

First prototype automation for deboning lamb shoulder - Stage 3

Project Code

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Project Description

In the butchery of lamb forequarter for deboned end products, the shoulder and the foreleg are removed from the primal ribcage. The manual process uses judgement and ability to manipulate both the primal and a knife to cut to achieve the deboning task.

This AMPC project at stage 3 has consolidated and extended the developments of Stages 1 and 2, reach a world first prototype robotic deboning process for ribcage separation from a forequarter lamb primal.

Practical trials in an Australian processing plant, place the performance to be equivalent to the manual process for the ribcage separation with respect to yield and separation speed.

Stage 3 has placed important focus on simplification and robustness of the subsystems as a prototype, whilst cost engineering the integration as a practical and transportable implementation.

The R&D has achieved a final solution after several iteration. The project has been technically challenged and hindered in its execution, whilst having reached important target outcomes. The impact of Covid19 has impacted timelines as well as stretched the resources. Post Covid period the project completed the integration with basic safety to allow testing to begin. Over a period of 9 months several test periods were scheduled and prior to the final testing planned for early 2024, it became necessary to upgrade the robot unit with a higher payload and longer reach to allow trials with the range of weights up to 8.5 Kg forequarter primals.

With the best efforts applied the integrated transportable cell was completed and tested early in 2024. Figure 1 shows the installation set up reached at location where the trials were performed.



World first integrated robot unit for forequarter ribcage separation, deboning of lamb shoulders.

The key technical achievements of the project as whole have been:

- Development of a handling solution for manual loading and unloading of a forequarter primal on to a robotic grasping unit incorporating sensing for initiating of a gripping action as a first step in the cycle.
- Definition of a handling process and the method for robotic deboning with the implementation of robot programs using soft servo methodology: the cartesian soft servo process, replacing the 3D force sensing, which revealed slow and ineffective in this application.
- Implementation and testing of appropriate rotary cutter blade, for use with a powered tool arrangement for meat separation.
- An integrated unit (Figure above) tested for performance in a lamb processing plant in Australia.

The project execution has required an upgrade of the robot arm, extending the capability to handle the weight of larger forequarter primal pieces. The upgraded system was used to separate ribcage of primals up to 8.5 Kg in weight. Benchmarking of the robot and manual process as figure below has focused on cycle times.

The speed performance of the robot separating the ribcage was benchmarked by video analysis at 22.45 seconds compares 22.18 seconds for the same in manual deboning.

Tests show the yield performance to be at 85% targeted at the start of the project.

The table shows the overview assessment of the results from trial runs for 10 forequarters in the range up to 8.7 Kg 4-rib quarters.



Manual and robot time cycles for ribcage separation

The outcome and the findings of the project provide the basis and necessary information for future implementation of a robotic line applying the soft servo programming that has been applied by this project, demonstrating its practical use for the first time in a deboning application.

Forequarter lamb deboning is an intensive manual process, requiring judgment and skill of butchery under demanding work conditions. The task involves lifting and manipulation of primal pieces of 5 - 8.5 Kg weight with a time allocation of around 1 minute to perform the full task of deboning.

This project has concentrated on the separation of ribcage, achieving the same process cycle with comparable yield, reducing the exposure to heavy work by people who can perform the remaining steps in a full deboning of shoulders handling smaller weight pieces and less straining knife actions.

FQ lamb ribcage deboning trial summary				
Test	Spine score	Shoulder score		
1	3	3		
2	4	3		
3	3	1		
4	3	3		
5	3	2		
6	2.5	2		
7	5	3		
8	3	1		
9	2	2		
10	2	1	Overall %	Target %
1-3 Score	8	10	90	85%
>3 score	2	0	10	15%

Stage 1 and 2 reached experimental solution for the task under earlier AMPC projects. The target to reach a transportable unit that may be used in trials in a meat processing environment has been the focus of Stage 3, now concluded and reported at TRL5.

Benefit for Industry

The automation under development increases efficiency and avoids risk of respective strain in deboning and health related issues in the handling of heavy primals during the deboning of forequarter.