Final Report

AMPC
AUSTRALIAN MEAT PROCESSOR CORPORATION

Shadow Robotics

Remote Operations- Shadow Robots

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1.0 Executive Summary

AMPC (and the industry) have an innovation vision, to eliminate all WHS incidents from processing operations. This journey comprises of two main possible paths:

1) Automation of tasks.
2) Removing operators from danger using various safety techniques on tasks that are not cost-effective to automate.

One such way to remove an operator from danger is using shadow robotics, or tele-remote operated robots. Allowing an operator to control a robot on the processing line from a safe location removes risk of injuries from sharp implements (saws, knives etc) and stress on the human body (through force multiplication through the robot). One of the main issues with normal tele-remote robot is the lack of haptic feedback required in meat processing operations. As a result, a haptic feedback unit was combined with a collaborative robot as a step towards remote operations within meat processing.

Throughout this project, the primary aim was to investigate the possible use of a haptic feedback device to control a robot for use within the red meat industry and display the technology to industry at Beef Week in 2021. This involved the commissioning of the Shadow Robotic System, development, and creation of a Trade-Show suitable display from the equipment and attending Beef Week 2021 to support the demonstration.

The exhibition of the technology at Beef Week 2021 was a success, with a large number of visitors to the stand being able to use the technology. The range of visitors included:

- Senators and politicians.
- Abattoir workers.
- Processors.
- Universities and various research institutions.

The discussion with the various possible stakeholders during the exhibition brought up new benefits to industry, and further cemented the initial thoughts of benefits to the industry as a whole. These benefits included:

- Ability to remove staff from dangerous operations.
- Attraction to adoption of the technology based on wide number of uses.
- Retention of people, by improving working conditions and reducing stress to the body.
- Carcase primal profitability optimisation, through potential yield benefits due to assistive technology and reduction of fatigue and forces required.
- Digitisation, by acquiring product information and leveraging data insights.
- Increased labour pool due to ease of access of technology location and reduced strength required.

The dexterity, strength and force feedback sensitivity of the Shadow Robotic system allow for a large number of deboning tasks to be undertaken with possible yield benefits. The next stage in the development of this technology will be to begin to trial a number of meat processing operations in order to determine which tasks should be carried out with the current technology, and what it could be used for in the future.

2.0 Introduction

AMPC (and the industry) have an innovation vision, and support R&D program, to eliminate all WHS incidents from processing operations. Where possible dangerous tasks will be fully automated. Where automation is not currently viable (either due to technology limitations or ROI), semi-automated/remote solutions will be developed that will remove the operator from dangerous tools and implements. As a result of this innovation vision, research, and development into the concept of shadow robotics was conceived.

One way of removing operators from dangerous environments, is through the use of a tele-remote operated robot. Utilisation of a controller with a handle allows for more anthropomorphic control of a robot arm, to perform operations normally carried out by humans on a processing line. This is the enabler for a much larger range of tasks on the processing line to be carried out, rather than building assistive devices for each task individually, which allows for redundant uses of the technology on multiple operations.

In addition to removal of personnel from dangerous environments, there are a range of secondary benefits to the technology. These include:

- Providing a wider labour pool for the task, including those otherwise abled.
- Providing possible yield benefits through carcase optimisation by less fatigue or assistive programming.
- Retention of people within the industry, through better working conditions.
- Digitisation of processes to allow for leveraging data insights for efficiency increases.

The purpose of this research project is to provide technology that could be used for tele-remote robot operation and present the technology to industry at Beef Week 2021. This includes:

1) the identification of the technology
2) Procurement of required technology
3) Programming and commissioning of the technology
4) Presentation and Exhibition at Beef Week 2021
5) Analysis of the technology and plans for next steps of evaluation and development of the technology.

This process will evaluate the chosen technology and decide on next steps to progress the technology towards adoption.

3.0 Project Objectives

AMPC (and the industry) have an innovation vision, and support R&D program, to eliminate all WHS incidents from processing operations. Where possible dangerous tasks will be fully automated. Where automation is not currently viable (either due to technology limitations or ROI), semi-automated/remote solutions will be developed that will remove the operator from dangerous tools and implements. Where semi-automated solutions are not viable then the remaining hands-on tools will be made as safe as possible.

This project focuses on further developing solutions, and approaches, for semi-automated / remote solutions, with the goal of putting together a trade show demonstration of the technology. This will include a haptic controller being used by an operator to remotely control a robot which is performing some form of task for demonstration. The display will be able to demonstrate not only the ability to tele-remotely operate a robot, but ideally also the force feedback which is able to be provided.

The objectives of the project are as follows:

1. Obtain haptic controller and robot
2. Perform programming to allow haptic controller to move robot
3. Create Trade-Show suitable display from equipment, including ‘props’
4. Attend Beef Week to support demonstration

4.0 Methodology

3.1 Trade Show Exhibition Design

While waiting for the Haptic Feedback device, the layout for the exhibition was designed. For the demonstration, it was decided that a laser would be mounted to the rollface of a 7kg Kuka Iiwa. This laser would be pointed towards a large poster of a beef side to enable a user to “perform cuts” with the robot using the haptic controller. The aim for the Beef Week 2021 demonstration was for a “general public” member to be able to use the haptic controller, under the guidance of an Intelligent Robotics (IR) engineer, to move the laser on the Iiwa across the beef poster to simulate performing cuts. There would also be a demonstration whereby the operator would perform some movements and the IR engineer would push against the iiwa to provide varying levels of resistance back through the haptic device to demonstrate force feedback.

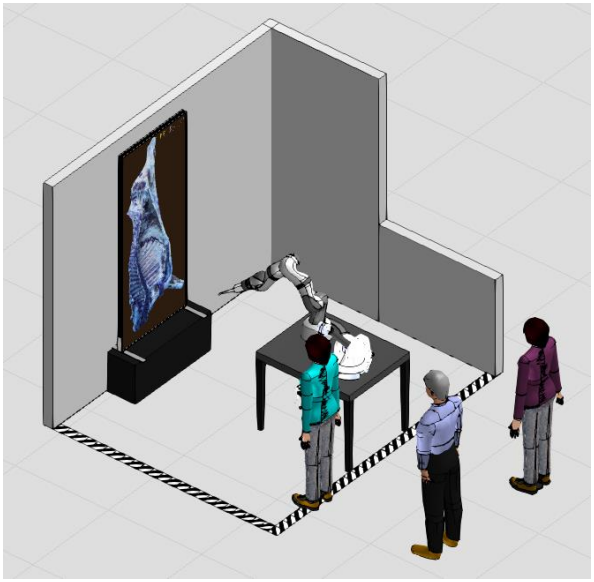

Figure 1- Original Stand Design

This design was carried out concurrently with the manufacturing and freight of the unit to Australia. In addition, the stand to be taken to the trade show was designed and ordered for manufacture.

Figure 2- Manufactured Stand for Beef Week 2021

3.2 System Setup and Commissioning

Once the Kuka robot and the Haptic Feedback device had arrived, the system was installed onto the stand, and the laser box was mounted onto the rollface of the Kuka Iiwa.

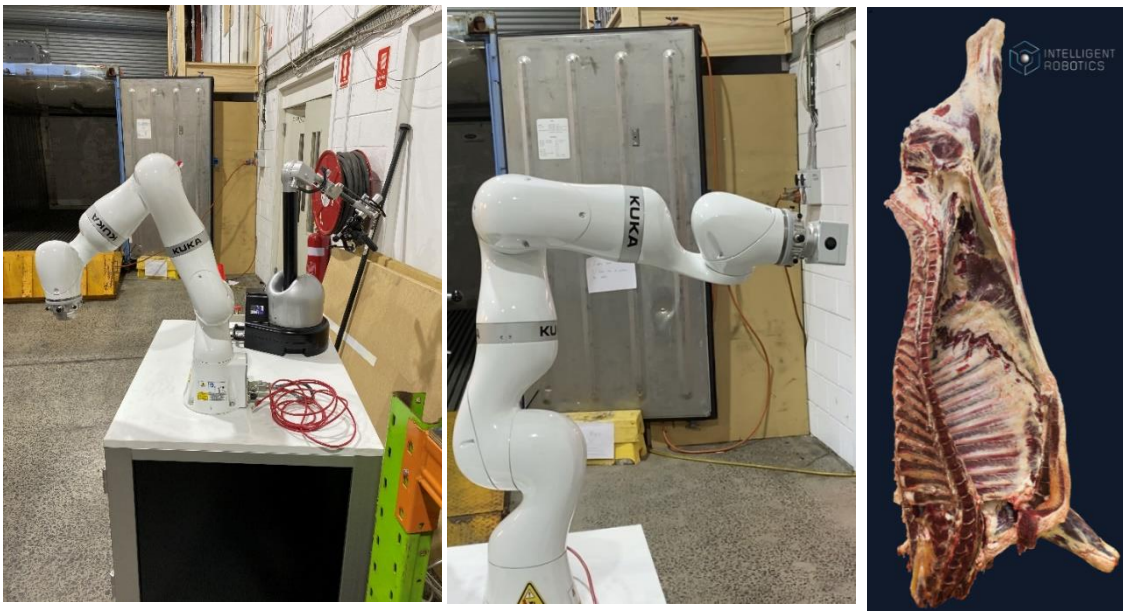

Figure 3- System Installation, and Beef Banner

The banner was also designed and created during the installation phase, so that it would be ready for use when the system was fully commissioned. The Iiwa was connected to the Haptic Feedback device, and successfully linked once each component was installed and successfully commissioned.

Figure 4- Working System Previous to Freight to Rockhampton

3.3 Beef Week 2021 Setup and Exhibition

The pallets were delivered up to Rockhampton on Thursday, to allow for the set-up of the stand on the weekend prior to the show.

Figure 5- AMPC Stand Pre-Setup

The system was set up successfully on Saturday and further tested on Sunday, to ensure that it was ready for the show.

Figure 6- Completed Shadow Robotics Exhibit

Throughout the week, there were a large range of people visiting the AMPC stand, and the Shadow Robotics Exhibit within it. This included locals, processors, schools, colleges, and various other people within the industry.

Figure 7- AMPC Stand with Crowds

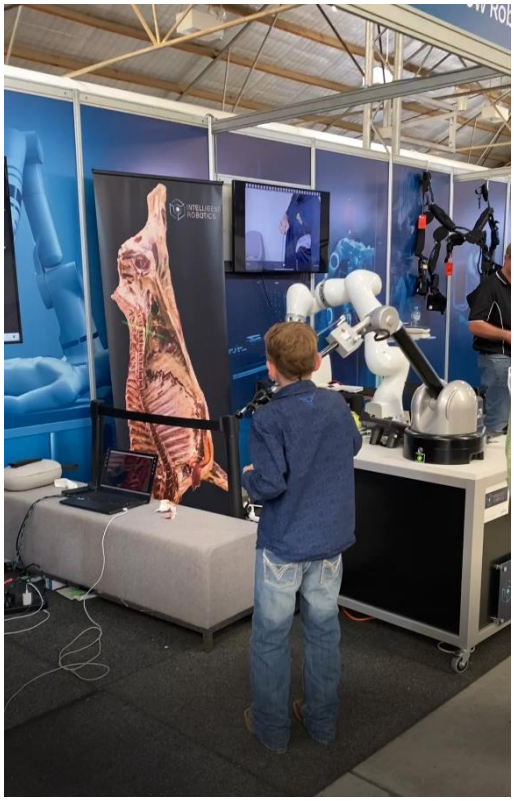

Figure 8-Use of System by Children at Beef Week 2021

At the end of the week, the equipment was packed up and sent back to Sydney.

Figure 9- Packed up Haption Unit

Figure 10- Packed up Robot and Stand

5.0 Project Outcomes

Throughout Beef Week 2021, there were discussions with people who have had experience on the processing lines, farmers, processors, and WHS personnel, who all added to the research being performed on this product. The weaknesses found within this current technology were found to be:

1) A lack of dexterity
    a. More work on the dexterity of the robot and the connection has to be carried out
2) Cost
    a. The cost of the system is currently too much. The return on investment on the system in its current state is not enough to be worthwhile for processors
3) Cleanability and protection of the robot
    a. The robot is not a washdown robot and will not handle a caustic washdown. For further developments this will have to be taken into account.

Even with these weaknesses, there were many different upsides that were developed and discovered throughout the week.

1) The haptic feedback was sensitive enough that ex-boners agree it could be used for some purposes
2) Some meat processors expressed their interest in such technology.
3) The WHS benefits for the workers are quite substantial. Many ex-meatworkers no longer do hard boning operations due to the hard strain on the body. Many could see their longevity in the industry increase by using such technologies.
4) Possibility for assistance for yield gain
    a. Through extra programming with the robot, assistive operations can be carried out in order to assist in the yield gain through this technology. Taking rib scribing as a use case, the robot could be programmed to keep certain axis of the robot locked out to ensure that each scribe is parallel, to increase the yield gain.
    b. This yield gain decreases the time required for the ROI.
5) Widening of the labour pool
    a. Within a COVID-affected Australia, red meat processors are struggling to find workers to help fill their labour requirements. By using this sort of technology, people without as much strength as a typical boner could then enter the workforce. This could include:
        i. Older people
        ii. People with disabilities
        iii. People not able to carry out heavy duties all day without becoming too fatigued.

It was previously thought that the time for the return on investment was too long to make this technology viable, but through discussions and further learnings, this is no longer seen as the case. The next step is to find applications for this technology and determine the best actions to assist the operator in achieving yield gain through extra sensing technology or assistance through the manipulator.

6.0 Conclusions / Recommendations

At the completion of this project, there were some valuable learnings attained through discussions with a range of diversely skilled people. Concurrently, the trade show was a success with the AMPC exhibits being one of the most popular stands at Beef Week 2021. The next stage in the development of this technology is to:

1) Discuss with processors where they see the technology being applied in their plant.
2) To further investigate use-cases and determine the achieve yield gains with the assistive technology.
3) Find a robot suitable for future applications within the red meat industry.
4) Perform trials of the unit on some deboning tasks in order to validate its usefulness as a tele-remote deboning tool within red meat processing.

These steps above will allow for the further development of the technology with a greater chance of adoption within industry.