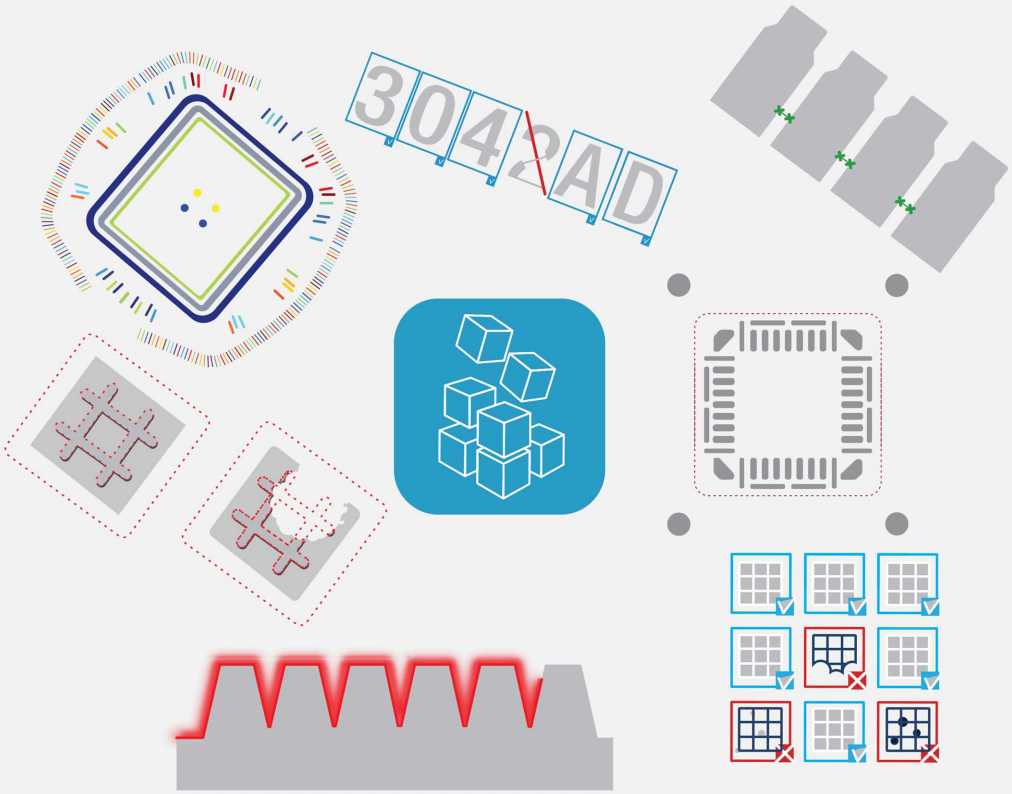
euresys
Empowering Computer Vision

CODE SNIPPETS

Open eVision



This documentation is provided with **Open eVision 24.02.0** (doc build **1198**).
www.euresys.com

Contents

1. Basic Types

1.1. Loading and Saving Images

Functional Guide | Reference: Load, Save, SaveJpeg

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

Functional Guide | Reference: SetImagePtr

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

Functional Guide | Reference: GetImagePtr

```
////////////////////////////////////////////////////////////
// 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. Importing Bitmap from the Resources

Functional Guide | Reference: SetImagePtr

```
////////////////////////////////////////////////////////////
// This code snippet shows how to import a bitmap from       //
// the resources.                                            //
////////////////////////////////////////////////////////////

// Use this function to fasten the copy of the bitmap
[DllImport("kernel32.dll", EntryPoint = "CopyMemory", SetLastError = false)]
public static extern void CopyMemory(IntPtr dest, IntPtr src, uint count);

// Get the bitmap
Bitmap bitmap = new Bitmap(WindowsFormsApp1.Properties.Resources.Image1);

int width = bitmap.Width;
int height = bitmap.Height;

BitmapData bmd = bitmap.LockBits(new Rectangle(0, 0, width, height), ImageLockMode.ReadOnly,
bitmap.PixelFormat);

EImageC24 image = new EImageC24(width, height);


// Number of bytes per row to copy
uint strideWidth = (uint)(3 * width);

for (int y = 0; y < height; ++y)
{
```

```
  CopyMemory(image.GetImagePtr(0, y), bmd.Scan0 + y * bmd.Stride, strideWidth);
}

bitmap.UnlockBits(bmd);
bitmap.Dispose();

// Process the image

image.Dispose();
```

1.5. ROI Placement

Functional Guide | Reference: Attach, SetPlacement

```
////////////////////////////////////////////////////////////////
// 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);
```

1.6. Vector Management

Functional Guide | Reference: Empty, AddElement

```
////////////////////////////////////////////////////////////////
// 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);
```

1.7. Exception Management

Functional Guide | Reference: GetPixel, What

```
//////////////////////////////////////////
// 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 = patterns[0].ToRegion();


// 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.
// WARNING: EGrabberCallbackOnDemand is using an EGenTL instance,
// you must dispose the former before disposing the latter.
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 the EGenTL instance.
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 the EGenTL instance.
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 = (int)grabber.getIntegerRemoteModule("Width");
grabber.setIntegerRemoteModule("Width", 1024);

float exposureTime = (float)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. VimbaXBridge

See also: VimbaXBridge - Using Images from VimbaX Sources

4.1. Using VimbaXBridge

Sorry, this code snippet is currently not available for the selected API.

5. EasyImage

5.1. Thresholding

Single Thresholding

Functional Guide | Reference: SetSize, Threshold

```
//////////////////////////////////////////////////////////////////
// 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, unchecked((uint)EThresholdMode.Relative), 0, 255, 0.7f);
```

Double Thresholding

Functional Guide | Reference: DoubleThreshold

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

Functional Guide | Reference: Histogram, HistogramThreshold

```
////////////////////////////////////////////////////////////////
// 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
uint thresholdValue= , unchecked((uint)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

Functional Guide | Reference: Histogram, ThreeLevelsMinResidueThreshold, DoubleThreshold

```
////////////////////////////////////////////////////////////////////
// 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.Value , highThr.Value);
```

5.2. Arithmetic and Logic Operations

Functional Guide | Reference: Oper

```
//////////////////////////////////////////////////////
// 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);
```

5.3. 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);
```

5.4. Non-Linear Filtering

Functional Guide | Reference

Morphological Filtering

Functional Guide | Reference: ErodeBox, DilateBox, OpenDisk

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

Functional Guide | Reference: SetValue, HitAndMiss

```
//////////////////////////////////////////////////////////////
// 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);
```

5.5. Vector Operations

Functional Guide | Reference

Path Sampling

Functional Guide | Reference: Empty, AddElement, ImageToPath

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

Functional Guide | Reference: ImageToLineSegment, LineSegmentToImage

```
////////////////////////////////////////////////////////////
// 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);
```

5.6. 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

Functional Guide | Reference: LocalAverage, LocalDeviation

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

Functional Guide | Reference: Histogram, AnalyseHistogram

```
////////////////////////////////////////////////////////
// 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);
```

5.7. Noise Reduction by Integration

Functional Guide | Reference

Temporal Noise Reduction

Functional Guide | Reference: Oper

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

Functional Guide | Reference: Oper, SetRecursiveAverageLUT, RecursiveAverage

```
////////////////////////////////////////////////////
// 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);
```

5.8. Feature Point Detectors

Harris Corner Detector

Functional Guide | Reference: GetPointCount, GetPoint

```
////////////////////////////////////////////////////////////////
// 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
uint index = interestPoints.PointCount;

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

Canny Edge Detector

Functional Guide | Reference: Apply

```
////////////////////////////////////////////////////
// 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);
```

5.9. Using Flexible Masks

Functional Guide | Reference

Computing Pixels Average

Functional Guide | Reference: PixelAverage

```
////////////////////////////////////////////////////////
// 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);
```

5.10. Warping

Performing a Ring Warping

```
// Create normal and warp images
EImageBW8 img = new EImageBW8();
EImageBW8 imgWarped = new EImageBW8();

EImageBW16 WarpX = new EImageBW16();
EImageBW16 WarpY =new EImageBW16();

// Load the image
img.Load("");

// Set size of imgWarped to what is wanted
imgWarped.SetSize(, );

// Set size of imgUnwarped to previous original image
imgUnwarped.SetSize(img);


// Set size of warp images
```

```
WarpX.SetSize(imgWarped);
WarpY.SetSize(imgWarped);
EasyImage.Oper(EArithmeticLogicOperation.Copy, new EBW8(0), imgWarped);

// Do a regular ring warp
EasyImage.SetCircleWarp(, , , , , , , , WarpX, WarpY);
EasyImage.Warp(img, imgWarped, WarpX, WarpY);
```

Performing an Inverse Warping

NOTE: We use the same notation as the code snippet "Performing a Ring Warping" on page 27.

```
// Create imgUnwarped and inverseWarp images
EImageBW8 imgUnwarped = new EImageBW8();
EImageBW16 InverseWarpX = new EImageBW16();
EImageBW16 InverseWarpY = new EImageBW16();

// Set size of inverse warp images
InverseWarpX.SetSize(img);
InverseWarpY.SetSize(img);

EasyImage.Oper(EArithmeticLogicOperation.Copy, new EBW8(0), imgUnwarped);

EasyImage.SetInvCircleWarp(, , , , , , , , &InverseWarpX, &InverseWarpY);
EasyImage.Warp(imgWarped, imgUnwarped, InverseWarpX, InverseWarpY);
// Use an oper Set zero to add the background into the image
EasyImage.Oper(EArithmeticLogicOperation.SetZero, imgUnwarped,img, imgUnwarped);
```

5.11. Fourier Transforms

Performing a Direct Fourier Transform

```
////////////////////////////////////////////////////
// This code snippet shows how to compute         //
// the direct Fourier transform of a grayscale image //
// (from the spatial domain to the frequency domain) //
////////////////////////////////////////////////////

// Assuming you have the following loaded image
EImageBW8 spatialImage;

// Initialize an empty image that will contain frequencies information
// Be aware of the specified dimensions
EImageBW32f frequencyImage = new EimageBW32f(spatialImage.Width*2, spatialImage.Height);

// Compute the direct Fourier transform
EFourierTransformer fourier = new EFourierTransformer();
fourier.FrequentialDomainFormat = EfrequentialDomainFormat.ComplexExtended;
fourier.DirectTransform(spatialImage, frequencyImage);
```

Performing an Inverse Fourier Transform

```
////////////////////////////////////////////////////////
// This code snippet shows how to compute            //
// the inverse Fourier transform to get              //
// the original grayscale image                      //
// (from the frequency domain to the spatial domain) //
////////////////////////////////////////////////////////

// Assuming you have the following loaded image
EImageBW32f frequencyImage;

// Initialize an empty image that will contain spatial information
// Be aware of the specified dimensions
EImageBW8 spatialImage = new EImageBW8(frequencyImage.Width / 2, frequencyImage.Height);

// Compute the inverse Fourier transform
EFourierTransformer fourier = new EFourierTransformer();
fourier.FrequentialDomainFormat = EFrequentialDomainFormat.ComplexExtended;
fourier.InverseTransform(frequencyImage, spatialImage);
```

6. EasyColor

6.1. Colorimetric Systems Conversion

Functional Guide | Reference: ConvertFromRgb, Transform

```
//////////////////////////////////////////////////////////
// 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);
```

6.2. Color Components

Functional Guide | Reference: Compose, ConvertFromRgb, GetComponent

```
//////////////////////////////////////////////////////////
// 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);
```

6.3. White Balance

Functional Guide | Reference: PixelAverage, WhiteBalance, Transform

```
////////////////////////////////////////////////////////////
// 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);
```

6.4. Pseudo-Coloring

Functional Guide | Reference: SetShading, PseudoColor

```
////////////////////////////////////////////////////////////
// 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);
```

6.5. Bayer Pattern Decoding

Functional Guide | Reference: BayerToC24

```
//////////////////////////////////////////////////////////////////
// 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);
```

7. Deep Learning Tools

7.1. 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= 90.0F;

// Enabling horizontal flips
dataset.EnableHorizontalFlip= true;

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

// 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();
```

7.2. 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();
```

7.3. 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.Threading;
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();
```

7.4. 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 = result.SegmentationMap() ;

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

8. EasyObject

8.1. Constructing the Blobs

Image Encoder

Functional Guide | Reference: Encode, SetBlackLayerEncoded, SetWhiteLayerEncoded, SetMode, SetAbsoluteThreshold, GetGrayscaleSingleThresholdSegmenter

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

Functional Guide | Reference: SetSegmentationMethod, GetGrayscaleDoubleThresholdSegmenter, SetHighThreshold, SetLowThreshold

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

Functional Guide | Reference: GetHoleCount, GetHole, GetObjCount, GetObj

```
//////////////////////////////////////////////////////////////
// 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 (uint blobIndex = 0; blobIndex < codedImage.GetObjCount(); blobIndex++)
{
       EObject blob = codedImage.GetObj(blobIndex);

       // Browse the holes of the current object
```

```
	for (uint holeIndex = 0; holeIndex < blob.HoleCount; holeIndex++)
	{
		// Retrieve a given hole
		EHole hole = blob.GetHole(holeIndex);
	}
}
```

Continuous Mode

Functional Guide | Reference: SetContinuousModeEnabled, FlushContinuousMode

```
////////////////////////////////////////////////
// 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);
```

8.2. Computing Blobs Features

Functional Guide | Reference: GetGravityCenter, GetObj

```
////////////////////////////////////////////////////////////
// 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 (uint 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;
}
```

8.3. Selecting and Sorting Blobs

Functional Guide | Reference: AddObjects, ElementCount, RemoveUsingUnsignedIntegerFeature, Sort

```
//////////////////////////////////////////////////////////
// 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
uint numBlobs= selection.ElementCount;

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

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

8.4. Using Flexible Masks

Constructing Blobs

Functional Guide | Reference: Encode

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

Functional Guide | Reference: RenderMask

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

Functional Guide | Reference: RenderMask

```
//////////////////////////////////////////////////////////
// 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);
```

8.5. Using the Object Template Matcher

Functional Guide | Reference: EObjectTemplateMatcher

```
//////////////////////////////////////////////////////////////
// This code snippet shows how to use EObjectTemplateMatcher //
// for alignment and template matching                      //
//////////////////////////////////////////////////////////////

// Encode the template image
EImageEncoder encoder = new EImageEncoder();
ECodedImage2 coded_img = new ECodedImage2();
```

```
EImageBW8 template_img = new EImageBW8();
encoder.Encode(template_img, coded_img);

EObjectSelection object_select = new EObjectSelection();
object_select.AddObjects(coded_img);

// Initialize EObjectTemplateMatcher
EObjectTemplateMatcher object_matcher = new EObjectTemplateMatcher();
object_matcher.EnableAlignment = true; // optional
object_matcher.MaximumDistance = 60;   // optional

// set the template
object_matcher.BuildTemplate(object_select);

// Encode the test image
EImageBW8 test_img = new EImageBW8();
encoder.Encode(test_img, coded_img);

// Build a selection of test objects
object_select.Clear();
object_select.AddObjects(coded_img);
object_select.RemoveUsingUnsignedIntegerFeature(EFeature.Area, 10, ESingleThresholdMode.Less);  // optional
filter

// Perform the alignment and the matching
object_matcher.SortSelection(object_select);

// Get the number of matches
int num = object_matcher.NumberOfPairedObjects;

// Retrieve the template indexes for each selection object
int[] template_indexes = object_matcher.TemplateIndexes;
```

9. EasyMatch

9.1. Pattern Learning

Functional Guide | Reference: LearnPattern

```
////////////////////////////////////////////////////
// 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);
```

9.2. Setting Search Parameters

Functional Guide | Reference: SetMaxPositions, SetMinAngle, SetMaxAngle, SetMinScore, SetInterpolate, Save

```
//////////////////////////////////////////////////////////
// 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");
```

9.3. Pattern Matching and Retrieving Results

Functional Guide | Reference: Load, Match, GetNumPositions, GetPosition

```
////////////////////////////////////////////////////
// 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
uint 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;
```

9.4. Pattern Learning with ERegion

Functional Guide | Reference: LearnPattern

```
////////////////////////////////////////////////////
// This code snippet shows how to learn a pattern    //
// whose region of interest is defined by an ERegion //
```

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

EImageBW8 srcImage = new EImageBW8();
EROIBW8 pattern = new EROIBW8();
EMatcher matcher = new EMatcher();
// ...
// Attach the ROI to the source image and set its position
pattern.Attach(srcImage);
pattern.SetPlacement(214, 52, 200, 200);

// pattern is a 200*200 square but here we are only
// interested in the inner circle

// OLD method (warning, advanced learning is not compatible with this)
matcher.DontCareThreshold = 1;
// must paint the part of pattern we are not interested in in black
matcher.LearnPattern(pattern);

// NEW method (compatible with advanced learning)
ECircleRegion region = new ECircleRegion(100.0f, 100.0f, 100.0f);
matcher.LearnPattern(pattern, region);
```

10. EasyFind

10.1. Pattern Learning

Functional Guide | Reference: Learn

```
////////////////////////////////////////////////////
// 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);
```

10.2. Setting Search Parameters

Functional Guide | Reference: SetMaxInstances, SetAngleTolerance, SetMinScore, Save

```
////////////////////////////////////////////////////////
// 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");
```

10.3. Pattern Finding and Retrieving Results

Functional Guide | Reference: Load, Find, GetScore, GetCenter

```
//////////////////////////////////////////////////
// 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;
```

10.4. Learning Using a DXF File

Functional Guide | Reference: LoadDXF, Find

```
//////////////////////////////////////////////////
// This code snippet shows how to perform          //
// pattern learning and finding operations         //
// using a DXF file.                               //
//////////////////////////////////////////////////
// Image constructor
EImageBW8 srcImage = new EImageBW8();
```

```
// EPatternFinder constructor
EPatternFinder finder = new EPatternFinder();
// EVectorModel constructor
EVectorModel myModel = new EVectorModel();
// Load the model from a dxf file
myModel.LoadDXF("myModel.dxf");
// Learn the model
finder.Learn(myModel);
// EFoundPattern constructor
EFoundPattern[] foundPattern = null;
// ...
// Perform the pattern finding
foundPattern = finder.Find(srcImage);
```

10.5. Learning Using an EPolygonShape

Functional Guide | Reference: SetPolygon, Find

```
////////////////////////////////////////////////////
// This code snippet shows how to perform  //
// pattern learning and finding operations //
// using EPolygonShape to define the model.//
////////////////////////////////////////////////////
// Image constructor
EImageBW8 srcImage = new EImageBW8();
// EPatternFinder constructor
EPatternFinder finder = new EPatternFinder();
// EVectorModel constructor
EVectorModel myModel = new EVectorModel();
// Get the root EFrameShape of the model
EFrameShape root = myModel.Root;
// EPolygonShape constructor
EPolygonShape polygon = new EPolygonShape();
// Define the vertices of a polygon
EPoint[] vertices = new EPoint[] { new EPoint(0, 0), new EPoint(1, 0), new EPoint(1, 1), new EPoint(0, 1) };
// Define the polygon
EPolygon basePolygon = new EPolygon(vertices, true);
// Define the EPolygonShape
polygon.Polygon = basePolygon;
// Attach the EPolygonShape to the root EFrameShape
polygon.Attach(root);
// Sets the polarity of the EPolygonShape
polygon.SetProperty("polarity", "direct");
// Learn the model
finder.Learn(myModel);
// EFoundPattern constructor
EFoundPattern[] foundPattern = null;
// ...
// Perform the pattern finding
foundPattern = finder.Find(srcImage);
```

11. EasyGauge

11.1. Point Location

Functional Guide | Reference: SetTransitionType, SetTransitionChoice, SetCenterXY, SetTolerance, Measure, GetMeasuredPoint, GetX, GetY

```
////////////////////////////////////////////////////////////////
// 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");
```

11.2. Line Fitting

Functional Guide | Reference: SetTransitionType, SetTransitionChoice, SetTransitionIndex, SetLine, Measure, GetMeasuredLine, GetOrg, GetEnd

```
////////////////////////////////////////////////////////////////
// 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.Line= 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");
```

11.3. Circle Fitting

Functional Guide | Reference: SetTransitionType, SetTransitionChoice, SetCircle, Measure, GetMeasuredCircle, GetCenter, GetRadius

```
////////////////////////////////////////////////////////////////////////
// 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");
```

11.4. Rectangle Fitting

Functional Guide | Reference: SetTransitionType, SetTransitionChoice, SetRectangle, Measure, GetMeasuredRectangle, GetSizeX, GetSizeY, GetAngle

```
////////////////////////////////////////////////////////////////////////
// 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");
```

11.5. Wedge Fitting

Functional Guide | Reference: SetTransitionType, SetTransitionChoice, SetWedge, Measure, GetMeasuredWedge, GetInnerRadius, GetOuterRadius

```
////////////////////////////////////////////////////////////////////
// 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.Wedge= 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");
```

11.6. Gauge Grouping

Gauge Hierarchy

Functional Guide | Reference: Attach, SetName, Save

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

Functional Guide | Reference: Load, GetNumDaughters, Process, GetDaughter, GetShapeNamed

```
////////////////////////////////////////////////////////////
// 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
uint 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;
```

11.7. Calibration using EWorldShape

Functional Guide | Reference

Calibration by Guesswork

Functional Guide | Reference: SetSensor, GetXResolution, GetYResolution

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

Functional Guide | Reference: EmptyLandmarks, AddLandmark, Calibrate

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

Functional Guide | Reference: EmptyLandmarks, AddPoint, RebuildGrid, AutoCalibrate

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

Functional Guide | Reference: SensorToWorld, WorldToSensor

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

Functional Guide | Reference: SetupUnwarp, Unwarp

```
//////////////////////////////////////////////////////////
// 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);
```

12. EasyOCR

12.1. Learning Characters

Functional Guide | Reference: NewFont, SetTextColor, SetMinCharWidth, SetMaxCharWidth, SetMinCharHeight, SetMaxCharHeight, SetNoiseArea, LearnPatterns, BuildObjects, FindAllChars, Save

```
//////////////////////////////////////////////////////
// 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");
```

12.2. Recognizing Characters

Functional Guide | Reference: Load, Recognize

```
////////////////////////////////////////////////////
// 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)
uint[] charFilter = new uint[5];
charFilter[0] = (uint)EOCRClass.UpperCase;
charFilter[1] = (uint)EOCRClass.UpperCase;
charFilter[2] = (uint)EOCRClass.Digit;
charFilter[3] = (uint)EOCRClass.Digit;
charFilter[4] = (uint)EOCRClass.Digit;

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

13. EasyOCR2

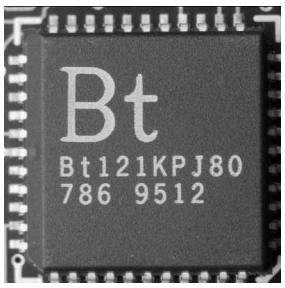
13.1. Detecting Characters

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

13.2. 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

13.3. 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(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.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(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.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(image, 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();
```

13.4. 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;
```

14. EasyBarCode

14.1. Reading a Bar Code

Functional Guide | Reference: Read

```
////////////////////////////////////////////////////
// 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);
```

14.2. Reading a Bar Code Following a Given Symbology

Functional Guide | Reference: SetAdditionalSymbologies, Detect, Decode

```
////////////////////////////////////////////////////////////////
// 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
uint numDecoded = reader.NumDecodedSymbologies;

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

14.3. Reading a Bar Code of Known Location

Functional Guide | Reference: SetCenterXY, SetReadingSize

```
//////////////////////////////////////////////////////
// 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);
```

14.4. Reading a Mail Bar Code

Functional Guide | Reference: Read

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

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

// Image constructor
EImageBW8 srcImage = new EImageBW8();
// Mail bar code 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;
}
```

15. EasyBarCode2

15.1. Reading a Bar Code

Functional Guide | Reference: Read, SetMaxNumCodes, GetDecodedString

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

// Image constructor
EImageBW8srcImage= new EImageBW8();

// Bar code reader constructor
Euresys.Open_eVision_0_0.EasyBarCode2.EBarCodeReaderreader= new Euresys.Open_eVision_0_
0.EasyBarCode2.EBarCodeReader();

// Set the max number of bar codes to find
reader.MaxNumCodes=...;

// Read the bar codes in the source image
Euresys.Open_eVision_0_0.EasyBarCode2.EBarCode[]results=reader.Read(srcImage);

//Get decoded string
stringdecodedString=results[0].GetDecodedString();

// cleanup
foreach (Euresys.Open_eVision_0_0.EasyBarCode2.EBarCode code in barcodes)
{
  code.Dispose();
}
reader.Dispose();
srcImage.Dispose();
```

15.2. Reading a Bar Code of a Specific Symbology

Functional Guide | Reference: Read, DisableAllSymbologies, EnableSymbology, GetDecodedString

```
////////////////////////////////////////////////////
// This code snippet shows how to read bar codes //
// of a specific symbology                       //
////////////////////////////////////////////////////

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

// Bar code reader constructor
Euresys.Open_eVision_0_0.EasyBarCode2.EBarCodeReader reader = new Euresys.Open_eVision_0_
0.EasyBarCode2.EBarCodeReader();


// Set the max number of bar codes to find
```

```
reader.MaxNumCodes = ...;


// Set symbology to use
reader.DisableAllSymbologies();
reader.EnableSymbology(...);

// Read the barcodes in the source image
Euresys.Open_eVision_0_0.EasyBarCode2.EBarCode[] results = reader.Read(srcImage);

// Get decoded string
string decodedString = results[0].GetDecodedString();

// cleanup
foreach (Euresys.Open_eVision_0_0.EasyBarCode2.EBarCode code in barcodes)
{
  code.Dispose();
}
reader.Dispose();
srcImage.Dispose();
```

15.3. Reading a Grid of Bar Codes

Functional Guide | Reference: Read, EBarCodeGrid

```
////////////////////////////////////////////////////////////////
// This code snippet shows how to read bar codes that are    //
// disposed in a 5 by 3 grid with 10% overlap between grid   //
// cells                                                     //
////////////////////////////////////////////////////////////////

EImageBW8 srcImage = new EImageBW8();
ERectangleRegion gridRegion = new ERectangleRegion();
Euresys.Open_eVision_0_0.EasyBarCode2.EBarCodeReader reader = new Euresys.Open_eVision_0_
0.EasyBarCode2.EBarCodeReader();

// Reading
Euresys.Open_eVision_0_0.EasyBarCode2.EBarCodeGrid grid = reader.Read(srcImage, gridRegion, 3, 5, 0.1f);

Euresys.Open_eVision_0_0.EasyBarCode2.EBarCode[] codesMiddleCell = grid.GetResults(1, 2);

// cleanup
foreach (Euresys.Open_eVision_0_0.EasyBarCode2.EBarCode code in codesMiddleCell)
{
  code.Dispose();
}
grid.Dispose();
reader.Dispose();
gridRegion.Dispose();
srcImage.Dispose();
```

15.4. Learning a Bar Code

Functional Guide | Reference: Read, Learn

```
//////////////////////////////////////////
// This code snippet shows how to learn //
// from a given set of images           //
//////////////////////////////////////////

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

// Set of images that are close to srcImage
EImageBW8[] learningImages = new EImageBW8[4];

// Bar code reader constructor
Euresys.Open_eVision_0_0.EasyBarCode2.EBarCodeReader reader = new Euresys.Open_eVision_0_
0.EasyBarCode2.EBarCodeReader();

// Reading fails (so we don't need to call dispose)
Euresys.Open_eVision_0_0.EasyBarCode2.EBarCode[] barcodesFail = reader.Read(srcImage);

// Learns the learningImages
reader.Learn(learningImages);

// Reading succeeds
// Euresys.Open_eVision_0_0.EasyBarCode2.EBarCode[] barcodes = reader.Read(srcImage);

// cleanup
foreach (Euresys.Open_eVision_0_0.EasyBarCode2.EBarCode code in barcodes)
{
  code.Dispose();
}
reader.Dispose();
foreach (EImageBW8 img in learningImages)
{
  img.Dispose();
}
srcImage.Dispose();
```

15.5. Grading a Bar Code

Functional Guide | Reference: Read, SetComputeGrading, GetGradingParameters

```
/
//////////////////////////////////////////
// This code snippet shows how to compute //
// the ISO15416 grading of a barcode      //
//////////////////////////////////////////

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

// Bar code reader constructor
Euresys.Open_eVision_0_0.EasyBarCode2.EBarCodeReader reader = new Euresys.Open_eVision_0_
0.EasyBarCode2.EBarCodeReader();

// Enables grading computation
reader.ComputeGrading = true;

// Read the image and retrieve the computed grade
Euresys.Open_eVision_0_0.EasyBarCode2.EBarCode[] barcodes = reader.Read(srcImage);
if (barcodes.Length != 0)
{
```

```
  Euresys.Open_eVision_0_0.EasyBarCode2.EBarCodeGradingParameters grades = barcodes[0].GradingParameters;

  // global grade on a range from 0 to 40
  byte grade = grades.GlobalGrade;

  // global grade on a range from F to A
  Euresys.Open_eVision_0_0.EasyBarCode2.EBarCodeGradingParameters.ConvertToAlphabeticGrade(grades.GlobalGrade);
}

// cleanup
foreach (Euresys.Open_eVision_0_0.EasyBarCode2.EBarCode code in barcodes)
{
  code.Dispose();
}
reader.Dispose();
srcImage.Dispose();
```

16. EasyMatrixCode

16.1. Reading a Data Matrix Code

Functional Guide | Reference: Read, GetDecodedString

```
////////////////////////////////////////////////////////////
// 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;
```

16.2. Learning a Data Matrix Code

Functional Guide | Reference: SetLearnMaskElement, Learn, Read, GetDecodedString

```
////////////////////////////////////////////////////////////
// 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;
```

16.3. Tuning the Search Parameters

Functional Guide | Reference: GetSearchParams, ClearLogicalSize, AddLogicalSize, ClearFamily, AddFamily, Read, GetDecodedString

```
////////////////////////////////////////////////////////////////
// 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
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;

// ...

// 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
mxCode = reader.Read(srcImage);

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

16.4. Grading a Data Matrix Code

Functional Guide | Reference: Read, GetComputeGrading, GetAxialNonUniformityGrade, GetContrastGrade, GetPrintGrowthGrade, GetUnusedErrorCorrectionGrade

```
//////////////////////////////////////////////////////////
// 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;
```

17. EasyMatrixCode2

17.1. Reading Data Matrix Codes

Functional Guide | Reference: Read, SetMaxNumCodes, GetDecodedString

```
////////////////////////////////////////////////////////////
// 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;
```

17.2. Learning a Data Matrix Code

Functional Guide | Reference: Read, Learn, GetDecodedString

```
////////////////////////////////////////////////////////////////
// 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;
```

17.3. Reading a Grid of Matrix Codes

Functional Guide | Reference: Read, EMatrixCodeGrid

```
//////////////////////////////////////////////////////////////
// This code snippet shows how to read matrix codes that are //
// disposed in a 5 by 3 grid with 10% overlap between grid   //
// cells                                                      //
//////////////////////////////////////////////////////////////


EImageBW8 srcImage = new EImageBW8();
ERectangleRegion gridRegion = new ERectangleRegion();
EMC2.EMatrixCodeReader reader = new EMC2.EMatrixCodeReader();

// Reading succeeds
EMC2.EMatrixCodeGrid grid = reader.Read(srcImage, gridRegion, 3, 5, 0.1f);

EMC2.EMatrixCode[] codesMiddleCell = grid.GetResults(1, 2);

// cleanup
foreach (EMC2.EMatrixCode code in codesMiddleCell)
{
  code.Dispose();
}
grid.Dispose();
reader.Dispose();
gridRegion.Dispose();
srcImage.Dispose();
```

17.4. Grading a Data Matrix Code

Functional Guide | Reference: Read, SetComputeGrading

```
//////////////////////////////////////////////////////////////
// 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;
```

17.5. 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();
}
```

18. EasyQRCode

18.1. Reading QR Codes

Functional Guide | Reference: Read

```
//////////////////////////////////////////////////
// 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 ();

// ...

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

18.2. Reading a Grid of QR Codes

Functional Guide | Reference: Read, EQRCodeGrid

```
//////////////////////////////////////////////////////////////
// This code snippet shows how to read QR codes that are     //
// disposed in a 5 by 3 grid with 10% overlap between grid   //
// cells                                                     //
//////////////////////////////////////////////////////////////

EImageBW8 srcImage = new EImageBW8();
ERectangleRegion gridRegion = new ERectangleRegion();
EQRCodeReader reader = new EQRCodeReader();

// Reading succeeds
EQRCodeGrid grid = reader.Read(srcImage, gridRegion, 3, 5, 0.1f);

EQRCode[] codesMiddleCell = grid.GetResults(1, 2);

// cleanup
foreach (EQRCode code in codesMiddleCell)
{
  code.Dispose();
}
grid.Dispose();
reader.Dispose();
gridRegion.Dispose();
srcImage.Dispose();
```

18.3. Grading a QR Code

Functional Guide | Reference: Read, SetComputeGrading

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

// Load an image
EImageBW8 image;
image.Load("image.bmp");

// Prepare a qr code reader
EQRCodeReader reader = new EQRCodeReader();;

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

// Read the codes in this image
EQRCode[] codes = reader.Read(image);

// Retrieve the detected codes
// Retrieve the ISO15415 grades of the first code
EQRCodeIso15415GradingParameters grades = codes[0].Iso15415GradingParameters;

// Retrieve the scan grade of the code
float scanGrade = grades.ScanGrade;
```

18.4. Retrieving Information of a QR Code

Functional Guide | Reference: Read, GetVersion, GetModel, GetGeometry

```
////////////////////////////////////////////////////
// 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 ();

// ...

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

// 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;
}
```

18.5. Tuning the Search Parameters

Functional Guide | Reference: Read, GetDecodedString, SetSearchedModels, SetMaximumVersion, SetMinimumIsotropy

```
////////////////////////////////////////////////////
// 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 search parameters
reader.MaximumVersion = 7;
reader.MinimumIsotropy = 0.9f;

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

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

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

18.6. Retrieving the Decoded String (Simple)

Functional Guide | Reference: Read, GetDecodedString

```
////////////////////////////////////////////////////
// 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();

// ...

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

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

18.7. Retrieving the Decoded String (Safe)

Functional Guide | Reference: Read, GetDecodedString

```
////////////////////////////////////////////////////
// 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();

// ...

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

// 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);
}
```

18.8. Retrieving the Decoded Data (Advanced)

Functional Guide | Reference: Read, GetDecodedStream, GetDecodedData, GetCodingMode, GetDecodedStreamParts

```
////////////////////////////////////////////////////
// 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();

// ...

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

```
// 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
  ...
}
```

19. Easy3D

19.1. Using EFilters to Remove the Noise on a ZMap Based on the Standard Deviation

```
////////////////////////////////////////////////////////////
// The code below removes pixels with a standard deviation //
// higher than a defined threshold in a ZMap.              //
////////////////////////////////////////////////////////////

// Load the ZMap data
EZMap16 zmap = new EZMap16();
zmap.Load("...");

// Compute the filtered ZMap. The new ZMap is called filteredZmap
// The size of the kernel is 7x7, the threshold is 30.0
EZMap16 filteredZmap = new EZMap16();
filteredZmap.SetSize(zmap);

EFilters.RemoveNoise(zmap, filteredZmap, ENoiseRemovalMethod.HighStandardDeviation, 3, 30.0F, 0.0F);
```

19.2. Using EFilters to Remove the Noise on a ZMap Based on the Derivation from Neighborhood

```
////////////////////////////////////////////////////////////////////
// The code below first applies a low pass filter to a ZMap.      //
// It then removes from the result the pixels showing a deviation //
// from the neighborhood larger than the defined threshold.       //
////////////////////////////////////////////////////////////////////

// Load the ZMap data
EZMap16 zmap = new EZMap16();
zmap.Load("...");

// Compute the filtered ZMap. The new ZMap is called averagedZMap
// The size of the kernel is 7x7, the threshold is 30.0
EZMap16 averagedZMap = new EZMap16();
averagedZMap.SetSize(zmap);
EStatistics.ComputeAverageMap(zmap, averagedZMap, 3, 0.2F);

// Compute the filtered ZMap. From averagedZMap, compute filteredZMap
// The size of the kernel is 31x31, the threshold is 20.0
EZMap16 filteredZMap = new EZMap16();
filteredZMap.SetSize(zmap);

EFilters.RemoveNoise(averagedZMap, filteredZMap, ENoiseRemovalMethod.AbsoluteDifferenceFromMean, 15, 20.0F,
0.2F);
```

19.3. Reducing the Size of a Cloud with Random Decimation

```
////////////////////////////////////////////////////////////////////
// The code reduce the size of a cloud by removing points randomly //
////////////////////////////////////////////////////////////////////

EPointCloud pc = new EPointCloud();
pc.Load("");

// Explicitly decimate the point cloud to keep 5000 points
ERandomDecimator decimator = new ERandomDecimator(5000);
EPointCloud pcDecimated = new EPointCloud();

decimator.Decimate(pc, pcDecimated);
```

19.4. Reducing the Size of a Cloud with Grid Decimation

```
//////////////////////////////////////////////////////////
// The code reduce the size of a cloud by removing points //
// to keep at most one per cell of a regular grid         //
//////////////////////////////////////////////////////////

EPointCloud pc = new EPointCloud();
pc.Load("");

// Explicitly decimate the point cloud to keep
// one point in every cube of 10*10*10
EGridDecimator decimator = new EGridDecimator(10.0F);
EPointCloud pcDecimated = new EPointCloud();

decimator.Decimate(pc, pcDecimated);
pcDecimated.SavePCD("");
```

19.5. Using Photometric Stereo

```
////////////////////////////////////////////////
// The code shows how to use Photometric Stereo //
// from calibration to retrieve the results     //
////////////////////////////////////////////////

EPhotometricStereoImager photometricStereo = new EPhotometricStereoImager();

EImageBW8[] calibrationImages = new EImageBW8[4];
// Load calibration images (Todo)
EROIBW8[] calibrationROIs = new EROIBW8[4];
// Set the calibration ROIs (Todo)

// Calibrate
float score = photometricStereo.CalibrateFromSphere(calibrationROIs);
```

```
EImageBW8[] objectImages = new EImageBW8[4];
// Load object images in the same order than the calibration images/angles (Todo)

EROIBW8[] objectROIs = new EROIBW8[4];
// Set the object ROIs (Todo)

// Compute
photometricStereo.Compute(objectROIs);

// Retrieve the results
EImageC24 normals = photometricStereo.Normals;
EImageBW8 albedos = photometricStereo.GetAlbedos(EPhotometricStereoContrast.HighContrast);
EImageBW8 gradientsX = photometricStereo.GradientsX;
EImageBW8 gradientsY = photometricStereo.GradientsY;
EImageBW8 gaussianCurvatures = photometricStereo.ComputeGaussianCurvatures
(EPhotometricStereoContrast.HighContrast);
EImageBW8 meanCurvatures = photometricStereo.ComputeMeanCurvatures(EPhotometricStereoContrast.HighContrast);
EZMap8 heightMap = photometricStereo.ComputeHeightMap();
```

19.6. Using Flat Images to Improve Photometric Stereo

```
////////////////////////////////////////////
// The code shows how to use flat images to //
// improve photometric stereo's results     //
////////////////////////////////////////////

EPhotometricStereoImager photometricStereo = new EPhotometricStereoImager();
// calibrate imager or sets its angles (Todo)

// Load flat images in the same order than the calibration images/angles (Todo)

EROIBW8[] flatROIs = new EROIBW8[4];
// Set the flat images ROIs (Todo)

// Configure flat images, this could optionally be done with a dark image as well
photometricStereo.ConfigureNonUniformLightingCorrection(flatROIs);

EROIBW8[] objectROIs = new EROIBW8[4];
// Set the object ROIs (Todo)

// Perform one or more computations, each will use the flat images (Todo)
photometricStereo.Compute(objectROIs);

// Optional: non uniform lighting correction could be disabled or (re-)enabled
// using SetEnableNonUniformLightingCorrection
```

19.7. Performing Plane Leveling on Point Clouds

```
////////////////////////////////////////////////
// The code shows how to perform plane leveling //
// on point clouds                              //
////////////////////////////////////////////////
```

```
// find the reference plane on the point cloud
E3DPlane ref_plane = new E3DPlane();
EPointCloud point_cloud = new EPointCloud();

// define the ground plane as the plane Z=0
E3DPlane ground_plane = E3DPlane.ZPlane();

// get the transformation that moves
// the reference plane to the ground plane
E3DTransformMatrix transformation;
transformation = ref_plane.GetTransformationTo(ground_plane);

// apply the transformation to the point cloud
EAffineTransformer.ApplyMatrix(transformation, point_cloud);
```

19.8. Using an ERegion to Crop a ZMap

```
//////////////////////////////////////////////////////
// The code shows how to perform cropping on a zmap //
//////////////////////////////////////////////////////

EZMap8 zmap = new EZMap8();
zmap.Load("");

// prepare an ERegion
EPoint[] points = new EPoint[] { new EPoint(90, 76), new EPoint(432, 87),
  new EPoint(466, 91), new EPoint(502, 122), new EPoint(513, 169),
  new EPoint(485, 218), new EPoint(436, 231), new EPoint(86, 215) };
EPolygonRegion region = new EPolygonRegion(points);  // could be any type of ERegion

EZMap8 zmapCropped = new EZMap8(zmap.Width, zmap.Height);
EUtils.Copy(zmap.UndefinedValue, zmapCropped);
EUtils.Copy(zmap, region, zmapCropped);
```

19.9. Add an Attribute to an EPointCloud with Initial Data

```
//////////////////////////////////////////////////////
// The code shows how to add an attribute           //
// to a cloud when you already have the data        //
//////////////////////////////////////////////////////

EPointCloud cloud = new EPointCloud();
EC24A[] data = new EC24A[17];

// case 1: data is Color, Normal, Intensity, Texture, Index, Confidence or Distance
cloud.FillAttributeBuffer((int)E3DAttribute.Color, data);

// case 2: data is something else
int attributeOffset = cloud.AddCustomAttributeBuffer(data);
```

19.10. Add an Attribute to an EPointCloud without Initial Data

```
////////////////////////////////////////////////////
// The code shows how to add an attribute         //
// to a cloud when you don't have the data        //
////////////////////////////////////////////////////

EPointCloud cloud = new EPointCloud();
EC24A defaultValue = new EC24A(17, 17, 17);

// case 1: data is Color, Normal, Intensity, Texture, Index, Confidence or Distance
cloud.AllocateAttributeBuffer((int)E3DAttribute.Color, defaultValue);

// case 2: data is something else
int attributeOffset = cloud.AllocateCustomAttributeBuffer(defaultValue);
```

19.11. Retrieve an Attribute from an EPointCloud

```
////////////////////////////////////////////////////////////
// The code shows how to retrieve an attribute from a cloud //
////////////////////////////////////////////////////////////

EPointCloud cloud = new EPointCloud();
int ItemsizeInBytes = 4;  // an EC24A is 4 bytes
Byte[] data = new Byte[cloud.NumPoints * ItemsizeInBytes];

// case 1: data is Color, Normal, Intensity, Texture, Index, Confidence or Distance
Marshal.Copy(cloud.GetAttributeBuffer((int)E3DAttribute.Color), data, 0, cloud.NumPoints * ItemsizeInBytes);

// case 2: data is something else
int attributeOffset = 17;  // value retrieved when we initialized the attribute
Marshal.Copy(cloud.GetAttributeBuffer(attributeOffset), data, 0, cloud.NumPoints * ItemsizeInBytes);
```

20. Easy3DObject

20.1. Extracting 3D Objects with a Selection Criterion

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

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

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

// Extracts the objects from the EZMap
int regionNB = extractor.Extract(zMap);


// Retrieve the extracted objects
E3DObject[] objects = extractor.Objects;
```

20.2. 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;
```

20.3. 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));
```

20.4. 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(orgX, orgY, width, height);
viewer3D.Register3DObjects(objects);


// Define and use a render style for the ReferenceTopPosition feature
ERenderStyle renderStyle = new ERenderStyle();
renderStyle.pointRGB = new EC24A(100, 0, 0);
viewer3D.SetFeatureStyleForAll3DObjects(renderStyle, E3DObjectFeature.ReferenceTopPosition);

// Set a different rendering color for the first object
ERenderStyle selectedRenderStyle = new ERenderStyle();
selectedRenderStyle.pointRGB = new EC24A(255, 255, 0);
viewer3D.SetFeatureStyleFor3DObject(0, selectedRenderStyle, E3DObjectFeature.ReferenceTopPosition);

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

21. Easy3DMatch

21.1. E3DAligner Minimal Code

```
////////////////////////////////////////////////////
// This code snippet shows how to compute the     //
// alignment between a sample and a cad reference.//
////////////////////////////////////////////////////

// load the reference mesh and define the pose
E3DAligner aligner = new E3DAligner();
EMesh cad = new EMesh();
cad.Load("...");
float azimuthReference = 0.0f, elevationReference = 90.0f;
aligner.SetReference(cad, azimuthReference, elevationReference);

// load the sample
EPointCloud sample = new EPointCloud();
sample.Load("...");
float azimuthSample = 0.0f, elevationSample = -90.0f;

// perform alignment
E3DAlignment alignment = aligner.Align(sample, azimuthSample, elevationSample);
```

21.2. E3DAligner Reprojection Plane

```
////////////////////////////////////////////////////
// This code snippet shows how to set the         //
// reprojection plane when performing alignment.  //
////////////////////////////////////////////////////

// load the reference mesh and define the pose
E3DAligner aligner = new E3DAligner();
EMesh cad = new EMesh();
cad.Load("...");
float azimuthReference = 0.0f, elevationReference = 90.0f;
aligner.SetReference(cad, azimuthReference, elevationReference);

// define the reprojection plane
bool userKnowsPlaneEquation = false; // depending on the user
if (userKnowsPlaneEquation)
{
  E3DPlane reprojectionPlane = new E3DPlane(new E3DPoint(0, 0, -1), -15);
  aligner.ScanReprojectionPlane = reprojectionPlane;
}
else
{
  EPointCloud cloud = new EPointCloud();
  cloud.Load("...");
  bool objectAbovePlane = true; // is the object above the plane on the cloud
  aligner.SetFlatScan(cloud, objectAbovePlane);
```

```
}

// load the sample
EPointCloud sample = new EPointCloud();
sample.Load("...");
float azimuthSample = 0.0f, elevationSample = 90.0f;

// perform alignment
E3DAlignment alignment = aligner.Align(sample, azimuthSample, elevationSample);
```

21.3. E3DAlignment Align Sample

```
////////////////////////////////////////////////
// This code snippet shows how to apply the   //
// transformation of the E3DAlignment to the  //
// sample to overlap it on the reference      //
////////////////////////////////////////////////

// perform alignment (see previous examples)
E3DAlignment alignment = new E3DAlignment(); // obtained with E3DAligner
EPointCloud sample = new EPointCloud(); // same pointcloud as the input of the E3DAligner

// align sample on reference
EPointCloud alignedSample = new EPointCloud();
EAffineTransformer.ApplyMatrix(alignment.Pose, sample, alignedSample);
```

21.4. E3DComparer Minimal Sample

```
////////////////////////////////////////////////
// This code snippet shows how to compare a sample //
// with a golden scan reference.                //
////////////////////////////////////////////////

// load the reference golden scan and set reference
E3DComparer comparer = new E3DComparer();
EPointCloud reference = new EPointCloud();
reference.Load("...");
comparer.PointCloudReference = reference;

// set thresholds
float distanceThresh = 0.2f, areaThresh = 1.0f;
comparer.SetAnomalyThresholds(distanceThresh, areaThresh);
// Prepare data structures (optional)
comparer.PrepareReference();

// load the sample and perform comparison
EPointCloud sample = new EPointCloud();
sample.Load("...");
comparer.Compare(sample);

// compute anomalies
E3DAnomaly[] anomalies = comparer.ComputesAnomalies();

// TODO: if (anomalies.Length != 0): an anomaly was detected: inspect the sample manually? throw it away?

// get cloud to inspect it manually
```

```
EPointCloud visualisationCloud = new EPointCloud();
comparer.GetComparisonPointCloud(visualisationCloud);
```

21.5. E3DComparer Advanced Sample

```
////////////////////////////////////////////////////
// This code snippet shows how to set the options //
// when comparing two elements with E3DComparer.  //
////////////////////////////////////////////////////

// load the reference cad and set reference
E3DComparer comparer = new E3DComparer();
EMesh cad = new EMesh();
cad.Load("...");
comparer.MeshReference = cad;

// set thresholds
float distanceThresh = 0.2f, areaThresh = 1.0f;
float hystDistanceThresh = 1.5f, hystAreaThresh = 0.5f;
comparer.SetAnomalyThresholds(distanceThresh, areaThresh);
comparer.SetAnomalyHysteresis(hystDistanceThresh, hystAreaThresh);  // defined relatively to base thresholds

// set ROIs
E3DBox[] rois = new E3DBox[1];
rois[0] = new E3DBox(15, 15, 15);
comparer.ROI = rois;
E3DBox[] dontCare = new E3DBox[1];
dontCare[0] = new E3DBox(5, 5, 5);
comparer.DontCare = dontCare;
E3DBox[] noExtraMaterial = new E3DBox[1];
noExtraMaterial[0] = new E3DBox(new E3DPoint(10, 15, 20), 0, 0, 0, 5, 5, 5);
comparer.NoExtraMaterial = noExtraMaterial;

// prepare data structures (optional)
comparer.PrepareReference();

// load the sample and perform comparison
EPointCloud sample = new EPointCloud();
sample.Load("...");
comparer.Compare(sample);

// compute anomalies
E3DAnomaly[] anomalies = comparer.ComputesAnomalies();

// TODO: if (anomalies.Length) != 0): an anomaly was detected: inspect the sample manually? throw it away?

// get cloud to inspect it manually
EPointCloud visualisationCloud = new EPointCloud();
comparer.GetComparisonPointCloud(visualisationCloud);
```

21.6. E3DMatcher Minimal Sample

```
////////////////////////////////////////////////////
// This code snippet shows how to match a sample  //
// with a golden scan reference.                  //
////////////////////////////////////////////////////
```

```
// load the reference golden scan and set reference
E3DMatcher matcher = new E3DMatcher();
EPointCloud reference = new EPointCloud();
float azimuthReference = 0.0f, elevationReference = 90.0f;
reference.Load("...");
matcher.SetReference(reference, azimuthReference, elevationReference);

// set thresholds
float distanceThresh = 0.2f, areaThresh = 1.0f;
matcher.SetAnomalyThresholds(distanceThresh, areaThresh);

// prepare data structures (optional)
matcher.PrepareReference();

// load the sample and perform comparison
EPointCloud sample = new EPointCloud();
float azimuthSample = 0.0f, elevationSample = -90.0f;
sample.Load("...");
E3DMatch match = matcher.Match(sample, azimuthSample, elevationSample);
E3DAnomaly[] anomalies = match.Anomalies;

// TODO: if (anomalies.Length != 0): an anomaly was detected: inspect the sample manually? throw it away?

// get cloud to inspect it manually
EPointCloud visualisationCloud = new EPointCloud();
matcher.GetComparisonPointCloud(visualisationCloud);
```

21.7. E3DMatcher Advanced Sample

```
////////////////////////////////////////////////////
// This code snippet shows how to set the options //
// when matching two elements with E3DMatcher.    //
////////////////////////////////////////////////////

// load the reference golden scan and set reference
E3DMatcher matcher = new E3DMatcher();
EPointCloud reference = new EPointCloud();
float azimuthReference = 0.0f, elevationReference = 90.0f;
reference.Load("...");
matcher.SetReference(reference, azimuthReference, elevationReference);

// use advanced comparison mode
matcher.ComparisonDistanceMode = EComparisonDistanceMode.Advanced;


// ignore shadows
matcher.EnableMissingPointAsAnomaly = false;


// set thresholds
float distanceThresh = 0.2f, areaThresh = 1.0f;
float hystDistanceThresh = 1.5f, hystAreaThresh = 0.5f;
matcher.SetAnomalyThresholds(distanceThresh, areaThresh);
matcher.SetAnomalyHysteresis(hystDistanceThresh, hystAreaThresh);  // defined relatively to base thresholds

// retrieve reference poses (reference must have been set)
EZMap8[] referencePoseProjections;
matcher.RetrieveReferencePosesProjections(out referencePoseProjections);
```

```
// set ROI on the left half of the object
float originX = 0.0f, originY = 0.0f, width = referencePoseProjections[0].Width / 2, height =
referencePoseProjections[0].Height / 2;
ERectangleRegion roiRegion = new ERectangleRegion(originX, originY, width, height);
matcher.SetComparisonROI(roiRegion);

// set No Extra material on the whole object
originX = 0.0f; originY = 0.0f; width = referencePoseProjections[0].Width / 2; height =
referencePoseProjections[0].Height / 2;
ERectangleRegion noExtraMatRegion = new ERectangleRegion(originX, originY, width, height);
matcher.SetComparisonNoExtraMaterial(roiRegion);

// prepare data structures (optional)
matcher.PrepareReference();

// load the sample and perform comparison
EPointCloud sample = new EPointCloud();
float azimuthSample = 0.0f, elevationSample = -90.0f;
sample.Load("...");
E3DMatch match = matcher.Match(sample, azimuthSample, elevationSample);
E3DAnomaly[] anomalies = match.Anomalies;


// TODO: if (anomalies.Length != 0):an anomaly was detected: inspect the sample manually? throw it away?

// get cloud to inspect it manually
EPointCloud visualisationCloud = new EPointCloud();
matcher.GetComparisonPointCloud(visualisationCloud);
```

21.8. EPointCloudMerger Sample

```
////////////////////////////////////////////////////////////
// This code snippet shows how to perform sensor fusion. //
////////////////////////////////////////////////////////////


// Calibration
EPointCloudMerger merger = new EPointCloudMerger();
EPointCloud[] calibrationClouds = new EPointCloud[4];  // TODO: load or grab
float calibrationObjectSize = 100.0f;  // size of an edge of the cube in the calibrationClouds
float calibrationScore = merger.Calibrate(calibrationClouds, calibrationObjectSize, true);

// Merging
EPointCloud[] clouds = new EPointCloud[4];  // TODO: load or grab, must be in same order as calibrationClouds
EPointCloud mergedCloud = new EPointCloud();

merger.Merge(clouds, mergedCloud);
```