What is Algorithm for X-ray Inspection Systems?

Have you heard the word “algorithm”? You may have heard of algorithm but most of you may never handle it by yourself and leave it to your serviceperson. This paper explains what algorithm is as well as both advantages and disadvantages of finding different algorithms.

【1】What is algorithm?

X-ray inspection system performs image processing on x-ray image of the product obtained by x-ray irradiation, and extract only favorable shades (a mass of lines) to emphasize contaminants for evaluation. There are multiple numbers of image processing filters that can be processed at a time and a combination of these filters is called algorithm. Desirable algorithm may vary depending on the density and shape of products and contaminants.

【2】What happens when algorithm is changed?

An optimal algorithm can make the shade of a product lighter to emphasize shade of contaminants. However, there are variety of shapes and composition of foods, for instance cereal, which small pieces overlap each other in a bag and butter which comes in a lump shape with certain thickness. X-ray image for each product appears in specific degrees of light and shade; however, a distinctive shade which can be easily mistaken for contaminants may appear. In order to suppress the appearance of this shade, prepare image processing which predicts the appearance of this distinctive shade. By this, false negatives (false detection) are reduced and the detection limit is lowered, making it possible to detect even smaller contaminants. On the contrary, choosing an algorithm which is not appropriate for the product’s characteristics can cause false negatives.
Fig. 2-1: Influence of shade

Lowering shade that can be easily mistaken for contaminants can reduce false negatives and lower the detection limit.

[3] Actual examples

Let’s see how the shadow of a product transforms by changing algorithm using a projection monitor in KD7405AWH. (*)

*Projection monitor

The projection monitor displays signal waveforms after x-ray images are processed. Projection monitor exists by the number of processing imaging. Usually about six to nine projection monitors are displayed on a screen and any waveform that exceeds the detection limit is detected as NG. Some manufacturers of inspection systems use a bar graph for showing the intensity of a signal instead of a waveform.

Example of a pack of dumplings with a tray

Keep in mind that joint parts of dumpling skins can be mistaken for linear contaminants. An increase in the thickness of a joint part of dumpling skins tends to produce the linear shade; therefore, it is essential to reduce the effect of joint part for higher detection sensitivity.

Example of cube-shaped chocolates in a bag

Since chocolate has a square shape, the contents of the bag shift unevenly when the product rotates and overlaps with each other. This leads shades of x-ray image to get darker steeply. It is essential to separate the product and contaminants by assuming the change in the level of product effect that is hard to predict.
例3 重叠的香肠的示例

香肠重叠时，由于产品具有圆形形状，其密度的阴影变化会产生变化。重要的是要通过预测产品效果来分离产品和杂质。

图3-5: Sausages
图3-6: T4 波形图

例4 硬质且粗糙表面的烤猪肉

产品的X光图像呈现成块状，密度随时间逐渐变化。通过调整阴影至更平滑和较亮的阴影，可以更容易地识别由杂质引起的图像变化。

图3-7: Roast pork
图3-8: T4 波形图

如果你在生产过程中停止系统以更改算法，可能会大幅增加假阴性的发生。为了避免这种风险，应停止生产线更改算法。通过使用样品产品（形状不同的同种产品）和测试件，观察“投影监视器”屏幕上波形的变化，并查看当算法更改时测试件的检测是否会变小。务必在更改算法之前记录当前算法编号和其他用户设置。
【4】Let's try choosing algorithms.
Let's try choosing different algorithms with test pieces.

① Feed the product without test pieces
First, convey only the product and check the following points from the waveform displayed on the projection monitor screen.

☑ Does the height of a waveform get smaller?
The sensitivity is unlikely to be improved if a waveform does not get smaller or remains unchanged in comparison with a waveform before changing an algorithm, so please try different algorithms.

☑ Is a waveform stable?
It is desirable to have the condition of having no waveforms which rise irregularly when the product is conveyed. The distinction between the product and contaminants becomes difficult to draw if the waveform rises irregularly when the product is.

② Feed the product with test pieces
Next, feed the product with test pieces and observe the waveform displayed on the projection monitor. Check if the followings are achieved.

☑ Does the part of a waveform where the product with test pieces is conveyed rise?
The algorithm is changed successfully if the part of a waveform where the product is conveyed with test pieces rises remarkably. Please try again the same procedure from the beginning in Step 1 "Convey the product without test pieces" if there is no change in the waveform.

【5】Conclusion
In this paper, we explained how the waveform appeared on the projection monitor transforms when an algorithm is changed as means of enhancing the inspection performance. Changing the algorithm normally does not cause an increase in load on the system or an increase of the processing time for evaluation. To find out if the system you are using is capable of changing algorithms, contact your local Anritsu representative.