HALCON

- robust
- fast
- accurate
- flexible
- comprehensive

the Power of Machine Vision

MVTec Software GmbH

Building Vision for Business

HALCON

Professional Software
for all Machine Vision Applications

Used in many industry sectors

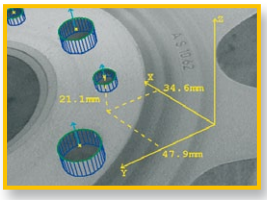
Aerospace and space travel
Agriculture, food
Automobile parts and manufacturers
Ceramics
Chemicals
Electric components and equipment
Glass production and processing
Government and military
Health care and life science
Iron, steel and metal
Machinery
Medical supplies
Mining
Packaging
Paper products
Pharmaceutical
Photogrammetry and remote sensing
Precision engineering and optics
Printing
Railroads and trains
Retail
Rubber, synthetic material, foil
Semiconductors
Shipbuilding
Solar, renewable energy, recycling
Surveillance and security
Telecommunication
Transport, logistics, trade
Wood and timber

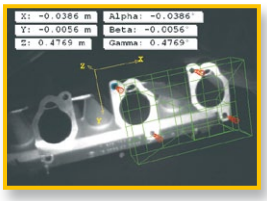
Food, Health Care & Life Sciences

Surface and print inspection, fill level measurement, packaging inspection, OCR, bar code, and data code reading: HALCON features robust and reliable solutions for all applications.

Automotive & Robotics

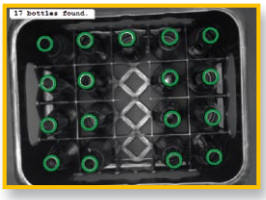
Determine the 3D pose of objects based on a CAD model, extract 3D data for bin picking and robot path planning: HALCON's unique 3D vision techniques open new possibilities for numerous automotive and robotics applications.





Packaging

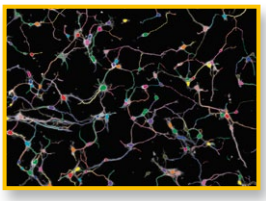
Quality control, completeness inspection, identification – HALCON offers outstanding methods in all areas of packaging.



Medical Image Analysis

CT, MR, X-ray – no matter what source and resolution: HALCON processes 8/16/32 bit integer and float images.

Angiogenesis: Testing the growth of new blood vessels.



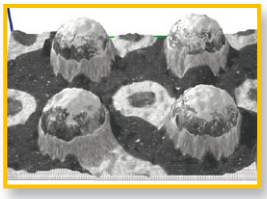
Axons: Finding cell nuclei with HALCON.

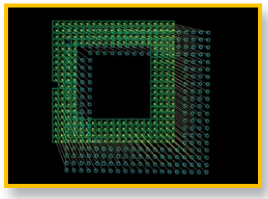
Machine Vision & Industrial Inspection

HALCON offers speed, accuracy, and robustness for a wide variety of applications such as quality inspection, robot vision, and material flow control.

Board, Wafer & Die Inspection

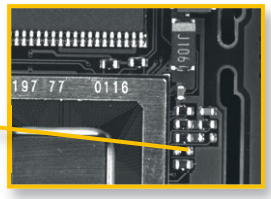
PCB, BGA, AOI/AXI, ball-wedge and wire bonding machines: HALCON recognizes defects with an accuracy better than 1µm.





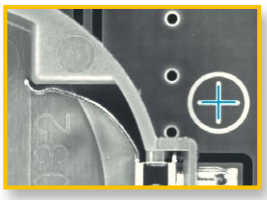
Completeness Inspection

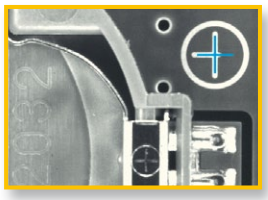
Insufficient soldering paste, missing diodes, rotated components: HALCON detects all incomplete or incorrectly positioned parts within milliseconds.



Positioning & Alignment

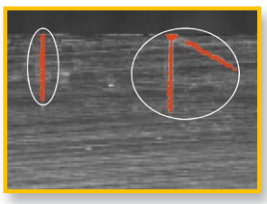
Board alignment, fiducial localization: HALCON reliably finds objects with an accuracy better than 1/20 pixel also if they are partially occluded.





Surface Inspection

Different materials, different error classes like holes, wrinkles, edge cracks, inclusions, contaminants, coating voids, scratches, spots, and dents: HALCON's advanced filtering techniques are tailored to your needs.



Photometric stereo is used to detect a hole in a blister.

Quality Assurance

Quality assurance of bar codes and data codes: HALCON rates in compliance with the standards ISO/IEC 15415, ISO/IEC 15416, and AIM DPM-1-2006. HALCON secures the quality of your codes.

Print quality inspection of bar codes for ISO/IEC 15416.

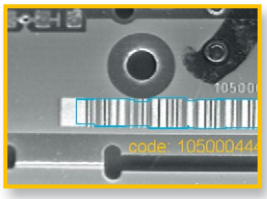
Print quality inspection of data codes for AIM DPM-1-2006.

Print Inspection

Labels and forms printed on paper, plastic, or metal by any kind of printer: HALCON automatically compares trained patterns with your prints.

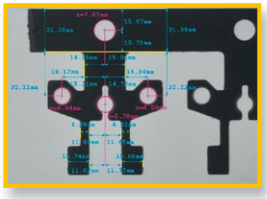
Identification

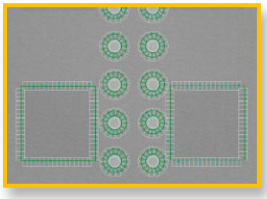
Identify and read bar codes, data codes and perform OCR: HALCON reads a single character in < 0.1 ms.



Measuring

HALCON's superior edge detection and contour analysis techniques, in combination with powerful 3D camera calibration, extends measurement accuracy to the entire field of view.





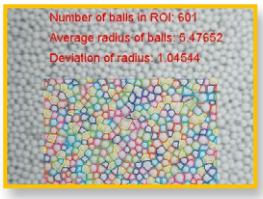
HALCON

Leading-Edge Techniques
and Optimal Performance

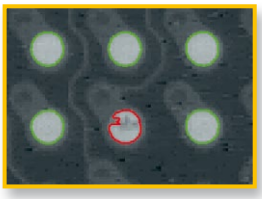
Included methods
1D measuring
3D matching
3D object processing
3D primitives fitting
Alignment
Bar code
Blob analysis
Camera calibration
Classification
Color processing
Contour processing
Data code
Depth from focus
Edge extraction
Feature extraction
FFT
Filtering
Geometric measurements
GPU acceleration
Hand-eye calibration
Hough transformation
Image acquisition
Laser triangulation
Matching
Morphology
Mosaicking
Movement detection
OCR
OCV
Parallelization
Photometric stereo
Point extraction
Pose estimation
Radiometric calibration
Rectification
Region processing
Sample-based identification
Segmentation
Stereo
Texture analysis
Variation model
Visualization

Blob Analysis

Hysteresis, local, binary, and standard thresholding, plus more than 20 additional segmentation operators; area, orientation, and 50 more shape and gray value features: HALCON performs blob analysis within milliseconds.

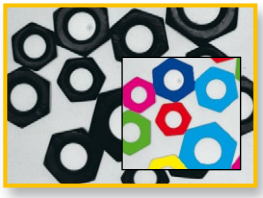


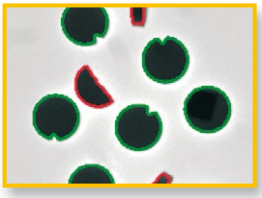
Processing of partially overlapping blobs.


Extract blobs with subpixel accuracy.

Morphology

Erosion, dilation, opening, and closing with arbitrary structuring elements: HALCON excels with the fastest and most comprehensive implementation of morphological algorithms.


Distinguish touching objects.


Detect contour defects.

Bar Code & Data Code Reading

All common bar codes can be read in any orientation even with an element width of only 1.5 pixels. HALCON also reads ECC 200, QR, Micro QR, Aztec, and PDF417 codes of any size with modules even smaller than 2x2 pixels, as well as data codes with a distorted finder pattern.


PDF417 code


GS1 DataBar

OCR & OCV

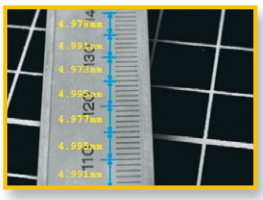
Train, classify, or verify your font using HALCON's powerful classifiers. Many pre-trained fonts from different application areas lead to highest recognition rates "out of the box", such as 0.65% error rate on the MNIST data set.


Read dot prints on complex background.

HALCON provides a syntactic and lexicon-based autocorrection.

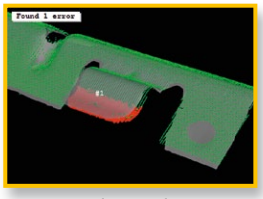
3D Vision

3D Calibration
A small set of internal and external camera parameters map the image coordinates to real world coordinates permitting, for example, subpixel-accurate measurements up to 1 µm in a field of view of 10 mm – also with line scan cameras. HALCON's hand-eye calibration is crucial for robotic applications.


Distances on the calliper can be measured in the presence of perspective distortions.


Hand-eye calibration enables robotic grasping applications.

3D Object Processing
Using HALCON's 3D object model, 3D registration, 3D object processing as well as 3D object recognition and surface comparison can be performed.



Errors are detected using 3D surface inspection.

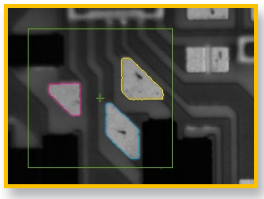
A 3D object model is segmented into connected components.

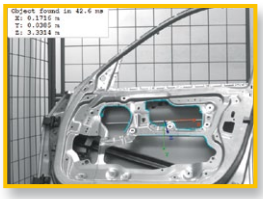
Matching

Correlation-based Matching
HALCON's gray-value-based matching offers different methods, e.g., correlation-based matching. This method is particularly robust against defocus, shape deformation, and texture.

Shape-based Matching
HALCON's superior subpixel-accurate matching technology finds objects robustly and accurately in real-time, even if they are rotated, scaled, perspectively distorted, locally deformed, partially occluded or located outside of the image, or undergo non-linear illumination changes. It can process images with 8 or 16 bits and also handles color or multi-channel images. Objects can be trained from images or from CAD-like data. Moreover, HALCON's unique component-based matching is able to locate objects that are composed of multiple parts that can move with respect to each other.

Descriptor-based Matching
Planar objects with texture are localized with HALCON's descriptor-based matching. This method is extremely fast and localizes the objects in any rotation and tilt.





HALCON's perspective deformable matching robustly localizes objects with perspective distortions.

HALCON's descriptor-based matching locates planar objects extremely fast.

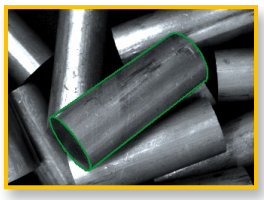
HALCON's local deformable matching finds objects with surface deformations.

HALCON's component-based matching finds compound objects fast and reliably in one step.

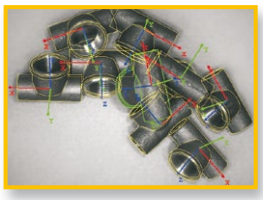
3D Matching

Shape-based 3D Matching
Recognition and 3D pose determination of arbitrary 3D objects: HALCON's cutting-edge 3D matching determines the position and orientation of 3D objects represented by their CAD model.

Surface-based 3D Matching
As an alternative to the shape-based 3D matching, HALCON's surface-based 3D matching is optimized to also find objects with arbitrarily shaped surfaces in distance images.



3D matching in combination with binocular stereo.



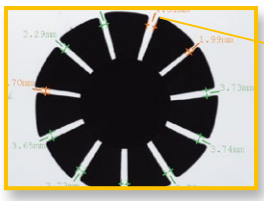
Surface-based 3D matching with multi-view stereo.

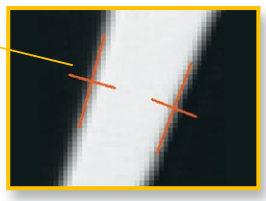
Measuring

1D Measuring
Measure edges along lines or arc segments: HALCON's powerful algorithms perform subpixel-accurate measurements in less than a millisecond. In combination with gray-value calibration even non-linear gray-value responses can be compensated to achieve highest accuracy.

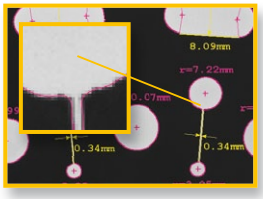
2D Measuring
Fitting an ellipse to a subpixel contour output of an edge filter allows you to achieve highest precision. HALCON's advanced algorithms extract contour data from images with more than one channel, e.g., from color images.

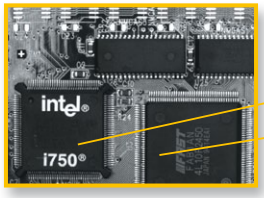
3D Measuring
HALCON's outstanding algorithms reconstruct the disparity or distance images or 3D coordinates of surfaces with many different methods: binocular, multi-view and photometric stereo, sheet of light, and depth from focus. You can also determine the 3D pose of circles and rectangles easily with only one camera. The segmentation and fitting of 3D primitives allows accurate measurement of, e.g., cylinders and spheres.

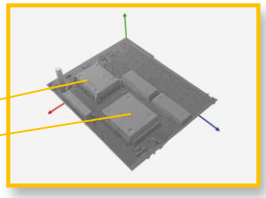


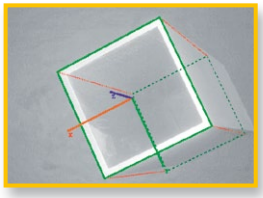


Inspect the distances between the blades of a fan.









HALCON

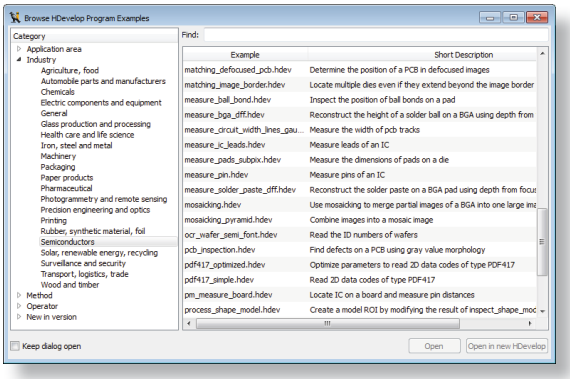
More than **Software**

Extensive Support and Training

- Free application evaluation, also prior to purchase
- Free worldwide support for HALCON users by MVTec's distributors
- Free upgrade to new versions within the first year after purchase
- Worldwide trainings, also individually tailored to the customer's needs
- Easy maintenance by free web download of newest software releases

Comprehensive Documentation and Fast Development

- Documentation for every user and level – ranging from the "Quick Guide" to the "Solution Guide"
- Numerous example programs for every application area
- Easy-to-use browser for example programs
- Integrated Development Environment (IDE) for machine vision



Examples Browser

Reliability

HALCON is proven worldwide in tens of thousands of applications. The sophisticated algorithms are developed by MVTec's engineers, who have more than 25 years experience in machine vision. HALCON is concentrated core competence – developed by the only software manufacturer worldwide purely developing software for machine vision.

Speed

HALCON is implemented for highest performance, e.g., by actively exploiting multi-core computers, SSE2 and AVX, as well as GPU acceleration.

Protection of Investment

Compatibility is an important key for protection of investment. The machine vision software in which you invest today, must still be suitable tomorrow – wherever the advances in technology lead us and however the requirements of individual systems will change. In order to meet all needs, HALCON supports a great amount of image acquisition devices as well as a large variety of operating systems and programming languages.

HALCON naturally provides maintenance and availability of a version for years, also after purchase. Every new HALCON version is released with many technical innovations as well as improvements and enhancements in all areas – including, of course, also documentation and examples.

Shape-based matching (template size: 100 x 100, search area: complete image with 360° rotation)	0.875 ms
Affine transformation (nearest neighbor)	0.157 ms
Sobel edge filter (3 x 3)	0.089 ms
Median (3 x 3)	0.111 ms
Binomial filter (5 x 5)	0.078 ms
Gray opening (3 x 3)	0.075 ms
Binary dilation (50 x 50)	0.055 ms
Binary erosion (50 x 50)	0.014 ms
Threshold operation	0.061 ms
Subpixel-accurate threshold	0.257 ms
Feature calculation for 350 objects (blobs) (features: "center of gravity" & "number of pixels")	0.022 ms
Subpixel-accurate measuring of edge positions (search size 50 x 10)	0.004 ms
Fast Fourier transform	1.198 ms

The above runtime examples were measured using a byte image of size 640 x 480 on an Intel Core i7-2600K - 3.40 GHz computer using at most 4 threads. Note: runtime may vary with different input data.

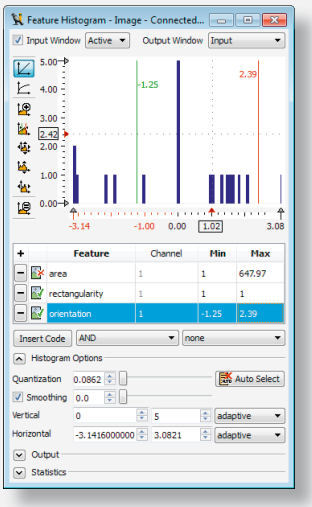
HALCON

HDevelop Integrated Development Environment (IDE)

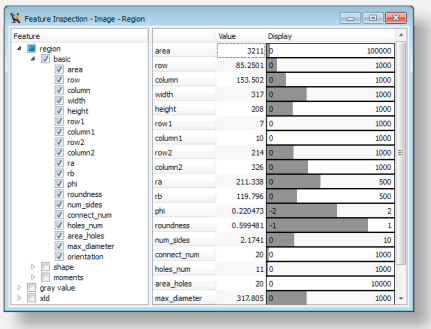
About HDevelop

HDevelop is HALCON's highly interactive programming environment. Running on Windows, Linux, and Mac OS X, it enables you to develop image processing solutions fast and efficiently. This can be done even while acquiring images from a capture device. There is a multitude of graphical tools for data and image inspection. The HDevelop GUI is available in various languages.

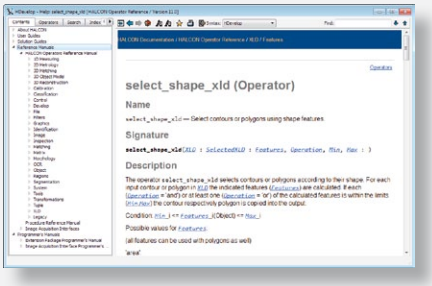
- The HDevelop dialog "Browse Examples" lets you select examples via topics and categories. No matter in which industry you are engaged, you will find appropriate examples out of more than 1000 with three mouse clicks.
- Programming becomes very easy: syntax checks, syntax highlighting, suggested values for parameters of operators, suggested successors and alternative operators, debugging the program, full text and dialog-based editor, integrated online help, which offers full-text search, and more.
- HDevelop enables easy code sharing between developers: code can be organized into procedures, which also can be stored as password-protected external procedures and organized in procedure libraries.
- HDevelop includes tools for real-time interactive inspection of image properties to obtain parameter settings for your program: gray histogram, feature histogram, line profile, zooming, and feature inspection. Further HDevelop tools allow to manage ROIs, breakpoints, error messages, bookmarks, and procedures.
- Get immediate feedback on the execution of an operator and let HDevelop visualize iconic variables, e. g., as 3D plots or contour lines.
  The HDevelop profiler tool helps analyzing each operator's execution time.
- Thanks to the long experience HALCON is based on, HDevelop is tailored to the needs of machine vision applications and provides a GUI that is optimized for usability.



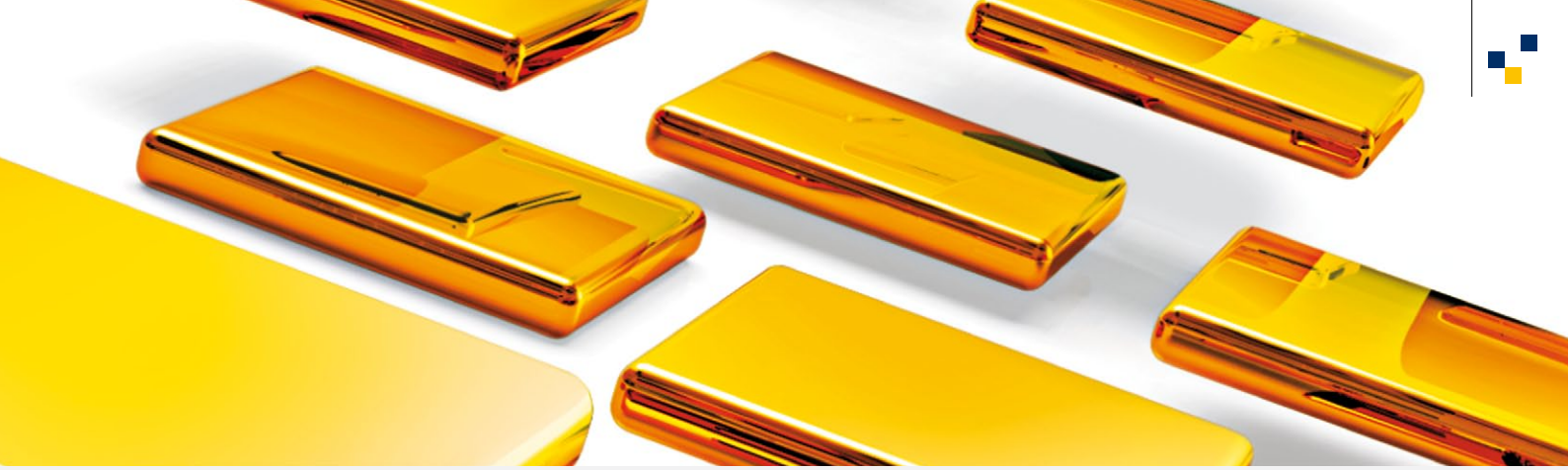
Feature Histogram



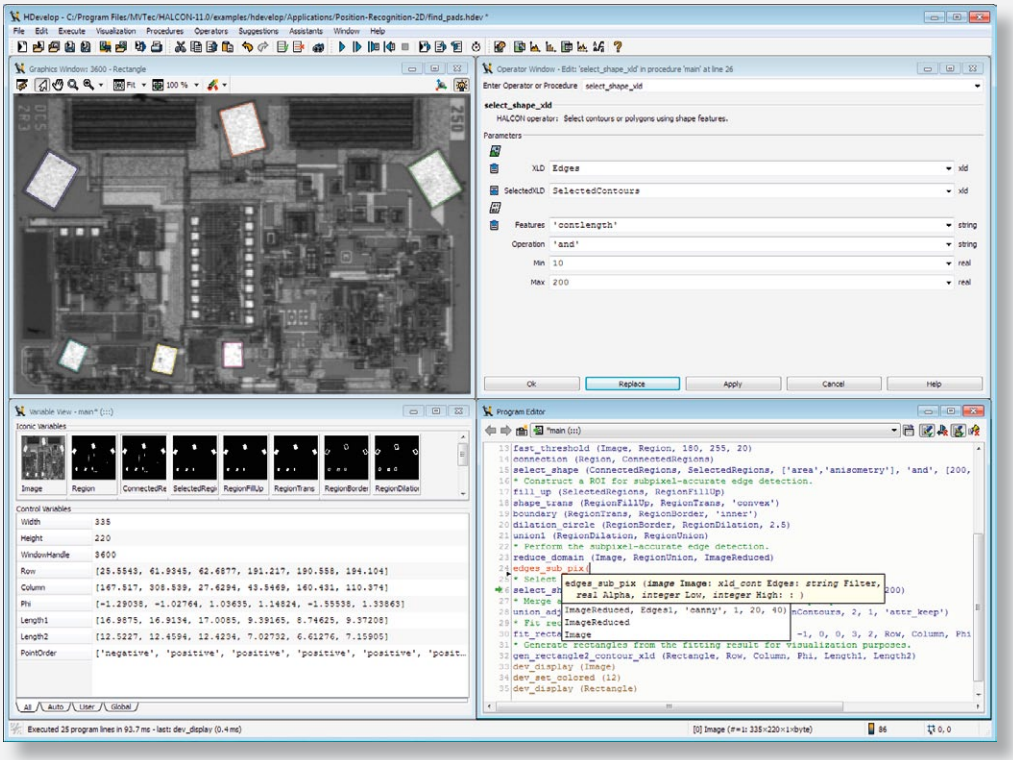
Feature Inspection



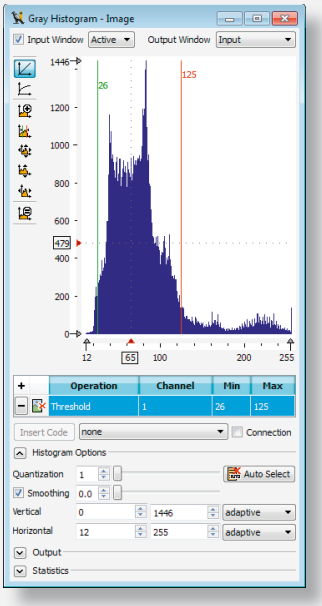
Online Help



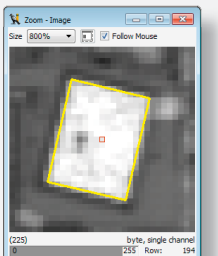
The software engineer has the choice between programming based on dialogs, with help of a full text editor, or in a combination of both. Editing assistance and the ability to copy and paste lines, as well as advanced autocompletion provide easy-to-use help for programming in the full text editor.



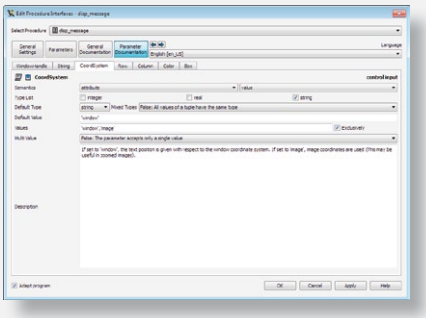
HDevelop



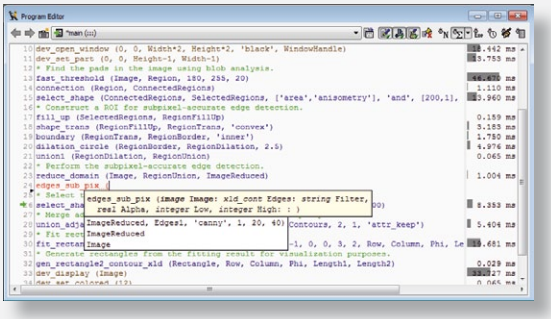
Gray Histogram



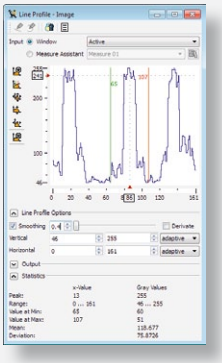
Zoom



Edit Procedure



Profiler Tool



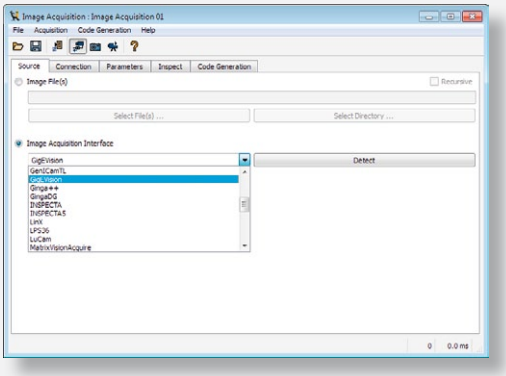
Line Profile

HALCON

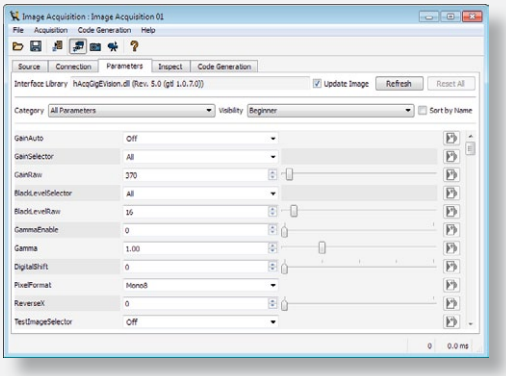
Working with **HDevelop**

Image Acquisition Assistant

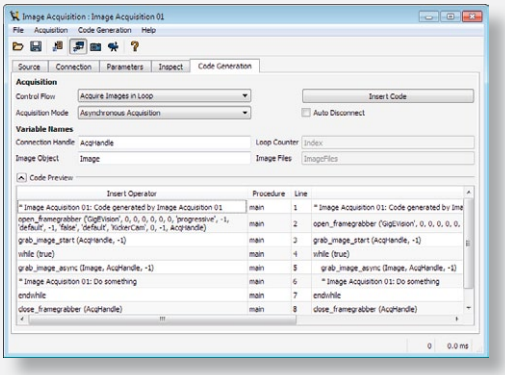
The image acquisition assistant simplifies the selection, initialization, and configuration of your image acquisition device. It allows to preview images and to interactively control all device-specific parameters. After adapting the parameters to your needs, the assistant inserts the corresponding code on demand into your program.



Device Selection



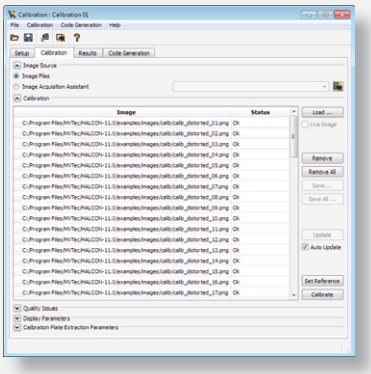
Device Configuration



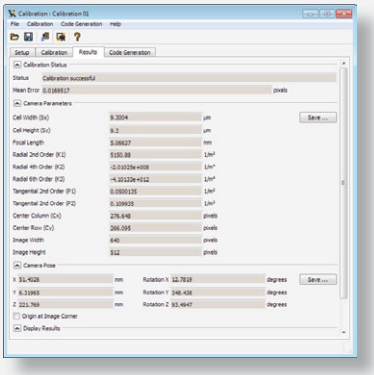
Code Generation

Camera Calibration Assistant

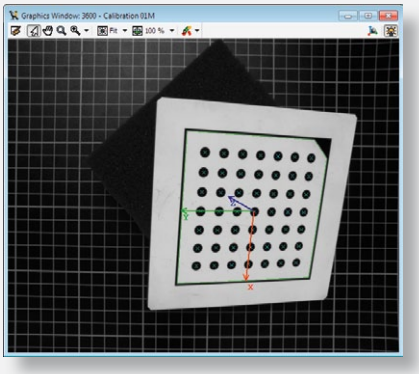
The camera calibration assistant helps the user to implement the necessary calibration of the camera easily and accurately in order to correct lens distortions from images and to be able to measure objects in 3D world coordinates. After setting the parameters, the assistant inserts the suitable program code on demand into the HDevelop program.



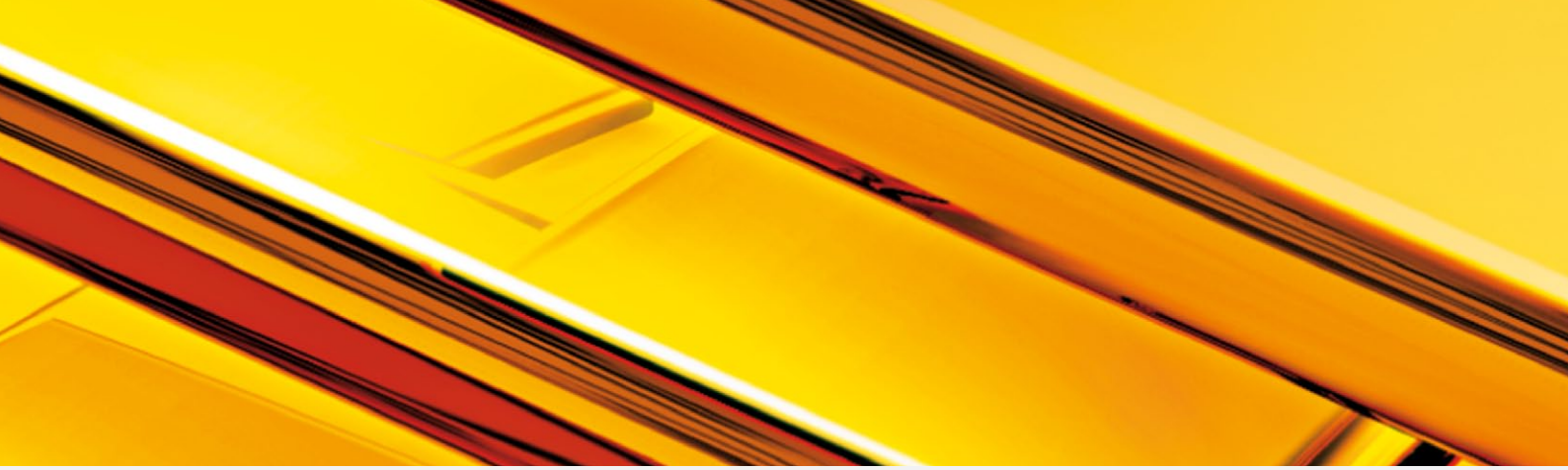
Calibration



Calibration Results

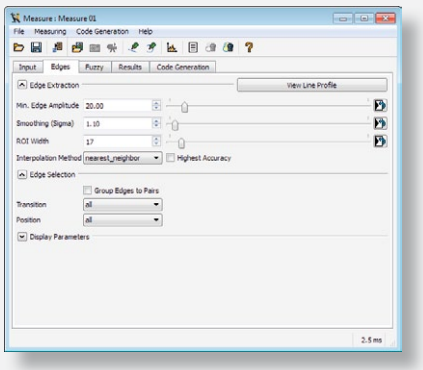


Visualization

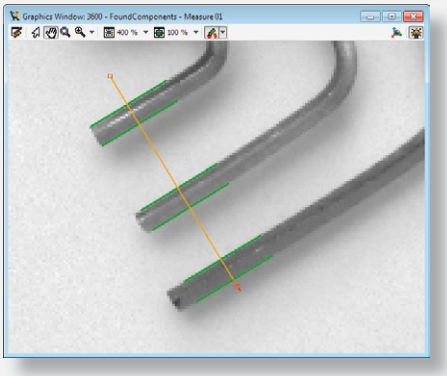


Measure Assistant

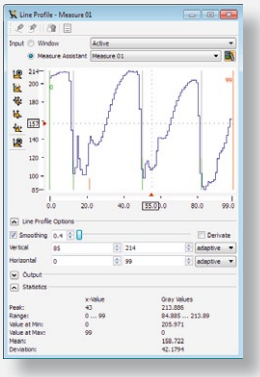
The HDevelop measure assistant is a front-end to HALCON's 1D measuring. It finds edges and measures distances between edges along a preselected line in an image. On demand, the assistant inserts the corresponding code into the program.



Configuration



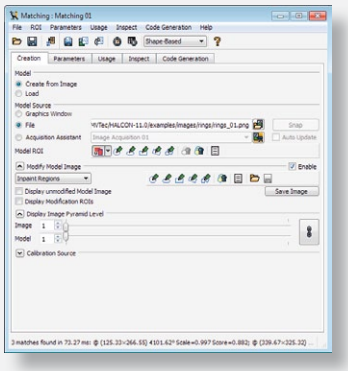
Visualization



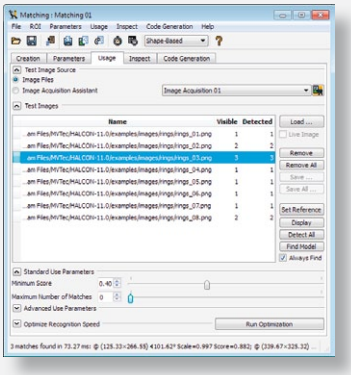
Line Profile

Matching Assistant

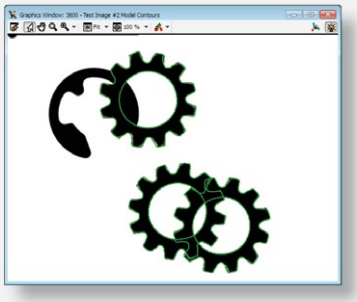
The matching assistant is a powerful tool specifically designed for the interactive use of HALCON's shape-based matching, correlation-based matching, descriptor-based matching, and deformable matching. It assists you in finding parameter settings for your object recognition and matching applications, and inserts the suitable code on demand into the program.



Model Creation



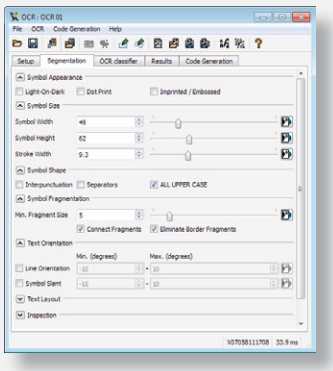
Model Use



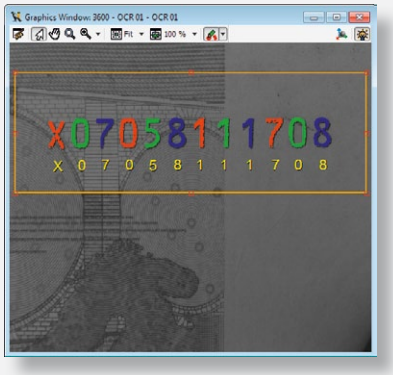
Visualization

OCR Assistant

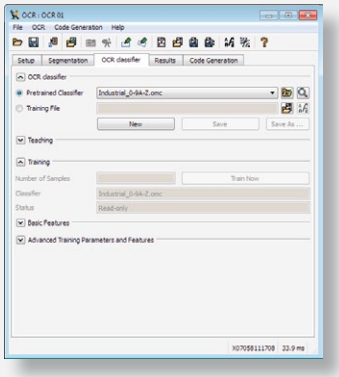
The HDevelop OCR assistant allows interactive use of HALCON's powerful OCR classification. It helps you to determine parameter settings, train custom OCR classifiers, verify your OCR classifier and inserts the corresponding code on demand into your program.



Segmentation



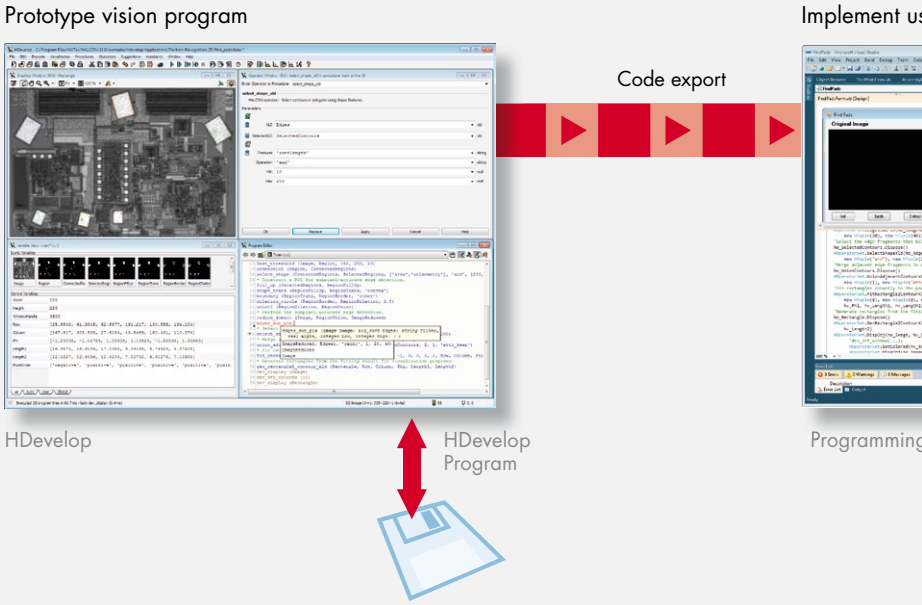
Visualization



OCR Classifier

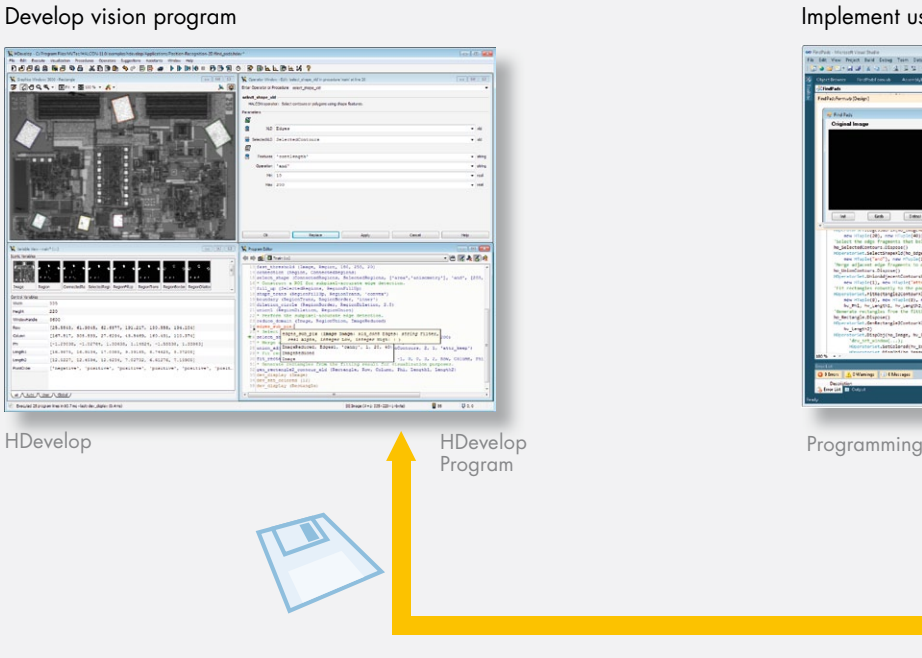
HDevelop – the "traditional way"

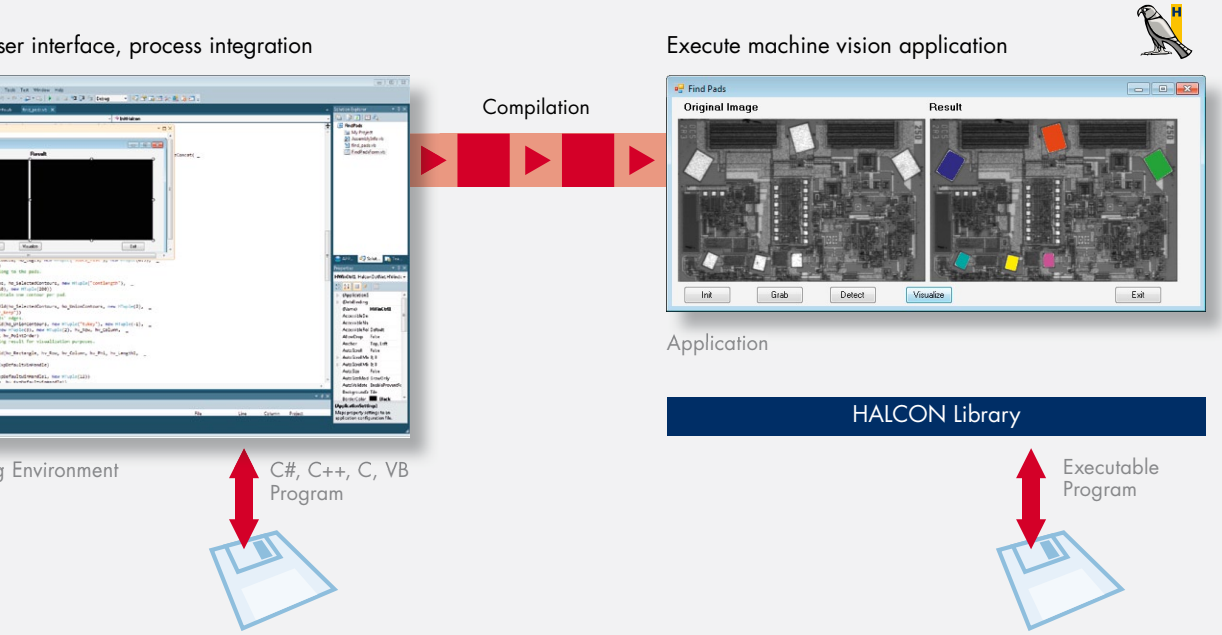
Programming with HDevelop allows rapid prototyping of the machine vision program. As soon as you are satisfied with your program code, HDevelop exports it as C++, C, C#, or Visual Basic source code, which can be easily integrated into your application.

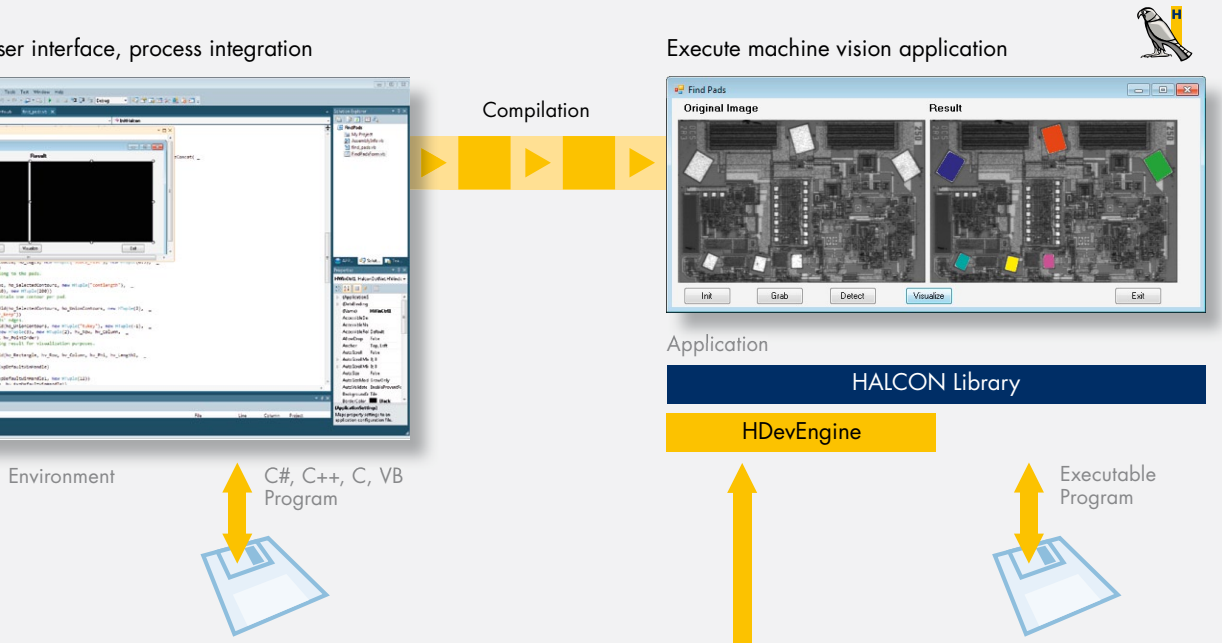


HDevelop & HDevEngine – the "smart way"

HDevEngine – the "HDevelop Engine" – is a library that acts as an interpreter and lets you directly load and execute HDevelop programs and procedures from within your C++, C#, or Visual Basic application. This allows you to change the vision part of your application without the need of compiling it again.







adapt code parts of application program

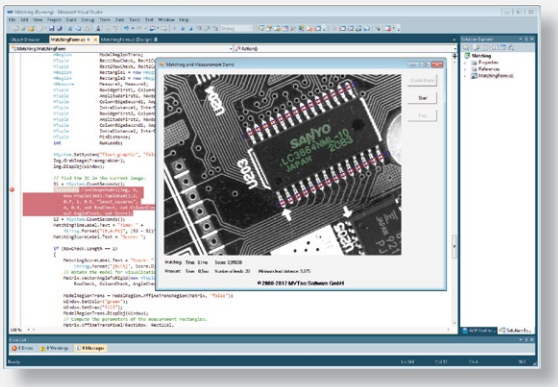
HALCON

Programming
with HALCON

HALCON offers various language interfaces, such as a C++ and a native .NET interface. Using these interfaces you can access all of HALCON's more than 1800 powerful operators from programming languages like C, C++, C#, Visual Basic, or Delphi. HALCON's open architecture allows you to access defined data structures and thus to integrate it with further software components such as a user interface or process control. HALCON's inbuilt high-performance memory management lets you concentrate on your application development.

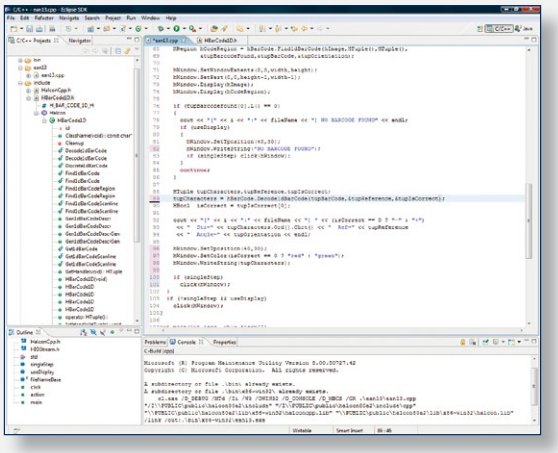
HALCON/.NET

In HALCON/.NET all HALCON operators and data structures are available as high-level classes, greatly simplifying the development of your application. HALCON/.NET can be used in .NET languages like C#, Visual Basic .NET, and C++. It can be used on Windows and with Mono also on Linux.



HALCON/C++

With HALCON/C++ you can access the whole functionality of HALCON based on a C++ class hierarchy. This enables you to develop programs that are very compact and easy to maintain. HALCON/C++ is available on Windows, Linux, and Mac OS X.



HALCON Codelets

Source code modules and classes – HALCON codelets – are used outside the development environment HDevelop. Many of these modules as well as corresponding example applications are available as source code and can be used as templates for new applications or directly called within newly developed code.

Protection of Know-how

HALCON secures the know-how of the software developer: code, which is saved in external or local procedures, as well as code of entire procedure libraries or programs can be secured with a password. Therefore, functionality can be shared without revealing the program code.

Multi-core and GPU
Performance

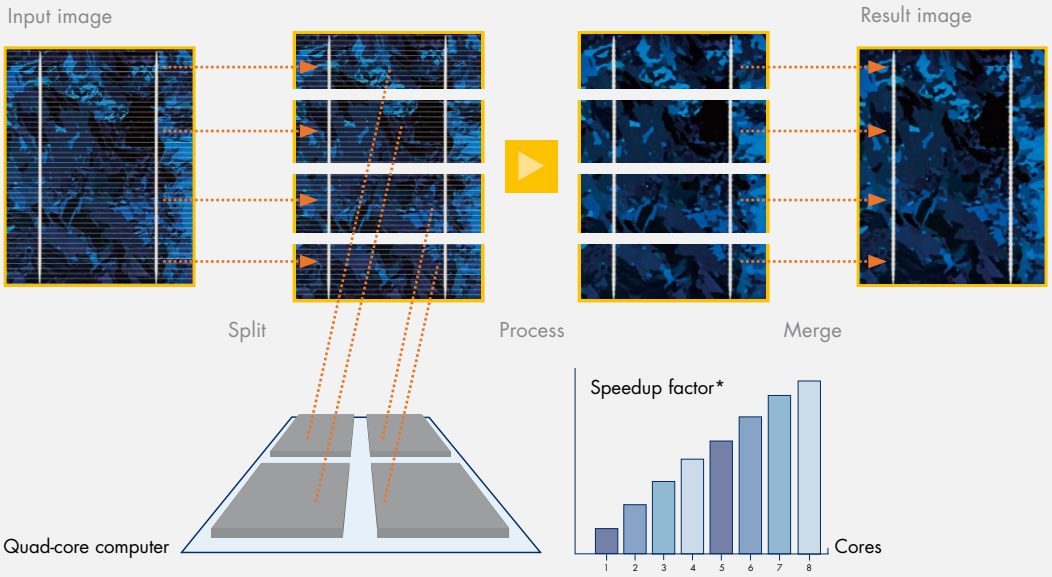
Automatic Operator Parallelization (AOP)

Multi-core and multiprocessor computers help vision systems to increase their speed considerably. For more than 10 years, HALCON offers an industry-proven automatic operator parallelization that actively supports this speed enhancement. Of course, not all vision operations profit in the same way from parallelization. Therefore, intelligent algorithms in HALCON decide whether a parallelization will be applied – taking into account the concrete operation, its input data, and the available hardware.

HALCON automatically parallelizes operators when started on a multi-core computer by distributing the data, e.g., the images, to multiple threads, one for each core.

Parallel Programming

HALCON also supports parallel programming, e.g., multithreaded programs, by being not only thread-safe but also reentrant. Thus, multiple threads can call HALCON operators simultaneously. Using this feature, you can split a machine vision application into independent parts and let them run in parallel on different cores.



When executing an operator on a quad-core computer, HALCON automatically splits the image into four parts, which are then processed in parallel by four threads executing the operator.

*1/ 1.96/ 2.90/ 3.79/ 4.51/ 5.48/ 6.34/ 6.93 of the operator median_image with mask size 13x13 on a 2 Quad-Core Intel Xeon E5345, 2.33 GHz, image size 1280x1024. Note that the achievable speedup generally depends on the used HALCON operator and the image size.

Automatic GPU Acceleration

For highest performance, HALCON provides an efficient automatic acceleration by optimal usage of the additional computing power of GPUs based on the OpenCL standard. Thereby, more than 75 HALCON operators can be accelerated considerably.

Processing time on GPU	
Binomial filter (3x3)	0.15 ms
Image subtraction	0.07 ms
Affine transformation (bilinear)	0.10 ms
Polar transformation	0.17 ms
Color space conversion (hsi)	0.30 ms

The above runtime examples were measured using images of size 1280 x 960 on a NVIDIA GeForce GTX 570 GPU.

HALCON
Architecture

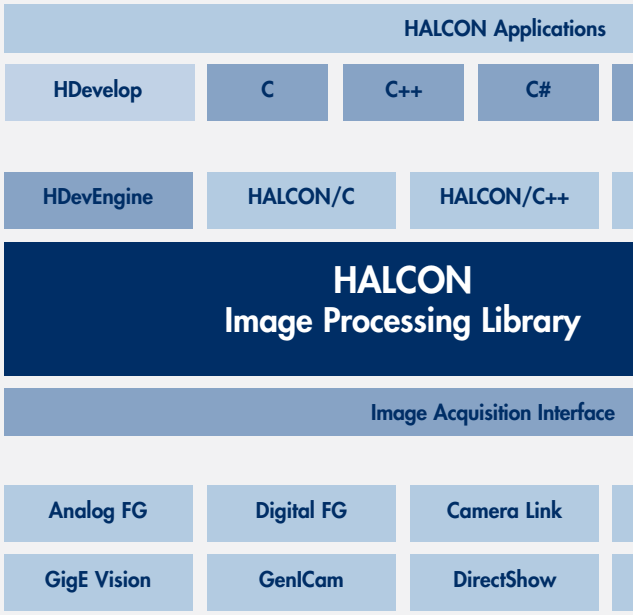
The flexible architecture of HALCON ensures its compatibility with future developments, for example, the portability to other operating systems or the integration into new programming environments. This protects your investment in your applications.

Image Acquisition Interfaces

HALCON includes a powerful software interface to provide a common view on different image acquisition devices. Thus, you can connect to your device, set device-specific parameters, and acquire images within a few lines of code. You can use all kinds of image acquisition hardware, including line scan cameras, 3D cameras, and cameras with non-standard resolutions and more than 8 bits per pixel.

HALCON guarantees hardware independence by providing interfaces to hundreds of industrial cameras and frame grabbers. HALCON also provides ready-to-use interfaces to all commonly used standards, including GenICam, GigE Vision, and IIDC 1394. Moreover, HALCON supports real-time preprocessing by directly running filter operations on the image acquisition device.

Because of the open architecture, you can even develop new interfaces to fully integrate additional image acquisition devices into HALCON. Furthermore, you can also pass images to HALCON via their memory address, or read them via a virtual acquisition interface from hard disk.

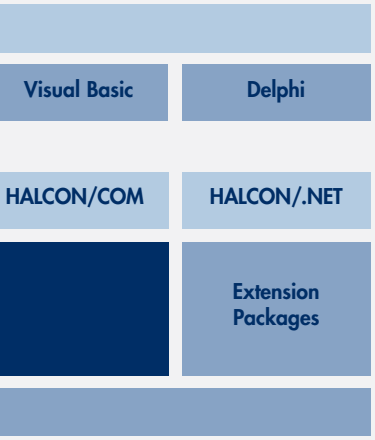


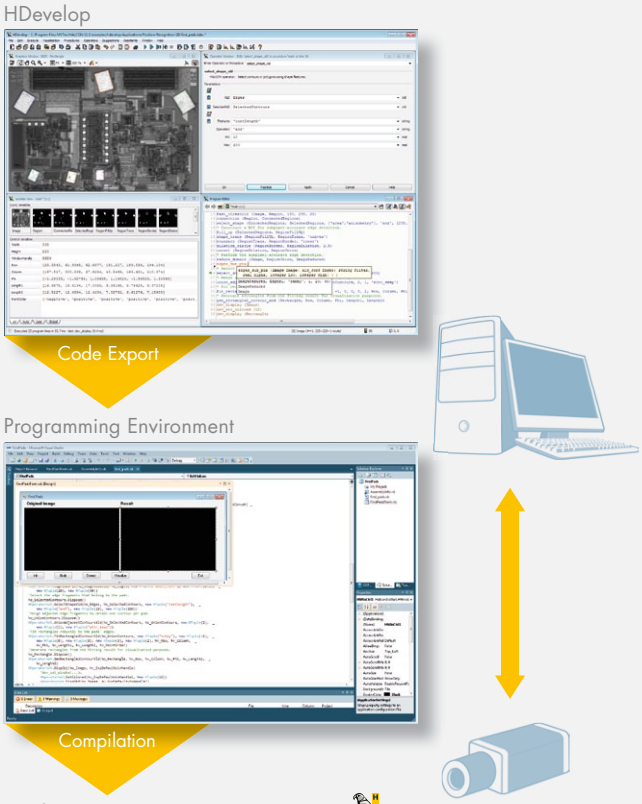
Extension Packages

This unique feature allows you to integrate your existing or newly developed image processing algorithms into HALCON. Thus, you get a common view on all the image processing parts of your application and facilitate maintenance and future development. An open, extensively documented interface enables you to utilize the powerful internal data structures of HALCON.

HALCON
Embedded

HALCON Embedded means HALCON running on your non-standard platform. HALCON is portable to various microprocessors/DSPs, operating systems, and compilers.





HALCON Embedded is available for various smart cameras and other embedded platforms.

For latest information see www.halcon-embedded.com

HALCON

Technical Data

Filtering
Image enhancement: Contrast enhancement, illumination correction, scaling, histogram equalization.
Smoothing: Edge-preserving and enhancing smoothing, Gaussian smoothing, binomial filter, mean filter, rank filters (median, separated median, weighted median, etc.), midrange filter, sigma filter, trimmed mean, salt and pepper noise elimination, recursive smoothing filters.
Edge filters: Canny, Deriche, Lanser, Shen, Frei, Kirsch, Roberts, Prewitt, Robinson, Sobel, Laplace, difference of Gaussians, derivatives of Gaussians, edge closing.
Point filters: Förstner, Harris, Lepetit, Sojka point extractors with subpixel accuracy.
Inpainting: Restoration of missing image information.
Texture: Laws filters (3x3, 5x5, 7x7), deviation, entropy.
Arithmetic: Scaling, addition, subtraction, multiplication, absolute value, maximum, minimum, inversion, square root, trigonometric functions, logarithm, exponential, power.
Color transformations: CIElab, hsv, hsi, yiq, yuv, CIExyz, hls, ihs, etc.
Fourier transform: Extremely fast FFT; Gaussian, mean, derivative, Gabor, bandpass, highpass, lowpass filters; energy, phase, power.
Hough transformation: Lines, circles.
Miscellaneous filters: User-defined filters, dot filter, gray skeleton, principal components, topographic sketch, Gauss pyramid, type conversion.

Subpixel Edge & Line Extraction
Canny, Deriche, Lanser, and Sobel edge detectors; facet model and Steger line detectors with an accuracy of up to 1/50 pixel; subpixel color edge and line detectors; subpixel threshold.

Subpixel Contour Processing
Contour processing: Affine and projective transformations; segmentation into and fitting of lines, circles, ellipses, and rectangles; merging of collinear contours; set operations (union, intersection, difference); creation of different standard shapes (circle, ellipse, line, rectangle).
Shape features: Area, center, orientation, circularity, compactness, contour length, convexity, elliptic axis, moments (arbitrary order), eccentricity, hulls (convex, circle, rectangle), selection of contours based on shape features.

Edge Position Measurement
Subpixel edge extraction along lines and circular arcs; automatic selection of edges (first, last, all, rising, falling, pairs); evaluation functions for selecting edges and edge pairs; measurement of standard shapes (circle, ellipse, line, rectangle).

Blob Analysis
Threshold: Range, local, automatic.
Region processing: Connected components, skeleton, junctions, end points, set operations (intersection, difference, union, complement), hulls (rectangle, circle, ellipse, convex), filling of holes, region generation (rectangle, circle, ellipse, polygon, checker, grid, random), access (runlength encoding, chain code, contour, polygons).
Gray-value features: Minimum, maximum, mean, deviation, co-occurrence, histogram, entropy, fuzzy features, gray moments.
Shape features: Area, center, orientation, circularity, rectangularity, compactness, number of holes, contour length, convexity, elliptic axis, moments (2nd and 3rd), eccentricity, Hamming distance, hulls (circle, rectangle), distance, spatial relations, Euler number.

Segmentation
Threshold: Color, hysteresis.
Regiongrowing: Gradient, mean value, color, texture.
Classification: Classifiers using multi-layer perceptron neural nets, support vector machines, Gaussian mixture models, k-nearest neighbors.
Variation model: Segmentation based on a reference image and trained tolerated variations of good objects.

Morphology
Binary: Minkowski addition/subtraction, dilation, erosion, opening, closing, hit-or-miss, boundary, pruning, thickening, thinning, distance transformation, closest-point transformation.
Gray value: Watersheds; dilation, erosion, opening, closing with subpixel mask sizes.

Classification
Multi-layer perceptron neural net classifier; support vector machine classifier; Gaussian mixture model classifier; k-nearest neighbors classifier; automatic feature selection.

Geometric Transformations
Rotation, scaling, translation, mirroring, cropping; affine, perspective, and polar transformations; approximation of transformations from point correspondences and angles; image mosaicking including automatic point matching; rectification of complex image distortions; tiling of multiple images into a single image; merging of regions and contours from adjacent line scan images.

Matching
Gray-value-based, correlation-based, shape-based, perspective deformable, local deformable, descriptor-based, and component-based matching with arbitrary template size and shape; robust recognition of rotated, scaled, cluttered, or partially occluded objects, even under changing illumination conditions; matching in color and multi-channel images; recognition of different objects or objects with parts that can move with respect to each other in a single call; creation of synthetic models, e.g., from polygon data; automatic determination of model parameters.

3D Matching
Creation of 3D models from DXF, OBJ, OFF, PLY, STL CAD files; shape-based matching with arbitrary 6-DOF pose in 3D; robust recognition of cluttered or partially occluded objects, even under changing illumination conditions; surface-based 3D matching.

Identification
Bar code: EAN 13, EAN 8, UPC-A, UPC-E, 2/5 Industrial, 2/5 Interleaved, Codabar, Code 39, Code 93, Code 128, PharmaCode, GS1 DataBar, bar code print quality inspection (ISO/IEC 15416).
Data code: ECC 200 (Data Matrix), QR Code, Micro QR Code, Aztec Code, PDF417 code, data code print quality inspection (ISO/IEC 15415 and AIM DPM-1-2006).
Sample-based: Identification based on sample images.

Optical Character Recognition
Character-based recognition, specialized segmentation, rotation elimination, trainable classifiers for custom fonts, selectable features, pre-trained classifiers for many applications.

Optical Character Verification
Gray-value based pattern comparison; invariant with respect to illumination, position, and size changes.

Gray-Value Calibration
Calibration of the response curve of the image acquisition device to increase the accuracy of subpixel measurements.

3D Calibration
Calibration of internal and external camera parameters from multiple images for pinhole and telecentric area scan cameras as well as line scan cameras; self-calibration of rotating cameras and of lense distortions; correction of lens distortions for images, contours, and points; transformation of contours and points into world coordinates; rectification of images (removal of lens and perspective distortions); hand-eye calibration.

3D Vision
3D Object Processing: Registration; surface comparison; uniform sampling; triangulation; connected components; intersection (with plane, region).
Multi-view stereo: Multi-view calibration, automatic determination of relative camera pose, image rectification, calculation of depth or disparity with subpixel accuracy; multi-view 3D reconstruction; support of cameras with telecentric lenses.
Further methods: Depth from focus; sheet of light; photometric stereo, segmentation and fitting of 3D primitives (planes, cylinders, spheres); extraction of the 3D position of circles and rectangles.

Image Sequences
Background estimation, optical flow.

Sockets
Exchange of images, regions, XLD, and control data between HALCON processes. Generic socket communication for data exchange with arbitrary systems.

Serialization
Objects; handles; tuples.

Serial Interface
Reading and writing of data.

Image File Formats
AVI, binary, BMP, GIF, JPEG, JPEG-2000, JPEG XR, PCX, PNG, PNM, Sun-Raster, TIFF, XWD.

Unique
Technique

From Basics to High Tech

HALCON offers the full set of standard machine vision technologies. Beyond that, HALCON offers many unique features.

HALCON offers the largest variety of robust matching techniques for any task:

- Correlation-based matching (NCC)
- Shape-based matching
- Component-based matching
- Descriptor-based matching
- Perspective deformable matching
- Local deformable matching
- Shape-based 3D matching
- Surface-based 3D matching

HALCON enters the next dimension with revolutionary methods for 3D vision:

- Multi-view 3D calibration
- Hand-eye calibration
- 3D alignment
- 3D matching
- 3D surface comparison
- Circle pose
- Rectangle pose
- 3D reconstruction
- Multi-view stereo
- Depth from focus
- Sheet of light
- 3D object processing
- 3D primitives fitting

HALCON contains many more unique techniques:

- Sample-based identification capable to differentiate a large number of objects
- Arbitrarily shaped regions of interest (ROIs) for significant flexibility and speed
- Extremely fast morphology and a wide set of subpixel-accurate methods
- Reading of bar codes and data codes with maximum robustness to occlusions and print quality
- Processing of extremely large images (more than 32k x 32k) without a limit
- Automatic operator parallelization (AOP)

Complete Hardware Independence

HALCON supports many different operating systems and processors:

Operating System	Processor	Compiler
Windows Windows x64	Intel Pentium 4 / AMD Athlon 64 or higher Intel 64 or AMD64	Visual Studio Visual Studio
Linux Linux x86_64	Intel Pentium 4 / AMD Athlon 64 or higher Intel 64 or AMD64	gcc-4.x gcc-4.x
Mac OS X 10.7	Intel 64	Xcode

HALCON is optimized to profit from the possibilities of the hardware:

HALCON utilizes SIMD, multi-core CPUs, multiprocessor computers, and supports FPGA technology. Moreover, HALCON provides an efficient automatic GPU acceleration based on the OpenCL standard.

HALCON supports a multitude of different image acquisition devices:

GigE Vision

GenICam

FireWire

TWAIN

- Universal acquisition interfaces for all GigE Vision compliant cameras from Allied Vision, Automation Technology, Basler, Baumer, e2v, Hitachi, Imperx, JAI, Kappa, Leutron Vision, MATRIX VISION, Mikrotron, NET, Photonfocus, Pleora, Point Grey, Smartek, Sony, SVS-VISTEK, Tattile, Teledyne DALSA, Toshiba Teli, Vieworks, and others.
- Universal acquisition interfaces for all GenICam GenTL compliant boards or cameras from Active Silicon, Leutron Vision, LMI, MATRIX VISION, VRmagic, XIMEA, and others.
- Universal acquisition interface for all IIDC 1394 (FireWire) compliant cameras from Allied Vision, Basler, Baumer, Hitachi, Kappa, NET, PixeLINK, Point Grey, Sony, The Imaging Source, Toshiba Teli, and others.
- Universal acquisition interface for all capture devices with DirectShow, TWAIN or Video4Linux driver.
- Specific acquisition interface for cameras und frame grabber boards from ABS, ADLINK, Andor, Basler, BitFlow, Crevis, Daheng, ELTEC, Euresys, IDS, Leuze, LinX, Lumenera, MATRIX VISION, Matrox, MESA Imaging, Mikrotron, Opteon, PixeLINK, Sentech, SICK, Silicon Software, Sony, Teledyne DALSA, and VRmagic.

For latest information see www.halcon.com/image-acquisition

MVTec Image Acquisition Partner

Image Acquisition Partner Program – in order to provide the best possible integration of hardware and software for the customer, MVTec cultivates close partnerships to a large number of suppliers of image acquisition devices.

HALCON

What is HALCON?

HALCON is the comprehensive standard software for machine vision with an integrated development environment (IDE) that is used worldwide. It enables cost savings and improved time to market: HALCON's flexible architecture facilitates rapid development of machine vision, medical imaging, and image analysis applications.

What is Included?

HALCON provides outstanding performance and a comprehensive support of multi-core platforms, SSE2 and AVX, as well as GPU acceleration. It serves all industries with a library of more than 1800 operators for blob analysis, morphology, matching, measuring, identification, and 3D vision, to name just a few.

Why HALCON?

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HALCON guarantees hardware independence by providing interfaces to hundreds of industrial cameras and frame grabbers, including support for standards like GenICam, GigE Vision, and IIDC 1394.

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HALCON licenses are modular – runtime licenses, which are acquired for finished applications, are divided into different modules. Therefore you only pay the modules you need for your application.

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