Final Report

AUSTRALIAN MEAT PROCESSOR CORPORATION

Collaborative Robots

Collaborative Robots Evaluation and Deployment Strategy Development – Stage 2

Project Code
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1.0 Executive Summary

With this Stage 2 of the Collaborative Robot Evaluation and Deployment Project the aim is to encourage, via reducing the risk, for collaborative robot manufacturers, integrators and the Australian red meat processing sector to ascertain:

1.1 An understanding as to where collaborative robots could be deployed today within a meat processing business.

1.2 An understanding as to where collaborative robots may be utilised in the future in the industry, and what is preventing this from occurring today. For example payload, washdown, speed, end-effectors, guarding, process changes. Outcomes from this step will feed into Stage 5.

1.3 Engagement with possible meat processing customers who by seeing the potential of the deployment of collaborative robots will engage with AMPC and providers/integrators to then deploy demonstration solutions at a range of Australian red meat processing facilities against the range of identified 'today' opportunities.

1.4 Development and submission of Stage 3 deployment projects for funding consideration by AMPC

Stage 2 was a great success. We established several use cases as further outlined later in this report.

The perfect use case and location to fit into this Stage for onsite trials was the Primal Identification and Packing using 3D and 2D Vision in combination with AI technology and a Collaborative Robot. The Robot can work right next Human Workers performing the same task and it reduces the workload on the Humans when there are not enough Human Resources available.

The Equipment required to complete the task was:

- Universal Robot UR10e
- Intel Real Sense 3D and 2 D Camera
- Vision PC for processing our Vision Code
- A Suitable Gripper to pick the selected Primals off the Conveyor

Our work process consisted of:

- Software Development in our workshop which included
  - Identifying the selected Primals with the Vision System
  - Getting the Co-ordinates of the Primal on the Conveyor including direction
  - Tracking the Primal along the Conveyor
  - Getting the Robot to pick the Primal off the Conveyor while it is moving
- Finding a suitable Gripper
- Onsite visit to collect Sample Data and measure the area for the Trial
- Build the Onsite framework for the Robot and Camera
- Complete the Onsite Trials

The Software we developed identifies the Primal by size, shape and volume using the 3D Image as well as AI Vision Technology using the 2D Colour Image. Combined with the Robots ability to track the Conveyor movement we are able to send the co-ordinates of the Primal to the Robot at the time the Images was taken and the Robot will track it from there, it will pick it up when it is within reach and the place into a shipper carton.

The Current Software has limited Primal Samples programmed into it and for a permanent installation further Samples are required for the AI to me more robust across a wider range of Primals.

After the initial software development and building the framework for the Robot and Camera in our Workshop, we conducted the Onsite Trial at JBS Scone. We received great feedback from JBS and immediate interest for a permanent installation at that site.

Further positive feedback was received from our Demo System at the AMPC Innovation Showcase this year and we anticipate more installation inquiries once the first system is installed.

2.0 Introduction

This project focuses on commencing the understanding of how current, and pending, collaborative robots may be deployed within the Australian red meat processing sector. Initially AMPC would like to understand where they can be deployed today. AMPC will also like to understand where they might also be deployed in the future and what additional developments are required of either the collaborative robot platform, end effectors, sensing/visioning, guarding and or changes to current meat processing practices are required to realise future opportunities identified.

An Innovation Theme has been developed for this program of work (depicted within the Project Description in Section 9) and shows both the proposed development stages of the area as well as implementing an innovation competition where more than one provider may be supported in the early stages to evaluate different approaches to the primary goal of using collaborative Robots in the Industry.

Note: It is anticipated that by the time that Stage 3 is being supported the number of providers being supported will have significantly reduced, and eventually probably only one selected for Stage 4 developments onwards.

The Primary Goal of this Project is to reduce the human operator risks and effort in material handling and meat processing activities.

Additional goals include:

- improving yield, if possible,
- developing opportunities for the number of engineering and technical staff to join the industry,
- increasing food safety, and resulting shelf life product extensions,
- extending the working life of staff,
- applications outside of the meat processing chain / logistics, such as in maintenance, rendering, laboratories, office, etc, and
- changing the image perception of the industry from a pure manual sector to a high-tech sector that has a strategic blend of equipment and human operational staff intertwined in daily processing operations.

This project is focused on Stage 2 development scope only (refer Section 9).

3.0 Project Objectives

The Research Organisation will achieve the following objectives to AMPC's reasonable satisfaction.

3.1 Objective 1

To ascertain an understanding as to where collaborative robots could be deployed today withing the meat processing business.

3.2 Objective 2

To ascertain an understanding as to where collaborative robots may be utilised in the future in the industry and what is preventing this from occurring today. For example, payload, washdown, speed, end-effectors, guarding and process changes. Outcomes of this step will feed into stage 5.

3.3 Objective 3

To engage with possible meat processing customers who by seeing the potential of deployment of collaborative robots engage with AMPC and providers/integrators to then deploy demonstration solutions at a range of Australian red meat processing facilities against the range of identified 'today' opportunities.

4.0 Methodology

1 - Undertake visitation process with AMPC at mutually agreed red meat (bovine, ovine and caprine processing facilities)

2 - Undertake opportunity analysis on each processing plant visited and categorise opportunities into the following summary:

a. Opportunity for today (with no, to minimal, technical risk and technology development)
b. Opportunity for today (with some development required)
c. Opportunity for the future (and identify what developments/changes are required)

3 - Trail Test the latest collaborative and cognitive Robot Technology for identified Opportunities

4 - Report to AMPC outlining the above and providing high level budgets for Items 2a and 2b.

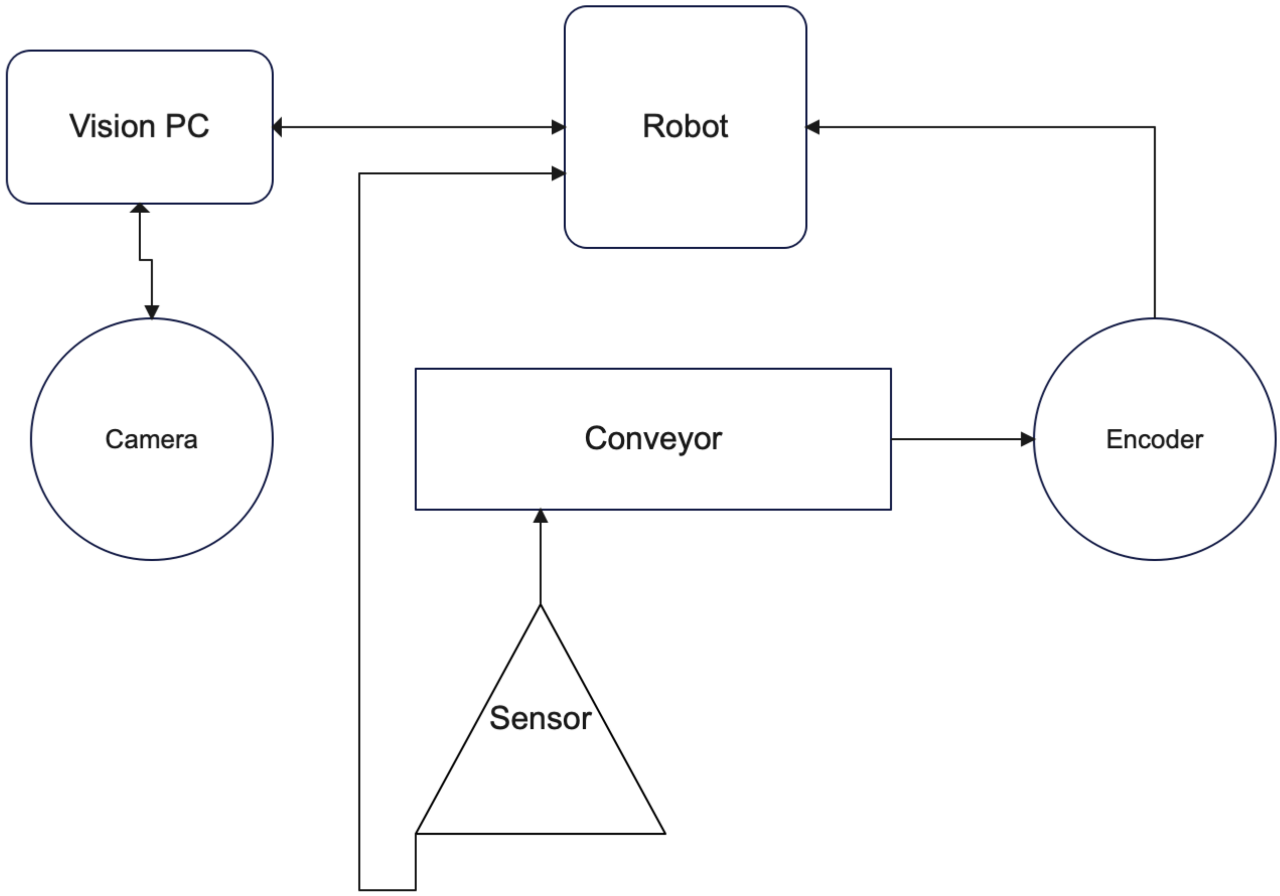
5.0 Project Outcomes

The Project was completed successfully against scope and budget, however the schedule was severely disrupted by the COVID 19 Pandemic and the long restrictions and lockdowns. Additionally, some further delays were introduced by the worldwide shortage of materials in the technology sector.

The selected trial of Primal identification and packing was conducted at JBS Scone, however additional applications for trials could be performed in future projects such as:

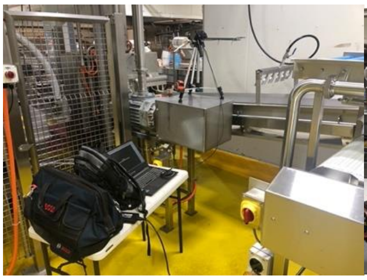
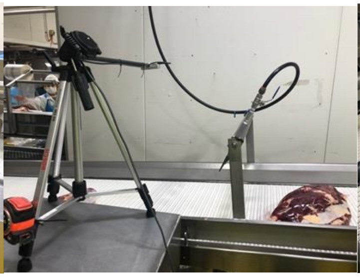
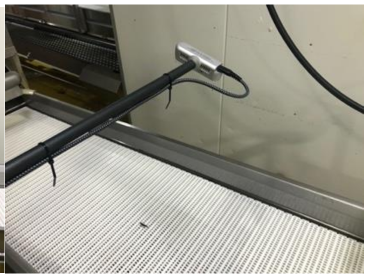
- Sani Vac at ALC Colac (standard 10kg or 16kg Collaborative Robot)
- De Boning at JBS (high payload 35kg Collaborative Robot with force guidance)
- Carton Stacking at JBS (high payload 35kg Collaborative Robot)

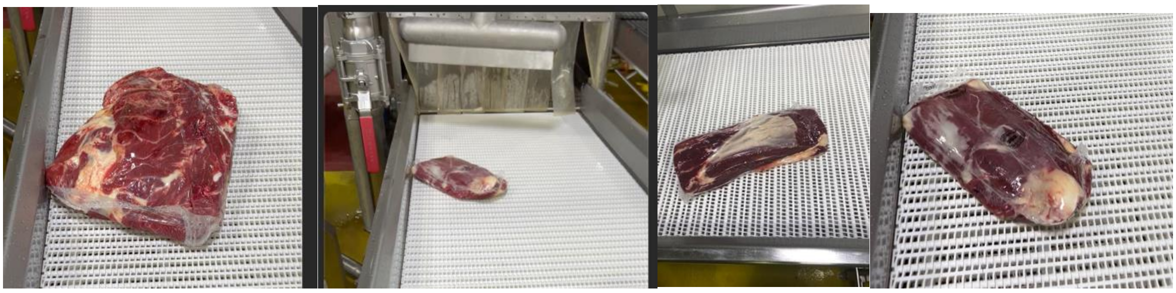
The Primal Identification System consists of the following elements.



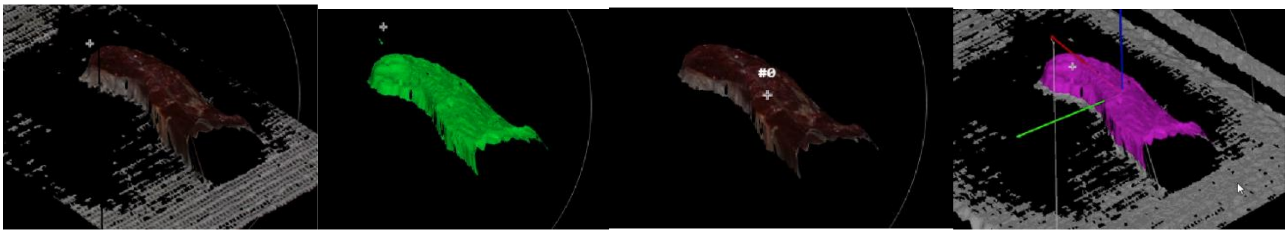
- The Sensor detects the Primal on the Conveyor and sends the signal to the Robot.
- The Robot requests the type and location of the Vision PC and starts tracking the primal with the Encoder.
- The Vision PC uses the Camera to capture and 3D and 2D image.
- The Vision PC analyses the data and send the Information to the Robot.
- This information could be to let the Primal pass or to pick it and pack it.

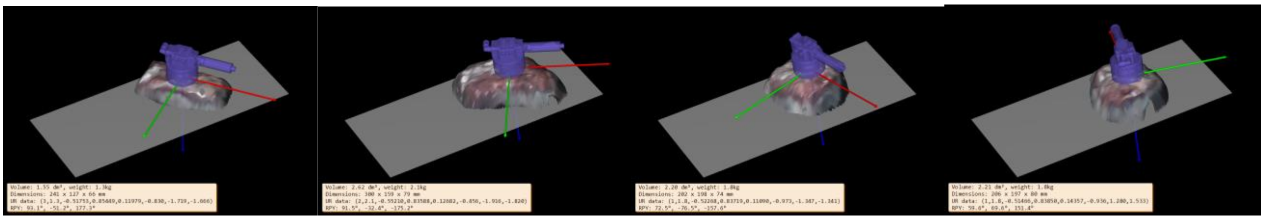
The development process started with taking sample Images on the conveyor to allow us to program the Vision System to identify selected Primals.

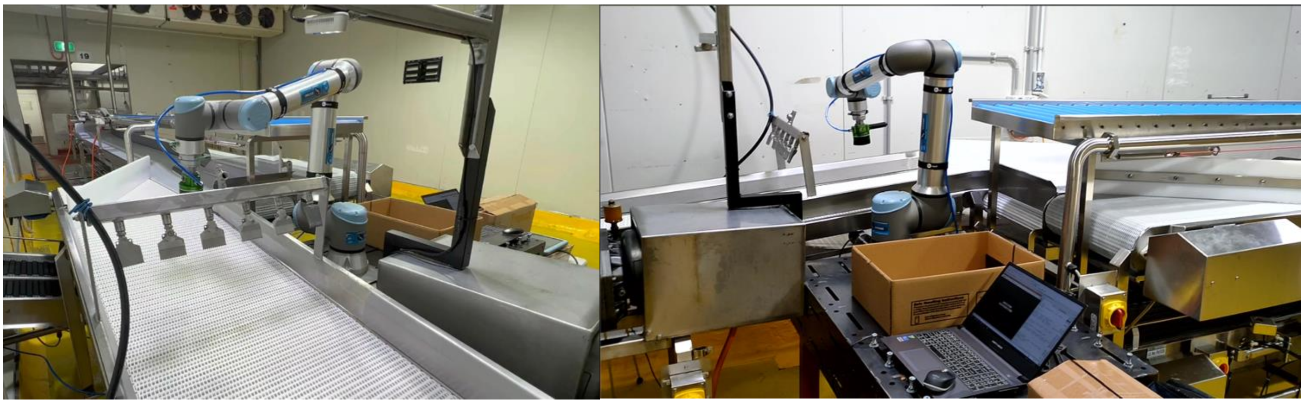


The Vision programming involved a few steps including 3D and 2D analysis of the Samples





From there we developed the Robot to Vision PC communication and calibration and tested the complete operation in our workshop before returning to site for the live trial.



The Vision System successfully identified the selected primal cuts by size and volume to complete the Trial at Scone. For future installations additional AI and Deep learning technology will also be implemented with the Vision System to create a very robust final solution for this application.

A Video of the Trial can be viewed at this link: https://youtu.be/RQHsjKRi2Xg

The Speed of the Robot can also be improved with an installation of the Robot being wall mounted above the work area and a more suitable Gripper for the specific Primal Cuts that will be selected. A Gripper quick change system will help with setup for different productions runs, this quick change system can also be fully automatic with a HMI interface where the operators just selects the Cut they wish to package and the Robot System will do everything automatically.

6.0 Discussion

The Trial was successfully completed, however it was conducted with limited samples and further work with the AI Vision Deep Learning is required to produce a final robust solution that can be applied to multiple installations. This additional AI Vision Deep Learning is a very suitable Project for Stage 3.

Other Collaborative opportunities we identified:

- Sani Vac at ALC Colac
- De Boning at JBS (high payload 35kg Collaborative Robot with force guidance)
- Carton Stacking at JBS (high payload 35kg Collaborative Robot)

The Sani Vac Robot can be a standard 10kg or 16kg Robot since the payload of the Sani Vac Robot attachement is not very heavy and the contact with the Carcass is controlled with Force Sensing in the Robot.

The Carton Stacking in areas where an industrial Robot Cell won’t fit is now possible with a 35kg Collaborative Robot available to be able to life the weight of the carton that are around 30kg.

The same 35kg can potentially be used for De Boning where the Robot would be controlled by an Operator with a force control system that allows the Operator to guide the Robot and engage with the Carcass where required and then pull the Meat of the Bone. The Operator would be just guiding the Robot and the Robot would be performing the hard work of pulling the Meat.

7.0 Conclusions / Recommendations

Positive feedback was received from management at JBS Scone regarding the Primal Identification and placement into the shipper cartons. The trials were a complete success and JBS Scone expressed interest for a permanent single Robot installation at the same location as the Trial. This presents a perfect opportunity for Stage 3.

8.0 Appendices