AI visual inspection from BUCHER EMHART GLASS for improved performance and reliability

In the first article of this series, published in issue 4/2021 of Glass Mchinery Plants & Accessories, Niki Estner, Software Development Manager at Bucher Emhart Glass, described how Emhart Glass Vision started using artificial intelligence (AI) for visual glass inspection in 2017. Since its original introduction, several additional AI based inspection solutions have been added to the already powerful inspection portfolio.

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AI PART 2

In this article, Niki highlights a few of the advantages and potential cost savings that are associated with the improved performance and reliability that is gained when using artificial intelligence (AI) for visual glass inspection. This state of the art technology, in fact, was first used by Emhart Glass Vision in 2017, which now includes numerous inspections solutions.

For AI to be successful in glass inspection machines, it has to have a clear benefit for the customer. As you may assume, using AI technology comes at a higher costs. Some of the cost drivers are obvious, like the need to use high-end hardware (super computers) that lead to increased development costs. However, the increase in cost is not just mon-

etary, there are other technical issues associated with AI that are less obvious. An example of this is the need for training samples used to teach the system, along with the time required for the system to complete its training.

When discussing AI technology with colleagues or customers, two important questions always seem to be asked:

1. What are the financial benefits of using artificial intelligence to inspect a glass bottle?
2. How do you deal with the lack of training samples? For example, you have samples for some critical defect for job "A", but not for job "B" but you still need to detect the defect on job "B".

Answering these questions with facts, figures and methodologies can be one of the hardest tasks for someone applying AI technology to this type of industrial application. The detailed answers of the "how"-questions are very specific for the application and are highly guarded trade secrets. However, to better explain the financial benefits that can be gained, we will give a high-level explanation using the Emhart Glass Vision AI based seven-segment numeric code reader.

SEGMENT CODE TASK

The task of a seven-segment numeric code reader is simple; it is designed to decode the mould number embossed on the base of glass containers. This number identifies the mould in which each container was formed. Reading the mould number with a high level of accuracy and repeatability is essential for process control, as this mould number is also used to reject defective containers from the line when defects are found that are mould related.

This is where the financial benefit of having a more accurate mould reader comes into play. When sorting bottles by a specific mould number, unreadable mould are often time rejected as well. Every fractional percent increase in the reading rate, saves money!

As an example, let us assume a typical container glass production line is equipped with a ten section, triple gob machine (10 x 3). That means the machine has 30 moulds that produce a bottle every cycle. If the machine is running production at 12 cycles per minute. (30 x 12 = 360 bottles every minute) That same line produces just over 500,000 containers per day.

During the course of the day, it is common to have an event that will force the operator to reject all of the bottles created on a certain mould. If you have 5 events that force you to place a mould on the reject list during the day and each event last for 1.5 hours, that means that 27 per cent of the time, at least one mould number and all non-readable mould numbers are being rejected. (The actual time may be less than 5 x 1.5 hours because sometimes, more than one mould will be on the reject list at the same time.)

If we assume that each rejected container costs around EUR 0.04, the total cost of one per cent non-readable containers is around EUR 20,000 each year.

With the AI based seven-segment numeric code reader, even difficult codes like the ones shown can be reliably identified.

Typically, switching from a conventional vision mould reader to our AI based reader increases reading rate from < 95 per cent to more than 99 per cent. The total return on investment is then higher than EUR 80,000 in the first year!

UNSEEN DIGITS

Common questions: What happens if I do not have a training sample for mould number 37? If AI technology is based on learning from samples. Is it possible to read a number that the system has not seen before? What if there are no training samples for the digit 7 for one job?

TRAIN WHAT WE WANT TO LEARN

If we picked off-the-shelf AI solutions, then the answer would probably be "Yes", you need to train all 99 mould numbers if you want to read them. In addition, if the next job looks darker, brighter, thicker or smaller – you will have to train all 99 moulds for that job, as well.

Off-the-shelf AI solutions use the "brute force" approach to AI: If we give a neural network millions of training samples of very possible case we want to detect, then eventually it will figure out what we want it to detect. For Google or Facebook, this is perfect, because they do not know much about the images they are processing.

However, in machine vision tasks, we typically know a lot about the images we work with. The smart approach is to then incorporate this knowledge into the network and the training. For the seven-segment code, that means we add information about where each segment is, where the corners and the t-crossings are to the training task, and ask the network to reproduce those:

With that, a neural network is smart enough to transfer knowledge (e.g. how one digit looks) from one type of container to the next.

INDUSTRY EXPERIENCE

The engineering development of the neural network-based seven-segment numeric code reader began in 2018 with the first production version delivered in 2019. Since then, it has been integrated into the FleXinspect B Gen-III machines and is available as an upgrade option for older Symplex machines.

As you can see on the screenshot taken from live production, the system running with AI was decoding these difficult to see numeric codes at a reading rate of 99.91 per cent.

Before the upgrade, the customer was using a seven-segment numeric code reader supplied by another supplier that could only achieve a reading rate of approximately 70 per cent valid reads on this container.

CONCLUSION

Using AI technology for glass container inspection improves the reliability of the inspection, improves the accuracy of the inspection as well as the repeatability. In the example of the seven-segment numeric mould code reader as described in this article the system quickly pays for itself while providing you with better process control data, less good ware loss and reduced setup times between job changes.

When AI is used in a smart way, it improves your pack quality, reduces your job change times and minimizes the need for defective samples to setup the control limits of your inspection equipment. That is the difference between a good AI system and a great AI system.