

Sapera Vision Software

Sapera™ Processing

Easy-to-use, versatile software for Industrial Imaging

As the core development platform within Teledyne DALSA's Sapera Vision Software family, Sapera Processing includes image processing tools to provide developers with the critical functionality to design, develop and deploy high-performance machine vision systems.



Key Features

Performance

- Cost effective packaging for machine vision applications combines powerful image-processing and analysis functions
- Delivers maximum performance using MMX, SSE and SSE2 supports both 32-bit and 64-bit Microsoft Windows® platform
- MCO: based on Intel's latest instruction set technology and supports for multi-core CPUs

Flexibility

- Hardware independence for maximum flexibility
- High-level C++ classes and .NET™ support to simplify application development on Windows® 7, 8 and 10 and platforms

Scalability

- Application specific tools perform Search, 1D/2D/Barcode decoding, OCR, Color, Blob analysis and Measurement 3D
- Modular components help reduce application footprint and deployment costs

¹ Some conditions and limitations apply, contact 1stVision sales for details.

Image Processing and Analysis Libraries

Sapera Processing includes a suite of image processing tools including a highly advanced, yet cost effective, geometric Search package that supports both area and edge-based pattern finding, a versatile Barcode tool for both 1-D and 2-D decoding, Blob Analysis and Calibration tools.

Image Processing Primitives

Sapera Processing provides a series of highly optimized basic image processing functions categorized in several groups including:

Filters

- Generalized convolution 1-D, 2-D
- Low and high-pass filters 1-D, 2-D
- Laplacian
- Gaussian
- Compass: eight-direction edge enhancement
- Gradient: magnitude and phase
- Edge and line detection

Geometry

- Flipping: horizontal, vertical, transpose and 90-degree rotation
- Rotation by an arbitrary angle
- Translation: pan and scroll at integer or sub-pixel precision
- Zooming by image dimensions or scaling factor
- Shearing: horizontal and vertical
- Affine and perspective calibration and warping
- Polar coordinate transform

Measurement

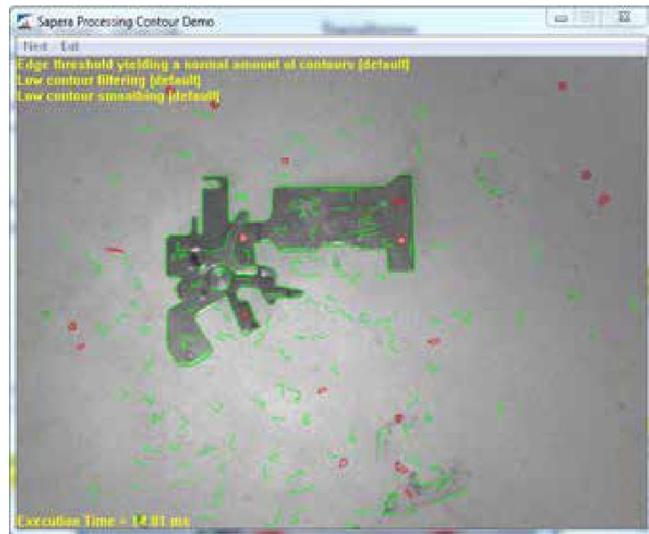
- Basic statistics such as histogram, pixel count, mean, variance, minimum and maximum based on the pixel values of an image
- Horizontal and vertical projections
- Histogram processing: smoothing and peak detection
- Normalized and non-normalized cross-correlation
- Sum-of-difference
- Vector difference
- Variance filter (variance computed on each pixel's neighborhood)
- Pixel sampling on a path (with sub-pixel accuracy)
- Linear and circular regression

Morphology

- Binary dilation, erosion, opening, closing and median on 1 or 8-bit images
- Grayscale dilation, erosion, opening, closing and median on 8 or 16-bit images
- Labeled dilation and erosion
- Outline, skeleton, thinning and thickening filters
- Conditional binary dilation
- Morphological gradient
- Rank filter
- Hit-or-miss transform
- Top-hat transform

Point-to-Point

- Arithmetic operations on one or two images: add, subtract,



- multiply, divide, absolute subtract, minimum, maximum and user-defined expression
- Logical operations on one or two images: AND, OR and XOR
- Fixed and adaptive thresholding
- Gaussian noise generation
- Lookup table transformation
- Contrast equalization manual or histogram-based
- Segmentation
- Distance map
- Directional edge detection
- K-means clustering
- Local peak detection
- Region-growing
- Watershed transform
- Zero-crossing detection

Transforms

- Spectral transforms: FFT (Fourier), DCT (Cosine), DHT (Hadamard)
- Hough transform: direct and reverse

Miscellaneous Features

- Sub-pixel edge crossing on a path
- Contour Following tool
- Frame averaging (true and recursive)

Barcode/Decoding

Sapera Processing offers two different barcode reading algorithms. Quick Barcode is the preferred tool as it allows very high speed reading while being tolerant to noise, occlusion, and geometric distortions.

However, in cases of highly degraded conditions, Standard Barcode might be a good alternative to Quick Barcode. Standard Barcode provides more flexibility in adjusting parameters as well as providing the ability to create golden models for increased robustness.

As part of the barcode tool, Sapera Processing also offers Print Quality Grading. Grading is usually used to verify the quality of 1D and 2D marks.

Quick Barcode

- Fast and robust decoding of most 1D barcode and 2D matrix code symbologies
 - 1D Symbologies: Code 11, 32, 39, 93, 128, 2 of 5 (Interleaved, Matrix, Straight, IATA, NEC Hong Kong), UPC-A/E, EAN-8/13, GS1 Databar, BC412, Pharmacode, Plessey, Telepen, Trioptic, Postal (Postnet, Planet, Intelligent Mail, Royal Mail)
 - 2D symbologies: Data matrix (ECC200), QR Code, Micro QR Code, PDF417, MicroPDF417, Composite (CC-A/B/C), Codablock F, Aztec, Han Xin, MaxiCode
- Quickly and accurately reads printed, stamped, or etched 1D/2D codes
- Reads poorly-printed, low-contrast, noisy, and warped barcodes
- Reliably reads Data Matrix and QR codes with damaged or missing finder patterns
- Decodes multiple barcodes in the same image ROI
- Resolution
 - 1D Codes: Min. distance between bars = 1.5 pixels (2.5 px for low contrast)
Min. bar width = 1.5 pixels (2.5 px for low contrast)
 - 2D Codes: Min. cell size = 2 x 2 pixels
Min. dot diameter = 2 pixels
- Two licensing options:
 - "Quick Barcode" decodes the majority of codes.
 - "Quick Barcode DPM" offers greater robustness for decoding marks etched or dot peened on plastic or metallic surfaces.

Standard Barcode

- Supports 1D and 2D industry standards (includes the majority of standards supported by Quick Barcode)
- High tolerance for noisy and poorly-illuminated images
- Asian native language and unicode output
- Includes Barcode Studio to set up barcode reading via Learning Assistant to help adjust optimal parameters
- Supports model training on Data Matrix for increased robustness handling highly-damaged images
- Two licensing options:
 - "Standard Barcode" supports a wide range of codes and options and does not require training.
 - "Advanced Barcode" offers the ability to train a Data Matrix model for increasing robustness while supporting the same codes and options as "Standard Barcode".

Print Quality Grading

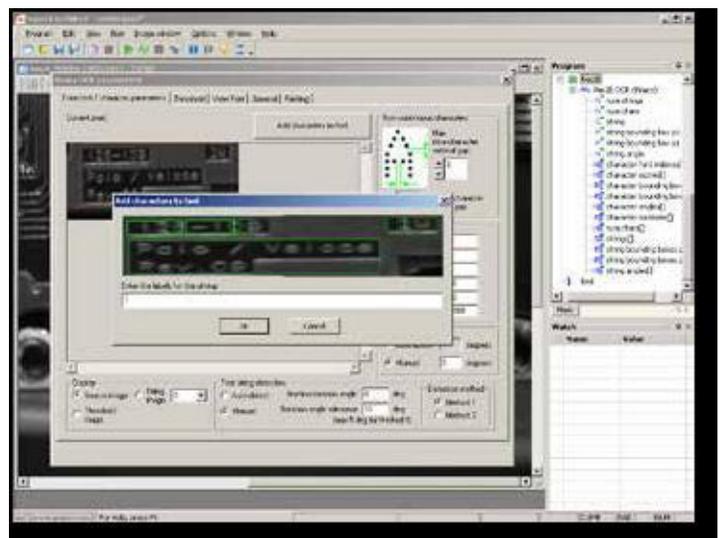
- Use in combination with Quick Barcode or Standard Barcode
- Includes the following standards:
 - ISO/IEC 15416 (Bar code print test specification - linear symbols)
 - ISO/IEC 15415 (Bar code symbol print quality test specification - two-dimensional symbols)
 - ISO/IEC 16022 (Data matrix barcode symbology specification)
 - AIM PDM (Direct Part Mark Quality)
 - AS9132 (Aerospace Standards - Data Matrix Coding Quality)

OCR (Optical Character Recognition)

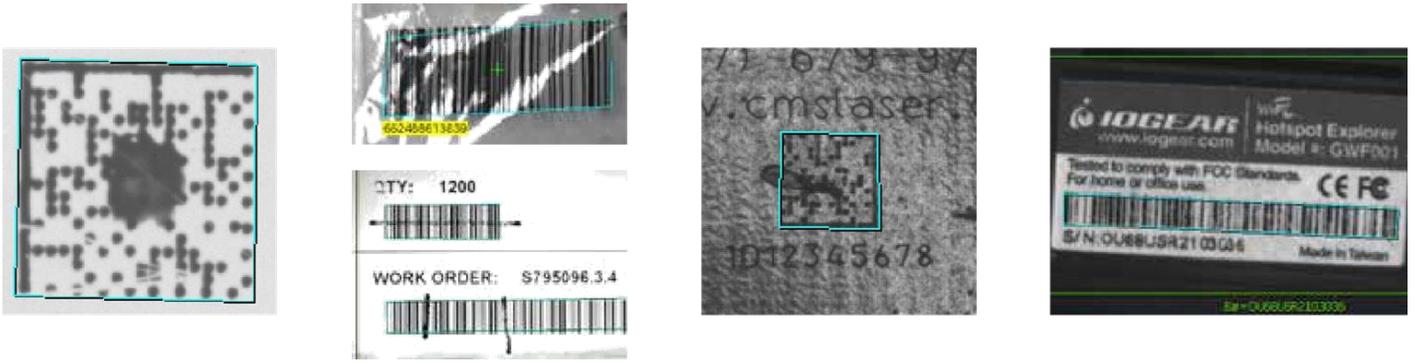
A highly integrated optical character recognition tool that is scale and contrast invariant, the OCR tool supports both solid and dot matrix fonts and can be trained on user fonts. Its robust recognition technique is optimized for speed and accuracy. The ability of the OCR tool to operate on significantly degraded images makes it ideal for repetitive inspection tasks performed in the pharmaceutical, electronics and semiconductor industries.

Features

- User trainable font set
- Supports solid and dot-matrix fonts including italic fonts
- Tolerates non-linear background variations
- Supports training of touching characters
- Two algorithms: binary-based (speed), greyscale-based (tolerant to extreme noise).
- Resolution level adjustment (robustness versus speed)
- Rotation, scale and aspect ratio invariance.
- Multi-string support (reads more than one string of characters in single execution).
- Support of Asian characters (output in Unicode mode).
- Adjustable effort level
- Alphabetical font sorting
- Automatic string detection



Sapera OCR Tool support user trainable fonts



Barcodes (left to right): damaged, warped, damaged, worn, and poor contrast

Search (Pattern Finding Tool)

A crucial performance component of Sapera Processing is a highly advanced Search tool that quickly and accurately recognizes multiple objects and patterns, regardless of orientation and scale. This high-level image analysis tool can locate arbitrary user-specified models in a target image at very high speeds at resolutions of up to 1/50th of a pixel. Designed to work under poor and uneven lighting conditions, the Search tool's fast, robust and accurate algorithms are well suited for demanding alignment applications in semiconductor and electronics manufacturing.

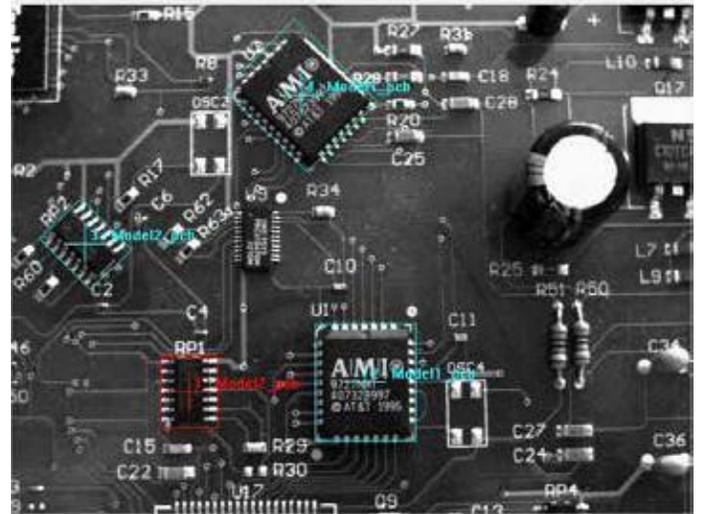
Edge-based Algorithm Features:

- Algorithm based on object contours
- Rotation, scale and contrast independent
- Tolerant to extensive occlusion
- Great for contrast reversal
- Great for overlapping and touching objects
- User-selectable model contours
- Position accuracy up to 1/50th pixel
- Angle accuracy up to 1/80th degree

Area-based Algorithm Features:

- Algorithm based on normalized cross-correlation (NCC)
- Extremely fast when no rotation and scale is involved
- Tolerant to extreme noise
- Position accuracy up to 1/25th pixel

Requirements for Parts Making



Sapera Search Tool supports rotation independent, simultaneous multiple target detection.

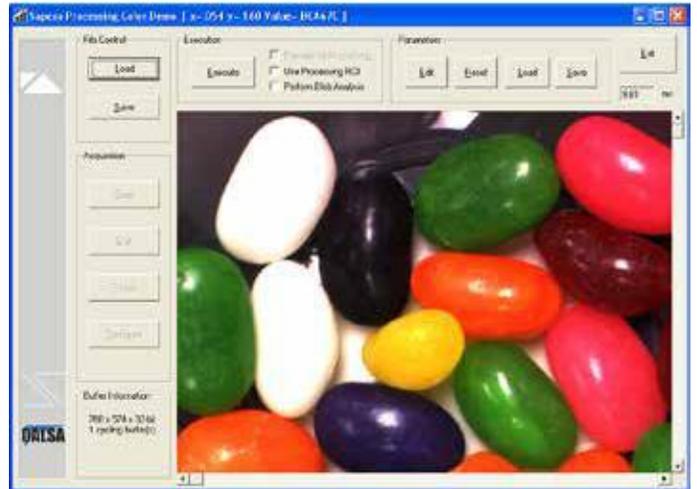
Calibration

Calibration tool provides functions to compensate for geometrical distortions caused by camera lens, camera positioning or any other kind of arbitrary image distortion.

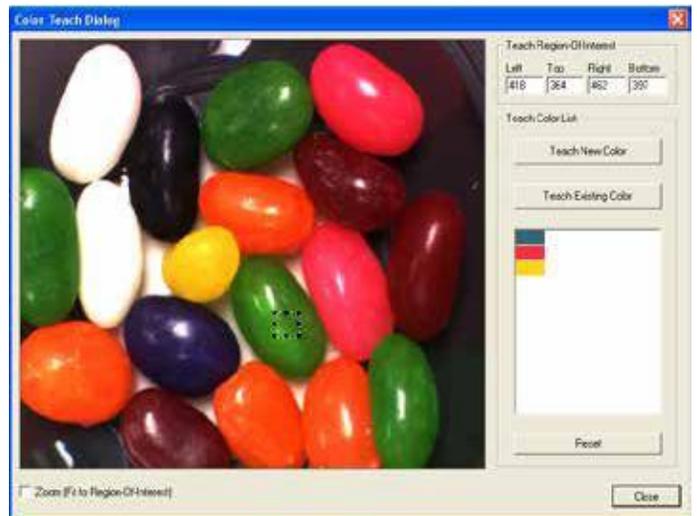
- Correction of perspective, radial (barrel or pin-cushion), combined or arbitrary distortions
- Automated calibration:
- Supported targets: checkerboard, grid of lines or dots, and randomly distributed points
- Fully automated detection of target shading (black/white or white/black), rotation, scaling, grid size and cell spacing
- Optional assisted calibration by specifying approximate target description
- Manual calibration: provide exact image and world grids
- Restoration of full image, single point or vector of points
- Forward (image to world) or reverse (world to image) restoration
- Different restoration modes to adjust speed versus accuracy

Color Tool

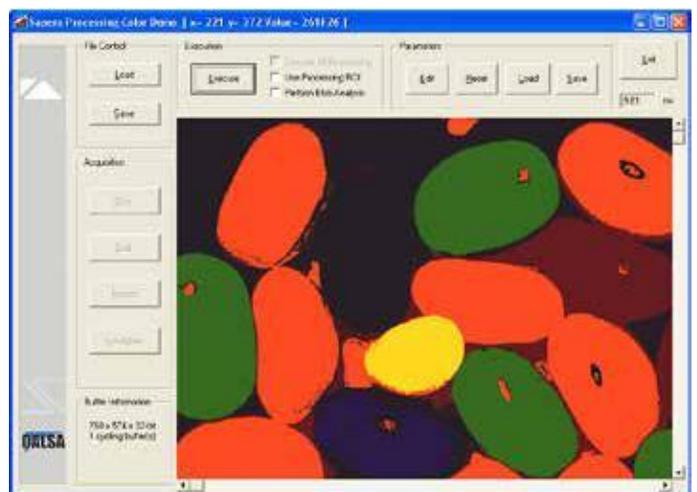
Sapera Processing features an advanced color tool for machine vision that delivers speed, accuracy and flexibility to applications that require color inspection. Ideal for sorting, verification and inspection in food, packaging, print, textile and electronics inspection, this powerful tool supports multiple color spaces such as HSI, CIELAB, RGB, and YUV and can perform color classification in native color space. With built-in support for color calibration, user trainable color classifier, Delat-E measurement and lookup table operations, the Sapera Processing Color tool augments the performance of Sapera Processing image processing and analysis libraries.



Title?



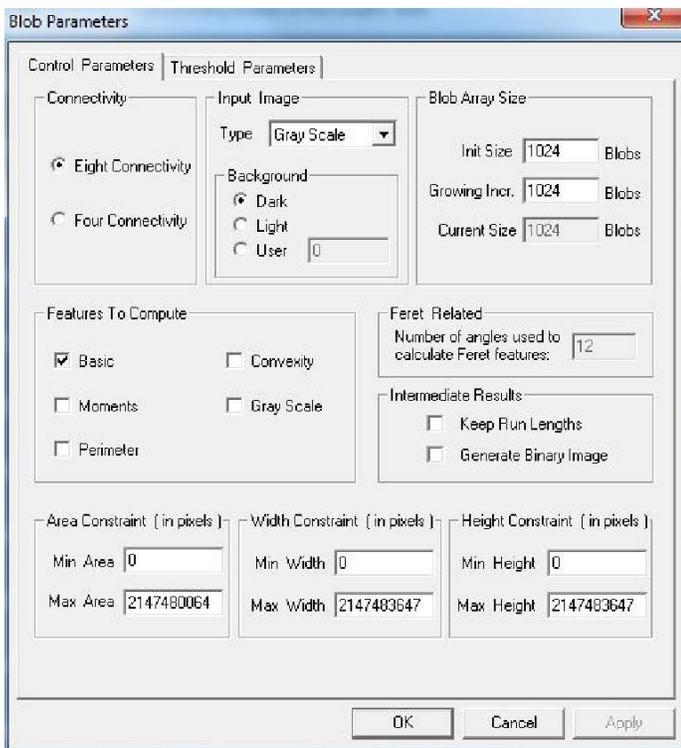
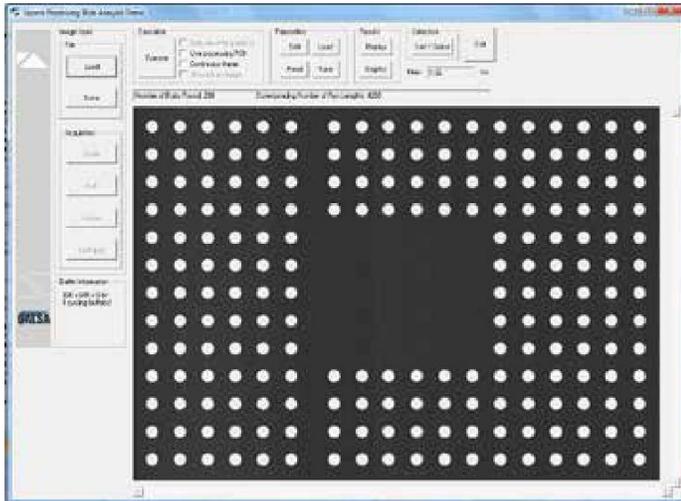
Training



Classification

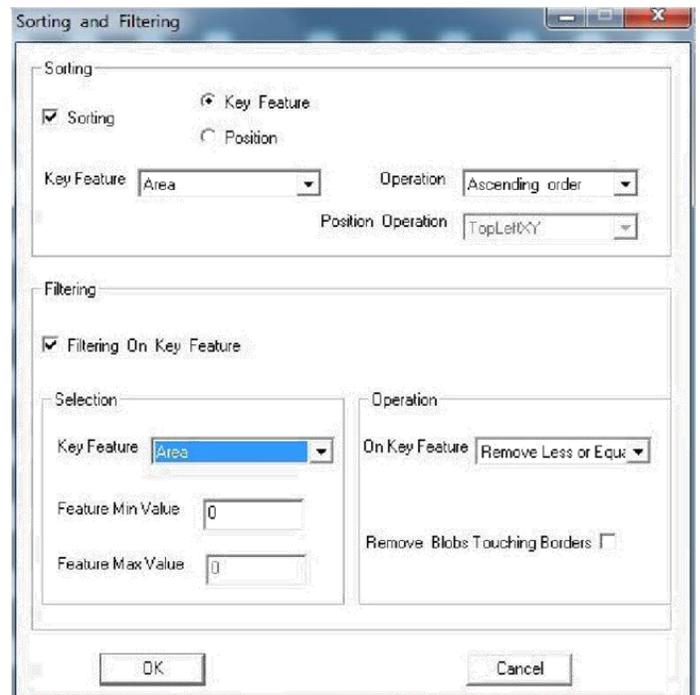
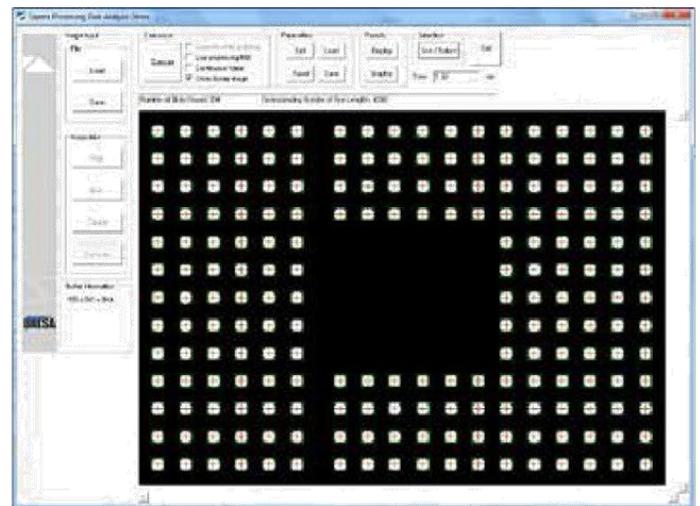
Blob Analysis

Blob analysis allows for the separating (segmenting) of objects in a scene from the background and then computes a series of geometric and grayscale features. Blob analysis is ideal for defect detection in the electronic and semiconductor industries.



Tool features:

- Supports 1-bit, 8-bit, 16-bit, binary or grayscale input
- Supports infinite frame size when using line scan cameras
- Supports hardware accelerated blob analysis operations
- Spatial and grayscale blob features include:
 - Blob centroid, area, and perimeter length
 - Bounding box location and size, number of holes
 - Best-fitting oriented ellipse with axes lengths
 - Blob roundness and elongation
 - Convex area and solidity (ratio of net area to convex area)
 - Feret diameters, bounding box location, size and orientation
 - External and internal perimeter points, filled area
 - Minimum, maximum, standard deviation of all pixels
 - Gray scale centroid
 - Sorting and blob selection based on calculated feature
 - Robust automatic threshold algorithms
 - Optional output of RLE (Run-Length-Encoding) for user-defined feature calculations



Measurement Tool

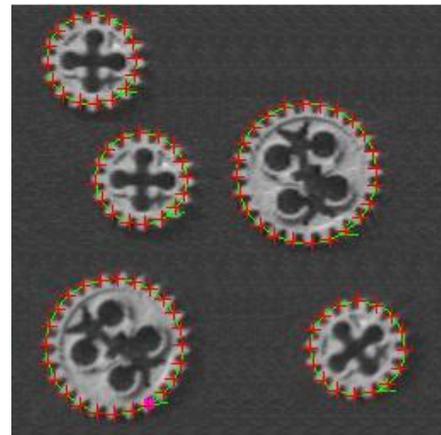
Key Features:

- Highly optimized execution
- Automatic simultaneous multiple measurements
- Sub-pixel Accuracy
- Measurement statistics for distances and angles.
- Built-in calibration tools ensure accurate real-world measurements
- Extensive set of markers include single or multiple points, lines, arcs and circles

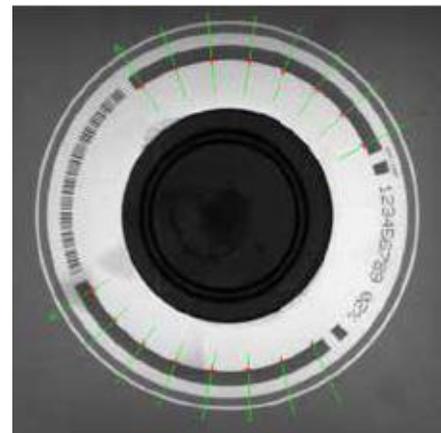
Sapera Processing's Measurement Tool is a video metrology tool for machine vision inspection applications including positioning, identification, and guidance. The measurement tool features a wide selection of image markers to facilitate multiple simultaneous measurements from one or more selected paths including point, line, polyline, arc, circle, spoke, and many more. The highly accurate results are computed with sub-pixel accuracy and can be combined with Sapera Processing's calibration tool to obtain consistent and accurate measurements.

Specifications:

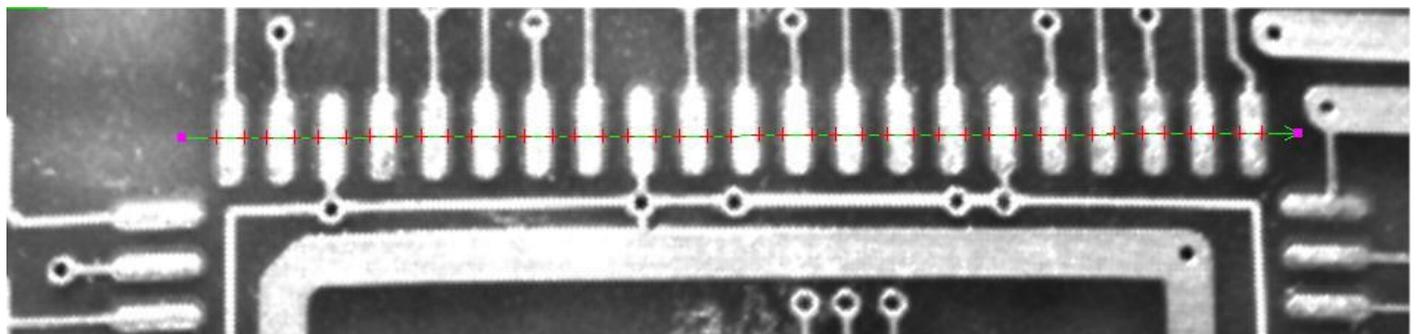
- Image acquisition
 - Supports 8, 10, 12-bit images
 - Supports area and line-scan cameras
- Accuracy
 - Sub-pixel accuracy
 - Corrects for lens, perspective and arbitrary distortion
- Measurements:
 - Distance
 - Radii
 - Diameter
 - Angle
 - Width
 - Intersections
 - Circularity
 - Straightness
 - Markers:
 - Point, Line, Polyline, Arc, Circle, Rake, Spoke, Bullseye



Multiple measurements on circular path



Multiple Measurements using Partial Spoke



Multiple Measurements across a line path

3D Tool

Key Features:

- Supports Z-Trak 3D Laser Profiler (add link to Z-Trak page when available)
- Device-independent 3D classes and functions (adapted to Z-Trak 3D output data)
- Can support third-party Linescan/AreaScan 3D devices via 16-bit data input
- World-unit measurements in 3D tool and other tools such as Blob and EdgeX.
- 3D data storage in TIFF and CRC (proprietary) file formats

3D Processing:

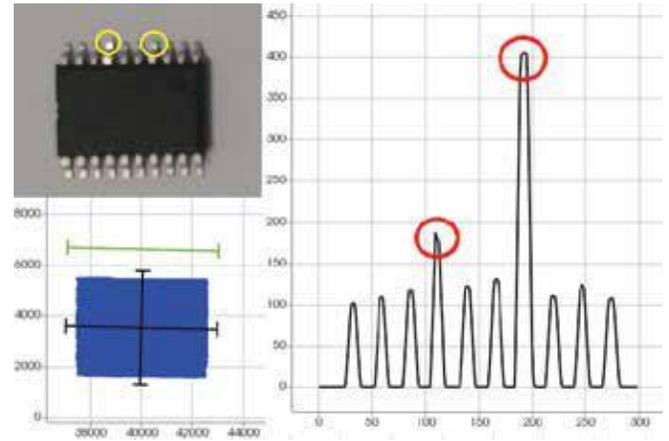
- Special data classes for 3D profiles and 3D range maps
- Adapted processing for invalid points
- Pixel-to-world and world-to-pixel conversions
- Region-based thresholding on profile data and feature computation
- Profile and range statistics and roughness measurement
- Profile un-tilting (correction of camera/floor orthogonality)
- Profile slicing and resampling
- Filtering: gap filling, spike cutting, smoothing, averaging
- Primitive fitting: line, circle, rotated ellipse and arbitrary quadratic
- Projection of profile data on curved model

Non-Rectangular Regions-Of-Interest:

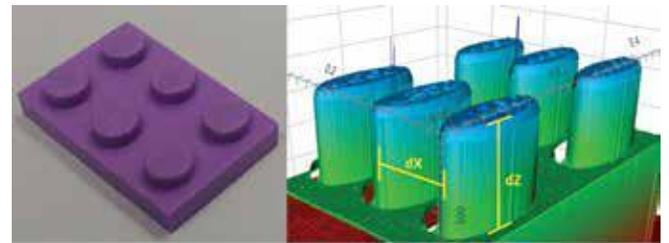
- Circle, Rotated Ellipse, Polygon and Annulus
- Operations between ROIs (union, intersection, etc.) for complex shape creation
- Geometric and Run-Length representation for ease-of-use and efficiency

Demo Programs:

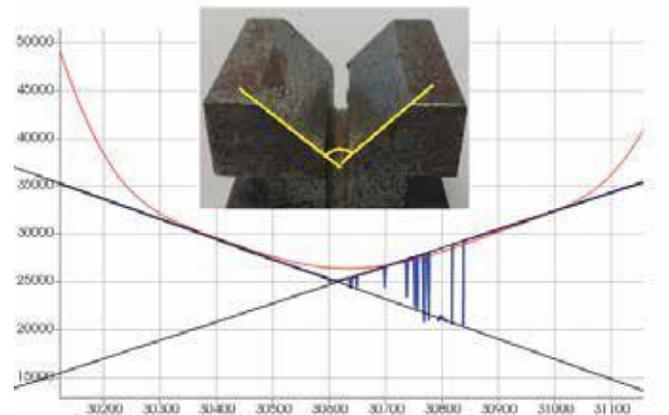
- Acquisition module for direct Z-Trak interface
- Acquisition emulator using file-based data with profile rate simulation
- Large number of small examples showing function-level processing
- Application specific demos illustrating real industrial cases such as v-groove angle measurement, protruded part inspection, height measurement on mechanical part, lead flatness inspection on chip, etc.
- New UI demo framework based on Qt
- New rendering capabilities based on VTK (Visual Toolkit) which uses latest GPU graphics



Chip Lead Flatness Inspection



Dimensional Measurements on Connectors



V-Groove Angle Measurement

■ About Sapera Vision Software

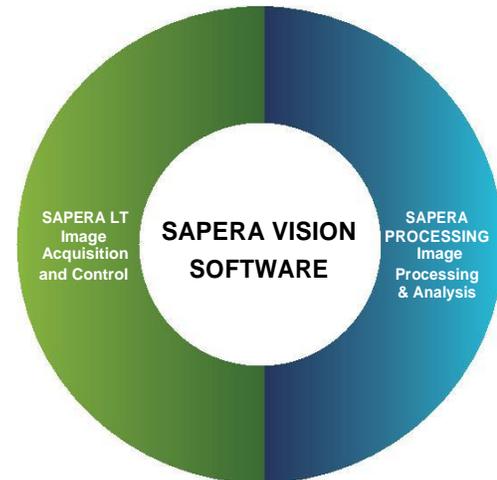
The Teledyne DALSA's field-proven Sapera Vision Software family includes Sapera LT for image acquisition and control and Sapera Processing for image processing and analysis. Both of these packages enable development of high performance machine vision applications.

Image Acquisition and Display

Sapera LT provides the ability to grab images from wide range of area and line scan color and monochrome camera. In addition, it supports image acquisition from standard format cameras like GigE Vision, Camera Link, analog, and LVDS. The acquired images can be displayed with non-destructive overlaid graphical annotations.

Comprehensive Hardware Support

As a value-add platform within the Sapera Vision Software family, Sapera LT supports Teledyne DALSA cameras and frame grabbers as well as hundreds of third party camera models across all common interfaces formats like GigE Vision®, Camera Link®, as well as emerging new image acquisition standards. Sapera Vision Software offers royalty free run-time licenses for select image processing functions when combined with Teledyne DALSA hardware products.



Multi-Processing/Multi-Threading Compliant Multi-processing and multi-threading capability improves application performance and productivity, while making efficient use of available CPU time and system resources by executing multiple routines concurrently. Often developers are burdened with the delicate and time-consuming task of thread management when sharing a common set of data.

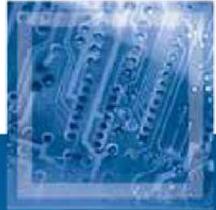
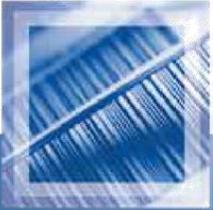
System Requirements

- P4 or higher class CPU
- Microsoft Windows 7, 8 and 10, Professional or 32-bit/64 bit
- Minimum 64MB of system memory, 100MB of free hard drive space
- Microsoft Visual Studio 2012 or higher, or Borland C++ Builder XE3 or higher

Multi-Core Optimized (MCO) Image Processing Primitives:

<p>Filters</p> <ul style="list-style-type: none"> • Generalized convolution 1-D, 2-D • Low and high-pass filters 1-D, 2-D • Laplacian • Gaussian • Compass: eight-direction edge enhancement • Gradient: magnitude and phase • Edge and line detection 	<p>Geometry</p> <ul style="list-style-type: none"> • Flipping: horizontal, vertical, transpose and 90-degree rotation • Rotation by an arbitrary angle • Translation: pan and scroll at integer or sub-pixel precision • Zooming by image dimensions or scaling factor • Shearing: horizontal and vertical • Affine and perspective calibration and warping • Polar coordinate transform 	<p>Measurement</p> <ul style="list-style-type: none"> • Basic statistics such as histogram, pixel count, mean, variance, minimum and maximum based on the pixel values of an image • Horizontal and vertical projections • Histogram processing: smoothing and peak detection • Normalized and non-normalized cross-correlation • Sum-of-difference • Vector difference • Variance filter (variance computed on each pixel's neighborhood) • Pixel sampling on a path (with sub-pixel accuracy) • Linear and circular regression
<p>Morphology</p> <ul style="list-style-type: none"> • Binary dilation, erosion, opening, closing and median on 1 or 8-bit images • Grayscale dilation, erosion, opening, closing and median on 8 or 16-bit images • Labeled dilation and erosion • Outline, skeleton, thinning and thickening filters • Morphological gradient • Rank filter • Hit-or-miss transform • Top-hat transform 	<p>Point-to-Point</p> <ul style="list-style-type: none"> • Arithmetic operations on one or two images: add, subtract, multiply, divide, absolute subtract, minimum, maximum and user-defined expression • Logical operations on one or two images: AND, OR and XOR • Fixed and adaptive global thresholding • Gaussian noise generation • Lookup table transformation • Contrast equalization manual or histogram-based • Distance map • Directional edge detection • K-means clustering • Local peak detection • Watershed transform • Spectral transforms: FFT (Fourier), DCT (Cosine), DHT (Hadamard) • Hough transform: direct and reverse 	<p>Additional Features</p> <ul style="list-style-type: none"> • Contour Following tool • Frame Averaging (true and recursive) • Search Tool – Area-Based Search • OCR Tool – Binary OCR • Color Tool – Color correction and Calibration

Harness the Power of MCO Sapera Processing provides seamless support for multi-core CPUs optimization (MCO). Existing Sapera applications can run Sapera without modification; immediately leveraging faster program execution. Sapera Processing offers flexible controls to harness the full power of multi-core CPUs for complex applications, and comes bundled with several demos and source code examples to delineate optimum coding practices. The MCO is based on Intel's latest instruction set technology and supports for AMD and Intel CPUs.*



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