

### ► Image analysis for the quality assurance of commercial vehicle brakes

**Zero-defect tolerance.** This is the guiding principle for disc brake production at Knorr-Bremse. An image processing system checks the correct mounting of the brakes. To ensure this for all 1,200 types in combination with 64 different inspection characteristics, the system is equipped with intelligent software and a connected data base.

The blue-grey cabin located at the end of the small series assembly line for disc brakes at Knorr-Bremse in Aldersbach in lower Bavaria seems unspectacular. However, it performs a quality assurance function: each heavyweight that leaves the disc brake production on a workpiece carrier is checked with great precision in the test cabin's work area. The illumination system turns on, three cameras and two line lasers focus on the brake. The corresponding software calculates within milliseconds whether the disc brake is correctly mounted according to the specified parts list and assembly guidelines, thus ensuring its operation in the vehicle. Additionally, the data base contains information whether a possible defect can be eliminated by reworking. "A brake is the most important safety component in the vehicle, everything must be perfect and the brake must not fail during vehicle operation", explains Thomas Bauer, project engineer in the industrial engineering disc brake sector at Knorr-Bremse.

Before the responsible persons at Knorr-Bremse opted for the image processing system from Neupro Solutions in Vilsbiburg, implemented in collaboration with STEMMER IMAGING in Puchheim, the production staff had to visually check the quality of the brakes. "Since a visual check is always subject to human influence, we have chosen a process-reliable and automatic solution", says Mr. Bauer. On this small series assembly line, Knorr-Bremse produces its complete range of disc brakes for commercial vehicles, ranging from 6-ton to 44-ton trucks, from buses and towing vehicles to the trailer sector. Mr. Bauer explains: "Currently, there are approximately 1,200 versions and the number is increasing. Upon customer request, we can also produce one single brake."

And it was precisely this variety that brought about the specific requirement for this project. In addition, the time frame for the realisation of the project was very tight. Knorr-Bremse has been using image processing systems in another sector in Aldersbach since 2004. Based on the experience gained in the use of image processing systems and increased requirements, Mr. Bauer was looking for a new, holistic hardware-independent and upwards-expandable image processing system. Furthermore, the possibility to implement existing own applications or software algorithms was also required.



At Knorr-Bremse, 1,200 disc brake types with 64 different characteristics are 100% inspected by an image processing system. A conveyor system transports the brakes mounted on workpiece carriers to the work area of the test cabin.



Three cameras, different illumination units and two line lasers are in use in the test cabin.

To meet these requirements, Mr. Bauer verified new application techniques and their application possibilities. He subsequently contacted Jörg Schmitz, sales specialist for image processing solutions at STEMMER IMAGING in Puchheim, with whom he has been in contact for many years. In the illumination laboratory in Puchheim, the STEMMER IMAGING engineers have been testing various applications for disc brakes and conducting feasibility studies for the last few years. Knowing the product range, Mr. Schmitz was able to design the components based on the results of the laboratory tests.

## ► Three specialised partners

To achieve the project within the planned time frame, a partnership alliance of three companies was formed. STEMMER IMAGING delivered the image processing components within a very short time to enable Neupro Solutions in Vilsbiburg, the leader of the project, to integrate them in their system. Streicher Maschinenbau in Deggendorf made the control cabinet including electrical diagram, mechanical construction of the test cabin and manufacturer declaration.

"Due to the low and varying customer-dependent quantities and the high-level of variance in disc brake production, we started to think about a data base", explains Dieter Progl, Managing Director at Neupro Solutions in Vilsbiburg. Neupro Solutions is the official partner of the data base manufacturer Oracle and was therefore able to provide a suitable solution for the combinatorics including part number and test number within the short period of time. Brakes are components requiring documentation. This is why both image data and inspection data are archived in the data base and then transferred to a higher-level control. Neupro Solutions also delivered the PLC interface, from where Knorr-Bremse recalls the data for further processing in the host computer.

But first of all, the corresponding data from the disc brake production must be collected in the test cabin. This is ensured by three AVT cameras equipped with Schneider lenses and two line lasers by Z-Laser in combination with the Sherlock image processing software of Teledyne DALSA. Finally, a Neupro Solutions-Sherlock plugin for Oracle transfers the data to the data base. "The individual check algorithms are global and are recalled via the data base using the part number. In addition, it is possible to statistically evaluate the measurement data stored in the data base and to perform a statistical approximation within the predefined threshold values", reports Mr. Progl.



Illuminated brake in the test cabin



Detailed view of one of the line lasers used. These illumination systems form the basis for the acquisition of characteristics according to the triangulation method.

The image processing system is focused on the inspection detail, but the part to be inspected may vary, so that the high variance of the parts to be inspected is no problem. Mr. Bauer says: "The image processing software teaches itself certain predefined threshold values. As an additional highlight, the upwards scalability can be counted, i.e. number of tests, number of cameras up to number of stations." "Moreover, the image processing system solves various tasks in a single run", adds Mr. Schmitz. These include laser triangulation, pattern recognition, colour recognition and measurement of components.

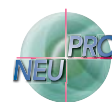
To reduce the size of the image data, the system combines three original images, compresses them to jpg format and saves them together with the serial number. "If necessary, all documents for the searched brake are thus available within seconds. Therefore, we know exactly which parts are mounted, thus ensuring traceability down to each individual screw", says Mr. Bauer, explaining the advantage.

### ► FACTS

**Industrial sector:** Automotive supply industry  
**Task:** Quality assurance of commercial vehicle brakes  
**System integrator:** Neupro Solutions, Vilsbiburg

#### Imaging components supplied by STEMMER IMAGING:

- |  |  |
|--|--|
| <input checked="" type="checkbox"/> Illumination | <input type="checkbox"/> Acquisition         |
| <input checked="" type="checkbox"/> Optics       | <input checked="" type="checkbox"/> Software |
| <input checked="" type="checkbox"/> Cameras      | <input type="checkbox"/> Systems             |
| <input checked="" type="checkbox"/> Cabling      | <input type="checkbox"/> Accessories         |



### ► Installation without system interruption

The image processing system was installed during running production. The control cabinet and the mechanical construction are designed such that the image processing system could be put into operation without system interruption. "We even loaded the PLC during ongoing operation", explains Mr. Bauer. "We worked together with specialists who master their field". The parallel interdisciplinary collaboration between the three companies and the known interfaces to the parties were for the benefit of the tight time schedule. "The cooperation between all companies involved was a total success", says Mr. Progl, enthusiastically.

Mr. Bauer is convinced that the time frame could only be met, because each of the involved companies is a specialist in its field. "STEMMER IMAGING is the only company which delivers all required image processing elements, regardless of the hardware components. And on top of that, I can also get the software there, including application and feasibility studies", reports Mr. Bauer and continues: "STEMMER IMAGING's fast service is also very convenient, as well as the illumination laboratory in Puchheim, where we could conduct initial feasibility studies."

In total, the project was founded on a partnership-based cooperation. Mr. Schmitz comments: "The collaboration with Knorr-Bremse is really great, because the necessary know-how in image processing is available in the company. The same applies to Neupro Solutions, we are all at the same level of expertise." Reviewing the project, Mr. Bauer is very happy with the result, as additional features, which were not required at first, could be inserted during the project phase.

The image processing application automatically checks the system after every lot change by qualifying or checking the exposure/position by means of predefined measuring areas and reference marks as well as reduced exposure time. As soon as a deviation



Dieter Progl, Managing Director at Neupro Solutions, explains the details of the evaluation.



Thomas Bauer (Knorr-Bremse, left), Jörg Schmitz (STEMMER IMAGING, centre) and Dieter Progl (Neupro Solutions, right) are discussing a test object.

from the predefined threshold values is detected, a message is output automatically to the higher-level host computer. This is the first maintenance-free system. The installed industrial Beckhoff PC, too, works without a fan, thus eliminating maintenance. "The project went smoothly from beginning to end. The experience gained through the new image processing system allows us to further improve available applications".

#### ► NEUPRO SOLUTIONS

Neupro Solutions ([www.neupro-solutions.de](http://www.neupro-solutions.de)) specialises in the development of innovative systems for the optimisation of automatic processes. The integrated solutions of the company are used in the fields of manufacturing automation, automatic handling systems, quality assurance and traceability. Neupro Solutions' technological focus is on the intelligent interlinking of optical systems with real-time data bases, PLC controls and mechanical or robotic components. With its available tailor-made modular solutions, the company supports customers in the mechanical engineering, automotive, chemical, electronics, plastics processing, food, metal processing, pharmaceutical, robotics and packaging and labelling technology industries. The range of services ranges from consulting and analysis via development and project management up to implementation, staff training and service.

#### ► KNORR-BREMSE GROUP

More than a billion people worldwide rely daily on Knorr-Bremse systems ([www.knorr-bremse.de](http://www.knorr-bremse.de)). Knorr-Bremse is the world's leading manufacturer of braking systems for rail and commercial vehicles. As a technology pioneer, for over 100 years Knorr-Bremse has been a driving force in the development, production and sale of modern braking systems for a variety of applications in the area of rail and commercial vehicles. Knorr-Bremse thus contributes significantly to safety on the road and on railways. Other lines of business include door systems and air conditioning systems for rail vehicles as well as torsional vibration dampers for internal combustion engines.