IMPRESSIONS™

Artifical Inteligence (AI) module

FOR **BRINELL MEASUREMENTS**

INNOVATEST®
Advanced Hardness Testing Solutions

ARTIFICAL INTELIGENCE (AI)

Explanation :
model = trained neural network
trained neural network = neural network + weight factors
model ≠ database
model ≠ dataset

MODULE FOR BRINELL MEASUREMENTS

We included advanced physics development for a breakthrough in the image analyses of our hardness testing machines. Our engineers work continuously on the thin line between technology research and product development. We generate sustainable added value for our customers because we focus our insights on developing and applying technology platforms that resolve technical issues that were hard to resolve with common existing technology.

One of our latest efforts are an intensive project on artificial technology, machine leaning or better "deep learning".

The conventional image processing methods on hardness testing machines are fairly successful for clean images that present clear indentation boundaries. In practice, however, workpieces or samples often have rough surfaces that compromise the quality of the image processing which could potentially result in incorrect hardness values.

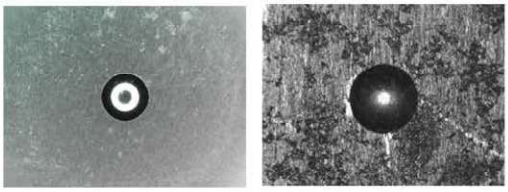

FIGURE 1: REFERENCE BLOCK INDENT (LEFT) AND WORK PIECE INDENT (RIGHT).

A human observer can easily find the indentation in both images and the exact boundaries of such indentation. For a computer algorithm, finding the indentation in the right image is much more challenging due to the many gradients in this image. Artificial intelligence can overcome this difficulty by training a complex computer neural network to "think" as a human observer.

Using a state of the art machine learning framework, TensorFlow, an artificial intelligence model (AI model) is generated based on a large dataset of images and masks. A mask defines which pixels in the image are part of the indentation (white/value1) and which pixels are not (black/value0).

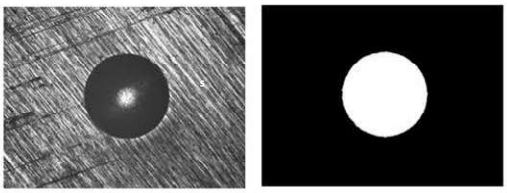

FIGURE 2: IMAGE WORK PIECE INDENT (LEFT) AND CORRESPONDING MASK (RIGHT).

The masks in the training dataset, (a large combination of indents and masks) are generated manually by a human observer. Their purpose is to "teach" (i.e. train) the neural network what an indentation looks like (and what it does not look like). To successfully train a neural network how to detect indentations in an image, a large set of image-mask combinations is required.

The training phase optimizes millions and millions of weight factors in a neural network using a gradient descent approach. Initially random weight factors are optimized to minimize the difference between the input masks (defined by the human observer) and the output masks (calculated by the AI). After the optimal weight factors are determined, an AI model can be created.

The INNOVATEST Brinell AI model is trained in our research facility/R&D department using powerful supercomputers. Using the AI model to detect new indentations is called inference and requires much less computing power. An Intel® Core™ i7 Processor can easily handle this task, which makes it possible to use the INNOVATEST IMPRESSIONS™ Brinell AI model in our hardness testers.

During inference, a new image (i.e. an image that has never been seen by the AI model) is fed into the neural network with the weights that were determined during training. The algorithm is now able to calculate a mask on its own. This mask is plotted on top of the image. The indentation edges can now be located by finding the edges of the AI generated mask. Using the locations of the edges in the image, the diameter of the indentation can be determined.

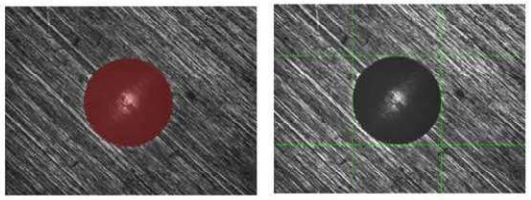

FIGURE 3: AI GENERATED MASK (LEFT) AND INDENTATION EDGES CALCULATED FROM MASK EDGES (RIGHT).

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