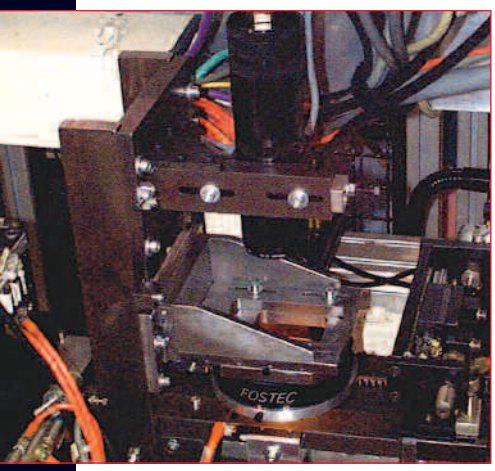
INDUSTRIAL VISION SYSTEMS LTD

CASE STUDY



How Machine Vision Can Replace Mechanical Inspection Systems

Car manufacturers have always played an important part in the area of quality control. This is partly due to the safety aspects relating to the automotive industry where trace ability of components is key. Digital image processing has now become a standard tool where100% quality control is needed and the tracking of manufactured parts, even many years after they were initially made, is essential.

In the last few years the costs for vision systems has fallen dramatically and coupled with the enhanced capability and ease of operation, the area of industrial image processing for optical quality control has greatly increased.

The Krupp Gerlach Company in Danville, Illinois, USA, manufacture cam parts for the automotive industry where trace ability is required. This is completed by a unique code on the part, which is created by etchings on the surface in a number of key areas. The type and position of these etchings creates a unique ID number for the part. Illustration 1 shows two typical parts and here you can see the already inherently difficult problems with picking up such marks. The punched area in the wide part of the upper edge surface has only a low contrast and yields a course edge.

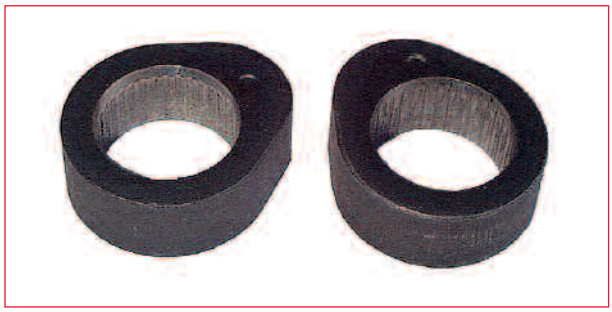


Illustration 1

The choice of vision system for Krupp was influenced by the following factors:

1. **Extensive lists of parts**, therefore the system must adapt to different set-ups for different parts.
2. **Simple ergonomics**, i.e. the operators on the shop floor must be able to understand and use the system.
3. **Long-distance monitoring**, to avoid expensive servicing of the system it must be capable of integration via the Internet
4. **Versatility**, the system may need to be adapted to tasks in the future, which are currently not known.

Based on these constraints they chose to use NeuroCheck,, a standard tool for machine vision from Industrial Vision Systems Ltd, developed by sister company NeuroCheck GmbH in Germany. Using this software they knew that maintenance of the system and set-up would be simple. Since it is a fully integrated Windows application, the software can benefit from the standard versatility of the operating system.

Vision Cell Design

A crucial element to getting any inspection process correct is the lighting arrangement. Tests were performed on the cam parts and dark field illumination was found to provide the best contrast. A suitable ring light was selected for the task, which had to be big enough to illuminate the part, but without restricting the view from the camera.

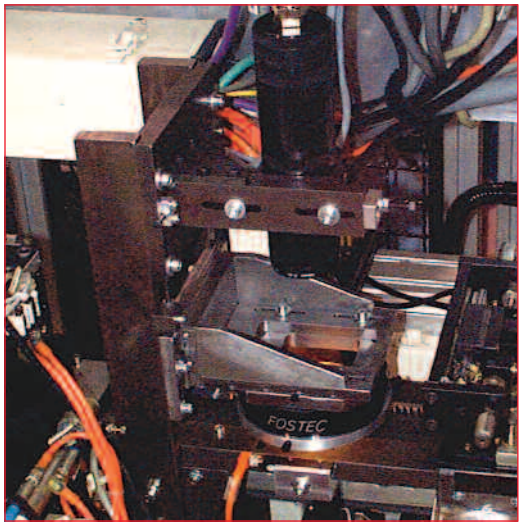


Illustration 2

The camera used in the vision cell was a standard high-resolution monochrome 60Hz type. Since the production line was running quite slowly (0.3s) there was no need to externally trigger the camera. Illustration 2 shows the completed solution in one of the assembly lines.

The entire vision solution including the communications with the PLC was handled by NeuroCheck, in an industrial rack mount PC, 1 per line.

The PC's were equipped with modems for remote maintenance of the system by Krupp's engineers overseas and were suitably password protected to stop illegal entry to the systems.

Vision Solution

During the development of the system the versatility of NeuroCheck, soon became evident. The solution developed in the pilot tests had to be changed twice, completely altering the mounting and production conditions but the core of the check routine was easily adapted to the changing environments. This meant the time between the development stage and final production was greatly reduced.

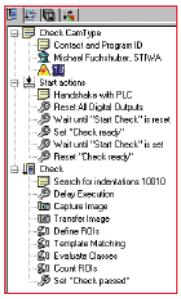


Illustration 3

As illustration 3 shows, a check routine with a simple structure was written but had the full flexibility to cope with any changes to either the communication with the PLC or in the components themselves. The solution consists of 2 separate sections. The first, the so-called 'start actions' are necessary only for communication with the PLC. This is where the various digital handshaking signals are set. The individual functions are labelled with user-defined names to give the operators of the system a better understanding of the check routine.

The second section is where the actual image processing takes place. The check routine executes in the following way:

Delay Execution

This is where a delay is implemented. The system waits for slightly more than a video frame so that the parts can come completely to rest. This prevents any movement within the image. This could also be achieved by shuttering but this could prove costly, as the lighting arrangement would have to be changed.

Capture image /Transfer image

The image is then captured and transferred into NeuroCheck. The size of the region to be transferred can be adjusted to suit the application.

Define Regions of Interest

For each of the possible encoding positions, an individual work area is defined for further processing. In the course of the development cycle, it was found that the positioning of the parts was sufficiently precise. Therefore, an additional position correction on the basis of the global position of the part was not needed. Illustration 4 shows the defined areas superimposed onto the parts. The areas are coloured differently in order to indicate that each area is treated individually in the further course of the check routine.

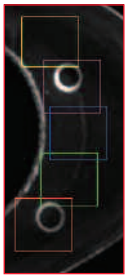


Illustration 4

Template Matching (model comparison)

For each of the defined regions a template is produced and saved. Multiple templates can be saved to increase the detection certainty although for most applications no more than ten are usually needed. These templates are then used to compare each new part in turn. Brightness compensation and sub pixel correlation can also be used to enhance the matching process as well as assigning different classes to the individual regions. In this particular application the customer was achieving about 90% accuracy.

In illustration 5 you can see the varied templates that have been saved but NeuroCheck, is able to cope with the differences in brightness and image clarity.

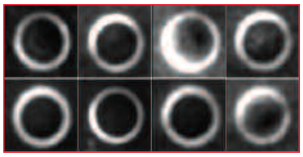


Illustration 5

Evaluate Classes, (classes appraised),

In this function the classes created in template matching are again used to check that the right match has be found .The specific classes needed can also be verified in the correct sequence to improve the overall accuracy. Due to the group function being checked in the “Define ROI” each region has it’s own class evaluated.

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Count Regions of Interest, work areas count

Here each region is then counted and verified against the correct quantity. In the case of the Krupps check, each region will either give a 1 or 0 thus producing a binary code. In illustration 6 you can see two examples of the cams.

In the picture on the left the sequence is 10010 which is equal to 18.This is the correct sequence for the routine as you can be seen by the green boxes. We can assign individual routines to specific cams by setting the check I/O number to correspond to the correct output code. The PLC can then be programmed to call the appropriate check depending on what is going through the line. As you can see on the right hand illustration this cam is not a number 18 so would fail the check.

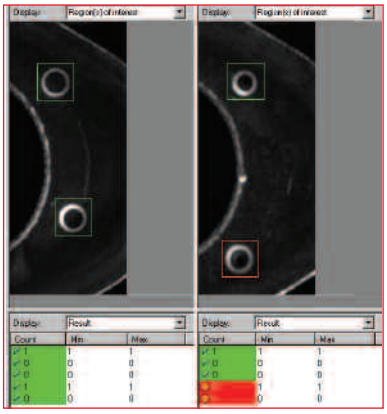

Illustration 6

Results

After the initial trials the new system was an improvement by a factor of 5 over the mechanical inspection system that was previously used. After a few months of operation that figure was up to 20 as both the Neurocheck, and Krupps engineers carried out optimisation of the system.

The crucial factors to the success of the project were; a good dark field illuminator set-up that could be adjusted during the trial phase, the flexibility of NeuroCheck, and the continued development of the routine by the engineering teams. It was also critical that images of bad parts were saved as the system could then be improved. This could be done very quickly by the tech support engineers at Neurocheck, and the changes then sent on line to Krupps.

The Krupps vision system is a typical example of how vision can replace a mechanical inspection system and bring with it increased productivity, traceability and reliability.

It has also decreased the overall PPM count of the line which, in an increasingly quality conscience marketplace, is probably very good news for the Krupps management team

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