TEST REPORT

X-Ray based detection of small pebbles and stones in un-roasted (green) coffee beans

Problem description

Scan a plastic bag with coffee beans, approximately 35 mm thick with added pebbles to determine detection performance.

The technology used

The object was scanned 2 times on a low energy X-ray scanner (HYMCIS): 1 time at 25kV / 12mA (300 Watt) and 1 time at 18kV / 8mA (144 Watt). HYMCIS is short for "Hygienic Modular Conveyor-based Inspection System". It is approved for use with food-products and operates at low energy to ensure optimum image.

The sample

Figure 1: Pebbles (provided by the client) were attached to the surface of the bag with coffee beans.

Results

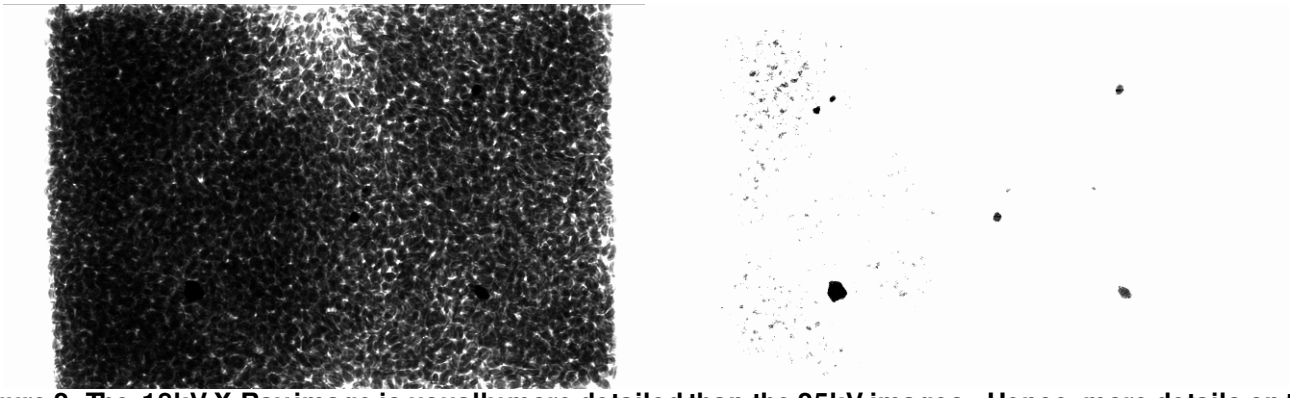

Figure 2: The 18kV X-Ray image is usually more detailed than the 25kV images. Hence, more details on the structure of the individual coffee beans can be seen- however the small stones are not clearly distinguished owing to the high absorption.

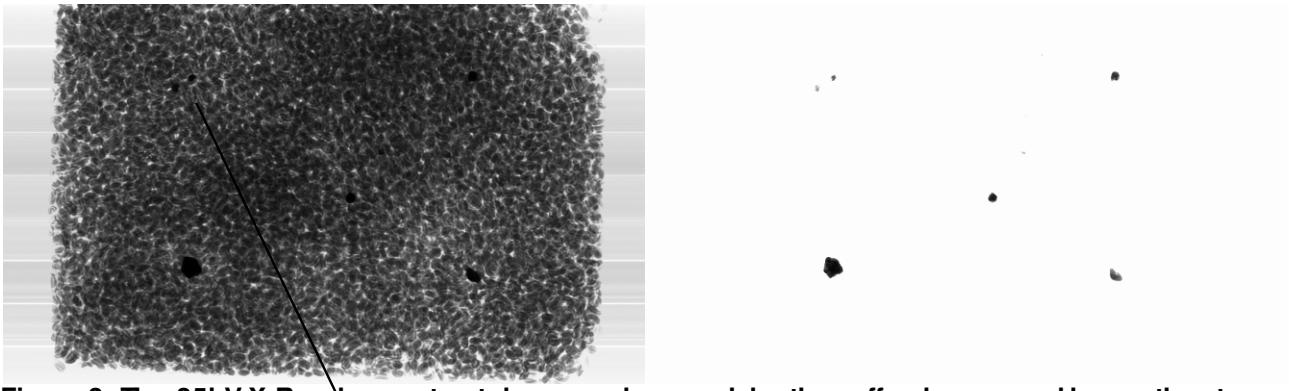

Figure 3: The 25kV X-Ray does not get dampened as much by the coffee beans, and hence the stones stand out it more relief. Simple threshold is applied to discriminate the stones from the coffee beans.

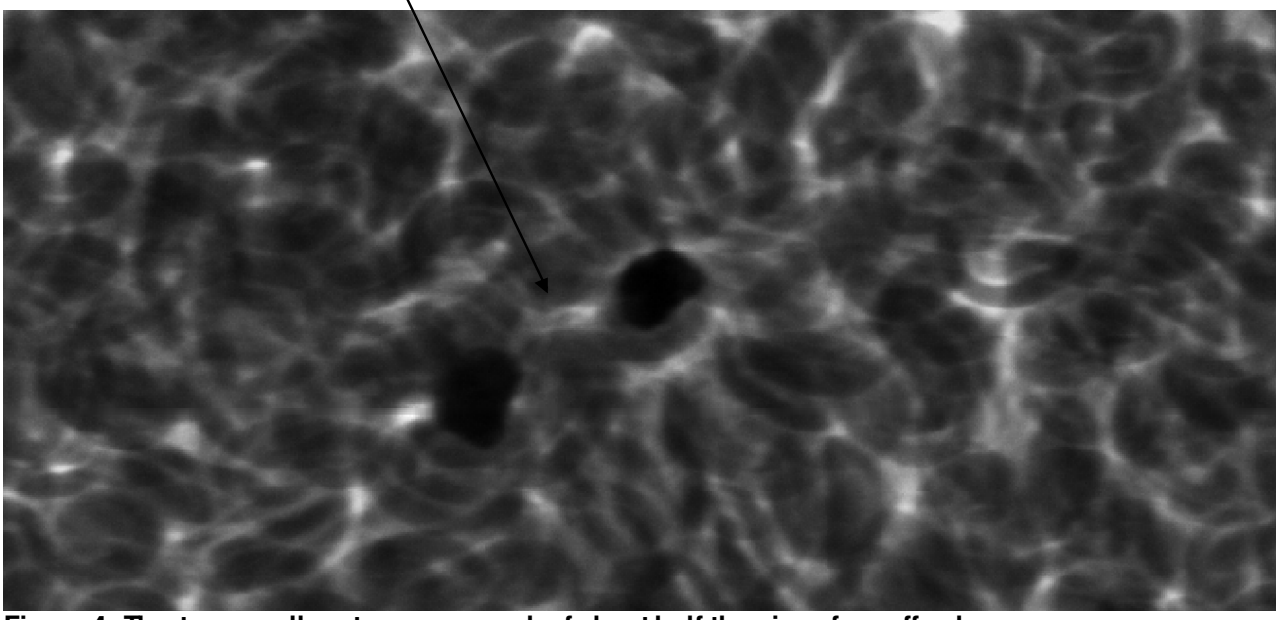

Figure 4: The two smaller stones are each of about half the size of a coffee bean.

Conclusion & Notes

The inspection of 1 kg can be accomplished in about 0.3 seconds, based on about 200 mm of layer width.
This means 3 kg per second, 180 kg per minute and 10 tons per hour.
However, the actual speed may have to be reduced due to the reject need.

We have confidence in our ability to detect foreign objects such as small pebbles down to a few mm in "diameter". The issue here is pay back time, sorting mechanism and especially the volume of product which must be discarded (due to abundant stones). It is hence a risk that the number of stones may cause multiple consecutive rejects which may affect the reject mechanism and the reliability of the sorting. This however is an automation problem that must be addressed. The stones are prominently detected relative to the coffee, thanks to the high contrast at the low energy (despite the low density of the stones).

Extra images

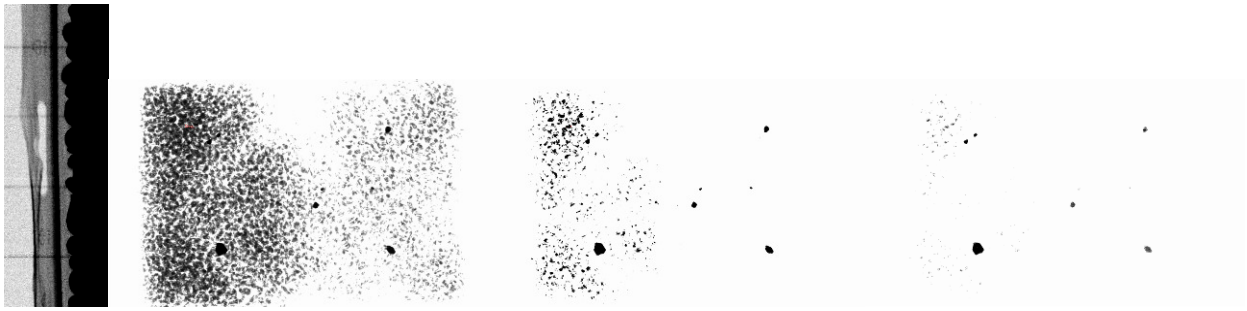

Figure 4: The contrast of the images can be adjusted according to the level of detail desired. Even the plastic bag is visible at 18kV (But not at 25kV – it is too thin to stop a 25kV X-ray).