robust
fast
accurate
flexible
comprehensive
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/AOI, 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.

### Quality Assurance

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

### Print Inspection

Labels, stamps, 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.
LEADING-EDGE
TECHNIQUES AND OPTIMAL PERFORMANCE

- **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.

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

- **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, and PDF417 codes of any size with modules even smaller than 2x2 pixels, as well as data codes with a distorted finder pattern.

- **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 image set of MNIST standard.

- **3D Camera Calibration**
  An explicit and precise description of your area or line scan setup, even for complex distortions: 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 fine scan cameras. Crucial for robotic applications is HALCON's hand-eye-calibration.
### Matching

#### Gray-value-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, partially occluded or located outside of the image, or undergo non-linear illumination changes. It can process images with 8 or 16 bits and handles also color or multi-channel images. Objects can be trained from images or from CAD-like data.

#### Component-based Matching
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.

### 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 calculate disparity or distance maps with many different methods: binocular or 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.
**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" up 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

**Browse Examples Dialog**

- **HALCON**
- **9.0**
- **Programs**
- **Quick Guide**
- **Solution Guide**
**Reliability**

HALCON is proven worldwide in tens of thousands of applications. The sophisticated algorithms are developed by MVTec’s engineers, who have more than 20 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, as well as MMX and SSE2.

**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) | 3.2 ms |
| Affine transformation (nearest neighbor) | 0.6 ms |
| Sobel edge filter | 0.6 ms |
| Median [3 x 3] | 0.4 ms |
| Binomial filter [5 x 5] | 0.8 ms |
| Gray opening [3 x 3] | 0.3 ms |
| Binary dilation [50 x 50] | 0.1 ms |
| Binary erosion [50 x 50] | 0.04 ms |
| Threshold operation | 0.1 ms |
| Subpixel-accurate threshold | 0.1 ms |
| Feature calculation for 250 objects (blobs) (features: "center of gravity" & "number of pixels") | 0.04 ms |
| Subpixel-accurate measuring of edge positions (search size 100 x 20) | 0.01 ms |
| Fast Fourier transform | 4.3 ms |

The above runtime examples were measured using a byte image of size 640 x 480 on an Intel Core 2 / 3 GHz computer. Note: runtime may vary with different input data.
About HDevelop

HDevelop is HALCON’s highly interactive programming environment. Running on Windows, Linux, and Solaris, 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 900 with three mouse clicks.

- Programming becomes as easy as possible: 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.

- HDevelop includes dialogs for real-time interactive inspection of image properties to obtain parameter settings for your program: gray histogram, feature histogram, zooming, and feature inspection.

- Get immediate feedback on the execution of an operator and let HDevelop visualize iconic variables, e.g., as 3D plots or contour lines.

- Thanks to the long experience HALCON is based on, HDevelop is tailored to the needs of machine vision applications with its usability optimized GUI.
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.
**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.

**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 world coordinates. After setting the parameters, the assistant inserts the suitable program code on demand into the HDevelop program.
Matching Assistant

The matching assistant is a powerful tool specifically designed for the interactive use of HALCON’s shape-based 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.
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.

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#, or Visual Basic source code, which can be easily integrated into your application.
Programming Environment

Application

HALCON Library

Compilation

C#, C++, C, VB Program

Executable Program

Execute machine vision application

HDevEngine

Add user interface, process integration

Execute machine vision application

adapt code parts of application program
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 1400 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/UNIX.

**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 not only for Windows but also runs on Linux/UNIX.

**HALCON Codelets**

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

**Secured Know-how**

HALCON secures the know-how of the software developer: code, which is saved in external procedures, can be secured with a password. Therefore, functionality can be shared without revealing the program code.
**Multi-Core Performance**

- **Automatic Operator-Parallelization (AOP)**

  Multi-core and multiprocessor computers help vision systems to increase considerably in speed. Since more than 8 years, HALCON offers an industry-proven automatic operator parallelization which 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 if started on a multi-core computer, by distributing the data, e.g., the images, to multiple threads, one for each core. You don’t even need to modify your existing HALCON programs to make use of this automatic parallelization and gain a significant speedup.

- **Parallel Programming**

  HALCON also supports parallel programming, e.g., multithreaded programs, by being not only threadsafe 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 reachable speedup generally depends on the used HALCON operator and the image size.
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 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 common 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 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
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.

Region growing: Gradient, mean value, color, texture.
Classification: Classifiers using multi-layer perceptron neural nets; support vector machines, Gaussian mixture models.

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.

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.

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.

Pattern Matching
Gray-value-based, correlation-based, shape-based, perspective 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 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.

Bar Code & Data Code Reader

2D data code reader: ECC 200 [Data Matrix], QR Code, PDF417 code, data code print quality inspection (ISO/IEC 15415 and AIM DPM-1-2006).

Optical Character Recognition
Character-based recognition, specialized segmentation, rotation elimination, trainable fonts, selectable features, pre-trained fonts 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 lens 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); extraction of the 3D position of circles and rectangles.

3D Vision
Binocular stereo: Stereo calibration, automatic determination of relative camera pose, image rectification, calculation of depth or disparity with subpixel accuracy.

Further methods: Depth from focus; sheet of light; photometric stereo.

Image Sequences
Background estimation, optical flow.

Sockets
Exchange of images, regions, XLD, and control data between HALCON processes.

Serial Interface
Reading and writing of data.

Image File Formats
AVI, binary, BMP, GIF, JPEG, JPEG-2000, PCX, PNG, PDF, Sun-Raster, TIFF, XWD.
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:
- Gray-value-based matching (incl. NCC)
- Shape-based matching
- Component-based matching
- Descriptor-based matching
- Perspective, deformable matching
- 3D matching

HALCON enters the next dimension with revolutionary methods for 3D vision:
- 3D calibration
- Hand-eye-calibration
- 3D alignment
- 3D matching
- Circle pose
- Rectangle pose
- 3D reconstruction
- Binocular stereo
- Depth from focus
- Sheet of light

HALCON contains many more unique techniques:
- Arbitrarily shaped Regions of Interest (ROIs) for significant flexibility and speed
- Extremely fast morphology and a wide set of subpixel accurate methods
- Gray-value calibration for high accuracy in subpixel-measurement
- Reading of 1D and 2D bar and data codes with maximum robustness to occlusions and print quality
- Processing of extremely large images (more than 32k x 32k) without a limit

Complete Hardware Independence
HALCON supports a multitude of different operating systems and processors:

<table>
<thead>
<tr>
<th>Operating System</th>
<th>Processor</th>
<th>Compiler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows</td>
<td>Pentium or compatible (with and without SSE2) Intel EM64T or AMD64</td>
<td>Visual Studio</td>
</tr>
<tr>
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<td>gcc</td>
</tr>
<tr>
<td>Solaris</td>
<td>SPARC</td>
<td>Sun Studio</td>
</tr>
</tbody>
</table>

HALCON is optimized to profit from the possibilities of the hardware:
HALCON utilizes SIMD, multi-core CPUs, multiprocessor computers, and supports FPGA technology.

HALCON supports a multitude of different image acquisition devices:
- Universal acquisition interface for all GigE Vision compliant cameras from Basler, Baumer, DALSA, e2v, FLIR, GEViCAM, Imperx, JAI, Leutron, MATRIX VISION, Mikrotron, NET, Pleora, Prosilica, SVS-Vistek, Toshiba Teli, and others.
- Universal acquisition interface for all IIDC 1394 (FireWire) compliant cameras from Allied Vision, Basler, Baumer, NET, PixelLINK, Point Grey, Prosilica, Sony, The Imaging Source, Toshiba Teli, and others.
- Universal acquisition interface for all capture devices with DirectShow or TWAIN driver.
- Specific acquisition interfaces for cameras and frame grabber boards from ABS, Basler, Baumer, BitFlow, CyberOptics, Daheng, DALSA, Eltec, Euresys, IDS, Integral, Leutron, LinX, Lumenera, MATRIX VISION, Matrox, Mikrotron, Öpteon, PixelLINK, Sick IVP, Silicon Software, Sony, Tattile, and VRmagic.

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

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.
What is HALCON?
HALCON is the comprehensive standard software with an integrated development environment (IDE) for machine vision that is used worldwide. It leads to 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, MMX, and SSE2. It serves all industries by a library of more than 1400 operators for blob analysis, morphology, pattern matching, measuring, identification, and 3D vision, to name just a few.

Why HALCON?
HALCON secures your investment by supporting the operating systems Windows, Linux, and Solaris. The full library can be accessed from common programming languages like C, C++, C#, Visual Basic .NET, and Delphi.

Image Acquisition
HALCON guarantees hardware independence by providing interfaces to hundreds of industrial cameras and frame grabbers, including GenICam, GigE Vision, and IIDC 1394.

Licensing
HALCON licences are flexible – the programming development licence can either be bound to a PC or a dongle. Also floating licences are offered, which can be used from different PCs alternately.

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

Your Distributor

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Download demo version, request free product DVD, use our free application evaluation service, or get contacted by a qualified distributor for in-house presentations or training possibilities: www.halcon.com/now