On-Line Poultry Carcass Inspection System

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The USDA has been involved with poultry inspection since the inception of the Federal Poultry Inspection Service in 1926. Currently, the USDA Food Safety and Inspection Service (FSIS) inspectors visually examine each poultry carcass on-line at slaughter plants. But, human visual inspection is very labor intensive and prone to error and variability. Also, it limits the processing line-speed and the output of the processing line. In recent years, the public has demanded that food safety inspection be more scientifically based. At this time, processing plants are looking for ways to increase processing speeds because of competition and dramatically increased demand for poultry products. However, higher line speeds would further burden the workload of federal inspectors since the total number of federal inspectors is expected to remain the same or decline. The current visual inspection system no longer serves the poultry industry and consumers adequately. We have developed a science-based, accurate, reliable, and low-cost instrumental system which retains individual carcass inspection mandated by law, incorporates new technological advances, and addresses public health concerns.

Our design is based on the principle that wholesome and unwholesome (diseased/defective) chickens have tissues with different chemical compositions and may have different skin color and texture. The automated chicken carcass inspection system evaluates chicken carcasses in real-time, without contact with the carcass. The system consists of a light probe spectrometer subsystem and a multispectral camera subsystem. The light probe shines both visible and invisible light on the carcass breast. It detects what kind of light is absorbed by the poultry tissue and skin, and then determines the condition of the bird. It scans the poultry tissue and skin at the breast area of each bird. The multispectral camera subsystem uses four cameras with filters to picture the exterior of each carcass. The multispectral cameras, as viewed through a red filter and a green filter, take pictures of a poultry carcass. A computer compares the different spectral images to determine if it is defective, and if so, the nature of the defect. The computer, based on the results of the light probe and multispectral camera subsystems, can also make a composite decision. The light probe subsystem was tested at line speeds of 60, 70, and 90 birds per minute, but is capable of inspecting 150 birds per minute. The multispectral camera subsystem was tested successfully at a line speed of 60 birds per minute.

On-line testing of the automated poultry carcass inspection system was conducted on an actual processing line at Tyson Foods, Inc., in New Holland, Pennsylvania, for three weeks in 1998. The system worked under the harsh conditions of temperature, humidity, and water and processing substance splashing found in poultry processing plants. The light probe subsystem worked very well, and was robust and consistent. The model was calibrated based on the first three days of spectra, and classified the birds in the following days with prediction accuracies for wholesome and unwholesome carcasses consistently about 95%. The multispectral camera subsystem was not fully tested because of the concern that intense lighting would be objectionable to the Tyson workers and FSIS Inspectors working on the processing line. Although we had re-engineered the lighting system, we found that the lighting was still not satisfactory. Since then, we have again modified the lighting for the camera subsystem and continue to conduct on-line tests of the multispectral camera subsystem.

We are presently assembling an industrial grade system that will be more rugged and waterproof in the processing environment. The industrial grade system will be implemented at a slaughter plant for long-term testing for accuracy and robustness.

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