glass WORLDWIDE

Deep Learning - The next big step in quality control

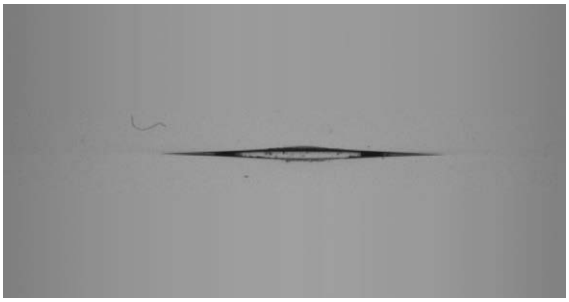
Esben Korre discusses the increasing importance of Deep Learning in the machine vision industry.

Traditionally, the inspection of glass has been about detecting defects, seen as areas with high contrast or high/low intensity. Then, in some cases, a post-processing algorithm has been applied to verify the defect and maybe also classify the type of defect, due to position, size, shape, intensity and other available information.

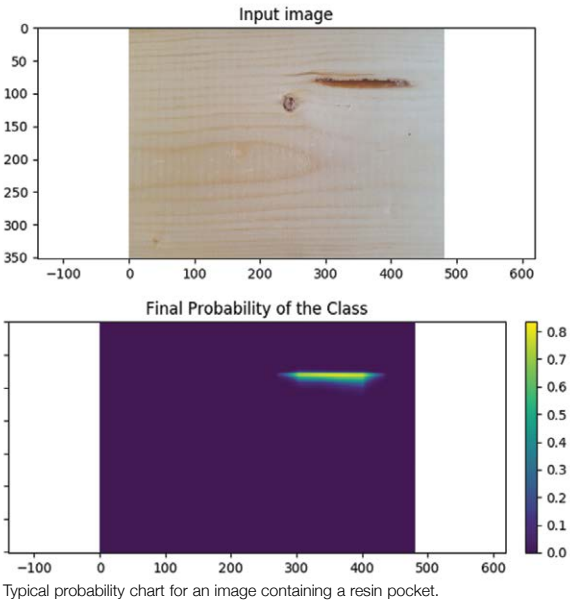
In the past, these features were handwritten, designed specifically to detect and classify a specific defect. Each dedicated algorithm, written at JLI, was tested by an engineer in a black box test. Essential algorithms would also undergo a code review, where subjects like memory leak, divide by zero, array indexes etc were checked. Finally, a functional test with hundreds of samples should be passed to prove the algorithm.

Neural networks

Artificial Intelligence (AI) is a major buzzword these days but in the machine vision industry, the term 'Deep Learning' is also used instead of AI. Deep Learning is the common term for a neural network that is given an input (image) and by applying filters (kernels) can produce a desired output.



Example of an open airline.



Typical probability chart for an image containing a resin pocket.

The filters are taught by letting the neural network iterate a lot of samples (+10.000). Depending on the neural network structure and the number of samples, this may take hours, days or in some cases several weeks.

The teaching outcome is a set of filters in the neural network structure. When the filters are applied to a given pre-processed input image, it produces the desired output with a given accuracy.

When teaching and validating a Deep Learning neural network, the size of the test set is essential, as well as the choice of network and network structure, such as layers and neurons (filters).

The computing power of today has enabled the use of self-teaching neural networks for image processing, using back propagation to compensate the errors and teach the network. That combined with a large amount of data (annotated or not) has been a game changer for computer vision systems.

Glass production uses

The accuracy of a Deep Learning network can be compared to a human. It will take a wrong decision every once in a while. An accuracy of 95% must be considered high and a few extra percent above 95% requires a lot of finetuning and work to be achieved.

However, a Deep Learning neural network is capable of detecting defects that are obvious to the human perception but are difficult to target with a handwritten vision algorithm. Defect detection in glass with embossing is an obvious area for Deep Learning. Also, classification tasks can be achieved with a relatively high accuracy.

Successful application

JLI has chosen not only to use Deep Learning as a standalone solution but also in conjunction with JLI vision algorithms to achieve higher certainty, including its successful use on SK 3000 tube inspection lines. The company has been able to train the system to detect the difference between open and closed airlines. Given a lot of training samples and fed to a complex classification neural network, the Deep Learning framework did the rest. And after completed teaching, the network performed very well. After finetuning of the individual layers/filters, a classification above 98% was reached on the validation test set.

The next generation Hot End Trend Analyser (HETA) is a backlight monitoring and measurement system for container production at the hot end. The HETA's justification is high precision dimensional measurements and defect detection. JLI vision is now developing machine learning as an add-on to improve defect classification and overall detection in embossed areas.

Future development

Another system where JLI is considering Deep Learning is the Hot End Tableware Inspector (HETI). This system is currently being upgraded with more cameras and high precision mechanics to deliver even more accurate dimensional measurements. Defect detection in the stem or rim of tableware is an example where Deep Learning can be applied in the near future.

The JLI experience with Deep Learning has been positive. Some remarkable results have been achieved in surface inspection and classification and significant benefits are anticipated in combining traditional vision algorithms with Deep Learning to gain a higher level of accuracy. Deep Learning has enabled JLI to do more classification and detections on complex defects. And the beauty of Deep Learning – it can be used in many different industries. ●

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