

Artificial intelligence since 2010

HEUFT *reflexx²*





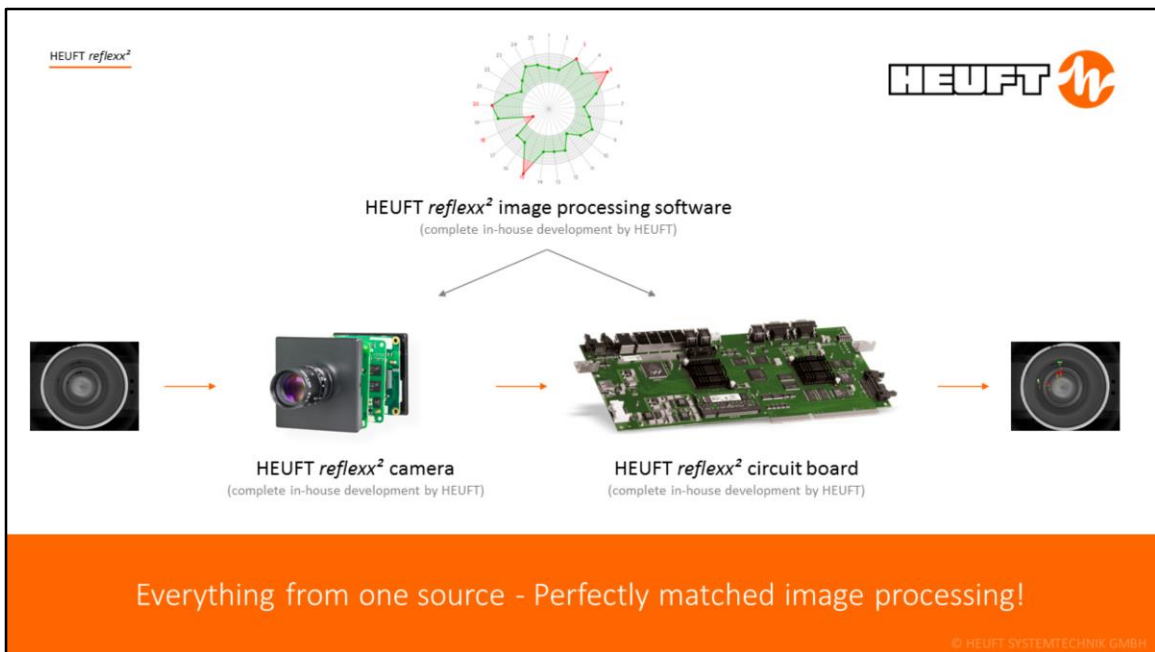
Artificial Intelligence since 2010

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Artificial intelligence since 2010. How does this grand claim come about?

HEUFT reflexx² is based on a machine learning classifier. In combination with other technologies HEUFT reflexx² is part of the field of artificial intelligence. However, in 2010 all the hype surrounding the topic was still a distant future.

Deep Learning has already been used in combination in isolated projects since 2019. Widespread use will only be possible with the enormous computing power of our new hardware HEUFT reflex A.I. which will be available soon.



At HEUFT the image processing software, the image processing hardware and the camera are a perfectly matched in-house development for high-speed image processing. The system is highly optimized for inspection in the filling process. The hardware and software offer highly parallel, high-speed image processing for reliable inspection even in fast lines. Special attention is paid to high detection reliability with minimum false rejection rate. Only this enormous computing power, introduced back in 2010, has since made it possible to reliably utilize artificial intelligence with the help of machine learning in the filling process.

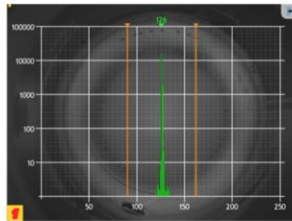


Yes, we built our own camera!

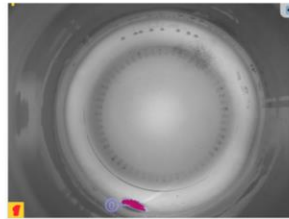
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This is in no way self-evident and requires a lot of know how and engineering. But why do we build our own camera? In purchased cameras there is already a pre-processing of the raw data from the image sensor. It is therefore not possible to directly access this data and extract possibly important information for our inspection task. Furthermore the bandwidth for transferring high resolution images to the HEUFT reflexx² boards is limited. Therefore each camera basically contains its own very powerful HEUFT reflexx² image processing card. This can evaluate the inspection image directly at the image sensor. The fastest area of application at present is in the HEUFT canLine II where up to 144,000 cans per hour can be inspected in full resolution. This is one can per 25 milliseconds or 40 cans per second!

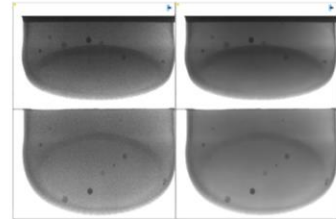
Thresholding



Machine Learning classifier



Deep Learning

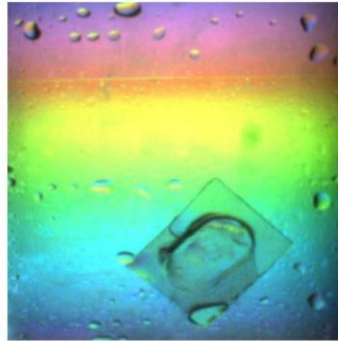


Modular system of classical and intelligent image processing techniques

Only a small excerpt of the possibilities is shown here

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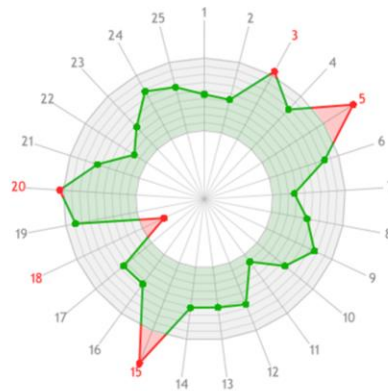
A very important aspect of the HEUFT reflexx² image processing system is its modular design. It is more of an extensively equipped toolbox than a fixed system. The right technology for the right inspection task. For example, if you only want to check the color of a cap, it makes sense to use a simple color sensor with a threshold value. A neural network would be overkill and far from easy to get reliable.



Continuous further development of highly efficient technologies
(Example: Patented HEUFT rainbow illumination)

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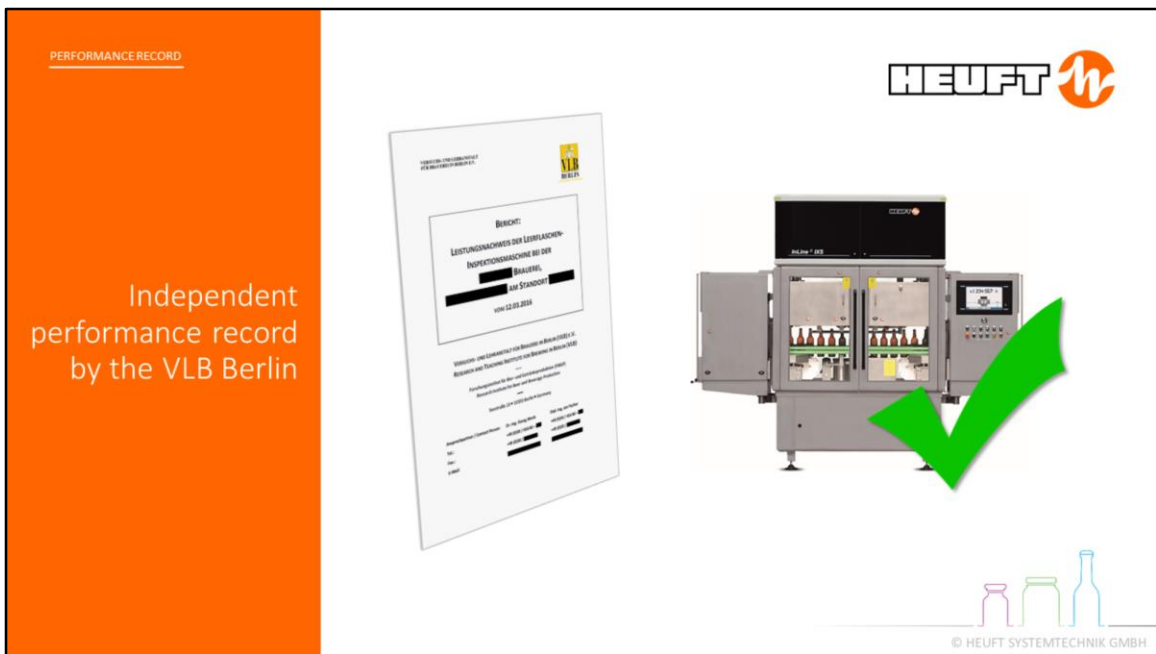
But the HEUFT reflexx² image processing does not only consist of hardware and software. HEUFT basically considers the whole process and this starts with the container transport, the illumination and the optics. Thus we develop our own flashers and illumination processes as well as optics cabinets with a great deal of know-how in order to image the container and the product perfectly. Only what can be seen on the image can ultimately be found by software and hardware. In addition, we develop special techniques such as the rainbow illumination that can be seen in the picture. Here, the lens effect of water drops is used to clearly distinguish them from the blister in the image. The shadows on the water drops are similar to those of the blister, which can affect the distinguishing accuracy. The rainbow pattern in the illumination makes distinction much more reliable. As you can see, the rainbow is reflected in the water drops, but not in the blister because it contains only air.



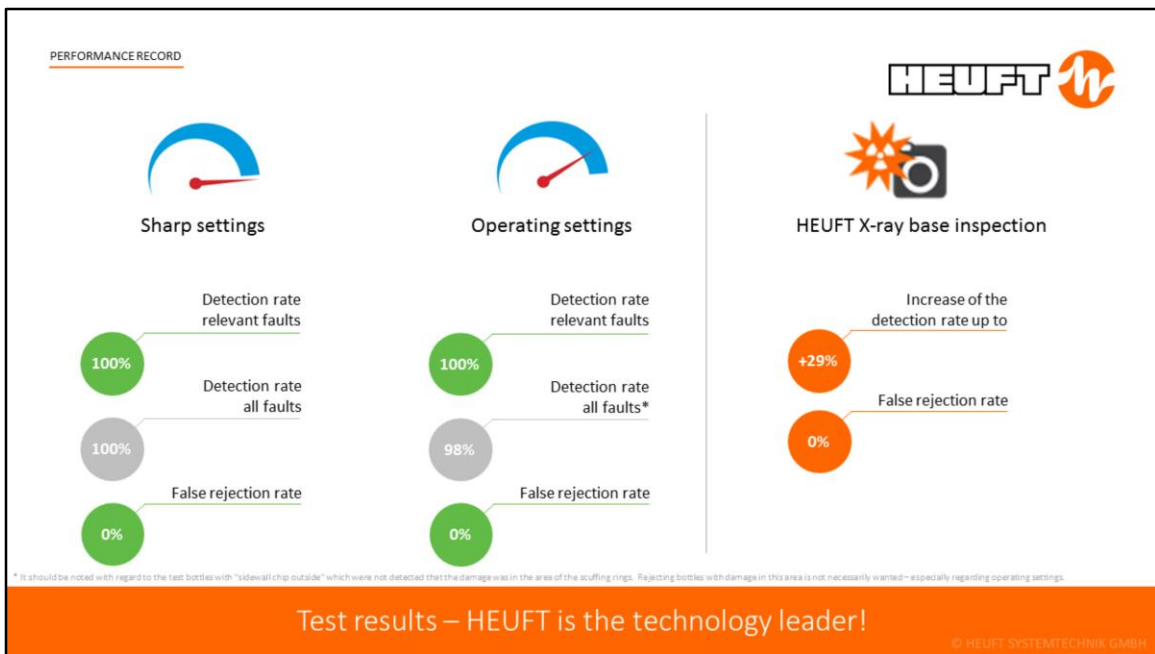
High traceability

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A crucial advantage of the HEUFT reflexx² classifier compared to a neural network is that it does not classify whole images but objects within them. For this purpose relevant objects are extracted from the images over several levels in the first step. This process is highly reliable and one of the most important strengths of the HEUFT reflexx². AI is also used to improve the extraction of the object candidates. The actual classification of these objects is carried out in the second step by the HEUFT reflexx² classifier and in contrast to a neural network it is very well traceable and adjustable. The spider web diagram shows different features of an object (the numbers). The red numbers, or features, are outside the good area for classification. If the object is actually a fault, the view is correct. If it is not a fault, the classification must be adjusted. This can be done in two ways. Either one learns the object as good, or one even adjusts the individual features manually. This is possible with the HEUFT reflexx² classifier and does not endanger the overall function of the classifier. With a neural network, such a targeted intervention would be unthinkable. Furthermore the HEUFT reflexx² classifier treats what it does not know as a fault. This ensures that faults do not pass through because they have not been trained.





HEUFT sold a HEUFT *InLine II IXS* empty bottle inspector of the latest generation with the unique X-ray base inspection and HEUFT reflexx² image processing technology to a large German brewery group at the end of 2015. The VLB carried out this performance record for this device after installation and commissioning. This test has been carried out at all the brewery group sites since 1991. A comprehensive "machine index" was created from the data determined in this way. In a nutshell this is a ranking list of corresponding machines from different manufacturers at different locations.




The results show very clearly at what perfect level we were already in 2015 with the HEUFT reflexx² and the HEUFT eXaminer technology.

"We can achieve a 100% detection rate with a 0% false rejection rate." 

"We can clearly exceed the guaranteed detection rate with a 0% false rejection rate." 

"We can achieve up to a 29% better detection rate for glass splinters in 0.65ml residual liquid with the X-ray base inspection." 

"We achieve a false rejection rate of 0% for ALL tests". 

Test results – HEUFT is the technology leader!

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