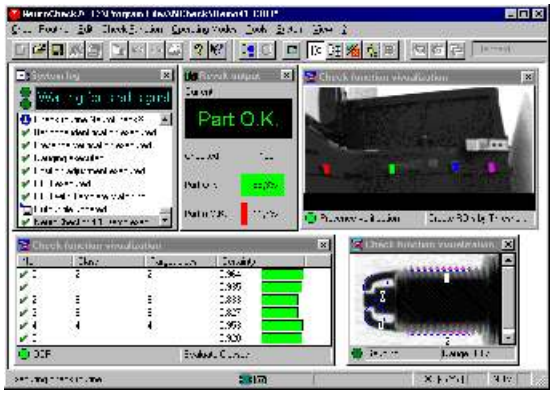
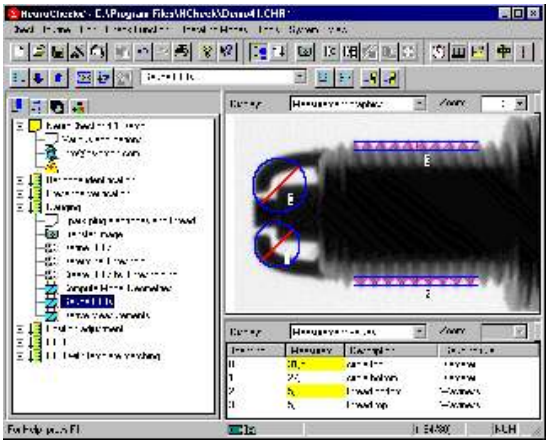
# INTRODUCTION TO NEUROCHECK® FEATURES

*NeuroCheck*® is a general purpose image processing system for industrial quality control. It's designed to meet the requirements of an up-to-date quality management system. Using *NeuroCheck*®, you can check completeness of assembly groups, surface quality and measurements of work pieces, correctness of inscriptions and precise positioning. The *NeuroCheck*® concept with its integration of development and runtime system and Windows™ user interface makes it easy to create image processing applications and reduces cost through easy reconfiguration and rapid turn-around. *NeuroCheck*® combines the advantages of the latest and most powerful machine vision technology with the practical, industrial design and reliability that have made it one of the world standards. It is available both as a separate product, or as the engine for a family of off-the-shelf vision systems.




## *The Concept*

What makes *NeuroCheck*® the software of choice for machine vision applications in quality control is a unique combination of features.

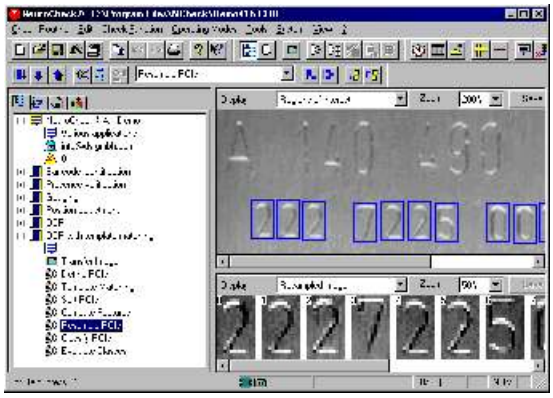


## *Universal*

*NeuroCheck*® encompasses the whole field of image processing. Functions from different areas supplement and strengthen each other. Whatever the type of application, you will be working within the same familiar environment.

## *Interactive*

There is no programming involved; rapid visual point & click development takes the place of time-consuming compile and link cycles. In contrast, library-based solutions require you to implement a dedicated front-end for every installation. This may mean spending hours for achieving correct and stable capture of a camera image, something you can do with a few mouse clicks in *NeuroCheck*®.



## *Integrated*

Check routines are developed directly on the target machine. You do not need a costly specialist to reconfigure your application; simply switch between developing and testing under real-world conditions.

## *PC-based*

Running on the most widespread hardware platform in the world, *NeuroCheck*® lets you benefit from the dynamic cost-performance evolution of the personal computer market. A lot of other image processing systems are based on special processors making you dependent on the technical progress of a single hardware supplier.

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## *Production-tested*

With *NeuroCheck*® you put your trust in software that has been used for years throughout the world in mission-critical inspection systems on the production line. Benefitting from our many years of experience in integrating industrial machine vision systems.

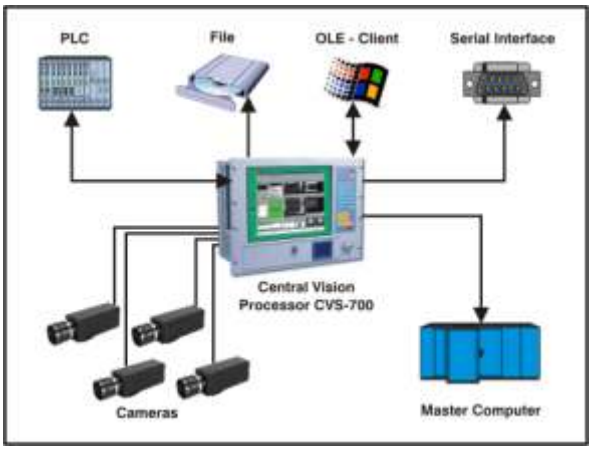
## *Windows compatible*

Do your image processing in the familiar Windows environment, exchanging images and data with all the standard desktop applications. This gives you an image processing system with the comfort and ease-of-use of a laboratory system, combined with all the function necessary for automated production applications.

## *Extensible*

Some things simply cannot be generalized; therefore you can add your own functions to *NeuroCheck*® to give it the little extra touch your application needs.

The following image displays a possible setup of an inspection system realized with *NeuroCheck*®:



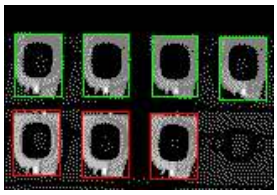

Images from one or more cameras are transferred to the PC via frame grabber boards. *NeuroCheck*® then analyzes the image, yielding results like measurement values, like size or distance of objects within the image; optical properties, like brightness or contrast of objects; identified texts or bar codes; or simply the statement: "Part O.K." or "Part not O.K.".These results can be passed on through various channels, e.g. via digital I/O boards or the serial interface directly to a PLC or master computers, or to files, which can be read by standard software like spreadsheet programs. *NeuroCheck's*® communication channels can also be used to remote-control the software. PLC and master computer can trigger the inspection process according to the production cycle time, switch check routines depending on the type of work piece to be inspected etc. Thus it is possible to achieve fully automatic inspection of every single item produced.

## *Application Areas*

Because of the integration of functions for many different areas of digital image processing under the same intuitive user-interface, *NeuroCheck*® can be applied cost-effectively even in small companies, since you can easily transfer the experience gained from one application to the next. This page shows some typical application areas.

## *Presence Verification*

The question to be answered in a presence verification problem is, whether a product is complete with all required components. As an example the image displays a palette of car parts with one part missing in the second row. *NeuroCheck's*® integrated concept enables you to check the detected objects for validity using all available features, even a neural classifier.



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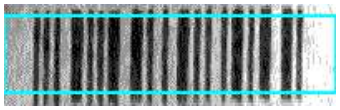
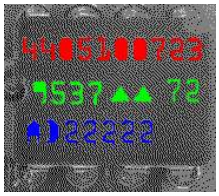
## *Bar Code Identification*



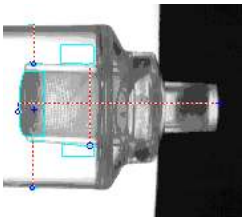
Bar code identification is especially important for process control in production systems. From the bar code the type of the work piece can be determined and control further inspection processes. *NeuroCheck's*® bar code algorithms provide reliable recognition of all standard bar code types even for very poor quality conditions, such as an ink-jet bar code on a metal surface.

## *Pattern Recognition*



Parts can also be identified by readable letters or arbitrary symbols instead of bar codes. The neural networks used by *NeuroCheck*® can learn from examples to recognize arbitrary patterns, enabling you to tune the recognition process to your particular application.

## *Gauging*

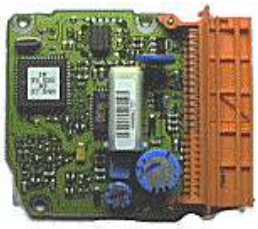


Gauging is a very important area of digital image processing. With *NeuroCheck*® you can measure dimensions of individual objects as well as distances between objects and properties of whole object groups. Depending on the camera's field of view, a precision of 5 to 10 micrometers can be achieved.

## *Print Quality Inspection*


Not only can *NeuroCheck*® recognize defects of printed labels, like malformed characters or color spots, the print quality inspection functionality can also be used to check the correspondence of the current image to any kind of reference image.

## *Color Matching*



A completely new range of applications for *NeuroCheck*® is opened by Color Matching. On the basis of user-defined reference colors, areas of different colors can be identified immediately. Do not only verify the presence of a component, but simultaneously its color. Besides, Color Matching often represents the only method to distinguish between equally shaped, but differently colored objects. Converting the full color images into gray scale images enables color inspection applications with the speed and efficiency of a highly optimized gray level system.

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### *Hardware support*

- Several frame grabber boards, each with several individually configurable camera inputs.
- Digital communication via 16 inputs and 16 outputs channels per digital I/O board.
- Field bus.
- Serial communication with fully documented protocol
- Communication with arbitrary peripherals via interface for custom communication DLLs.

### *Cameras*

- Standard CCIR/EIA video cameras.
- Asynchronous cameras for parallel image capturing and processing in high-speed applications.
- Line-scan cameras for large or rotating objects.
- Digital matrix cameras for high-precision gauging.
- Retriggerable progressive-scan cameras
- PAL/NTSC color cameras.

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### *Automatic operation*

- Start of check, type change and result output via digital I/O, serial interface and custom communication.
- Unlimited number of configurable screen layouts for each check routine.
- Target value input in automatic mode.
- Several digital I/O boards and field bus for remote-control.
- Configurable serial protocol (standard protocols upon request).

### *Security*

- Unlimited number of user profiles.
- System-wide password protection encoded in hardware key for maximum protection; program will not run without correct combination of hardware key and password.
- User activity logging according to ISO 9000.
- Separate password protection for individual check routines.

### *Data output*

- Automatic storage of error images for each individual check.
- Output of all measurements and classification results via serial interface or custom communication.
- Output of all results in standard formats (Excel, Lotus, ASCII) to file (also on network drives).
- Exchange of result images via clipboard or drag & drop.

### *Tools*

- Easy-to use device manager for managing all image processing and communication hardware with wizard-guided installation procedure.
- Full screen live image in application window.
- Reference image for easy camera adjustment in automatic mode.
- Gray level analysis for adjusting exposure.
- Dialog-based test of all communication devices.
- Application-specific designation of interfaces and functions.

## Image Processing Functions

### *Tools*

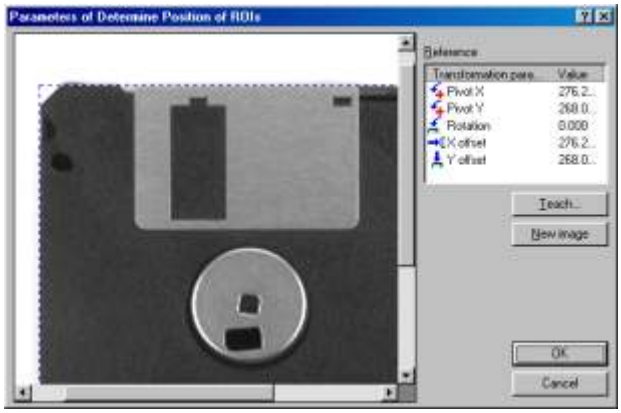
- *Delay Execution.*
- *Read Digital Input.*
- *Set Digital Output:* individual outputs or complete bit patterns.
- *Calibrate Pixels:* converts pixels to metrical units.

### *Image Acquisition*

- *Capture Image.*
- *Capture Image Asynchronously:* starts image capture in parallel to running check for high-speed applications.
- *Transfer Image:* transfers arbitrary image sections to host memory for further processing.
- *Transfer Image to Tray:* stores image sequences for later processing.

### *Position Adjustment*

- *Determine Position:* computes the current position of one or more reference objects in the image. X offset, Y offset, rotation angle and pivot point can be determined separately.
- *Position ROIs:* adjusts the positions of search regions according to the reference objects.

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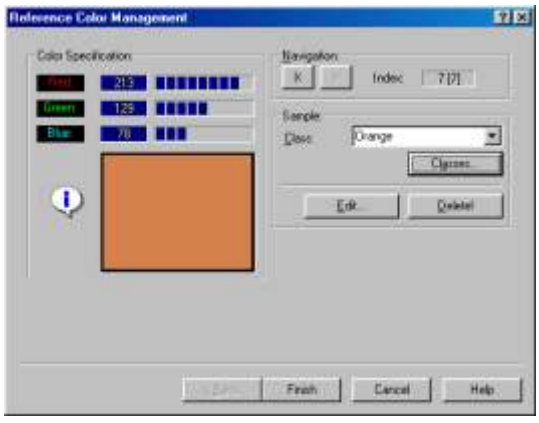
## *Image preprocessing*

- *Rotate Image.*
- *Copy Image.*
- *Enhance Image.*
- *Shading Correction.*
- *Apply Look-Up Table to Image* (linear, inverse, quadratic, square root, Gaussian, user-defined)
- *Combine Images*
  - Addition (with clipping)
  - Average
  - Subtraction (absolute, relative, positive, negative)
  - Maximum
  - Minimum
- *Filter Image:* appr. 50 predefined filters (including standard smoothing filters, morphological filters, edge detection, Sobel-Magnitude, top-hat and Gaussian filters); filter kernels can be edited at will and combined with various filter algorithms to adapt the standard filters to specifically to the application, if necessary.
- *Unroll ROI:* transforms arbitrarily shaped image regions into rectangular images. Smooth ROIs: special two-stage filtering of image regions for improved edge detection.
- *Draw ROIs:* fills objects or background with uniform gray level.

## *Color Analysis*

*Color Matching:* adaptive color space transformation for distinguishing arbitrary colors




## *Image analysis*

- *Define ROI:* defines rectangular, polygonal and circular regions for further analysis.
- *Determine Threshold:* computes optimal segmentation thresholds for every single region of interest. Range thresholding is also possible to mask bright and dark background areas simultaneously.
- *Create ROIs by Thresholding:* extracts complete objects, object parts or single edges (with subpixel precision)
- *Create Edges:* fast detection of subpixel precise edge points using an edge model, especially for gauging applications.
- *Template Matching:* searches objects based on similarity using correlation. Templates can be created interactively and optimized to the current patterns. Search is accelerated by using a pyramidal algorithm with adjustable step size.
- *Copy ROIs.*
- *Combine ROIs:* concatenates objects from different search stages for joint analysis.
- *Count ROIs:* counts objects and compares object count to target values specific for different object groups.
- *Compute Features:* computes object features, like
  - Coordinates of center of gravity
  - Coordinates of enclosing rectangle
  - X and Y dimension
  - Ratio of height to width
  - Length and direction of first and second axis
  - Average, minimum and maximum radius; angle between radii
  - Perimeter
  - Area
  - Form factor
  - Fiber length, width and elongation
  - Border contact (general and individual for each border)
  - Number of enclosed objects
  - Average, minimum and maximum gray level
  - Contrast
  - Standard deviation of gray levels
  - Average and maximum gradient
  - Standard deviation of gradient

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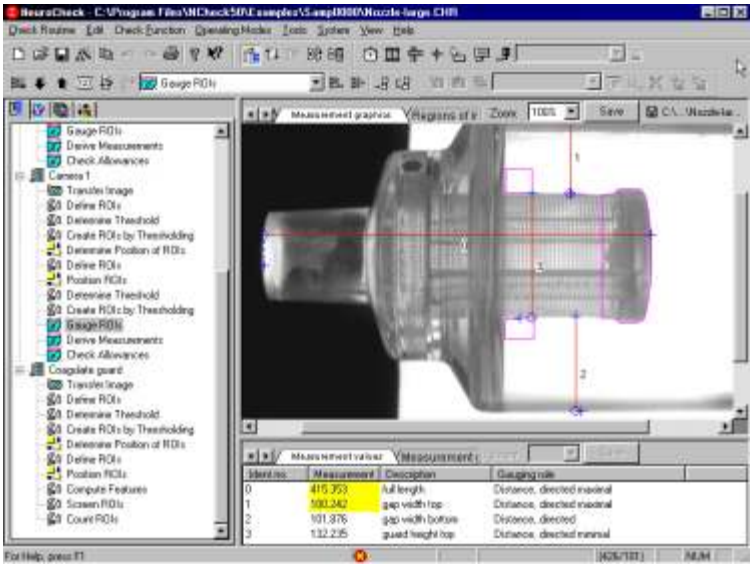
## *Image analysis (continued)*

- *Compute Curvature:* determines, average, minimum, maximum and standard deviation of the curvature of object contours, optionally for the whole contour or for concave or convex regions only (in preparation)
- *Sort ROIs:* sorts object groups by features, ascending or descending, with definable limits, e.g. only the four largest objects or the six medium-sized etc.
- *Screen ROIs:* checks validity of objects with respect to arbitrary combinations of features with adjustable limits.
- *Resample ROIs:* generates normalized object representation for classification.
- *Classify ROIs:* divides objects into classes, using all available features, e.g. to recognize characters or to distinguish arbitrary patterns.
- *Evaluate Classes:* compares object classes from Classify ROIs, Template Matching and Color Matching with target classes.
- *Identify Bar Code:* recognizes all standard bar codes (Code 39, Code 2/5i, UPC, EAN, PZN, ...) forward and backward under arbitrary angles of rotation.
- *Print Quality Inspection:* difference image computation with sophisticated three-stage positioning algorithm, fully configurable.

## *Gauging*

- *Compute Model Geometries:* calculates circles and straight lines, approximating object contours.
- *Gauge ROIs:* computes geometrical measurements for one or more objects (optionally with sub pixel precision and automatic rotation adjustment according to reference position computation):
  - Coordinates of center of gravity
  - Average, minimum, maximum radius of contour or model circle
  - Direction of model line
  - Waviness of contour with respect to model line
  - Diameter of model circle
  - Distance between object centers
  - Distance between object centers in pre-defined direction, optionally with respect to orientation
  - Minimum and maximum distance between object contours
  - Minimum and maximum distance between object contours in pre-defined direction
  - Minimum and maximum distance of overlapping pieces of object contours in pre-defined direction
  - Minimum and maximum distance between object contours and model circles
  - Perpendicular distance between object centers and model lines
  - Distance between objects and model lines in pre-defined direction



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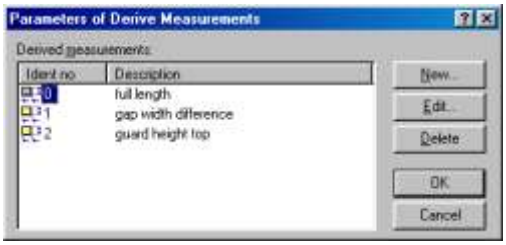
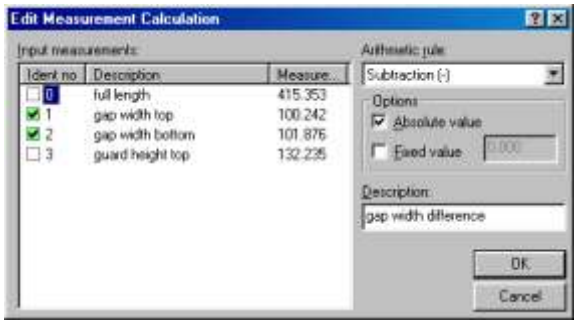
*Gauging (continued)*

Minimum and maximum perpendicular distance between object contour and corresponding model circle or model line
Parellelism of object contour and model line
Intersection coordinates of two model lines
Intersection angle of two model lines
Average, minimum and maximum distance of contours with respect to the bisection of their model lines
Concentricity of model circle
Angle of lines connecting three objects




- *Derive Measurements:* computes sum, difference, product, ratio, average, minimum, maximum, sum of squares, square root, and standard deviation of arbitrary combinations of geometrical measurements
- *Combine Measurements:* concatenates lists of measurements from different gauging stages for joint evaluation.
- *Calibrate Measurements:* Converts measurements to metrical units with automatic recalibration according to one or more reference objects.
- *Check Allowances:* compares every measurement to a target value with upper and lower allowance, optionally absolute or in percentages.

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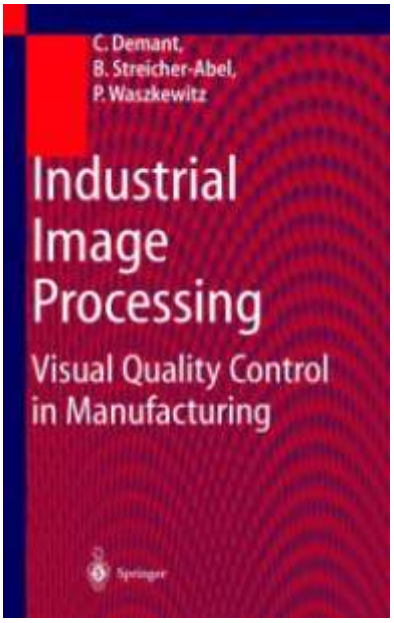
*"Industrial Image Processing": The Book*

Available from: Springer-Verlag (Berlin Heidelberg New York), ISBN 3-540-66410-6




Available since March 1998 in German, the English version released now: the book on visual inspection for industrial quality control, edited by the managing directors of DS GmbH, Christian Demantand Bernd Streicher-Abel, and the director of TechSupport, Peter Waszkewitz. In contrast to other digital image processing books on the market, this volume demonstrates how the various methods work together in real-world applications instead of stringing together isolated algorithms and formulas. DS GmbH's years of experience in developing industrial vision systems resulted in a completely new kind of introduction to the practical application of digital image processing. Treatment throughout the book is based on real-world problems, addressing the industrial practitioner as well as the student interested in modern methods of automated production and quality control. Of course, theory and algorithms are not neglected, but the focus is always on the practical application. A demo version of NeuroCheck together with comprehensive image material enables the reader to do his own experiments on real-world images from industrial production. "Actually," said one of the editors, "we wrote the book I would have liked to get my hands on when I started working in this field."

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