# HALCON

a product of MVTec

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## THE COMPREHENSIVE MACHINE VISION SOFTWARE FOR ALL INDUSTRIES

## What is HALCON?

HALCON is the comprehensive standard software for machine vision with an integrated development environment (HDevelop) that is used worldwide. It enables cost savings and improved time to market. HALCON's flexible architecture facilitates rapid development of any kind of machine vision application.

## What Is Included?

MVTec HALCON provides outstanding performance and a comprehensive support of multi-core platforms, special instruction sets like AVX2 and NEON, as well as GPU acceleration. It serves all industries, with a library used in hundreds of thousands of installations in all areas of imaging like blob analysis, morphology, matching, measuring, and identification. The software provides the latest state-of-the-art machine vision technologies, such as comprehensive 3D vision and deep learning algorithms. Beyond that HALCON comes with free support by the highly experienced experts at MVTec.

## Why HALCON?

HALCON secures your investment by supporting the operating systems Windows, Linux, and macOS. The full library can be accessed from common programming languages like C, C++, Python, and .NET languages like C# or VB.NET. HALCON guarantees hardware independence by providing interfaces to hundreds of industrial cameras and frame grabbers, in particular by supporting standards like GenICam, GigE Vision, and USB3 Vision. By default, MVTec HALCON runs on Arm®-based smart cameras and other embedded vision platforms. It can also be ported to various microprocessors / DSPs, operating systems, and compilers. Thus, the software is ideally suited for the use within embedded systems.

HALCON

# **Professional Software**
# for all Machine Vision Applications

### AGRICULTURE & FOOD

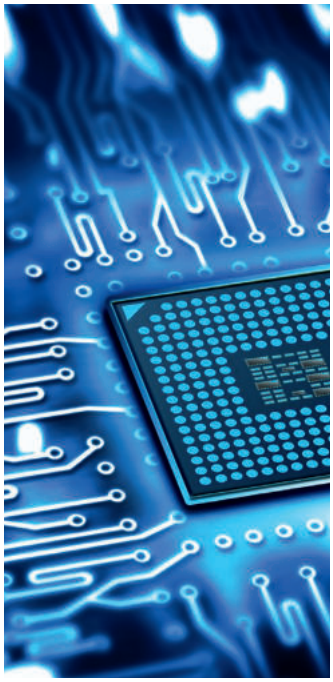
Identification of natural products, automated fruit picking and sorting, or fill level measurement: HALCON is a machine vision software for producers and packagers alike to achieve efficient and consistent production and keep up with the ever-changing demands of consumers.

### AUTOMOTIVE & ROBOTICS

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

### LOGISTICS & PACKAGING

Quality control, completeness inspection, identification, or bar & data code reading: HALCON offers outstanding methods in all areas of logistics and packaging.



### ELECTRONICS & SEMICONDUCTORS

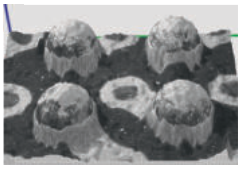
Precise assembly, surface inspection or defect detection during the entire manufacturing process: With HALCON, system manufacturers are fully equipped to implement advanced processes at reduced costs.

## Used in Many Industry Sectors

Aerospace and space travel
Agriculture and food
Automobile parts and manufacturers
Ceramics
Chemicals
Electric components and equipment
Glass production and processing
Health care and life science
Iron, steel, 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

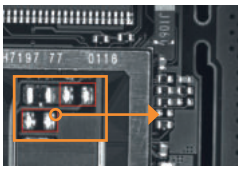
## BOARD, WAFER & DIE INSPECTION

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



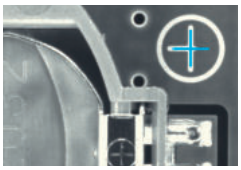
## COMPLETENESS INSPECTION

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



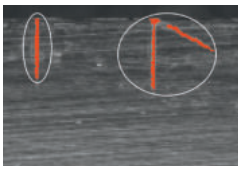
## POSITIONING & ALIGNMENT

Board alignment, fiducial localization: HALCON reliably finds objects with an accuracy better than 1/20 pixel in 2D and 3D scenes even if they are partially occluded.



## SURFACE INSPECTION

Various materials, even partially specular reflecting surfaces, as well as different error classes like holes, wrinkles, edge cracks, inclusions, contaminants, coating voids, scratches, spots, and dents: HALCON's advanced filtering techniques are tailored to diverse needs.



## PRINT INSPECTION

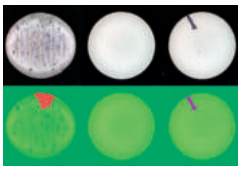
Labels and forms printed on paper, plastic, or metal by any kind of printer: HALCON automatically compares trained patterns with your prints.


## IDENTIFICATION

Identification, reading of bar and data codes as well as OCR (Optical Character Recognition): HALCON robustly reads a single character in less than 0.1 ms, even regardless of its orientation and font type. The ability to group characters automatically allows the identification of whole words.

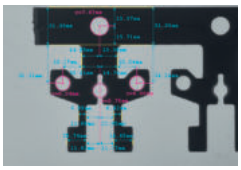
## CLASSIFICATION

Quality control, image segmentation, object recognition, or anomaly detection: HALCON offers various deep learning methods to assign an object to one of several categories based on selected features.



## 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.

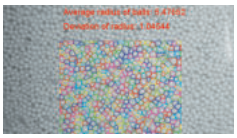


HALCON

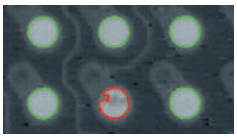
# Leading-Edge Techniques
## and Optimal Performance

### 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.*

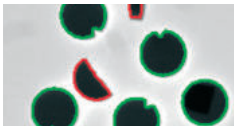


*Extract blobs with subpixel accuracy.*

### 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

HALCON reads all common bar codes and a wide variety of data codes (e.g., Data Matrix ECC 200, QR, Micro QR, Aztec, DotCode, GS1, and PDF417). Many of these can be read despite extremely small size, data codes even with a damaged finder pattern or violated quiet zone, while bar codes are still read with significant overexposure, print growth, and even partial occlusion.

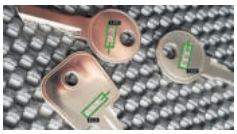
*Reading flawed data codes.*

*Reading strongly blurred bar codes.*

### OCR & OCV

HALCON's Deep OCR, a holistic deep-learning-based approach for OCR, localizes characters in a very robust way, even regardless of their orientation and font type. The ability to automatically group characters allows the identification of whole words which strongly increases the recognition performance as, e.g., misinterpretation of characters with similar appearances can be avoided. Furthermore, classifiers can be trained and fonts can be classified and verified with HALCON's traditional OCR. Many pretrained fonts from different application areas enable highest recognition rates "out of the box". Combined with HALCON's automatic text reader, performing OCR the "traditional way" has never been easier.

*Read dot prints on complex background.*



*HALCON localizes characters independent of their orientation.*

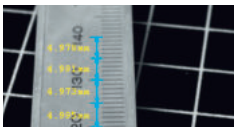
### 3D VISION

#### 3D CALIBRATION

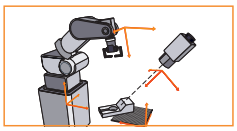
Calibrate internal and external camera parameters to perform highly accurate metric measurements, e.g., up to 1 µm in a field of view of 10 mm – also with line scan and telecentric tilt cameras. Use HALCON's hand-eye calibration for vision-guided robot applications, like pick-and-place.

#### 3D OBJECT PROCESSING

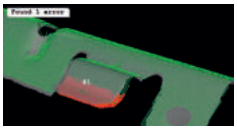
With HALCON's 3D object model various tasks can be performed, such as 3D registration, 3D object processing, as well as 3D object recognition and surface comparison.



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



*Hand-eye calibration enables robotic grasping applications.*



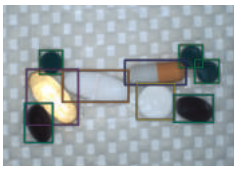
*Errors are detected using 3D surface inspection.*

*A 3D object model is segmented into connected components.*

## DEEP LEARNING

HALCON comes with various pretrained Convolutional Neural Networks (CNNs), that have been highly optimized for industrial applications. Due to the high flexibility in terms of hardware, training as well as inference is possible on GPUs as well as CPUs. HALCON enables the classification of whole images, detects objects within images with bounding box accuracy, or performs pixel-precise semantic segmentation. Additionally, it detects unknown anomalies based on only few good samples, or trains an application to extract application-specific edges. Its seamless integration into the HALCON library makes this technology a valuable addition to the most comprehensive toolset on the vision market. For more information see www.halcon.com/deep-learning

*Anomaly Detection*



*Bounding box object detection with deep learning.*

## MATCHING

HALCON's superior subpixel-accurate matching technologies find objects robustly and accurately in real-time. Images with 8 or 16 bits, as well as color or multi-channel images, can be processed regardless of rotation, tilt, local deformation, texture, scale, partial occlusion, or nonlinear illumination changes. Objects can be trained from images or from CAD-like data. Moreover, HALCON includes numerous variations of this technology, e.g., to locate objects that are composed of multiple parts that can move with respect to each other, or methods that are very fast or particularly robust against defocus, texture, or surface deformations.

*HALCON's advanced matching technology even finds objects which are partially occluded.*

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

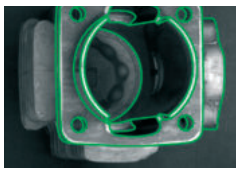
## 3D MATCHING

### SHAPE-BASED 3D MATCHING

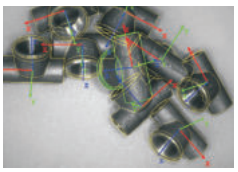
Recognition and 3D pose determination of arbitrary 3D objects: HALCON's cutting-edge 3D matching determines the position and orientation of 3D objects represented by their CAD model.

### SURFACE-BASED 3D MATCHING

HALCON's surface-based 3D matching is optimized to find objects with arbitrarily shaped or even deformed surfaces by combining 3D point cloud data and edge information from distance images.



*Localization of a known object with 3D matching.*



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

## MEASURING

### 1D MEASURING

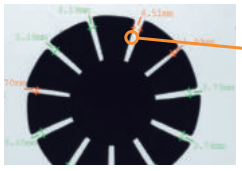
Measure edges along lines or arc segments: HALCON's powerful algorithms perform subpixel-accurate measurements in less than a millisecond. In combination with gray-value calibration even non-linear gray-value responses can be compensated to achieve highest accuracy.

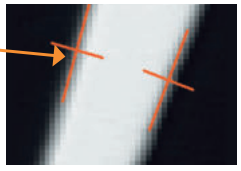
### 2D MEASURING

Fitting an ellipse to a subpixel contour output of an edge filter allows you to achieve highest precision. HALCON's metrology model automatically extracts contour data from images with more than one channel, e.g., from color images.

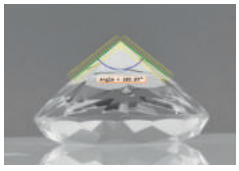
### 3D MEASURING

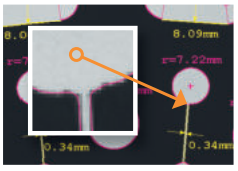
HALCON's outstanding algorithms reconstruct the disparity, distance images, or 3D coordinates of surfaces with many different methods: binocular, multi-view, and photometric stereo, sheet of light, and depth from focus. The 3D pose of circles and rectangles can also easily be determined with only one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



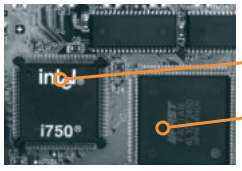


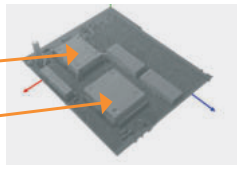
*Inspect the distances between the blades of a fan.*






*Measurement of geometric shapes, e.g., circle diameter*



*Measurement of height differences on boards*

HALCON

# More Than Software

## Worldwide Extensive Support and Training

- Free application evaluation, also prior to purchase
- Free worldwide support for HALCON users by MVTec's sales partners
- Worldwide trainings, also individually tailored to the customer's needs
- Easy maintenance by free web download of newest software releases

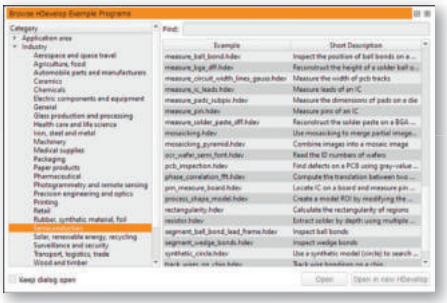
## Protection of Investment

Compatibility is an important factor for the protection of investment. To ensure this, HALCON supports a great amount of image acquisition devices as well as a large variety of operating systems and programming languages. MVTec naturally provides maintenance and availability of a version for years, also after purchase.

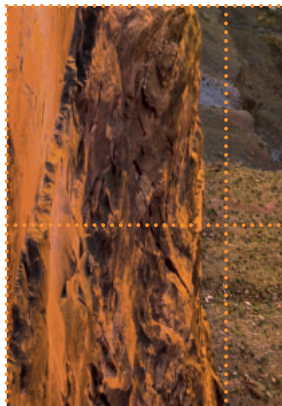
## Comprehensive Documentation

HALCON offers documentation for every user and level. Numerous example programs for every application area, which can be found with an easy-to-use browser, serve as starting point for own applications.


*Solution Guide*



*Browse example programs*




## Reliability

HALCON is proven worldwide in hundreds of thousands of installations. The sophisticated algorithms are developed by MVTec's engineers, who have more than 30 years of experience in machine vision.

## Speed

HALCON is implemented for highest performance, e.g., by actively exploiting multi-core platforms and special instructions sets like AVX2 and NEON, as well as GPU acceleration.

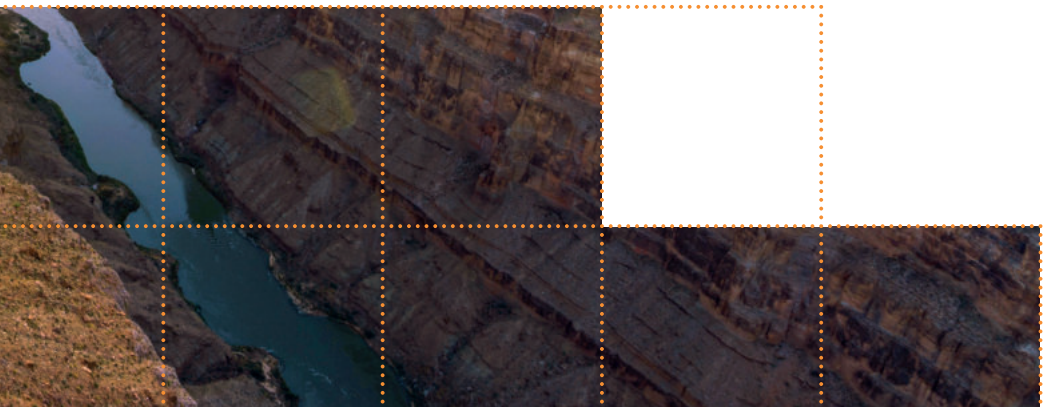
## Automatic Operator Parallelization (AOP)

Multi-core and multi-processor computers help vision systems to increase their speed considerably. HALCON offers an industry-proven automatic operator parallelization that actively supports this speed enhancement. Operators are automatically parallelized when started on a multi-core computer by distributing data, such as images, to multiple threads, one for each core.

## HALCON Editions

| Progress | Steady |
|---|---|
| ■ Receive new HALCON features as soon as they are ready for the market<br>■ New version ~ every 6 months<br>■ Subscription based (automatic yearly renewal, access to all features released within subscription period)<br>■ Support during subscription period<br>■ Maintenance through regular new releases<br>■ Deep Learning module is included | ■ Receive new HALCON features with the next major version<br>■ New release ~ every 2 years<br>■ Regular purchase (one time payment)<br>■ Lifelong free support<br>■ Regular maintenance updates<br>■ Deep Learning module can be purchased additionally |

For more information see www.halcon.com/editions



## HALCON is for developers who want

- the power of rapid prototyping
- support of a large variety of operating systems
- flexibility in programming languages
- to protect their code
- to develop also on non-standard platforms

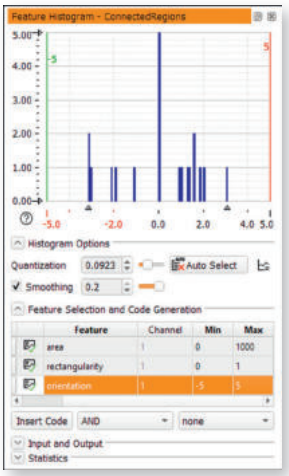
HALCON

# **HDevelop** Integrated Development Environment (IDE)

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

## Example Programs

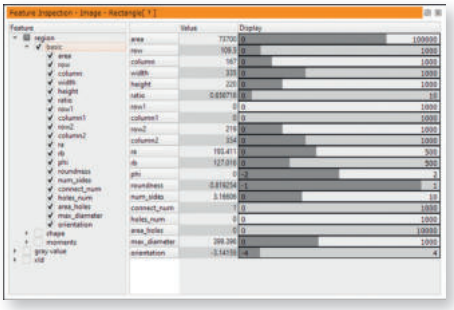
The dialog "Browse HDevelop Example Programs" lets you select examples via topics and categories. No matter in which industry you are engaged, you will find appropriate examples out of more than 1,000 with three mouse clicks.




*Feature Histogram*

## Programming Made Easy

Programming becomes very easy: syntax checks, suggested values for parameters of operators, suggested successors, and alternative operators reduce the chances of programming errors. Developers can also easily bundle various complex data types (e.g., an image, corresponding ROIs and parameters) into a single dictionary. This helps to structure programs when, e.g., passing many parameters to a procedure. Syntax highlighting, automatic highlighting of matching code elements, and an integrated online help with full-text search within the full text editor help debugging and maintaining complex applications. Additionally, HDevelop can display detailed information on important handle variables, allowing users to easily inspect the current properties of complex data structures.



*Feature Inspection*

## Parallel Programming

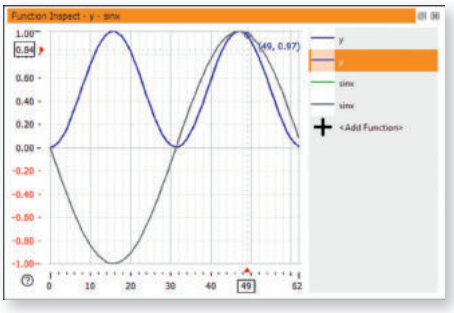
The benefits of multi-core architectures can easily be exploited: HDevelop supports concurrency through parallel programming, even during export to C, C++, and .NET languages like C# or VB.NET.

## Code Sharing

HDevelop enables easy code sharing between developers: code can be organized into procedures, which can also be stored as password-protected external procedures and organized in procedure libraries.

## Inspection of Image Features

HDevelop includes tools for real-time interactive inspection of image properties to obtain parameter settings for your program. Gray and feature histograms, as well as feature inspection and an ROI manager, allow to quickly select or create blobs in your images and generate code with a single click. For quick and intuitive visualization, there is a line profile and a zooming display. Breakpoints, detailed error messages, bookmarks, and procedures make development smooth.



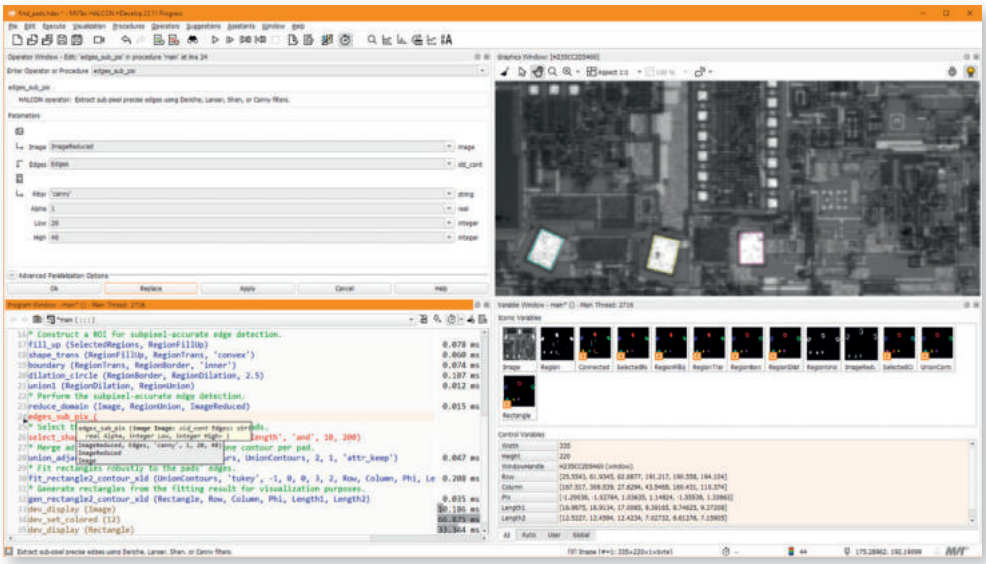

*Function Inspect*

## Immediate Execution Feedback

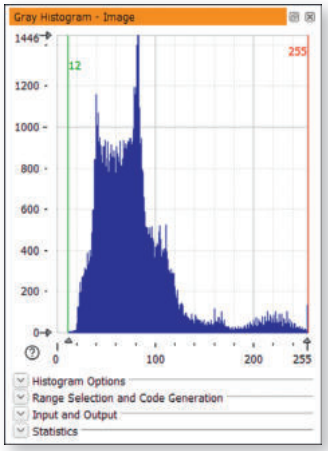
Get immediate feedback on the execution of an operator and let HDevelop visualize iconic variables, e.g., as 3D plots or contour lines. The HDevelop profiler tool helps analyzing each operator's execution time.

## Full Text Editor

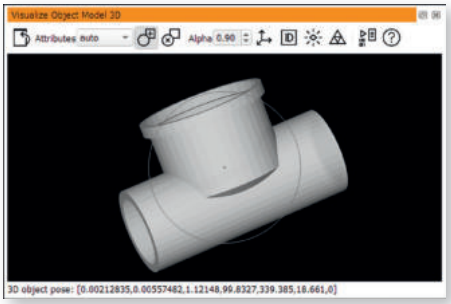
Develop the application with the help of a full text editor. Editing assistance and the ability to copy and paste lines, as well as advanced autocompletion provide easy-to-use help for programming in the full text editor.



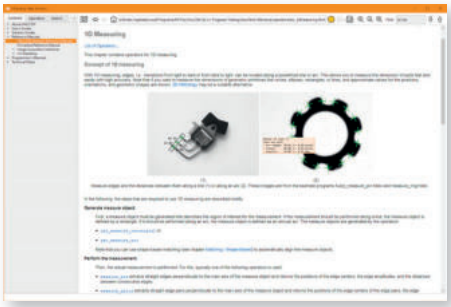
*HDevelop*




*Gray Histogram*




*3D Visualization*



*Online Help*

*Line Profile*

HALCON

# Working with **HDevelop**

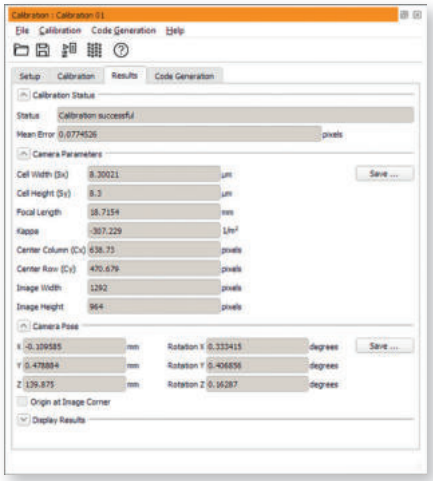
HDevelop contains assistants for common subtasks. The graphical user interface of those HDevelop assistants can be used to interactively set up and configure your solution and insert the corresponding code sequence into the HDevelop program on demand.

## Image Acquisition Assistant

The image acquisition assistant simplifies the selection, initialization, and configuration of hundreds of industrial cameras and frame grabbers. The assistant 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 into the program on demand.

## 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 into the HDevelop program on demand.



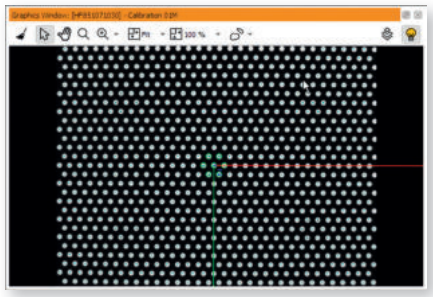

*Camera calibration assistant - Showing results*

## 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 or circular arc in an image. On demand, the assistant inserts the corresponding code into the program.

## 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 in finding parameter settings for object recognition, as well as matching applications, and inserts the suitable code into the program on demand.



*Camera calibration assistant - Visualization*

## OCR Assistant

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

# Programming with **HALCON**

HALCON offers various interfaces to access all of its more than 2,100 powerful operators from programming languages like C, C++, Python, and .NET languages like C# or VB.NET. HALCON's open architecture allows you to access defined data structures and thus to integrate HALCON with further software components such as a user interface or process control. HALCON also supports parallel programming, e. g., multithreaded programs. Thus, multiple threads can call HALCON operators simultaneously. All this, together with HALCON's inbuilt high-performance memory management, lets you concentrate on your application development and quickly come to a solution.

## HDevEngine

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. The HDevEngine library export makes calling HDevelop procedures from C++ as easy and intuitive as calling any other C++ function. This allows you to change the vision part of your application without the need of re-compiling it.

## HALCON/.NET

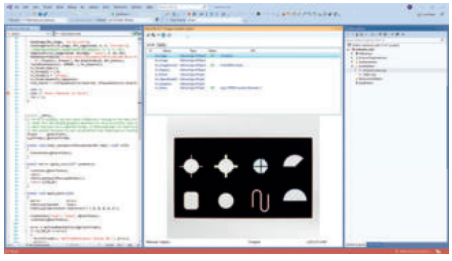
In HALCON/.NET all HALCON operators and data structures are available as high-level classes, greatly simplifying the development of your application. HALCON/.NET can be used in .NET languages like C#, Visual Basic .NET, and C++ within .NET Standard or .NET Core framework. It also can be used on Windows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

## Powerful Debugging

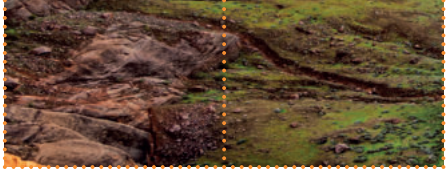
HALCON supports debugging efforts of software developers tremendously. Using HALCON's extension for Visual Studio, C++, and C#/.NET developers can inspect HALCON variables (tuples and iconic) directly within Visual Studio. When executing HDevelop procedures inside a C# or C++ application via HDevEngine, the machine vision part of the application can be debugged directly within HDevelop – even remotely – by connecting it with HDevEngine.

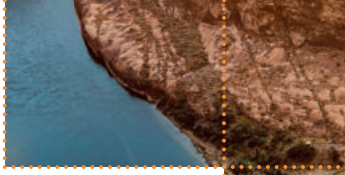


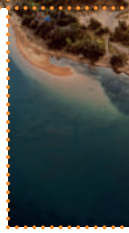
*Powerful Debugging*

## Protection of Know-how

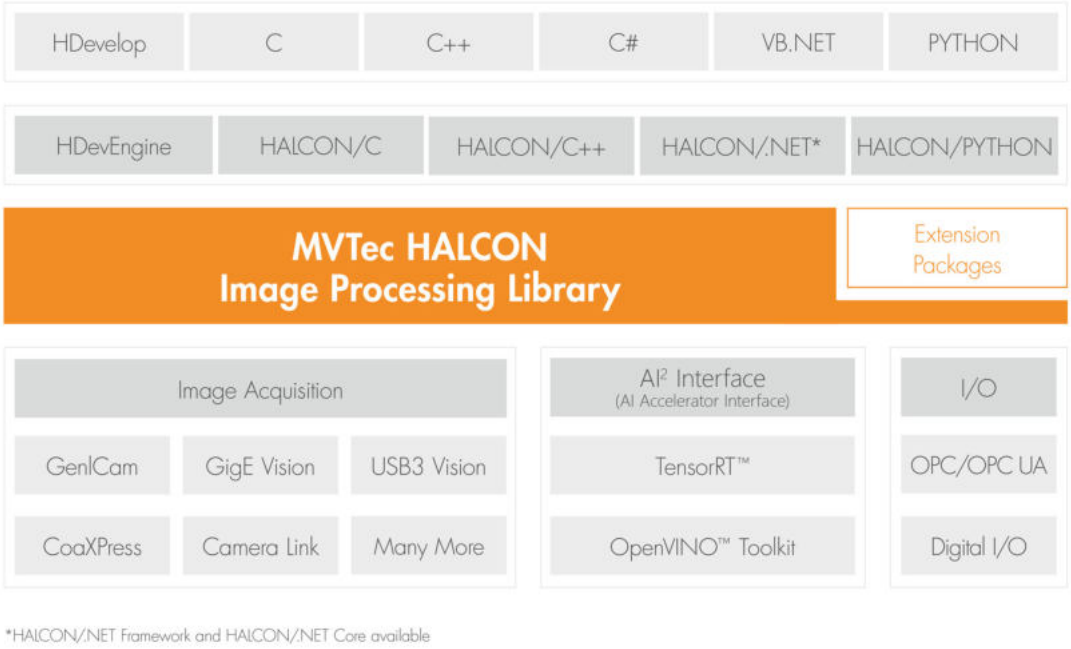
HALCON secures the know-how of the software developer: code, which is saved in external or local procedures, as well as code of entire procedure libraries or programs can be secured with a password. Therefore, functionality can be shared without revealing the program code.







# **Platforms** and Interfaces




*HALCON/.NET Framework and HALCON/.NET Core available

## 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.

## Operating Systems

HALCON is available for standard PCs running Windows (64-bit), Linux (64-bit), and macOS.

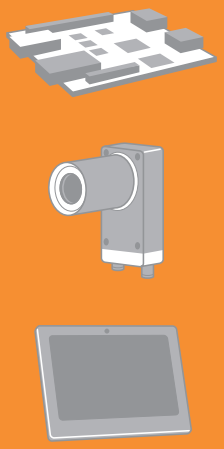
## Extension Packages

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

## Embedded Vision with HALCON

MVTec HALCON runs perfectly on embedded devices and thus enables innovative and high-performing embedded vision products, available on the market as bundles or standard software products. By default, HALCON is ready to be used on 32- and 64-bit Arm®-based platforms without further porting.
HALCON makes use of special acceleration technologies such as automatic operator parallelization, GPU acceleration, or the "NEON" instruction set extension, which can bring an enormous increase in performance on embedded platforms.
To optimize implementation, HALCON also supports all relevant interfaces, such as GigE Vision and Video4Linux for image acquisition or the OPC UA interface for communication with a PLC.

For the latest information see www.embedded-vision-software.com



## Image Acquisition Interfaces

HALCON includes a powerful software interface to provide a common view on different image acquisition devices, including line scan cameras, 3D cameras, and cameras with non-standard resolutions or more than 8 bits per pixel. A multitude of ready-to-use interfaces allow to easily connect to hundreds of industrial cameras and frame grabbers. In particular, HALCON supports all commonly used standards like GigE Vision, GenICamTL, and USB3 Vision.

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

## AI Accelerator Interface (AI²)

This generic interface allows customers to use supported AI accelerator hardware for the inference part of their deep learning applications – quickly and conveniently. In addition to plug-ins provided by MVTec, the integration of customer-specific AI accelerator hardware is also possible. Moreover, it is not only typical deep learning applications that can be accelerated via AI². All "classic" machine vision methods with integrated deep learning functions, such as HALCON's Deep OCR, benefit from this as well.

## Digital I/O Interfaces

HALCON includes a software interface for digital I/O. Thus, you can use various I/O devices directly with HALCON. Furthermore, HALCON provides ready-to-use interfaces to all PLC systems using the OPC UA and the OPC Classic standards.

# The Company behind **HALCON**

## MVTec Is Dedicated to Machine Vision Software

MVTec is the number one software manufacturer worldwide purely developing software for machine vision. The company employs highly qualified experts with more than 30 years experience in this technology. MVTec products are "Made in Germany", developed right at our competence center in Munich. The services and products are distributed worldwide by MVTec's extensive sales partner network and via the subsidiaries in Boston, MA (USA), in Kunshan near Shanghai in China, and in Lyon in France, as well as via its sales office in Taichung City in Taiwan.

## MVTec Actively Engages in Associations and Standardization Committees

MVTec shares its years-long experience with the machine vision community. Therefore, MVTec is a member of the Mechanical Engineering Industry Association (VDMA) and the Association For Advancing Automation (A3).

Furthermore, MVTec is a driving force behind standardization processes to increase its customers' flexibility and to reduce development costs. Therefore, MVTec is a long-term contributing member of the GenICam standard group, and an active member of the GenICam™ group, GigE Vision Technical Committee, USB3 Vision Technical Committee, Official CoaXPress Liaison Group, and VDMA OPC Machine Vision Initiative.

## MVTec Offers Various Services

MVTec offers a wide range of services in machine vision for companies with different needs. Our aim is to enable customers to use MVTec software so that they can deploy successful machine vision projects. Our services team draws from decades of experience in application development and therefore develops comprehensive and cost-effective software solutions based on MVTec's products HALCON and MERLIC.

- Free Application Evaluation
- Feasibility Studies
- Customer Specific Projects
- Trainings & Workshops
- Porting for HALCON

## MVTec Is Part of a Global Network

MVTec products are sold and supported exclusively by qualified and trained partners all over the world. Each partner in our big network has the resources, experience, and training to address your technical and commercial software needs.

### MVTEC IMAGE ACQUISITION PARTNER PROGRAM

In order to provide the best possible integration of hardware and software for customers, MVTec cultivates close partnerships to a large number of suppliers of image acquisition devices.

### MVTEC CERTIFIED INTEGRATION PARTNER PROGRAM

MVTec selects qualified engineering companies, who realize their implementations with MVTec's software products.

### MVTEC CERTIFIED TRAINING PARTNER PROGRAM

MVTec strives to ensure highly qualified support and the best training for its products. For this, the company runs the MVTec Certified Training Partner Program for its sales partners. Members of this program are trained to give specific courses for its products to customers.

HALCON

# Try HALCON FOR FREE!

Download HALCON and contact a sales partner for a free evaluation license or use our free application evaluation service.

www.halcon.com/now


## HALCON Sales Partners

MVTec has a dense, worldwide sales partner network. This enables us to offer qualified partners in all regions.