AMPC

SNAPSHOT

HYPERSPECTRAL ZT AND FOOD SAFETY DETERMINATION

Project Report Reference: 2017-1053 **Date: 22 October 2018**

Project Description

In this project a faeces and ingesta contaminant detection system is develop for a lamb abattoir. The system uses data from a hyperspectral camera to detect contaminants as small as 1 mm^2.

The final system consists of an adjustable rig that can being installed in a variety of locations in an abattoir kill floor and is capable of real time contaminant classification of whole lamb carcasses, moving at a maximum speed of up to 1 m/s. The system was trialled at an abattoir where more than 20,000 lamb and mutton carcasses were classified continuously over a period of two weeks. This trial demonstrated that visible contaminates can be reliably detected on the outer surface of lamb with the proposed system, and there is evidence to suggest that invisible levels of contamination can also be detected by the system.

Project Content

The project consisted of multiple data collection, data analysis, software development, hardware design and testing stages.

Lamb and contaminant samples were collected from a variety of sources. Preliminary samples were cut to contain equal amounts of fat and meat, and contaminants were applied in incremental amounts between scans to collect a diverse set of data.

The data was analysed using hyperspectral cameras capable of capturing 200+ bands of light per pixel - from the ultraviolet to the infrared. The analysis revealed that contaminants can be reliably classified in meat samples using as few as 4 bands. Therefore, in future designs cheaper, more accessible and more flexible multispectral camera technologies can be used to capture the 4 required bands.

A range of supervised and unsupervised machine learning techniques were used to develop classification algorithms to discriminate between clean and contaminated meat. Ultimately, a neural network model was chosen for its low computational complexity and high accuracy. A flow diagram of the model is shown in Figure 1.

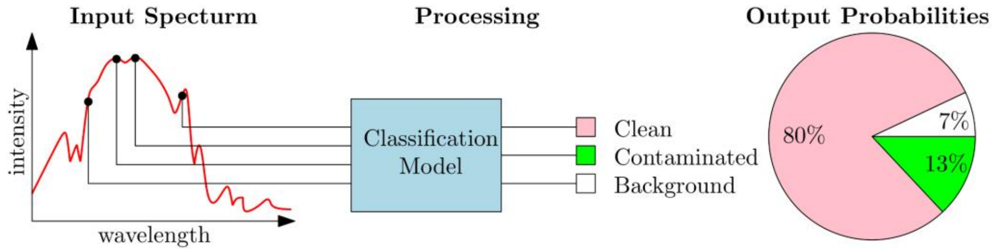

Figure 1: Flow diagram showing how the spectrum of a single pixel is samples and classified into three categories.

Custom software was developed to acquire, classify, display and save the hyperspectral data stream in real time. A graphical user interface (Figure 2) was also developed to perform calibrations, view the streaming data in real time, adjust camera parameters and save the data.

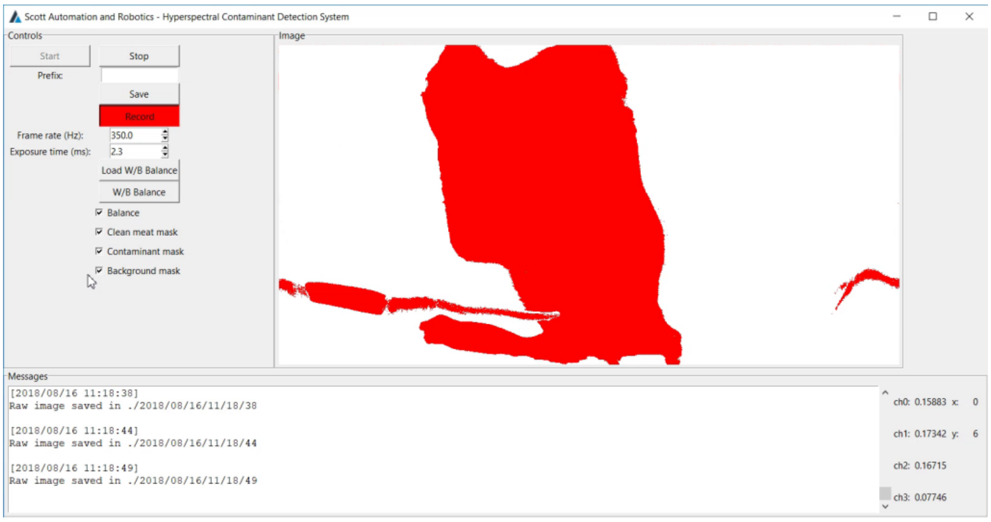

Figure 2: Screen shot of the graphical user interface as the system is classifying and saving data in real time. Clean (red), contaminant (green) and background (white) masks have been enabled. A hand is also shown, stabilizing the carcase from the left.

A portable and adjustable test rig was designed to perform onsite abattoir trials. The rig consisted of two adjustable light towers housing a total of 60 halogen lamps, a hyperspectral camera in an adjustable enclosure and an electrical cabinet. The camera was positioned to scan vertical lines of approximately 1.5m height and sat between the two light towers. As the overhead conveyor carries the carcases horizontally past the light towers, the camera scans vertically and constructs an image from the sequence of vertical lines. Photos from onsite trial are shown in Figure 3.

Figure 3: Onsite photos of the contaminant detection rig.

Project Outcome

Controlled tests showed that contaminants can be detected with an accuracy of more than 90% on a per pixel basis. To put that into perspective, if an image contains 10 contaminated pixels, then the probability of it being undetected is 1 in 10 Billion. During abattoir testing, more than 20,000 images were processed over a period of two weeks and the system was demonstrated to consistently detect all outer surface contaminants. Figure 4 shows classified images of contaminated carcasses and Figure 5 shows a photo and classified image of a contaminated offcut.

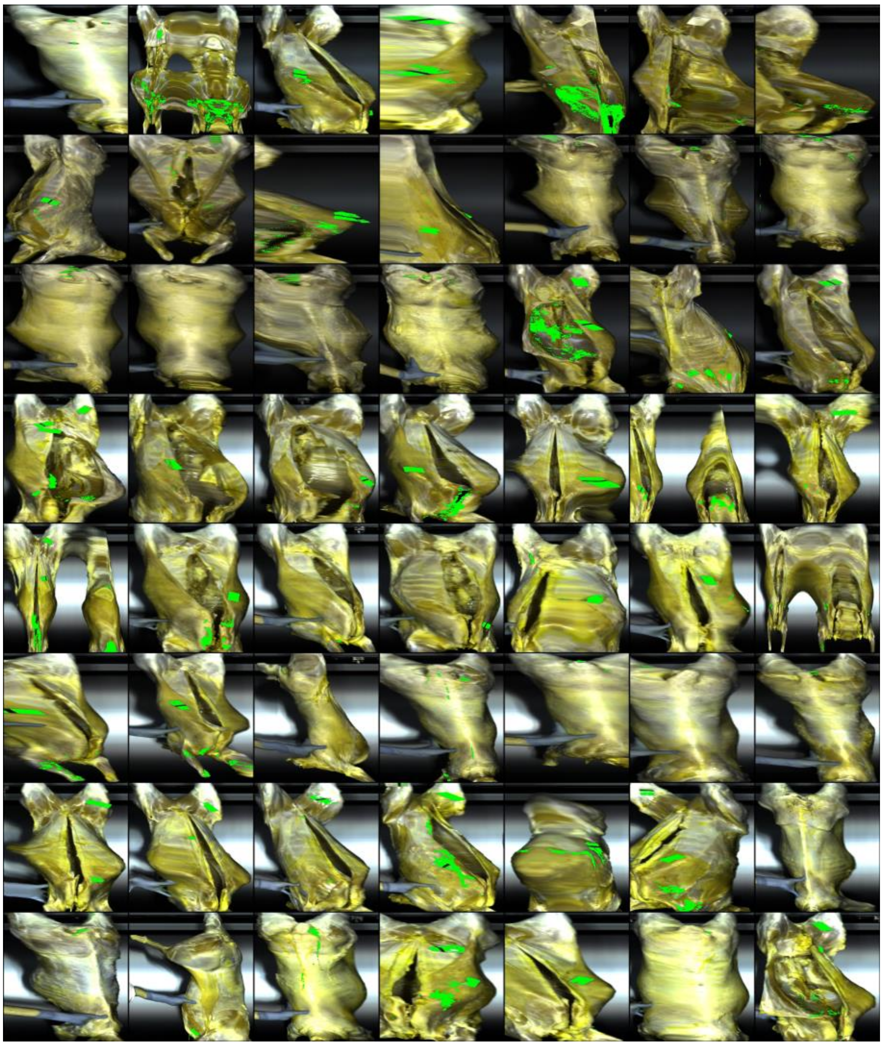

Figure 4: Classified images from abattoir trials.

Figure 5: Photo of contaminated offcut compared to classified image. Detected contaminants are shown in green.

Benefit for Industry

Hyperspectral imaging technology presents a unique opportunity to the red meat industry, particularly in the area of food safety. With the current growing need to drive down production costs and increase efficiency, the food industry is faced with a number of challenges, including maintenance of high quality standards and assurance of food safety while avoiding liability issues.

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