final report

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Robotic Brisket Cutting System Project Implementation Report

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Introduction

This document covers the implementation of a Robotic Brisket Cutting System for sheep/lamb. The robot system was installed at Country Fresh/Peel Valley Exporters plant located in Tamworth NSW by Machinery Automation and Robotics. The robot went into production on 1st July 2008.

The system adopts the use of a circular breaking saw fitted with a knife blade (serrated blade) and centring guides which replaces the manual operation of using a handheld brisket shear. The system is located right before the hide puller on the production line where the briskets are presented with carcass hanging from its forelegs. It consists of safety guarding, safety equipment, operator controls, sensors and a standard circular breaking saw fitted to a standard Kuka KR60 Robot.

This is a turn key solution which is started and stopped at the operator panel. Upon start-up the robot autonomously tracks and cuts the brisket of every carcass that passes through the cell.

Peel Valley has conducted swab testing to ensure before and after bacteria counts are acceptable. These results have indicated favourable for the automated brisket saw to date.

The first system that has been installed meets the solution requirements of the project with room for improvements and further development.

About the system

The system aims at replacing the actions of the current manual brisket shear operation. Moving from a brisket shear to a brisket saw reduces the complexity of automation. The centre of the carcass and the brisket height is recorded when it enters the cell and used to define the cut path starting point on the sheep/lamb. As the robot cuts the brisket it monitors the position of the conveyor and adjusts its position accordingly. The centring guides ensure the blade travels through the centre of the brisket.

Upon start up and after every cut the system sanitises the blade and centring guides in a sterilisation tank that is monitored to stay above a temperature of 82.5°C.

At present the system can cut 514sheep/hour (7sec per cycle).

Where to next

The second Robotic Brisket Cutting System will be installed at Burrangong Meat Processors, NSW within the coming months as part of the initial development project with a further two systems being installed late 2009/10 completing the development prior to commercialisation.

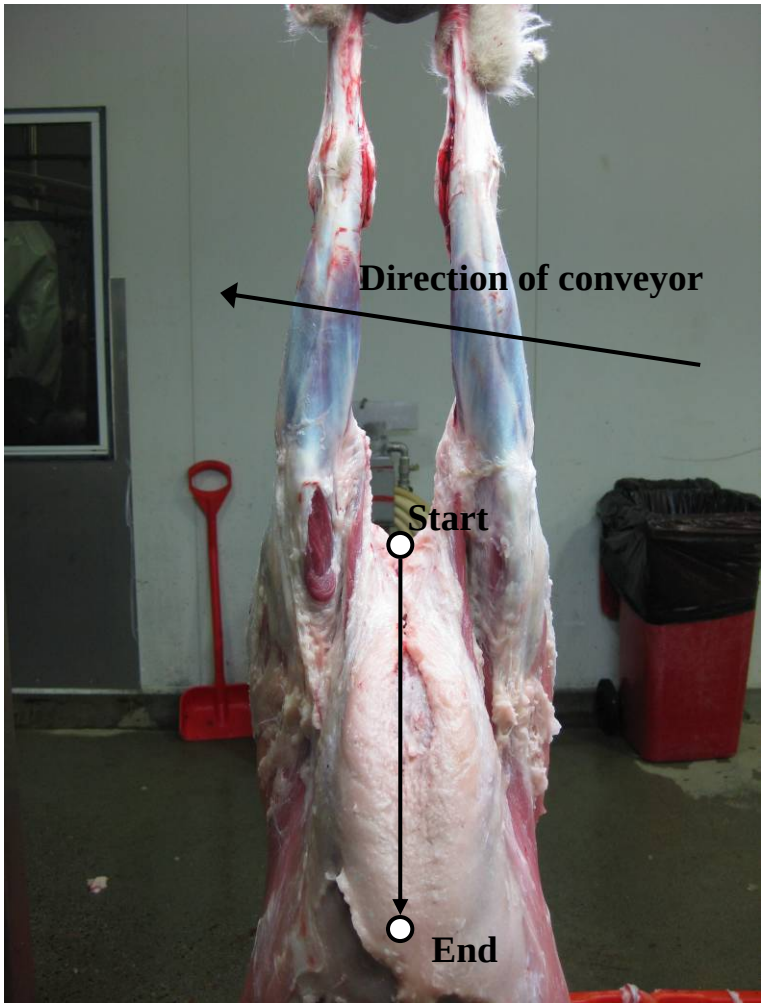

Figure 1 Robotic Brisket Cut Path

Figure 2 Fixed Spreader

System Design

The robot cell is located right before the hide puller. Figure 3 below shows both the forequarter vac san and brisket saw is installed in the same robot cell saving potential floor space. Note the safety guarding, safety mats, robot position, operator panels, access gate and the main line which passes through the cell.

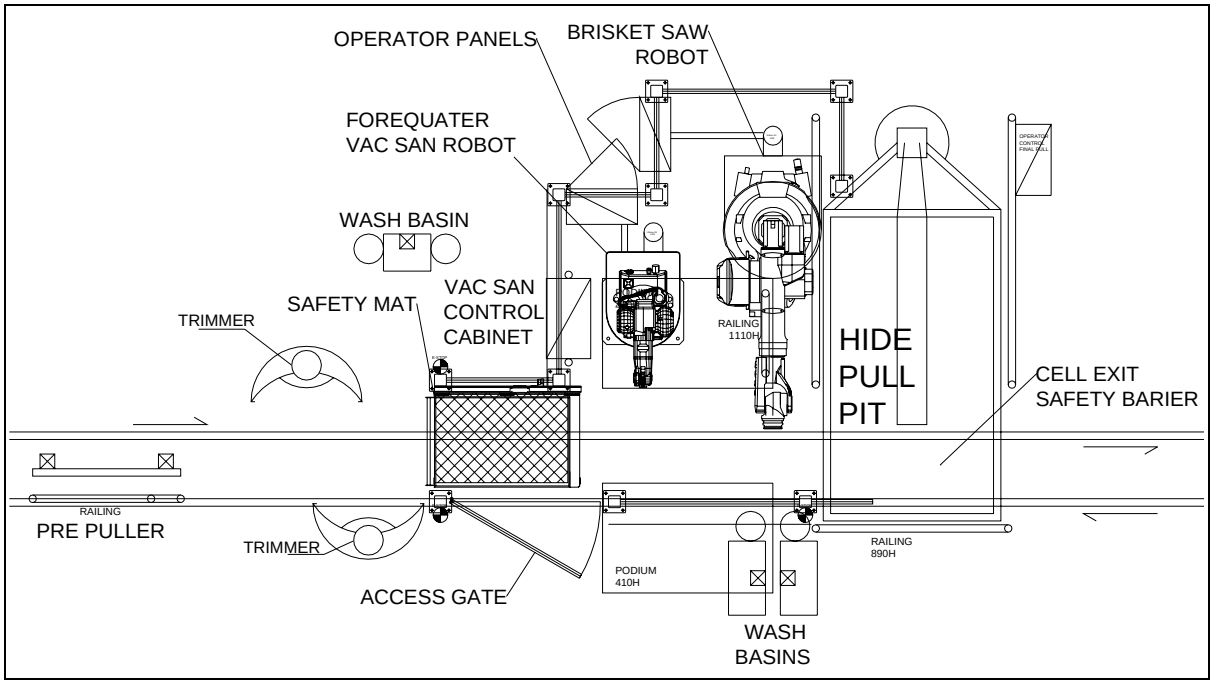

Figure 3 Robotic Brisket Cutting System layout

Safety Guarding

The safety guarding is made with stainless steel posts and 6mm clear scratch resistant polycarbonate sheets. The safety guarding is designed to prevent personnel from coming in contact with the robot.

Figure 4 Robot cell with protective guarding

Safety Mats

The safety mats have been installed to protect personnel around the robot cell from coming in contact with the robot. The safety mat triggers when a person or a weight is on them. The floors may be lifted up and held back with a chain and hook for cleaning purposes.

Figure 5 Safety Mat

Operator Panel

The robot system is started, stopped and reset from the operator panel. There is also a digital temperature gauge on the panel showing the temperature of the hot water in the sterilising tank. The operator panel may be used to stop the robot immediately using the emergency stop. The fortress key shown on the panel allows maintenance staff to isolate the system and attend to robot issue via the inspection gate located on one side of the robot cell.

Figure 7 Operator panel

Sensors

The main sensors include the following:

1. Brisket distance laser
2. Leg position sensor
3. Hot water temperature sensor

Brisket distance laser

This laser is located above the chain conveyor. When the carcass passes into the robot cell, the laser records the height of the brisket area between the legs. The robot program then selects the maximum distance reading which is the highest point on the brisket. The program uses the distance to position the start of the brisket cutting path.

Leg position sensor

This sensor locates the leading and trailing leg on the carcass and also begins tracking process. The program uses the leg positions to find the centre of the cutting path.

Hot water temperature Sensor

There is a temperature sensor located in the sterilising tank. The temperature is displayed on the digital display on the operator panel. Once the temperature reaches the minimum operating temperature of 82.5°C an output from the display allows the robot system to run. If the temperature falls below 82.5°C the error lamp will be lit and a warning message will be displayed on the teach pendant and allow the system to continue. If the temperature falls below 70°C during autonomous operation the system will automatically shut the cycle down.

Functional Operation

The system is started at the operator panel by the press of the start push button. Upon cold start, the robot sterilises the blade and centring guides and then moves to the waiting position ready for a carcass.

A cycle is started when the position and both forelegs and the height of the brisket is detect and threshold hold tested to ensure a carcass has been identified. If a carcass has been identified, the robot connects with the position of the carcass and performs a briskest cut.

After the cut the robot sterilises the blade again and returns to the waiting position.

In the unexpected event the saw on the robot collides with the carcass the robot stops and stops the chain conveyor to prevent damage. If the robot moves out of its working boundary, it will self reset, move to a safe position and continue its normal cycle.

The system is shutdown by pressing the shutdown push button. The robot will go to the shutdown position and turn off the saw. The shutdown position has been selected to remove the saw and robot away from the passing carcass and provide a position for cleaning.

At anytime if the temperature of wash tank falls below a set temperature, the robot will move to the home position and display an error on the operator panel.

AQIS inspection and Swab Testing

Before and after swab testing was carried out by the Peel Valley Quality Assurance Team.

We are waiting on swab testing results from the Quality Assurance Officers at Peel Valley.

These results have indicated favourable for the automated brisket saw to date.

Customer Feedback

John McClusky the Plant manager at Peel Valley Exporters , is keen to see a continuation of further robotic developments and innovation at Peel Valley in the near future based upon the success of this system.

Project Outcomes

Carcass Variation

The major challenge of this project is the ability to adapt to the variations in carcass shape and establishing the optimal cutting path. The variation in shape was mostly over come by using a combination of the centring guides and blade guard. These parts remove sophisticated measurement techniques such as vision, 3D laser scanning and thermal imaging simplifying the measurement down to a total of 1 single point laser and 1 photoelectric sensor. This method has considerably improved the durability and simplified fault tracing for the maintenance crew.

Carcass Tracking

Kuka robotic conveyor tracking equipment was used on the system and has proven to meet the requirements by being able to track carcasses at various speeds and even stoppages with an acceptable level of accuracy.

Product Integrity

The system will cut every carcass that enters the cell and varies the starting height. This provides a consistent cut on every carcass.

System Design

Clear polycarbonate offer a clear view of the robot in operation. Although the system is autonomous, it’s still necessary to check the robot periodically in the case meat is jammed in the blade or it’s malfunctioning in some way. Installing clear polycarbonate sheets is a good initiative.

The operator panel provides the simplest task of starting, resetting and stopping the machine. The panel is robust and suitable for the food industry.

Operation

The system is simple to start, reset and stop. During autonomous operation the robot will cut the brisket of every carcass provided they are within threshold.

Rates of Operation

The system is currently operating at a line speed of 8-9 carcasses/min and capable of higher line speeds for future developments.

Robot & Brisket Saw

The robot is a Kuka KR60 with a customised Jarvis SEC280-4 Circular Breaking Saw mounted to it with a white protective cover.

The centring guides are designed to maximise contact with a variation of carcass sizes. The guides will spring apart if the carcass has a large brisket. The blade cover has been fitted to prevent the blade entering too deep and cutting internal organs.

The protective cover is made from PVC taught-liner material and is custom designed to fit the robot and protect the robot from water entering into the motors. The bag is inflated to allow free movement of the robot within the bag and create positive pressure to also stop ingress of water into bag.

Figure 6 Brisket Saw Adapter

Future Improvements

- The system currently uses a submergible wash tank to sterilise the blade and centring guides. This method is adequate however protein from the carcasses collects on the gearbox housing. It's evident that this may be caused by the temperature of the water. Future development will look at a cold/hot/cold wash cycle to sterilise the blade and centring guides.

- The positions of the legs are currently found by using a single photoelectric reflex sensor. There has been an issue with excessive steam build up on the sensor and reflector which then provides false readings. Future development will look at the most appropriate sensor to use in a steam environment.

- Upon completion of future development of automated and robotic systems to be installed, the potential exists to provide a centralised SCADA package that will enable product integrity, down time, faults, and maintenance information to be displayed and recorded for production and maintenance staff.

- Further investigation and development is required to improve support system for cables attached to the manipulator. This will increase longevity of possible wear items such as bags and hoses.

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Attachments

Attachment Number	Description
1	Production Video

Questions/Feedback

For any questions or feedback on this report please contact:

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Feedback

Name	Comment / Feed Back