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A Proposal of Real-Time foreign object detection for Food Through Conveyor Belt Using hyperspectral Camera

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Abstract— Every year, foreign substances such as insects and hair are detected in the various foods we eat. Foreign substances found in these foods may be offensive to the consumer or adversely affect humans when consumed with the food. Considering the process of food passing through to consumers in terms of manufacturing and transportation, we propose a solution to the original problem in the manufacturing process. In manufacturing, hyperspectral cameras are used to inspect the raw materials and finished products of food passing through the conveyor belt. From the human eye, it is difficult to distinguish due to the small amount of foreign matter or the color similar to the food. Also, the speed of the conveyor belt is high and the ability to detect at high speed is also required. Therefore, by comparing the spectroscopy for each pixel in the VNIR (Visible and Near Infrared) region, the possibility of foreign material detection using a hyperspectral camera is suggested.

Keywords—; Hyperspectral Image; Real-Time; Conveyor Belt; Foreign Object Detection;

I. INTRODUCTION

Foreign objects can be found in the variety of foods we eat, which can be offensive to consumers or ingested with food, which can adversely affect humans. In the manufacturing process, foreign materials are precisely detected by using a hyperspectral camera for raw materials and finished products of food passing through the conveyor belt. In the human eye, if the foreign matter is small in size or similar in color to food, it is difficult to distinguish and inspect the foreign material at the speed of the conveyor belt. Therefore, this study presents the possibility of real-time detection of food on conveyor belts using hyperspectral cameras. Visible Near Infrared (VNIR) hyperspectral image is a 3D cube data set consisting of 2D spatial images and 1D spectral data at VNIR (400-1000 nm). Hyperspectral images have hundreds of bands in each pixel. For this study, because there are 256 bands and 512 pixels, there is a lot of spectral data in each pixel. This very large data needs to be processed in real time. In this paper, we present the possibility of detecting foreign substances in real time in food passing through the conveyor belt.

II. OBJECT SPECTRAL INFORMATION

Detection simulation methods include the manufacturing process environment of conveyor belts and hair and seaweed that cannot be distinguished by human eyes.

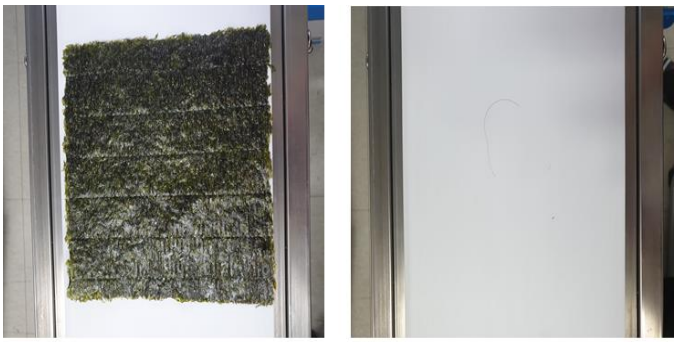

Figure 1 Object environment, (a) Seaweed, (b) Hair

Hyperspectral cameras are SPECIM's FX10E, which can detect a range of Visible and Near Infrared (VNIR) spectra of 400 to 1000 nm. Figure 2 shows the spectral information of hair and seaweed, and Figure 3 shows the selected pixels of each object.

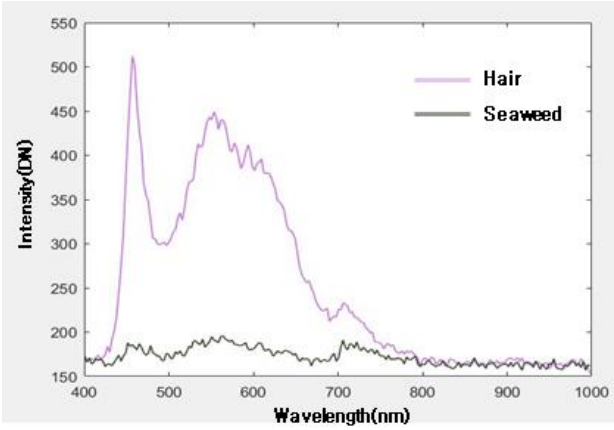

Figure 2 Hyperspectral spectrum

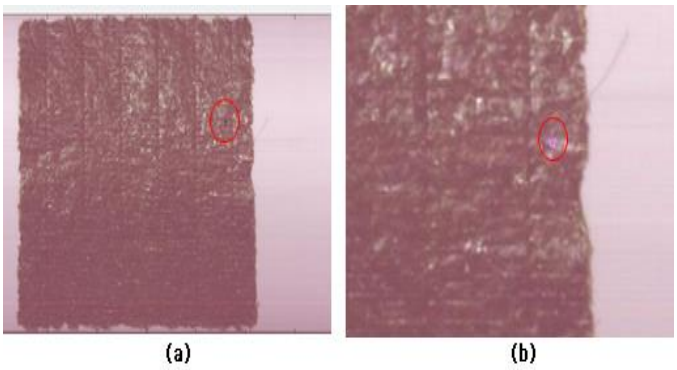

Figure 3 Selected pixels, (a) Seaweed, (b) Hair

III. Real-Time detection

In this paper, we present the possibility of detecting foreign substances in real time when food passes by conveyor belt using hyperspectral camera. In the experimental environment of this study, the conveyor belts actually used in the manufacturing process are used, and spectral image data are obtained with hyperspectral cameras (FX10e). During a single camera shoot, 224 band data are acquired at 512 pixels each.(Total 114,688 data) The conveyor belt speed is 0.5 m/s, and the camera transmits the shot at 200 FPS to the PC via GigE communication in ENVI-BIL format. The spectral image of each seaweed, hair, and conveyor belt are stacked in a database, stored, and the average value of the data is learned in advance to link to the PC program. The data obtained in advance and the incoming data in real time are compared pixel by pixel and shown in PC program as shown in Figure 4.

Figure 4 PC program

As shown in the picture above, the hair (foreign material) is placed on top of the seaweed and it can be seen in real time as it passes through the conveyor belt. Each spectral image was detected and the conveyor belt was recolored in white, seaweed in black, and hair in red.

IV. CONCLUSION

In this paper, there are limitations in distinguishing hair from seaweed by human eyes, so to overcome this, hyperspectral cameras are used. We present the possibility that food on the conveyor belt can detect foreign matter in real time as it passes by. Spectral data such as seaweed and hair were saved in the database in advance, and when compared with new incoming spectral image data and pixel units, it was confirmed that real-time processing was possible. Future research will focus on classifying substances other than designated foods as foreign objects, even if they are not in the database, in a real-time conveyor belt environment.

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