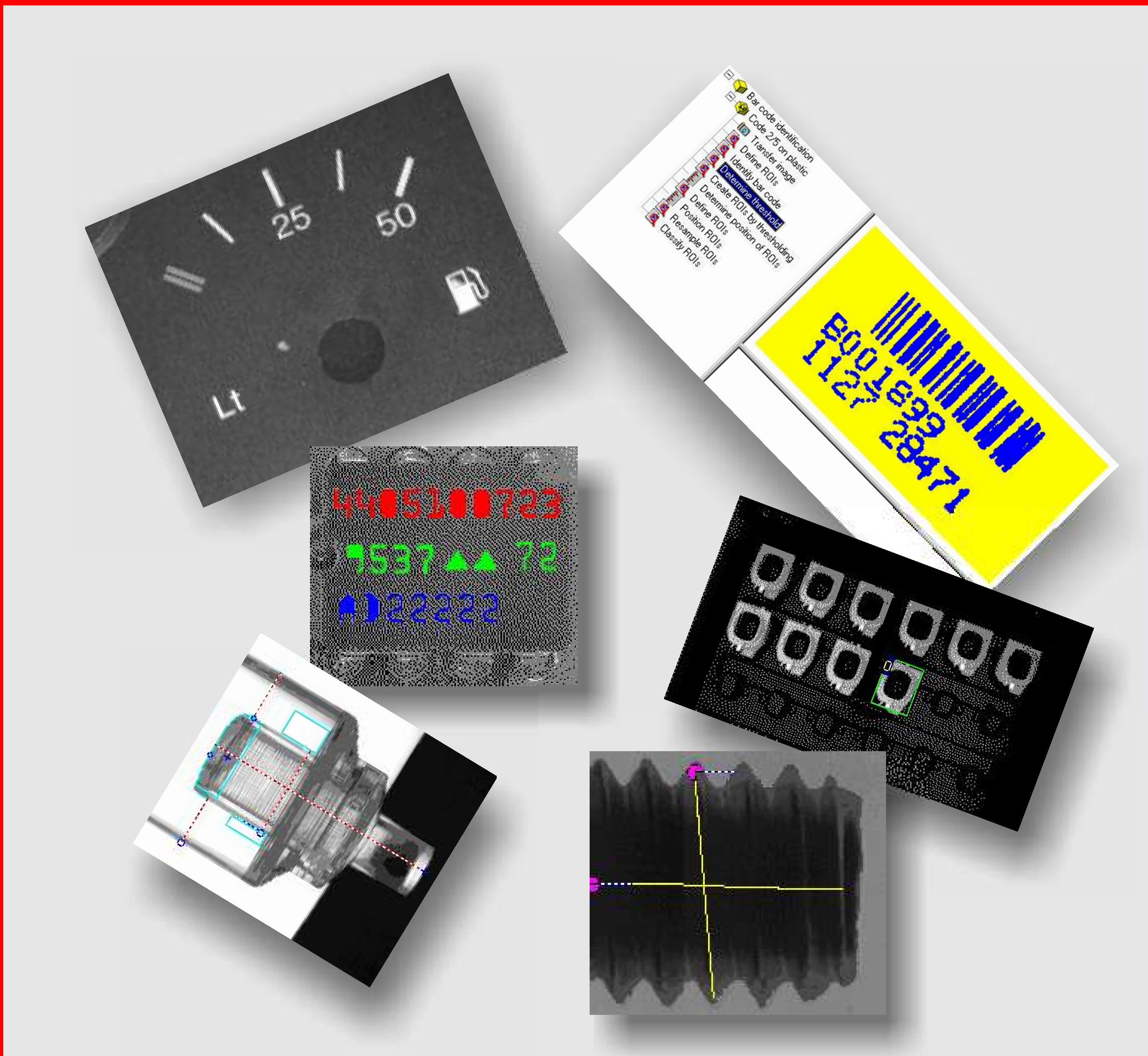
POWERED BY NEURO CHECK Industrial Vision Systems

APPLICATION NOTES



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.

FSI Machine Vision

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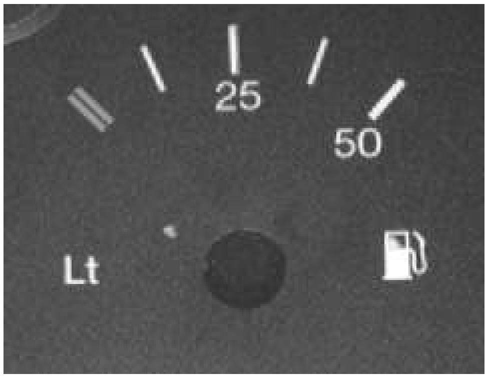
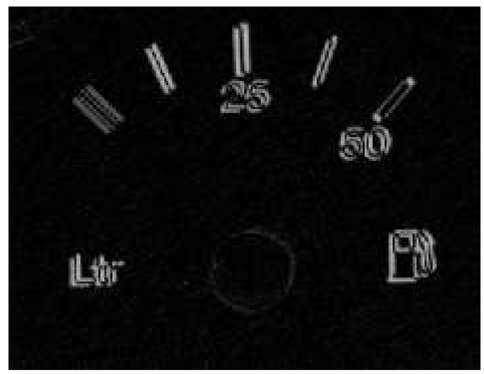
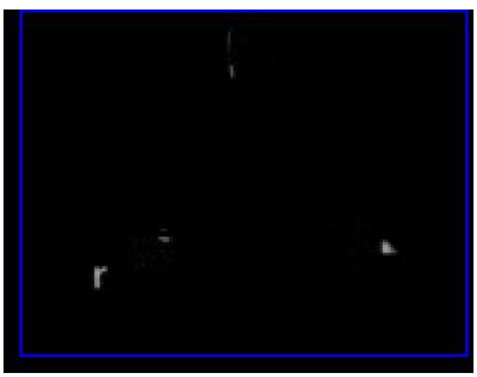
APPLICATION: PRINT QUALITY INSPECTION



This image shows a section of a dash board with some printing defects. The "r" of the "Ltr" mark is missing and the fuel pump exhibits a white spot in its display area.



Typically, the basis of a print quality inspection is a difference image, containing the differences between the current test piece and a reference image. The creation of a difference image for print quality inspection or any other type of reference image comparison is far from trivial. Because of positioning and image capturing inaccuracies, edges are practically never aligned precisely so that a simple subtraction would lead to the detection of severe pseudo errors along the edges. This is illustrated by the adjacent image. The pronounced errors are due to a misalignment of a perfectly correct print.



To deal with this problem, *NeuroCheck's*® Print Quality Inspection function uses a highly configurable, sophisticated three-stage positioning process and also adapts to the structure size of the objects to be checked. The parameters can accommodate any desired distinction between tolerable and inadmissible defects. Furthermore, the type of error (missing print, additional ink, both)may also be selected. The image shows detection of all defects by a hierarchical template matching algorithm.

Due to the consistent object-oriented approach of *NeuroCheck*® you are not restricted to a single inflexible function when building print quality inspection applications. The difference image can of course be analyzed with the full range of functions in *NeuroCheck*®.

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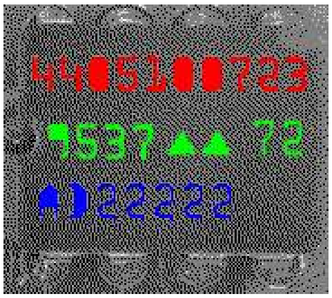
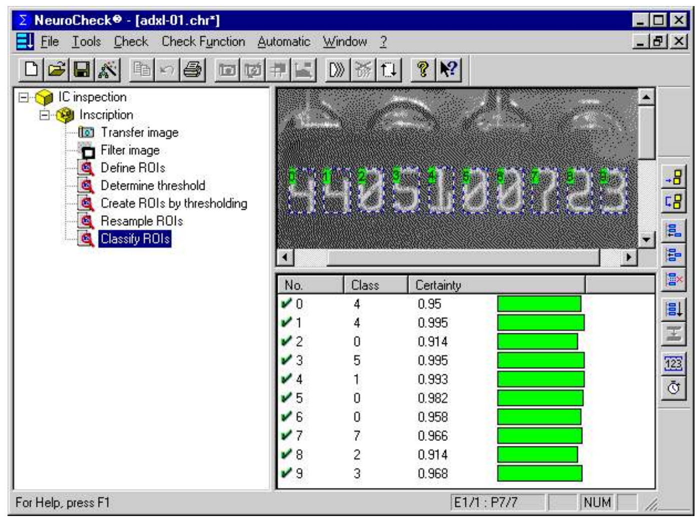
APPLICATION: CHARACTER RECOGNITION

Reading an Integrated Circuit Inscription

This sample application deals with reading the inscription on an integrated circuit (IC). The image displays the IC after the *NeuroCheck*® check routine has segmented the characters.



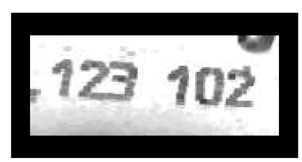
The original size of the IC is just about 0.25cm^2. Because the IC is used in air bag controllers, the inscription of every single IC has to be read prior to delivery of the circuit board. The main difficulty in this application consisted in light reflections from the circuit board, which interfered strongly with the segmentation of the characters from the background. This problem was solved by a circular illumination using polarized light. In addition, the image was subjected to a median filter prior to analysis to compensate for variations in the print quality. The system was then able to read the characters perfectly. This image shows the simple straightforward construction of a character recognition application in *NeuroCheck*®.



Needle-Stamped Digits on Metal

In this sample application, we present the possibilities opened by the template matching functionality. Needle-stamped characters are often used to mark on metal parts, because of their robustness. Unlike ink-jet characters, they are very hard to remove again and easily survive subsequent manufacturing processes and the rough environmental conditions in metal-working factories. Unfortunately they are also hard to recognize for an image processing system, because they tend to disintegrate into single points instead of contiguous, unbroken lines.

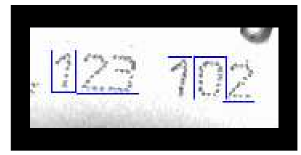
There are two ways to solve this problem:



1.Use a morphological filter, erosion or opening in this case, to widen the individual needle-marks until the lines become unbroken. This approach causes several problems. First of all morphological filter processes tend to be quite time-consuming. Furthermore, as can be seen in the image below, the 2 and 3 in the above image will easily be fused together by the filtering process. Although *NeuroCheck*® allows you to define highly specialized filter kernels adapted to the geometry of specific image structures, there would be a very difficult tradeoff between the requirements of the different

APPLICATION: CHARACTER RECOGNITION (continued)

2.Use template matching. This function has become available recently in *NeuroCheck*® (if you need this function and do not have the most recent version, contact your distributor). It searches for objects within an image based on the similarity of image regions to predefined templates. You can easily define templates tailored to your application by presenting some typical images to *NeuroCheck*® and indicating the template patterns using the mouse, as shown in the image below. *NeuroCheck*® will then search for a specified number of patterns in the image exhibiting a minimum similarity to the defined templates.

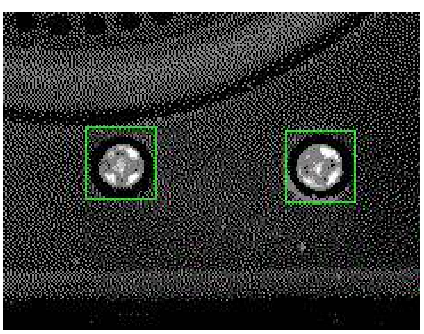


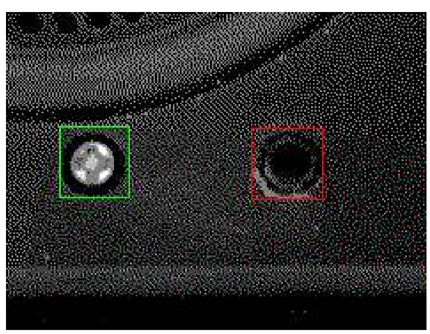
Despite the obvious differences in the appearance of the digits, a single template per digit class proves to be sufficient to detect all digits reliably, as in the following image. Recognizing the precisely located digits is then no problem at all.

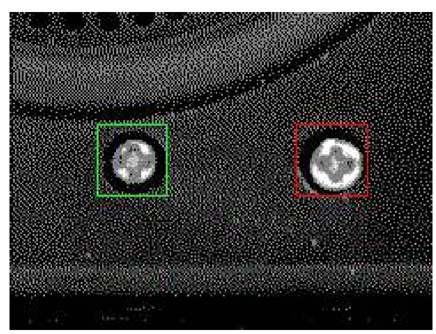
APPLICATION: PRESENCE VERIFICATION

Screws in Plastic Casing

In this sample application, we present two ways to detect the presence of screws in the plastic casing of a portable cassette player. The important point in this application is the essential equivalence of image objects and regions of interest in *NeuroCheck*®. Many people fail to see this, because it is such a new and unusual way of thinking, but we believe, this really constitutes object-oriented image processing: not simply programming in a certain language, but using a consistent object model throughout each image processing function. Only in this manner you can reach the degree of interoperability and interactivity offered by *NeuroCheck*® and create a system, in which each building block can work together with all the others to achieve hitherto unknown flexibility.


All screws present


One screw missing


One screw unfastened

The most obvious way for people familiar with *NeuroCheck*® would be to search for the dark casing, which is kind of hard to miss, then go on searching for light objects within the casing, compute some features of these objects (like their size and area and shape parameters) and decide whether two of them are the required screws. This is of course a perfectly viable solution, but the twofold object search and the evaluation of the objects takes some time: 60 milliseconds on a Pentium 133 (not including image capturing, whose duration with a standard camera may vary within the video frame rate).

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APPLICATION: PRESENCE VERIFICATION (continued)

But it can be done within 16 milliseconds by using a vertical edge as position reference to place two regions of interest where the screws have to appear in the image. The presence of the screws can then easily be determined by the brightness inside the rectangle. It is even possible to detect a partly unfastened screw, because it sticks out and reflects too much light. Combine this with a DT3152 frame grabber and *NeuroCheck's*® parallel image capturing capability and you get a real-time inspection!

Once again: whatever you can do with an object found in the image scene, you can also do with a manually defined region of interest. Of course, manual regions will behave differently in some respects, e.g. their position and size are fixed, but in all practical aspects they can be interchanged, and this is the cornerstone of the *NeuroCheck's*® versatility.

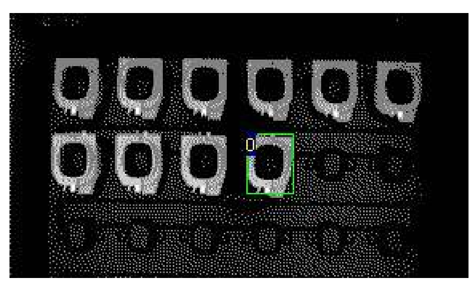
Of course, there are other, more traditional ways of performing such an inspection. It is of course possible and at first sight perhaps even cheaper to build a mechanical solution ,such as inductive calipers. But think of the future! A day will come, most probably not very far away, when the screws will be at a different position. You would be forced to a costly and time-consuming reconstruction of the mechanics, whereas moving the regions of interest in *NeuroCheck*® is a matter of minutes. And it does not end there: the next day someone will want an inscription on the casing to be read, and how will you do that with a caliper?

APPLICATION: ROBOT GUIDANCE

Picking Car Parts From a Crate

This sample application touches many industrial areas. It shows once again how the flexible combination of seemingly simple building blocks in a general-purpose system can solve many problems often though to require specialized single-purpose machines.

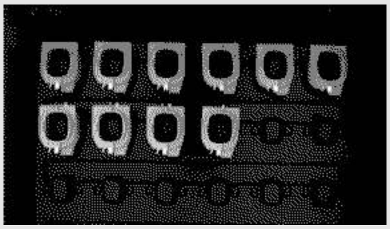
The image shows a (mostly empty) crate with car parts. The objective is to transmit the position of the last part present to a robot so that the robot can take the part out of the crate. The last part in this case is defined by the Western way of reading: row-wise from left to right.



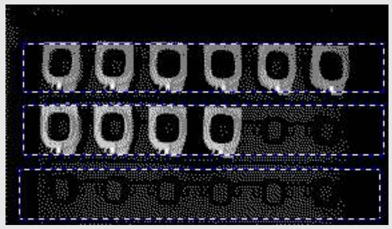
The solution with *NeuroCheck*® is very simple. The position of the crate before the camera is quite stable making it possible to place a region of interest over each row of possible part positions. Then all bright objects of the required size are searched. Making use of *NeuroCheck's*® group concept and the flexible parameter settings of the sort functions these rows of objects are sorted individually in such a way that only the object with the highest x-coordinate is left. The remaining objects are again sorted - globally this time - leaving only the object with the highest y-coordinate. This has to be the required last part. Its coordinates can now be transmitted via serial interface to the robot controller.

APPLICATION: ROBOT GUIDANCE (continued)

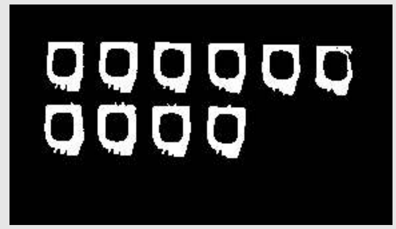
The following images show the processing steps in *NeuroCheck*®.



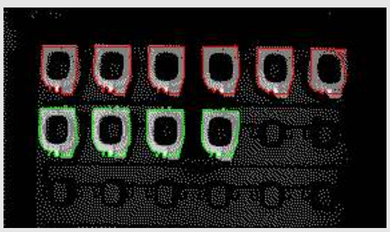
Step 1



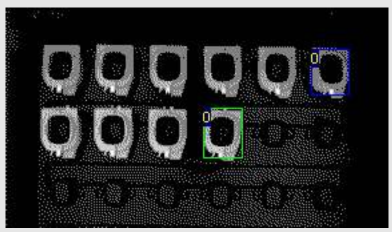
Step 2



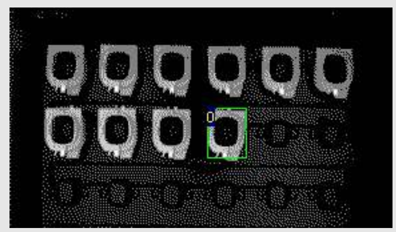
Step 3



Step 4



Step 5



Step 6

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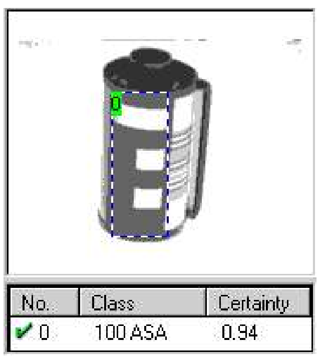
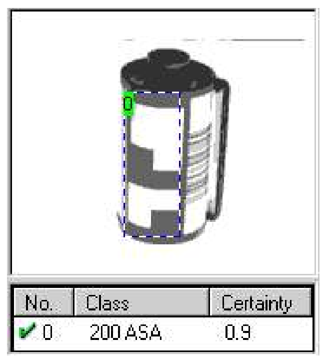
APPLICATION: PATTERN RECOGNITION

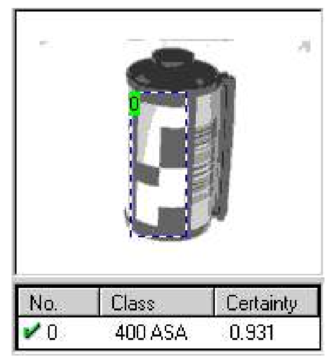
Film Roll Coding

In this sample application, neural networks are used to recognize the block coding on rolls of film.

The whole check requires about 30ms processing time on a 133 MHz Pentium including image transfer. Using *NeuroCheck's*® parallel image capturing capability, more than 20 rolls can be inspected per second, including identification of the bar code.







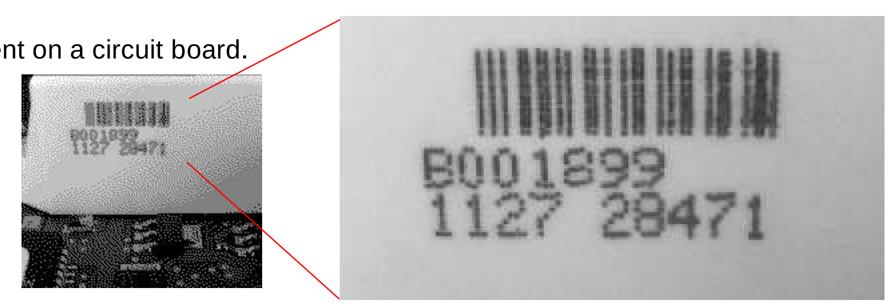
The images show the classification results on three different rolls of film. *NeuroCheck*® classifies all three codes perfectly, displaying a certainty of more than 90 %.

APPLICATION: PATTERN RECOGNITION

Bar Code Identification: Poor Quality Ink Jet Bar Code and Characters

This sample application demonstrates the power of *NeuroCheck's*® integrated concept as opposed to "dumb" special purpose machines. Of course you can use a low-price scanner for identifying a bar code, but as you can see from the image, *NeuroCheck*® can handle bar codes of quite poor quality without problems. In addition to bar code reading it can do many things a scanner simply is not capable of: perform preprocessing on the image, compute properties of image objects, send position parameters to a robot control system and in this case read characters.

The image shows an electronic component on a circuit board.



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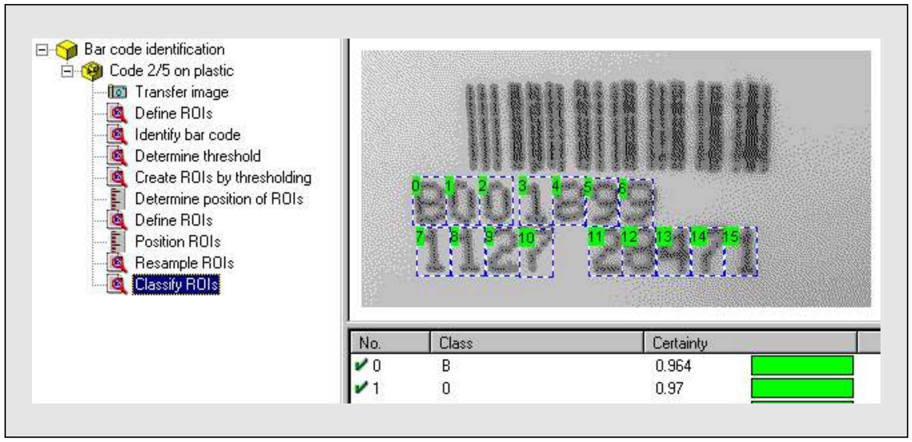
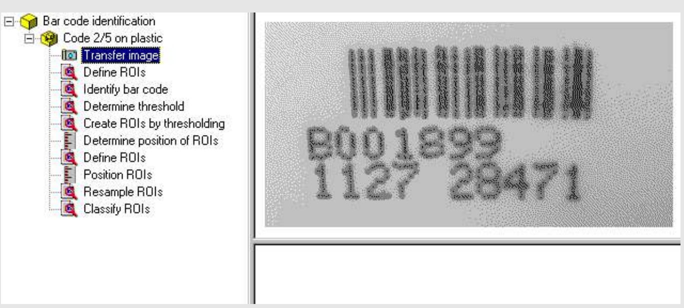
APPLICATION: PATTERN RECOGNITION

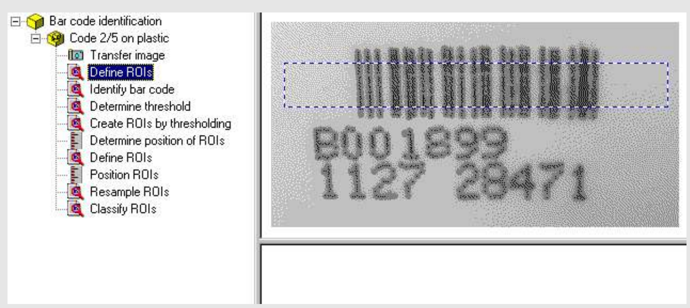
Not only is *NeuroCheck*® able to read the poorly printed bar code without any problems, it can also use the bar code as a position reference for the characters. The bar code, seen as a single image object, is very easy to find. *NeuroCheck*® is able to compute the position and orientation of this whole group of black lines with very high precision and use this as a reference for regions of interest used to identify the printed characters and digits below the bar code. The image shows the final processing stage with the classification results for the first two characters. As you can see, *NeuroCheck*® identifies the characters with remarkable certainty. And now compare the few steps required to solve this application in *NeuroCheck*® with the programming effort required for realizing such an application with an image processing library - and keep in mind that, in addition to the image processing functionality you see here, *NeuroCheck*® offers a powerful Windows user-interface, parallel and serial communication, visualization, standard file format output... without any extra effort!



The following sequence of images shows the processing steps in *NeuroCheck*®.

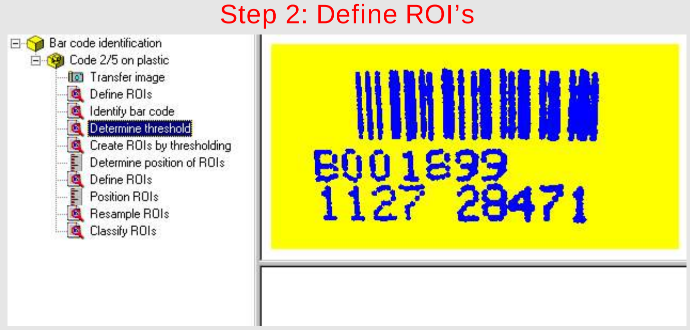


Step 1: Transfer Image



Step 2: Define ROI's

Step 3: Identify Bar Code



Step 4: Determine Threshold

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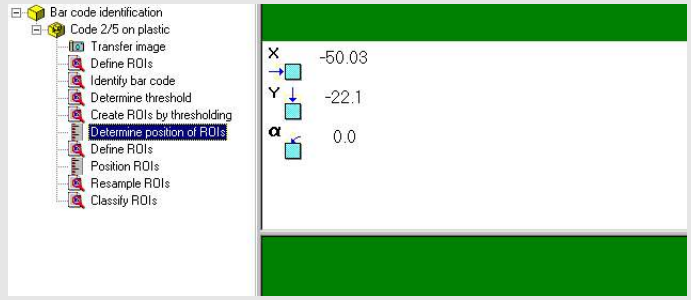
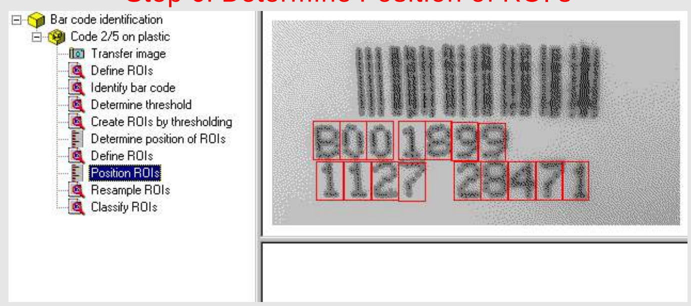
APPLICATION: PATTERN RECOGNITION (continued)

Step 5: Create ROI's by Thresholding

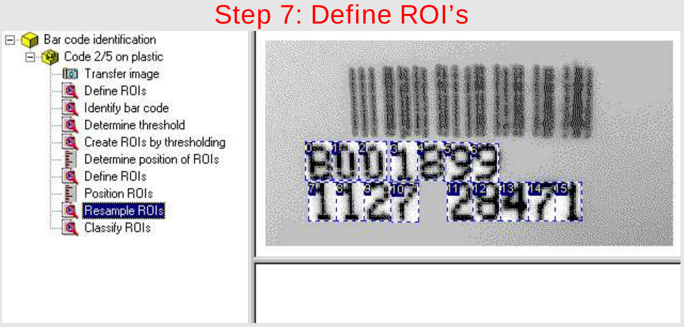


Step 6: Determine Position of ROI's

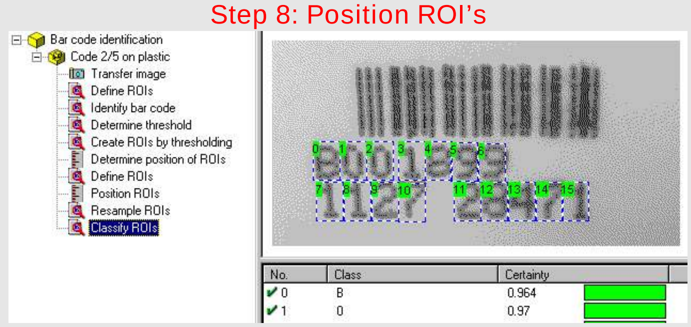
Step 7: Define ROI's



Step 8: Position ROI's



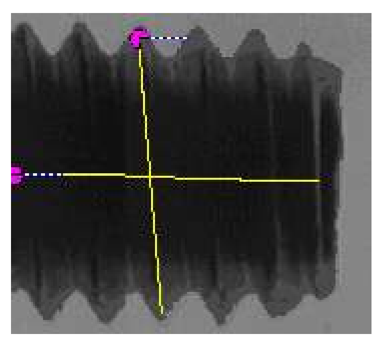
Step 9: Resample ROI's



Step 10: Classify ROI's

APPLICATION: GAUGING

Screw Pitch

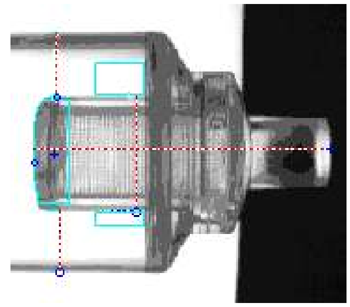


The topic of this sample application is screw gauging. The image displays a screw with the relevant measuring lines.

The backlighting gives a clear contour image, from which first the complete screw is created as a separate object, then two corresponding teeth of the outer contour. A straight line connecting the tips of the teeth is computed and measured against the axis of the screw to determine the thread pitch. The advantage of this method is that the screw has

APPLICATION: GAUGING (continued)

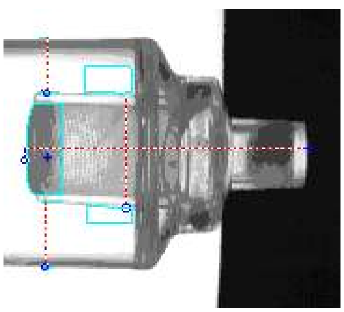
Medical Technology: Nozzle Gauging



In this application, correct assembly of a sight-feed nozzle has to be checked. The image displays a correctly assembled nozzle with the relevant measuring lines.

Such a nozzle is used for medical infusions. The sieve inside the nozzle acts as a protective guard against coagulations or other particles that must not enter the patient's blood circulation. It is therefore extremely important that this sieve is mounted correctly. Several measurements are used to verify this:

- Distance of the sieve bottom from the top of the nozzle (about 35mm) must not differ by more than 4mm.
- Width of the sieve must not be below a certain value.
- Distance of the sieve from the wall must not differ by more than 1mm on both sides.



The nozzle is captured with two cameras, one horizontal, the other vertical, in order to measure deviations in any direction.

This image shows a nozzle with a lop-sided sieve, which has been rejected because of different distances of the sieve from the nozzle wall.

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