR Codes
EQRCodeGeometry [] qrCodeGeometries = reader.Detect();

// Decode first detected QR Code
EQRCode qrCode = reader.Decode(qrCodeGeometries[0]);

// Retrieve the decoded string in best guess mode from the QR Code
string decodedString = qrCode.GetDecodedString(EByteInterpretationMode.Auto);
```

16.4. Tuning the Search Parameters

```
//////////////////////////////////////////////////
// This code snippet shows how to read a QR code  //
// and retrieve the decoded data after setting a  //
// number of search parameters.                   //
//////////////////////////////////////////////////

// Image constructor
EImageBW8 srcImage= new EImageBW8();

// QR code reader constructor
EQRCodeReader reader= new EQRCodeReader ();

// ...

// Set the source image
reader.SearchField = srcImage;

// Set the search parameters
```

```
reader.MaximumVersion = 7;
reader.MinimumIsotropy = 0.9f;

// Set the searched models
reader.SearchedModels = new EQRCodeModel[] {EQRCodeModel.Model2};

// Read
EQRCode [] qrCodes = reader.Read();

// Retrieve the decoded string in best guess mode of the first QR code found
string decodedString = qrCodes[0].GetDecodedString(EByteInterpretationMode.Auto);
```

16.5. Retrieving the Decoded String (Simple)

```
////////////////////////////////////////////////////
// This code snippet shows how to read a QR code  //
// and retrieve the decoded string.               //
////////////////////////////////////////////////////

// Image constructor
EImageBW8 srcImage = new EImageBW8();

// QR code reader constructor
EQRCodeReader reader = new EQRCodeReader();

// ...

// Set the source image
reader.SearchField = srcImage;

// Read
EQRCode [] qrCodes = reader.Read();

// Retrieve the data of the first QR code found in best guess mode
string decodedString = qrCodes[0].GetDecodedString(EByteInterpretationMode.Auto);
```

16.6. Retrieving the Decoded String (Safe)

```
////////////////////////////////////////////////////
// This code snippet shows how to read a QR code  //
// and retrieve safely the decoded string         //
////////////////////////////////////////////////////

// Image constructor
EImageBW8 srcImage = new EImageBW8();

// QR code reader constructor
EQRCodeReader reader = new EQRCodeReader();

// ...
```

```
// Set the source image
reader.SearchField = srcImage;

// Read
EQRCode [] qrCodes = reader.Read();

// Retrieve the data of the first QR code found
string decodedString = "";
try
{
  // The QR Code can be fully decoded without user input
  decodedString = qrCodes[0].GetDecodedString();
}
catch (EException exc)
{
  // Handle the exception
  // ...
  // The QR Code cannot be fully decoded without user input
  // use hexadecimal byte interpretation
  decodedString = qrCodes[0].GetDecodedString(EByteInterpretationMode.Hexadecimal);
}
```

16.7. Retrieving the Decoded Data (Advanced)

```
//////////////////////////////////////////////////
// This code snippet shows how to read a QR code  //
// and retrieve its coding mode,                  //
// the raw bit stream and the data part by part   //
//////////////////////////////////////////////////

// Image constructor
EImageBW8 srcImage = new EImageBW8();

// QR code reader constructor
EQRCodeReader reader = new EQRCodeReader();

// ...

// Set the source image
reader.SearchField = srcImage;

// Read
EQRCode [] qrCodes = reader.Read();

// Retrieve the data stream of the first QR code found
EQRCodeDecodedStream stream = qrCodes[0].DecodedStream;

// Retrieve the coding mode and the raw bit stream of the first QR code found
EQRCodeCodingMode codingMode = stream.CodingMode;
byte [] bitstream = stream.RawBitstream;

// Retrieve the encoding and the decoded data of each part of the first QR code found
EQRCodeDecodedStreamPart [] parts = stream.DecodedStreamParts;
for (uint i = 0; i < parts.Length; ++i)
{
  // Retrieve encoding
```

```
  EQRCodeEncoding encoding = parts[i].Encoding;

  // Retrieve the decoded data
  byte [] decodedData = parts[i].DecodedData;

  // Interpret the decoded data based on the retrieved encoding
  ...
}
```

17. Easy3DObject

17.1. Extracting 3D Objects with a Selection Criterion

```
// EZmap constructor
EZMap8 zMap = new EZMap8();

// Extractor constructor
E3DObjectExtractor extractor = new E3DObjectExtractor();

// Setting a selection criterion
extractor.ObjectWidth = new EFloatRange(10, 500);

// Extracts the objects from the EZMap
int regionNB = extractor.Extract(zMap);
// Retrieve the extracted objects
E3DObject[] objects = extractor.Objects;
```

17.2. Inspecting a Feature from the List of E3DObjects

```
// Get the list of E3DObjects
E3DObject[] objects = extractor.Objects;

// Get the volume of the first object
float volume = objects[0].Volume();

// Get the ERectangleRegion of the last (the largest) object
ERectangleRegion region = objects[objects.Length - 1].RectangleRegion();
```

17.3. Drawing a 2D Feature from the List of E3DObjects

```
// Get the list of E3DObjects
E3DObject[] objects = extractor.Objects;

// The GDI drawing surface
```

```
Graphics drawGDI;

// Draw the ERegion of each object
int nObjects = objects.Length;
for (int i = 0; i < nObjects; i++)
  objects[i].Draw(drawGDI, E3DObjectFeature.ERegion, new ERGBColor(0, 255, 0));
```

17.4. Drawing 3D Features from a List of E3DObjects

```
// Get the list of E3DObjects
E3DObject[] objects = extractor.Objects;

// Register the list of E3DObject to the 3D viewer
E3DViewer viewer3D = new E3DViewer();
viewer3D.Register3DObjects(objects);

// Define and use a render style for the ReferenceTopPosition feature
ERenderStyle renderStyle = new ERenderStyle();
renderStyle.pointRGB = new EC24(100, 0, 0);
viewer3D.SetFeatureStyleForAll3DObjects(renderStyle,
E3DObjectFeature.ReferenceTopPosition);

// Set a different rendering color for the first object
ERenderStyle selectedRenderStyle = new ERenderStyle();
selectedRenderStyle.pointRGB = new EC24(255, 255, 0);
viewer3D.SetFeatureStyleFor3DObject(0, selectedRenderStyle,
E3DObjectFeature.ReferenceTopPosition);

// Enable the display of the ReferenceTopPosition feature
viewer3D.ShowFeatureForAll3DObjects(E3DObjectFeature.ReferenceTopPosition);
```