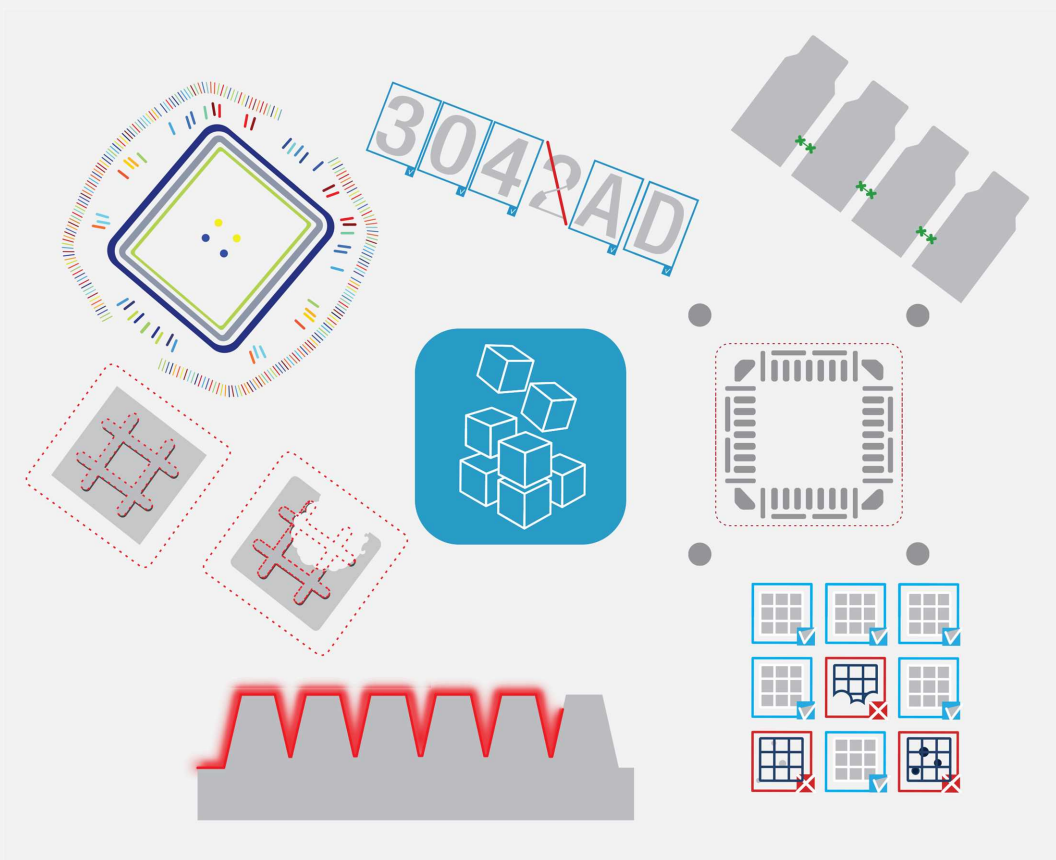


Open eVision



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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;
EImageBW8 dstImage;

// 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;

// Size of the third-party image
int sizeX;
int sizeY;

//Pointer to the third-party image buffer
EBW8* imgPtr;

// ...

// 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 (fastest) //
// to access the pixel values in a BW8 image //
////////////////////////////////////

EImageBW8 img;

OEV_UINT8* pixelPtr;
OEV_UINT8* rowPtr;
OEV_UINT8 pixelValue;
OEV_UINT32 rowPitch;
int x, y;

rowPtr = reinterpret_cast<OEV_UINT8*>(img.GetImagePtr());
rowPitch = img.GetRowPitch();

for (y = 0; y < height; y++)
{
    pixelPtr = rowPtr;

    for (x = 0; x < width; x++)
    {
        pixelValue = *pixelPtr;

        // Add your pixel computation code here

        *pixelPtr = pixelValue;
        pixelPtr++;
    }

    rowPtr += rowPitch;
}

```

1.4. Importing Bitmap from the Resources

Functional Guide | Reference: [SetImagePtr](#)

```

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

// Get the bitmap
HBITMAP hbitmap = (HBITMAP)LoadImage(GetModuleHandle(NULL), MAKEINTRESOURCE(IDB_BITMAP), IMAGE_BITMAP, 0, 0, LR_
CREATEDIBSECTION);
BITMAP bitmap;
GetObject(hbitmap, sizeof(bitmap), (LPVOID)&bitmap);

int width = bitmap.bmWidth;
int height = bitmap.bmHeight;
UINT8* buffer = reinterpret_cast<UINT8*>(bitmap.bmBits);

```

```
EImageC24 image(width, height);

for (int y = 0; y < height; ++y)
{
    // Copy the entire row
    memcpy(image.GetImagePtr(0, height - y), buffer, 3 * width);
    buffer += 3 * width;
}
```

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;

// ROI constructor
EROIBW8 myROI;

// ...

// 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;

// Clear the vector
ramp.Empty();

// Fill the vector with increasing values
for(int i= 0; i < 28; i++)
{
    ramp.AddElement((EBW8)i);
}

// Retrieve the 10th element value
EBW8 value= ramp[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;  
  
    // ...  
  
    // Retrieve the pixel value at coordinates (56, 73)  
    EC24 value= srcImage.GetPixel(56, 730);  
}  
  
catch(Euresys::Open_eVision_::EException exc)  
{  
    // Retrieve the exception description  
    std::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;  
EImageBW8 dstImage;  
  
//...  
  
// Create the region  
ECircleRegion circleRegion(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[10];  
EImageBW8 dstImage[10];  
  
//...  
  
// Create the region  
ECircleRegion circleRegion(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;
EImageBW8 dstImage;

//...

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

// Create second region
ERectangleRegion rectangleRegion(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 from a previous EasyFind process //
////////////////////////////////////

// Image constructors
EImageBW8 findImage;
EImageBW8 srcImage;
EImageBW8 dstImage;

// EPatternFinder constructor
EPatternFinder finder;

//...

// Use EasyFind
std::vector<EFoundPattern> patterns = finder.Find(&findImage);

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

// Threshold the image
EasyImage::Threshold(&srcImage, foundRegion, &dstImage);

```

3. EGrabberBridge

See also: [EGrabberBridge - Using Images from Coaxlink](#)

3.1. Using EGrabberBridge

```

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

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

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

//...

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

// Get the acquired buffer
ScopedBuffer buffer(grabber);

// Convert the ScopedBuffer to an Open eVision data container
EGrabberBridge::EGrabberImageBW8 image(buffer.getInfo());

// Stop the grabber
grabber.stop();

// Use the EGrabberImageBW8 as an Open eVision EImage Object
// Here an inversion of the image is performed
EImageBW8 invertedImage(image.GetWidth(), image.GetHeight());
EasyImage::Oper(EArithmeticLogicOperation_Invert, &image, &invertedImage);

```

3.2. Using EGrabberBridge with Format Conversion

```

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

// Construct the EGrabber objects.

```

```

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

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

//...

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

// Get the acquired buffer
ScopedBuffer buffer(grabber);

// Convert the ScopedBuffer to an Open eVision data container
EGrabberBridge::EGrabberImageBW8 image(converter, buffer.getInfo());

// Stop the grabber
grabber.stop();

// Use the EGrabberImageBW8 as an Open eVision EImage Object
// Here an inversion of the image is performed
EImageBW8 invertedImage(image.GetWidth(), image.GetHeight());
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      //
//////////////////////////////////////////////////////////////////

// Construct the EGrabber objects.
// The FormatConverter is optional and will automatically convert the EGenTL buffer to
// the chosen Open eVision image type
// WARNING: EGrabberCallbackOnDemand and FormatConverter are using an EGenTL instance, you must dispose them
// before disposing it.
EGenTL genTL;
EGrabber<CallbackOnDemand> grabber(genTL);
FormatConverter converter(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
std::string pixelFormat = grabber.getString<RemoteModule>("PixelFormat");
grabber.setString<RemoteModule>("PixelFormat", "Mono8");

int64_t width = grabber.getInteger<RemoteModule>("Width");
grabber.setInteger<RemoteModule>("Width", 1024);

```

```
double exposureTime = grabber.getFloat<RemoteModule>("ExposureTime");
grabber.setFloat<RemoteModule>("ExposureTime", 60.0f);

// ...

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

// Get the acquired buffer
ScopedBuffer buffer(grabber);

// Convert the ScopedBuffer to an Open eVision data container
// Not using converter:
// EGrabberBridge::EGrabberImageBW8 image(buffer.getInfo());
EGrabberBridge::EGrabberImageBW8 image(converter, buffer.getInfo());

// ...
```

4. EasyImage

4.1. 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;
EImageBW8 dstImage;

// ...

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

// Minimum residue thresholding (default method)
EasyImage::Threshold(&srcImage, &dstImage);

// Absolute thresholding (threshold = 120)
EasyImage::Threshold(&srcImage, &dstImage, 120);

// Relative thresholding (70% black, 30% white)
EasyImage::Threshold(&srcImage, &dstImage, 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;
EImageBW8 dstImage;

// ...

// 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, 28, 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;
EImageBW8 dstImage;

// Histogram constructor
EBWHistogramVector histo;

// Variables
unsigned int thresholdValue;
float avgBelowThr, avgAboveThr;

// ...

// Compute the histogram
EasyImage::Histogram(&srcImage, &histo);

// Compute the single threshold (and the average pixel values below and above the threshold)
thresholdValue= EThresholdMode_MinResidue;
EasyImage::HistogramThreshold(&histo, thresholdValue, avgBelowThr, 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;
EImageBW8 dstImage;

// Histogram constructor
EBWHistogramVector histo;

// Variables
EBW8 lowThr;
EBW8 highThr;
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, lowThr, highThr, avgBelowThr, avgBetweenThr, 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);
```

4.2. 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, srcGray1, dstGray;
EImageC24 srcColor, dstColor;

// ...

// All images must have the same size
dstGray.SetSize(&srcGray0);
// ...

// Subtract srcGray1 from srcGray0
EasyImage::Oper(EArithmeticLogicOperation_Subtract, &srcGray0, &srcGray1, &dstGray);

// Multiply srcGray0 by a constant value
EasyImage::Oper(EArithmeticLogicOperation_Multiply, &srcGray0, (EBW8)2, &dstGray);

// Add a constant value to srcColor
EasyImage::Oper(EArithmeticLogicOperation_Add, &srcColor, EC24(128,64,96), &dstColor);

// Erase (blacken) the destination image where the source image is black
EasyImage::Oper(EArithmeticLogicOperation_SetZero, &srcGray0, (EBW8)0, &dstGray);
```

4.3. Convolution

Pre-Defined Kernel Filtering

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

// Images constructor
EImageBW8 srcImage;
```

```

EImageBW8 dstImage;

// ...

// 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::ConvolHighpass(&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;
EImageBW8 dstImage;

// ...

// Create and define a user-defined kernel
// (Frei-Chen row gradient, positive only)
EKernel kernel;
kernel.SetKernelData(0.2929f, 0, -0.2929f,
                    0.442f, 0, -0.442f,
                    0.2929f, 0, -0.2929f);

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

// Apply the convolution kernel
EasyImage::ConvolKernel(&srcImage, &dstImage, &kernel);

```

4.4. Non-Linear Filtering

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;
EImageBW8 dstImage;

// ...

// 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;
EImageBW8 dstImage;

// ...

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

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

// Middle column of the kernel
leftCorner.SetValue(0, -1, EHitAndMissValue_Background);
leftCorner.SetValue(0, 0, EHitAndMissValue_Foreground);
leftCorner.SetValue(0, 1, EHitAndMissValue_Background);

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

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

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

4.5. Vector Operations

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;

// ...

// Vector constructor
EBW8PathVector path;

// Path definition
path.Empty();
for (int i = 0; i < 100; i++)
{
    EBW8Path p;
    p.X = i;
    p.Y = i;
    p.Pixel = 255;
    path.AddElement(p);
}

// Get the image data along the path
EasyImage::ImageToPath(&srcImage, &path);

```

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;

// ...

// Vector constructor
EBW8Vector profile;

// Get the image data along segment (0,500)-(500,40)
EasyImage::ImageToLineSegment(&srcImage, &profile, 0, 500, 500, 40);

// Set all these points to white (255) in the image
EasyImage::LineSegmentToImage(&srcImage, 255, 0, 500, 500, 40);

```

4.6. Statistics

Image Statistics

```

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

// Image constructor
EImageBW8 srcImage;

// ...

// Count the number of pixels above the threshold (↵28)
INT32 count;
EasyImage::Area(&srcImage, ↵28, count);

// Compute the pixels' average and standard deviation values
float stdDev, average;
EasyImage::PixelStdDev(&srcImage, stdDev, average);

// Compute the image gravity center (pixels above threshold)
float x, y;
EasyImage::GravityCenter(&srcImage, ↵28, x, y);

```

Sliding Windows Statistics

Functional Guide | Reference: [LocalAverage](#), [LocalDeviation](#)

```

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

// Images constructor
EImageBW8 srcImage;
EImageBW8 dstImage0, dstImage↵;

// ...

// All images must have the same size
dstImage0.SetSize(&srcImage);
dstImage↵.SetSize(&srcImage);

// Local average in a ↵↵↵ window
EasyImage::LocalAverage(&srcImage, &dstImage0, 5, 5);

// Local deviation in a ↵↵↵ window
EasyImage::LocalDeviation(&srcImage, &dstImage↵, 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;

// ...

// Histogram constructor
EBWHistogramVector histo;

// Compute the histogram
EasyImage::Histogram(&srcImage, &histo);

// Compute the average gray-level value
float average = EasyImage::AnalyseHistogram(&histo, EHistogramFeature_AveragePixelValue, 0, 255);

// Compute the gray-level standard deviation
float deviation = EasyImage::AnalyseHistogram(&histo, EHistogramFeature_PixelValueStdDev, 0, 255);

```

4.7. Noise Reduction by Integration

Functional Guide | [Reference](#)

Temporal Noise Reduction

Functional Guide | Reference: [Oper](#)

```

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

// Images constructor
EImageBW6 noisyImage, cleanImage;

// 6 bits work image used as an accumulator
EImageBW6 store;

// ...

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

// Clear the accumulator image
EasyImage::Oper(EArithmeticLogicOperation_Copy, (EBW6)0, &store);

// Accumulation loop
int n;
for (n=0; n < 6; 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

```

```
EasyImage::Oper(EArithmeticLogicOperation_Divide, &store, (EBW-6)n, &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, cleanImage;

// ↵6 bits work image used as an accumulator
EImageBW-6 store;

// ...

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

// Clear the accumulator image
EasyImage::Oper(EArithmeticLogicOperation_Copy, (EBW-6)0, &store);

// Prepare the transfer lookup table (reduction factor = 3)
EBW-6Vector lut;
EasyImage::SetRecursiveAverageLUT(&lut, 3.f);

// Perform the noise reduction
EasyImage::RecursiveAverage(&noisyImage, &store, &cleanImage, &lut);

```

4.8. 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;

// ...

// Harris corner detector
EHarrisCornerDetector harris;
EHarrisInterestPoints interestPoints;
harris.SetIntegrationScale(2.f);

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

```

```
// Retrieve the number of corners
unsigned int index = interestPoints.GetPointCount();

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

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;
EImageBW8 dstImage;

// ...

// Canny edge detector
ECannyEdgeDetector canny;

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

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

4.9. Using Flexible Masks

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;
EImageBW8 mask;

// ...

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


5. EasyColor

5.1. 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;  
EImageC24 dstImage;  
  
// ...  
  
// Prepare a lookup table for  
// the RGB to La*b* conversion  
EColorLookup lookup;  
lookup.ConvertFromRgb(EColorSystem_Lab);  
  
// Source and destination images must have the same size  
dstImage.SetSize(&srcImage);  
  
// Perform the color conversion  
EasyColor::Transform(&srcImage, &dstImage, &lookup);
```

5.2. Color Components

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, green, blue;  
EImageC24 colorImage;  
EImageBW8 luminance;  
  
// ...  
  
// 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;
lookup.ConvertFromRgb(EColorSystem_Lsh);

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

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

5.3. White Balance

Functional Guide | Reference: [PixelAverage](#), [WhiteBalance](#), [Transform](#)

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

// Images constructor
EImageC24 srcImage, dstImage;
EImageC24 whiteRef;

// ...

// Create a lookup table
EColorLookup lut;

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

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

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

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

5.4. Pseudo-Coloring

Functional Guide | Reference: [SetShading](#), [PseudoColor](#)

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

// Images constructor
EImageBW8 srcImage;
EImageC24 dstImage;

// ...

// Create a pseudo-color lookup table
EPseudoColorLookup pcLut;

// Define a shade of pure tints, from red to blue
```

```
pcLut.SetShading(EC24(255, 0, 0), EC24(0, 0, 255), EColorSystem_Ish);

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

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

5.5. Bayer Pattern Decoding

Functional Guide | Reference: [BayerToC24](#)

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

// Images constructor
EImageBW8 bayerImage;
EImageC24 dstImage;

// ...

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

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

6. Deep Learning Tools

6.1. Creating a Dataset and Training a Classifier

```

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

// Creating dataset and classifier objects
EClassificationDataset dataset;
EClassificationDataset trainingDataset;
EClassificationDataset validationDataset;
EClassifier classifier;

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

// Enabling data augmentation on the dataset
dataset.SetEnableDataAugmentation(true);

// Rotation of up to 90°
dataset.SetMaxRotationAngle(90);

// Enabling horizontal flips
dataset.SetEnableHorizontalFlip(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.GetBestEpoch());

```

6.2. Loading a Classifier and Classifying a New Image

```

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

// Image and classifier constructor
EClassifier classifier;
EImageBW8 srcImage;

// String and probability for the most probable result

```

```

std::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.GetBestLabel();
probability = result.GetBestProbability();

```

6.3. Using Multithreading for Classification

```

////////////////////////////////////
// This code snippet shows how to parallelize the //
// classification of new images on the CPU. //
// This code snippet is in C++ and requires a recent //
// compiler. //
////////////////////////////////////

#include <thread>
#define NUM_THREADS 4

void task(EasyDeepLearning::EClassifier *classifier, EImageC24 img)
{
    // Classification of the image
    EasyDeepLearning::EClassificationResult result = classifier->Classify(img);
    std::string label = result.GetBestLabel();
    float proba = result.GetBestProbability();

    // Perform other actions based on the result
    ...
}
...
// Vector of classifier: one per thread
std::vector<EasyDeepLearning::EClassifier> classifiers;
classifiers.resize(NUM_THREADS);
for (int i = 0; i < NUM_THREADS; i++)
{
    classifiers[i].Load("classifier.ecl");
}

// Our thread pool
std::vector<std::thread> threads;
threads.resize(NUM_THREADS);

// The next thread to use
int threadToUse = 0;
bool hasImage = true;
while (hasImage)
{
    EImageC24 image;

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

    // Check that the threads has done its previous work
    if (threads[threadToUse].joinable())

```

```
{
    threads[threadToUse].join();
}

// Launch a new thread
threads[threadToUse] = std::thread(task, &classifiers[threadToUse], image);
threadToUse = (threadToUse + 1) % NUM_THREADS;

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

// Make sure that all threads are finished
for (int i = 0; i < NUM_THREADS; i++)
{
    if (threads[i].joinable())
        threads[i].join();
}
```

6.4. Loading an Unsupervised Segmenter and Segmenting an Image

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

// Image
EImageBW8 image;
image.Load(...);

// Segmenter
EUnsupervisedSegmenter segmenter;
segmenter.Load(...);

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

// Retrieve the segmentation map
EImageBW8 segmentationMap = r.GetSegmentationMap();
```

7. EasyObject

7.1. 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;

// Image encoder
EImageEncoder encoder;

// Coded image
ECodedImage2 codedImage;

// ...

// 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 (↔0)
Segmenters::EGrayscaleSingleThresholdSegmenter& segmenter= encoder.GetGrayscaleSingleThresholdSegmenter();
segmenter.SetBlackLayerEncoded(true);
segmenter.SetWhiteLayerEncoded(false);

segmenter.SetMode(EGrayscaleSingleThreshold_Absolute);
segmenter.SetAbsoluteThreshold(↔0);

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;

// Image encoder
EImageEncoder encoder;

// Coded image
ECodedImage2 codedImage;

// ...

// Set the segmentation method to GrayscaleDoubleThreshold
encoder.SetSegmentationMethod(ESegmentationMethod_GrayscaleDoubleThreshold);

// Retrieve the segmenter object
Segmenters::EGrayscaleDoubleThresholdSegmenter& segmenter= encoder.GetGrayscaleDoubleThresholdSegmenter();

// Set the high and low threshold values
segmenter.SetHighThreshold(150);
segmenter.SetLowThreshold(50);

// Specify the layers to be encoded (neutral layer only)
segmenter.SetBlackLayerEncoded(false);
segmenter.SetNeutralLayerEncoded(true);
segmenter.SetWhiteLayerEncoded(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;

// Image encoder
EImageEncoder encoder;

// Coded image
ECodedImage2 codedImage;

// ...

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

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

    // Browse the holes of the current object
    for (unsigned int holeIndex = 0; holeIndex < blob.GetHoleCount(); 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;

// Image encoder
EImageEncoder encoder;

// Coded image
ECodedImage2 codedImage;

// ...

// Enable the continuous mode
encoder.SetContinuousModeEnabled(true);

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

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

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

```

7.2. Computing Blobs Features

Functional Guide | Reference: [GetGravityCenter](#), [GetObj](#)

```

////////////////////////////////////
// This code snippet shows how to retrieve blobs' features. //
// in the continuous mode context. //
////////////////////////////////////

// Image constructor
EImageBW8 srcImage;

// Image encoder
EImageEncoder encoder;

// Coded image
ECodedImage2 codedImage;

// ...

// Encode the source image

```

```

encoder.Encode(srcImage, codedImage);

for (unsigned int index = 0; index < codedImage.GetObjectCount(); index++)
{
    // Retrieve the selected blob gravity center
    EObject& blob = codedImage.GetObject(index);
    float centerX = blob.GetGravityCenter().GetX();
    float centerY = blob.GetGravityCenter().GetY();
}

```

7.3. 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;

// Image encoder
EImageEncoder encoder;

// Coded image
ECodedImage2 codedImage;

// ...

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

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

// Remove the Small blobs
selection.RemoveUsingUnsignedIntegerFeature(EFeature_Area, 100, ESingLeThresholdMode_Less);

// Retrieve the number of remaining blobs
unsigned int numBlobs= selection.GetElementCount();

// Sort the remaining blobs based on their area
selection.Sort(EFeature_Area, ESortDirection_Ascending);

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

```

7.4. 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;
EImageBW8 mask;

// Image encoder
EImageEncoder encoder;

// Coded image
ECodedImage2 codedImage;

// ...

// 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;
EImageBW8 mask;

// Image encoder
EImageEncoder encoder;

// Coded image
ECodedImage2 codedImage;

// ...

// 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, >);

```

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;
EImageBW8 mask;

// Image encoder
EImageEncoder encoder;

// Coded image
ECodedImage2 codedImage;

// ...

// 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;
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);

```

7.5. 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;
ECodedImage2 coded_img;

EImageBW8 template_img;
encoder.Encode(template_img, coded_img);

// Initialize EObjectTemplateMatcher

```

```
EObjectTemplateMatcher object_matcher;
object_matcher.SetEnableAlignment(true); // optional
object_matcher.SetMaximumDistance(60); // optional

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

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

// Build a selection of test objects
EObjectSelection object_select;
object_select.AddObjects(coded_img);
object_select.RemoveUsingUnsignedIntegerFeature(EFeature_Area, 0, ESingleThresholdMode_Less); // optional
filter

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

// Display the number of matches
std::cout << object_matcher.GetNumberOfPairedObjects() << " paired objects" << std::endl;
// Retrieve the template indexes for each selection object
std::vector<int> template_indexes = object_matcher.GetTemplateIndexes();
```

8. EasyMatch

8.1. 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;  
  
// ROI constructor  
EROIBW8 pattern;  
  
// EMatcher constructor  
EMatcher matcher;  
  
// ...  
  
// Attach the ROI to the source image  
// and set its position  
pattern.Attach(&srcImage);  
pattern.SetPlacement(24, 52, 200, 200);  
  
// Learn the pattern  
matcher.LearnPattern(&pattern);
```

8.2. 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;  
  
// EMatcher constructor  
EMatcher matcher;  
  
// ...  
  
// Learn the pattern  
matcher.LearnPattern(&pattern);  
  
// Set the maximum number of occurrences  
matcher.SetMaxPositions(5);
```

```
// Set the rotation tolerances
matcher.SetMinAngle(-20.f);
matcher.SetMaxScale(20.f);

// Enable sub-pixel accuracy
matcher.SetInterpolate(true);

// Set the minimum score
matcher.SetMinScore(0.70f);

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

8.3. 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;

// EMatcher constructor
EMatcher matcher;

// ...

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

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

// Retrieve the number of occurrences
int numOccurrences= matcher.GetNumPositions();

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

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

9. EasyFind

9.1. Pattern Learning

Functional Guide | Reference: [Learn](#)

```
////////////////////////////////////  
// This code snippet shows how to learn a pattern //  
// defined by a region of interest (ROI).         //  
////////////////////////////////////  
  
// Image constructor  
EImageBW8 srcImage;  
  
// ROI constructor  
EROIBW8 pattern;  
  
// EPatternFinder constructor  
EPatternFinder finder;  
  
// ...  
  
// Attach the ROI to the source image  
// and set its position  
pattern.Attach(&srcImage);  
pattern.SetPlacement(24, 52, 200, 200);  
  
// Learn the pattern  
finder.Learn(&pattern);
```

9.2. 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;  
  
// EPatternFinder constructor  
EPatternFinder finder;  
  
// ...  
  
// Learn the pattern  
finder.Learn(&pattern);  
  
// Set the maximum number of occurrences  
finder.SetMaxInstances(5);  
  
// Set the rotation tolerances
```



```
finder.SetAngleTolerance(20.f);

// Set the minimum score
finder.SetMinScore(0.70f);

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

9.3. 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;

// EPatternFinder constructor
EPatternFinder finder;

// EFoundPattern constructor
std::vector<EFoundPattern> foundPattern;

// ...

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

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

// Retrieve the number of instances
int numInstances= (int)foundPattern.size();

// Retrieve the score and the
// position of the first instance
float score= foundPattern[0].GetScore();
float centerX= foundPattern[0].GetCenter().GetX();
float centerY= foundPattern[0].GetCenter().GetY();
```

10. EasyGauge

10.1. 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;

// EPointGauge constructor
EPointGauge pointGauge;

// Adjust the transition parameters
pointGauge.SetTransitionType(ETransitionType_Wb);
pointGauge.SetTransitionChoice(ETransitionChoice_Closest);

// Set the gauge nominal position
pointGauge.SetCenterXY(256.f, 256.f);

// Set the gauge length to 100 units and the angle to 45°
pointGauge.SetTolerances(100.f, 45.f);

// Measure
pointGauge.Measure(&srcImage);

// Get the measured point coordinates
float measuredX = pointGauge.GetMeasuredPoint().GetX();
float measuredY = pointGauge.GetMeasuredPoint().GetY();

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

```

10.2. 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;

// ELineGauge constructor

```

```

ELineGauge lineGauge;

// Adjust the transition parameters
lineGauge.SetTransitionType(ETransitionType_Bw);
lineGauge.SetTransitionChoice(ETransitionChoice_NthFromEnd);
lineGauge.SetTransitionIndex(2);

// Set the line fitting gauge position,
// length (50 units) and orientation (20°)
EPoint center(256.f, 256.f);
ELine line(center, 50.f, 20.f);
lineGauge.SetLine(line);

// Measure
lineGauge.Measure(&srcImage);

// Get the origin and end point coordinates of the fitted line
EPoint originPoint = lineGauge.GetMeasuredLine().GetOrg();
EPoint endPoint = lineGauge.GetMeasuredLine().GetEnd();

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

```

10.3. 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;

// ECircleGauge constructor
ECircleGauge circleGauge;

// Adjust the transition parameters
circleGauge.SetTransitionType(ETransitionType_Bw);
circleGauge.SetTransitionChoice(ETransitionChoice_LargestAmplitude);

// Set the Circle fitting gauge position, diameter (50 units),
// starting angle (↺0°), and amplitude (270°)
EPoint center(256.f, 256.f);
ECircle circle(center, 50.f, ↺0.f, 270.f);
circleGauge.SetCircle(circle);

// Measure
circleGauge.Measure(&srcImage);

// Get the center point coordinates and the radius of the fitted circle
float centerX = circleGauge.GetMeasuredCircle().GetCenter().GetX();
float centerY = circleGauge.GetMeasuredCircle().GetCenter().GetY();
float radius = circleGauge.GetMeasuredCircle().GetRadius();

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

```

10.4. 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;

// ERectangleGauge constructor
ERectangleGauge rectangleGauge;

// Adjust the transition parameters
rectangleGauge.SetTransitionType(ETransitionType_Bw);
rectangleGauge.SetTransitionChoice(ETransitionChoice_LargestAmplitude);

// Set the rectangle fitting gauge position,
// size (50x30 units) and orientation (↙5°)
EPoint center(256.f, 256.f);
ERectangle rectangle(center, 50.f, 30.f, ↙5.f);
rectangleGauge.SetRectangle(rectangle);

// Measure
rectangleGauge.Measure(&srcImage);

// Get the size and the rotation angle of the fitted rectangle
float sizeX = rectangleGauge.GetMeasuredRectangle().GetSizeX();
float sizeY = rectangleGauge.GetMeasuredRectangle().GetSizeY();
float angle = rectangleGauge.GetMeasuredRectangle().GetAngle();

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

```

10.5. 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;

// EWedgeGauge constructor
EWedgeGauge wedgeGauge;

// Adjust the transition parameters
wedgeGauge.SetTransitionType(ETransitionType_Bw);
wedgeGauge.SetTransitionChoice(ETransitionChoice_NthFromBegin);
wedgeGauge.SetTransitionIndex(0);

```

```
// Set the wedge fitting gauge position, diameter (50 units),
// breadth (-25 units), starting angle (0°) and amplitude (270°)
EPoint center(256.f, 256.f);
EWedge wedge(center, 50.f, -25.f, 0.f, 270.f);
wedgeGauge.SetWedge(wedge);

// Measure
wedgeGauge.Measure(&srcImage);

// Get the inner and outer radius of the fitted wedge
float innerRadius = wedgeGauge.GetMeasuredWedge().GetInnerRadius();
float outerRadius = wedgeGauge.GetMeasuredWedge().GetOuterRadius();

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

10.6. 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;

// Gauges constructor
ERectangleGauge rectangleGauge;
ECircleGauge circleGauge1, circleGauge2;

// ...

// 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.SetName("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;

// EWorldShape constructor
EWorldShape worldShape;

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

// Retrieve the number of worldShape's daughters
int numDaughters= worldShape.GetNumDaughters();

// ...

// 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->GetMeasuredRectangle().GetSizeX();

// Retrieve the measurement result of a
// daughter gauge called "myCircleGauge"
ECircleGauge* circleGauge= (ECircleGauge*)worldShape.GetShapeNamed("myCircleGauge");
EPoint center= circleGauge->GetMeasuredCircle().GetCenter();
```

10.7. 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;

// EWorldShape constructor
EWorldShape worldShape;

// ...

// Compute the calibration coefficients
// Field of view: 32x24 mm
worldShape.SetSensor(srcImage.GetWidth(), srcImage.GetHeight(), 32.f, 24.f);

// Retrieve the spatial resolution
float resolutionX= worldShape.GetXResolution();
float resolutionY= worldShape.GetYResolution();
```

Landmark-Based Calibration

Functional Guide | Reference: [EmptyLandmarks](#), [AddLandmark](#), [Calibrate](#)

```

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

// EWorldShape constructor
EWorldShape worldShape;

// ...

// 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
    // ...

    // Add the I-th pair
    worldShape.AddLandmark(sensorPoint, worldPoint);
}

// Perform the calibration
worldShape.Calibrate(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;

// ...

// 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
    // ...

    // 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;

// EPoint constructor
EPoint sensor;
EPoint world;

// ...

// Perform the calibration
worldShape.Calibrate(ECalibrationMode_Scaled | 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;
EImageBW8 dstImage;

// EWorldShape constructor
EWorldShape worldShape;

// Lookup table constructor
EUnwarpingLut lut;

// ...

// Perform the calibration

```



```
worldShape.Calibrate(ECalibrationMode_Tilted | ECalibrationMode_Radial);  
  
// Setup the lookup table for unwarping  
worldShape.SetupUnwarp(&lut, &srcImage, true);  
  
// Perform the image unwarping  
worldShape.Unwarp(&lut, &srcImage, &dstImage, true);
```

11. EasyOCR

11.1. Learning Characters

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;

// EOCR constructor
EOCR ocr;

// Text to be learned (all digits)
// Assuming the image contains this text
const std::string text= "0-23456789";

// ...

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

// Adjust the segmentation parameters
ocr.SetTextColor(EOCRColor_BlackOnWhite);
ocr.SetMinCharWidth(↵5);
ocr.SetMinCharWidth(50);
ocr.SetMinCharHeight(↵5);
ocr.SetMinCharHeight(75);
ocr.SetNoiseArea(↵5);

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

// Learn the characters
ocr.LearnPatterns(&srcImage, text, EOCClass_Digit);

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

```

11.2. 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;  
  
// EOCR constructor  
EOCR ocr;  
  
// Load the font file  
ocr.Load("myFont.ocr");  
  
// ...  
  
// Recognize the characters  
std::string text= ocr.Recognize(&srcImage, 10, EOCRClass_AllClasses);  
  
// Alternatively  
// Define the character filter (2 letters and 3 digits)  
std::vector<UINT32> charFilter;  
charFilter.push_back(EOCRClass_UpperCase);  
charFilter.push_back(EOCRClass_UpperCase);  
charFilter.push_back(EOCRClass_Digit);  
charFilter.push_back(EOCRClass_Digit);  
charFilter.push_back(EOCRClass_Digit);  
  
// Recognize the characters with class filtering  
text= ocr.Recognize(&srcImage, 10, charFilter);
```

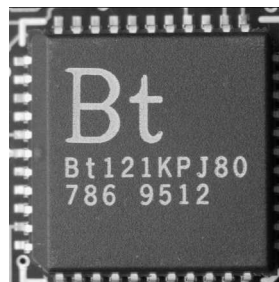
12. EasyOCR2

12.1. Detecting Characters

```

////////////////////////////////////
// This code snippet shows how to detect characters //
// in an image, using a few parameters and a topology //
////////////////////////////////////
// Load an Image
EImageBW8 image;
image.Load("image.tif");
// Attach a ROI to the image
EROIBW8 roi;
roi.Attach(&image, 50, 224, 340, 96);
// Create an EOCR2 instance
EOCR2 ocr2;
// Set the expected character sizes
ocr2.SetCharsWidthRange(EIntegerRange(25,25));
ocr2.SetCharsHeight(37);
// Set the text polarity, in this case WhiteOnBlack
ocr2.SetTextPolarity(EasyOCR2TextPolarity_WhiteOnBlack);
// Set the topology
ocr2.SetTopology(".{0}\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);

```



The image used in this code snippet

12.2. Learning Characters

```

////////////////////////////////////
// This code snippet shows how to learn characters //
// based on an image featuring a known text and //
// save the corresponding character database //
////////////////////////////////////
// Load an Image
EImageBW8 image;

```

```

image.Load("image.tif");
// Attach a ROI to the image
EROIBW8 roi;
roi.Attach(&image, 50, 224, 340, 96);

// Create an EOCR2 instance
EOCR2 ocr2;

// Set the required parameters
ocr2.SetCharsWidthRange(EIntegerRange(25,25));
ocr2.SetCharsHeight(37);
ocr2.SetTextPolarity(EasyOCR2TextPolarity_WhiteOnBlack);
ocr2.SetTopology(".{-0}\n.{3} .{4}");

// Learn from the reference image:
// ↳ Detect the text in the image
EOCR2Text text = ocr2.Detect(roi);
// 2) Set the true values of the text
text.SetText("Bt-2-KPJ80\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");

```



The image used in this code snippet

12.3. Reading Characters

Reading Using TrueType Fonts

```

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

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

// Attach an ROI
EROIBW8 roi;

```

```

roi.Attach(&image, 50, 224, 340, 96);

// Create an EOCR2 instance
EOCR2 ocr2;

// Set the required parameters
ocr2.SetCharsWidthRange(EIntegerRange(25,25));
ocr2.SetCharsHeight(37);
ocr2.SetTopology("[LN]{-0}\nN{3} N{4}");
ocr2.SetTextPolarity(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
std::string result = ocr2.Read(roi);

```



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;
image.Load("image.tif");

// Attach an ROI
EROIBW8 roi;
roi.Attach(&image, 50, 224, 340, 96);

// Create an EOCR2 instance
EOCR2 ocr2;

// Set the required parameters
ocr2.SetCharsWidthRange(EIntegerRange(25,25));
ocr2.SetCharsHeight(37);
ocr2.SetTopology("[LN]{-0}\nN{3} N{4}");
ocr2.SetTextPolarity(EasyOCR2TextPolarity_WhiteOnBlack);

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

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

```

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;
image.Load("image.tif");

// Attach an ROI
EROIBW8 roi;
roi.Attach(&image, 50, 224, 340, 96);

// Create an EOCR2 instance
EOCR2 ocr2;

// 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
std::string result = ocr2.Read(roi);

```

12.4. View Bitmap

```

////////////////////////////////////
// This code snippet shows how to inspect the //
// characters in a character database //
////////////////////////////////////
// Create an EOCR2 instance
EOCR2 ocr2;
// Load the character database
ocr2.AddCharactersToDatabase("database.o2d");
// Extract the character database
EOCR2CharacterDatabase db = ocr2.GetCharacterDatabase();
// 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.GetBitmap();

```

13. EasyBarCode

13.1. Reading a Bar Code

Functional Guide | Reference: [Read](#)

```
////////////////////////////////////  
// This code snippet shows how to read a bar code //  
////////////////////////////////////  
  
// Image constructor  
EImageBW8 srcImage;  
  
// Bar code reader constructor  
EBarcode reader;  
  
// String for the decoded bar code  
std::string result;  
  
// ...  
  
// Read the source image  
result = reader.Read(&srcImage);
```

13.2. Reading a Bar Code Following a Given Symbology

Functional Guide | Reference: [SetAdditionalSymbologies](#), [SetVerifyChecksum](#), [Detect](#), [Decode](#), [GetNumDecodedSymbologies](#)

```
////////////////////////////////////  
// 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;  
  
// Bar code reader constructor  
EBarcode reader;  
  
// String for the decoded bar code  
std::string result;  
  
// ...  
  
// Disable all standard symbologies  
reader.SetStandardSymbologies(0);  
  
// Enable the Code32 symbology only  
reader.SetAdditionalSymbologies(ESymbologies_Code32);
```



```
// Enable checksum verification
reader.SetVerifyChecksum(true);

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

// Retrieve the number of symbologies for
// which the decoding process was successful
int numDecoded = reader.GetNumDecodedSymbologies();

if(numDecoded > 0)
{
    // Decode the bar code according to the Code32 symbology
    result = reader.Decode(ESymbologies_Code32);
}
}
```

13.3. Reading a Bar Code of Known Location

Functional Guide | Reference: [SetKnownLocation](#), [SetCenterXY](#), [SetReadingSize](#)

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

// Image constructor
EImageBW8 srcImage;

// Bar code reader constructor
EBarcode reader;

// String for the decoded bar code
std::string result;

// ...

// Disable automatic bar code detection
reader.SetKnownLocation(TRUE);

// Set the bar code position
reader.SetCenterXY(450.0f, 400.0f);
reader.SetSize(250.0f, 100.0f);
reader.SetReadingSize(100.0f, 50.0f);

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

13.4. 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;
// Mail barcode reader constructor
```

```
EmailBarcodeReader reader;

// Select expected symbologies and orientations (optional)
reader.SetExpectedSymbologies(...);
reader.SetExpectedOrientations(...);
// ...
// Read
std::vector<EmailBarcode> codes = reader.Read(srcImage);
// Retrieve the data included in found mail barcodes
for (unsigned int index= 0; index < codes.size(); index++)
{
    std::string text = codes[index].GetText();
    std::vector<EStringPair> components = codes[index]. GetComponentStrings();
}
```

14. EasyMatrixCode

14.1. Automatic Reading

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;  
  
// Matrix code reader constructor  
EMatrixCodeReader reader;  
  
// Matrix code constructor  
EMatrixCode mxCode;  
  
// String for the decoded information  
std::string result;  
  
// ...  
  
// Read the source image  
mxCode = reader.Read(srcImage);  
  
// Retrieve the decoded string  
result = mxCode.GetDecodedString();
```

14.2. Reading with Prior Learning

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;  
EImageBW8 srcImage;  
  
// Matrix code reader constructor  
EMatrixCodeReader reader;  
  
// Matrix code constructor  
EMatrixCode mxCode;  
  
// String for the decoded information  
std::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.GetDecodedString();
```

14.3. Advanced Tuning of 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;

// Matrix code reader constructor
EMatrixCodeReader reader;

// Matrix code constructor
EMatrixCode mxCode;

// String for the decoded information
std::string result;

// ...

// Remove the default logical sizes
reader.GetSearchParams().ClearLogicalSize();

// Add the 5x5 and 7x7 logical sizes
reader.GetSearchParams().AddLogicalSize(ELogicalSize__5x5);
reader.GetSearchParams().AddLogicalSize(ELogicalSize__7x7);

// Remove the default families
reader.GetSearchParams().ClearFamily();

// Add the ECC050 family
reader.GetSearchParams().AddFamily(EFamily_ECC050);

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

// Retrieve the decoded string
result = mxCode.GetDecodedString();
```

14.4. Retrieving Print Quality Grading

Functional Guide | Reference: [SetComputeGrading](#), [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;  
  
// Matrix code reader constructor  
EMatrixCodeReader reader;  
  
// Matrix code constructor  
EMatrixCode mxCode;  
  
// ...  
  
// Enable grading computation  
reader.SetComputeGrading(TRUE);  
  
// Read the source image  
mxCode = reader.Read(srcImage);  
  
// Retrieve the print quality grading  
int axialNonUniformityGrade= mxCode.GetAxialNonUniformityGrade();  
int contrastGrade= mxCode.GetContrastGrade();  
int printGrowthGrade= mxCode.GetPrintGrowthGrade();  
int unusedErrorCorrectionGrade= mxCode.GetUnusedErrorCorrectionGrade();
```

15. EasyMatrixCode2

15.1. Reading Matrix Codes from an Image

```

////////////////////////////////////
// This code snippet shows how to read data matrix codes //
// and retrieve the decoded string. //
////////////////////////////////////
namespace EMC2 = Euresys::Open_eVision_x_x::EasyMatrixCode2;
// Load an image
EImageBW8 image;
image.Load("image.bmp");
// Prepare a matrix code reader
EMC2::EMatrixCodeReader reader;
// Let the reader know that there are no more than 3 codes in the image
reader.SetMaxNumCodes(3);
// Read the source image
reader.Read(image);
// Retrieve the detected codes
std::vector<EMC2::EMatrixCode> codes = reader.GetReadResults();
// Retrieve the decoded string for the first code
std::string result = codes[0].GetDecodedString();

```

15.2. Reading with Prior Learning

```

////////////////////////////////////
// This code snippet shows how to learn from a given image, //
// perform the reading and retrieve the decoded string. //
////////////////////////////////////
namespace EMC2 = Euresys::Open_eVision_x_x::EasyMatrixCode2;

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

// Prepare a matrix code reader
EMC2::EMatrixCodeReader reader;

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

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

// Retrieve the detected codes
std::vector<EMC2::EMatrixCode> codes = reader.GetReadResults();

// Retrieve the decoded string of the first code
std::string result = codes[0].GetDecodedString();

```

15.3. Inspecting Print Quality Grades

```

////////////////////////////////////
// This code snippet shows how to read a data matrix code //
// and retrieve its print quality grades.                //
////////////////////////////////////
namespace EMC2 = Euresys::Open_eVision_x_x::EasyMatrixCode2;
// Load an image
EImageBW8 image;
image.Load("image.bmp");
// Prepare a matrix code reader
EMC2::EMatrixCodeReader reader;
// Tell the reader to compute grades for the read codes
reader.SetComputeGrading(true);
// Read the codes in this image
reader.Read(image);
// Retrieve the detected codes
std::vector<EMC2::EMatrixCode> codes = reader.GetReadResults();
// Retrieve the SemiT0 grades of the first code
EMatrixCodeSemiT0GradingParameters semiT0Grades = codes[0].GetSemiT0GradingParameters();
// Retrieve specific grade values
float cellDefects = semiT0Grades.CellDefects;
float symbolContrast = semiT0Grades.SymbolContrast;
float unusedErrorCorrection = semiT0Grades.UnusedErrorCorrection;

```

15.4. Asynchronous Processing

```

////////////////////////////////////
// This code snippet shows how to read data matrix codes asynchronously //
// from three separate images.                //
// The code in this snippet is valid for C++11 and newer.                //
////////////////////////////////////
#include <thread>
#include <atomic>
namespace EMC2 = Euresys::Open_eVision_x_x::EasyMatrixCode2;
// create a subroutine that reads the codes from an image
void Read(EImageBW8& image, EMC2::EMatrixCodeReader& reader, std::vector<EMC2::EMatrixCode>& codes,
std::atomic<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;
}
int main()
{
    // Prepare three images
    EImageBW8 img1, img2, img3;

    // Prepare three matrix code readers
    EMC2::EMatrixCodeReader reader1, reader2, reader3;

    // Prepare three vectors of matrix code instances
    std::vector<EMC2::EMatrixCode> codes1, codes2, codes3;

```

```
// Prepare three booleans to track the thread progress
std::atomic<bool> finished, finished2, finished3;

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

// Set the progress trackers to false
finished = false;
finished2 = false;
finished3 = false;

// Launch three threads to read the codes in each image
// the threads will run in the background.
std::thread thr1 = std::thread([&]{ Read(img1, reader1, codes1, finished); });
std::thread thr2 = std::thread([&]{ Read(img2, reader2, codes2, finished2); });
std::thread thr3 = std::thread([&]{ Read(img3, reader3, codes3, finished3); });

// Wait until one of the threads has finished
while (!(finished || finished2 || finished3))
    std::this_thread::sleep_for(std::chrono::milliseconds(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();

return 0;
}
```


16. EasyQRCode

16.1. Automatic Reading of a QR Code

Functional Guide | Reference: [Read](#), [EQRCodeDecodedStream Class](#)

```

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

// Image constructor
EImageBW8 srcImage;

// QR code reader constructor
EQRCodeReader reader;

// ...

// Set the source image
reader.SetSearchField(srcImage);

// Read
std::vector<EQRCode> qrCodes = reader.Read();

```

16.2. Retrieving Information of a QR Code

Functional Guide | Reference: [Read](#), [EQRCode Class](#)

```

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

// Image constructor
EImageBW8 srcImage;

// QR code reader constructor
EQRCodeReader reader;

// ...

// Set the source image
reader.SetSearchField(srcImage);

// Read
std::vector<EQRCode> qrCodes = reader.Read();

// Retrieve version, model and position information
// of the first QR code found, if one was found
if (qrCodes.size() > 0)
{
    int version = qrCodes[0].GetVersion();
    EQRCodeModel model = qrCodes[0].GetModel();
}

```

```
EQRCODEGeometry geometry = qrCodes[0].GetGeometry();
}
```

16.3. Tuning the Search Parameters

Functional Guide | Reference: [Read](#), [GetDecodedString](#)

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

// QR code reader constructor
EQRCODEReader reader;

// ...

// Set the source image
reader.SetSearchField(srcImage);

// Set the search parameters
reader.SetMaximumVersion(7);
reader.SetMinimumIsotropy(0.9f);

// Set the searched models
std::vector<EQRCODEModel> models;
models.push_back(EQRCODEModel_Model2);
reader.SetSearchedModels(models);

// Read
std::vector<EQRCODE> qrCodes = reader.Read();

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

16.4. Retrieving the Decoded String (Simple)

Functional Guide | Reference: [Read](#), [EQRCODE Class](#)

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

// Image constructor
EImageBW8 srcImage;

// QR code reader constructor
EQRCODEReader reader;

// ...

// Set the source image
reader.SetSearchField(srcImage);
```

```
// Read
std::vector<EQRCode> qrCodes = reader.Read();

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

16.5. Retrieving the Decoded String (Safe)

Functional Guide | Reference: [Read](#), [EQRCode Class](#)

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

// Image constructor
EImageBW8 srcImage;

// QR code reader constructor
EQRCodeReader reader;

// ...

// Set the source image
reader.SetSearchField(srcImage);

// Read
std::vector<EQRCode> qrCodes = reader.Read();

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

16.6. Retrieving the Decoded Data (Advanced)

Functional Guide | Reference: [Read](#), [EQRCode Class](#)

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

```
// QR code reader constructor
EQRCodeReader reader;
// ...

// Set the source image
reader.SetSearchField(srcImage);

// Read
std::vector<EQRCode> qrCodes = reader.Read();

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

// Retrieve the coding mode and the raw bit stream of the first QR code found
EQRCodeCodingMode codingMode = stream.GetCodingMode();
vector<UINT8> bitstream = stream.GetRawBitstream();

// Retrieve the encoding and the decoded data of each part of the first QR code found
vector<EQRCodeDecodedStreamPart> parts = stream.GetDecodedStreamParts();
for(unsigned int i = 0 ; i < parts.size(); ++i)
{
    // Retrieve encoding
    EQRCodeEncoding encoding = parts[i].GetEncoding();

    // Retrieve the decoded data
    vector<UINT8> decodedData = parts[i].GetDecodedData();

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

17. Easy3DObject

17.1. Extracting 3D Objects with a Selection Criterion

```
// EZmap constructor
EZMap8 zMap;

// Extractor constructor
E3DObjectExtractor extractor;

// Setting a selection criterion
extractor.SetWidthRange(EFloatRange(10, 500));

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

// Retrieve the extracted objects
std::vector<E3DObject> objects = extractor.GetObjects();
```

17.2. Inspecting a Feature from the List of E3DObjects

```
// Get the list of E3DObjects
std::vector<E3DObject> objects = extractor.GetObjects();

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

// Get the ERectangleRegion of the last (the largest) object
ERectangleRegion region = objects.back().GetRectangleRegion();
```

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

```
// Get the list of E3DObjects
std::vector<E3DObject> objects = extractor.GetObjects();

// Get a render context
HDC drawHDC;

// Draw the ERegion of each object
int nObjects = (int)objects.size();
for (int i = 0; i < nObjects; i++)
    objects[i].Draw(drawHDC, E3DObjectFeature_ERegion, ERGBColor(0, 255, 0));
```

17.4. Drawing 3D Features from a List of E3DObjects

```
// Get the list of E3DObjects
std::vector<E3DObject> objects = extractor.GetObjects();

// Register the list of E3DObjects to the 3D viewer
E3DViewer viewer3D(0,0,640,480);
viewer3D.Register3DObjects(objects);

// Define and use a render style for the ReferenceTopPosition feature
ERenderStyle renderStyle;
renderStyle.pointRGB = EC24A(0, 0, 0);
viewer3D.SetFeatureStyleForAll3DObjects(renderStyle, E3DObjectFeature_ReferenceTopPosition);

// Set a different rendering color for the first object
ERenderStyle selectedRenderStyle;
selectedRenderStyle.pointRGB = EC24A(255, 255, 0);
viewer3D.SetFeatureStyleFor3DObject(0, selectedRenderStyle, E3DObjectFeature_ReferenceTopPosition);

// Enable the display of the TopZPosition feature
viewer3D.ShowFeatureForAll3DObjects(E3DObjectFeature_ReferenceTopPosition);
```

18. Easy3DMatch

18.1. 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
Easy3D::E3DAligner aligner;
Easy3D::EMesh cad;
cad.Load("...");
float azimuthReference = 0.f, elevationReference = 90.f;
aligner.SetReference(cad, azimuthReference, elevationReference);

// load the sample
Easy3D::EPointCloud sample;
sample.Load("...");
float azimuthSample = 0.f, elevationSample = 90.f;

// perform alignment
Easy3D::E3DAlignment alignment = aligner.Align(sample, azimuthSample, elevationSample);

```

18.2. E3DAligner Reprojection Plane

```

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

// load the reference mesh and define the pose
Easy3D::E3DAligner aligner;
Easy3D::EMesh cad;
cad.Load("...");
Easy3D::E3DPlane refPlane(Easy3D::E3DPoint(0, 0, ↲), 0);
aligner.SetReference(cad, refPlane);

// define the reprojection plane
bool userKnowsPlaneAZEL = false; // depending on the user
if (userKnowsPlaneEquation)
{
    Easy3D::E3DPlane reprojectionPlane(Easy3D::E3DPoint(0, 0, ↲), ↲5);
    aligner.SetScanReprojectionPlane(reprojectionPlane);
}
else
{
    Easy3D::EPointCloud cloud;
    cloud.Load("...");
    bool objectAbovePlane = true; // is the object above the plane on the cloud
    aligner.SetFlatScan(cloud, objectAbovePlane);
}

```

```
// load the sample
Easy3D::EPointCloud sample;
sample.Load("...");
float azimuthSample = 0.f, elevationSample = 90.f;

// perform alignment
Easy3D::E3DAlignment alignment = aligner.Align(sample, azimuthSample, elevationSample);
```

18.3. 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)
Easy3D::E3DAlignment alignment;
EPointCloud sample;

// align sample on reference
Easy3D::EPointCloud alignedSample;
Easy3D::EAffineTransformer::ApplyMatrix(alignment.GetPose(), sample, alignedSample);
```

18.4. 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
Easy3D::E3DComparer comparer;
Easy3D::EPointCloud cloud;
cloud.Load("...");
comparer.SetReference(cloud);

// set thresholds
float distanceThresh = .2f, areaThresh = 1.f;
comparer.SetAnomalyThresholds(distanceThresh, areaThresh);

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

// load the sample and perform comparison
Easy3D::EPointCloud sample;
sample.Load("...");
comparer.Compare(sample);

// compute anomalies
std::vector<Easy3D::E3DAnomaly> anomalies = comparer.ComputesAnomalies();

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

// get cloud to inspect it manually
Easy3D::EPointCloud visualisationCloud;
comparer.GetComparisonPointCloud(visualisationCloud);
```


18.5. E3DComparer Advanced Sample

```

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

// load the reference golden scan and set reference
Easy3D::E3DComparer comparer;
Easy3D::EPointCloud cloud;
cloud.Load("...");
comparer.SetReference(cloud);

// set thresholds
float distanceThresh = .2f, areaThresh = 1.f;
float hystDistanceThresh = 1.5f, hystAreaThresh = .5f;
comparer.SetAnomalyThresholds(distanceThresh, areaThresh);
comparer.SetAnomalyHysteresis(hystDistanceThresh, hystAreaThresh); // defined relatively to base thresholds

// set ROIs
std::vector<Easy3D::E3DBox> rois = { Easy3D::E3DBox(15, 15, 15) };
comparer.SetROI(rois);
std::vector<Easy3D::E3DBox> dontCare = { Easy3D::E3DBox(5, 5, 5) };
comparer.SetDontCare(dontCare);
std::vector<Easy3D::E3DBox> noExtraMaterial = { Easy3D::E3DBox(Easy3D::E3DPoint(10, 15, 20), 0, 0, 0, 5, 5, 5) };
comparer.SetNoExtraMaterial(noExtraMaterial);

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

// load the sample and perform comparison
Easy3D::EPointCloud sample;
sample.Load("...");
comparer.Compare(sample);

// compute anomalies
std::vector<Easy3D::E3DAnomaly> anomalies = comparer.ComputesAnomalies();

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

// get cloud to inspect it manually
Easy3D::EPointCloud visualisationCloud;
comparer.GetComparisonPointCloud(visualisationCloud);

```

18.6. 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
Easy3D::E3DMatcher matcher;
Easy3D::EPointCloud reference;
float azimuthReference = 0.f, elevationReference = 90.f;
reference.Load("...");
matcher.SetReference(reference, azimuthReference, elevationReference);

// set thresholds

```

```

float distanceThresh = .2f, areaThresh = 1.f;
matcher.SetAnomalyThresholds(distanceThresh, areaThresh);

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

// load the sample and perform comparison
Easy3D::EPointCloud sample;
float azimuthSample = 0.f, elevationSample = -90.f;
sample.Load("...");
Easy3D::E3DMatch match = matcher.Match(sample, azimuthSample, elevationSample);
std::vector<Easy3D::E3DAnomaly> anomalies = match.GetAnomalies();

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

// get cloud to inspect it manually
Easy3D::EPointCloud visualisationCloud;
matcher.GetComparisonPointCloud(visualisationCloud);

```

18.7. 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
Easy3D::E3DMatcher matcher;
Easy3D::EPointCloud reference;
float azimuthReference = 0.f, elevationReference = 90.f;
reference.Load("...");
matcher.SetReference(reference, azimuthReference, elevationReference);

// use advanced comparison mode
matcher.SetComparisonDistanceMode(EComparisonDistanceMode_Advanced);

// ignore shadows
matcher.SetEnableMissingPointAsAnomaly(false);

// set thresholds
float distanceThresh = .2f, areaThresh = 1.f;
float hystDistanceThresh = 1.5f, hystAreaThresh = .5f;
matcher.SetAnomalyThresholds(distanceThresh, areaThresh);
matcher.SetAnomalyHysteresis(hystDistanceThresh, hystAreaThresh); // defined relatively to base thresholds

// retrieve reference poses (reference must have been set)
std::vector<Easy3D::EZMap8> referencePoseProjections;
matcher.RetrieveReferencePosesProjections(referencePoseProjections);

// set ROI on the left half of the object
ERectangleRegion roiRegion(0.f, 0.f, float(referencePoseProjections[0].GetWidth()) / 2.f, float
(referencePoseProjections[0].GetHeight()));
matcher.SetComparisonROI(&roiRegion);

// set No Extra material on the whole object
ERectangleRegion noExtraMatRegion(0.f, 0.f, float(referencePoseProjections[0].GetWidth()) / 2.f, float
(referencePoseProjections[0].GetHeight()));
matcher.SetComparisonNoExtraMaterial(&noExtraMatRegion);

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

```

```
// load the sample and perform comparison
Easy3D::EPointCloud sample;
float azimuthSample = 0.f, elevationSample = -90.f;
sample.Load("...");
Easy3D::E3DMatch match = matcher.Match(sample, azimuthSample, elevationSample);
std::vector<Easy3D::E3DAnomaly> anomalies = match.GetAnomalies();

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

// get cloud to inspect it manually
Easy3D::EPointCloud visualisationCloud;
matcher.GetComparisonPointCloud(visualisationCloud);
```