Snapshot Report

AI Beef Cutting

Artificial Intelligence - Non-X-ray Beef Cutting - Stage 2 (Intelligent Robotics)

Project Code
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Project Description

The first iteration of beef scribing at NCMC (**Semi-Automated Scribing development**) initially targeted fully automatic placement of cut lines using pattern matching with colour images. This approach was ultimately unsuccessful in terms of reaching an acceptable level of accuracy and a semi-automatic approach was adopted. Machinery Automation and Robotics (MAR) then worked with **JBS** (funded by MAR, JBS, AMPC, MLA & the Australian Federal Government) to evolve this concept into an automated solution using x-ray imaging. The solution details can be located at this link - **Automated Scribing development** and is still in operation at JBS today.

While the non-x-ray system at NCMC wasn't able to reach full automatic operation using just colour imaging, the advancement of artificial intelligence and machine learning technology in the past ten years presents a significant opportunity to enable a solution which doesn't require x-ray technology.

With this in mind, AMPC sought input from solution providers around an innovation theme exploring alternative sensing approaches for beef scribing. The primary goal for this innovation theme is a successful development(s) to enable automation of beef cutting activities without having to rely on x-ray imaging. This would enable a lower cost and potentially smaller footprint solution than one requiring x-ray imaging. It is expected that there will be some sacrifice in accuracy, but the magnitude of this is not yet understood.

As a result, the objective of this project is to evaluate possible designs for non-x-ray Automated Beef cutting systems (in terms of sensing design, neural network and algorithm design) and to report on the potential accuracy and reliability of such as system, to determine feasibility of the design.

Project Content

The methodology for conducting the project was as follows:

1. Preliminary sensing concept design for a 'non-x-ray cutting' system
2. Perform on-site trials to acquire a large amount of carcase images, emulating the sensing setup of the concept as closely as possible
3. Use the data to teach and verify a number of artificial intelligence models to determine the most promising
4. Assess the accuracy that is achievable using this method
5. Report on next steps in the development pathway

Project Outcome

Intelligent Robotics approached the project by first developing a preliminary sensing concept design for a 'non-x-ray beef scribing system'. From this design, site trials were performed to acquire sensing data. This was done over two trials spread across two plants, with two different sensing setups. The first trials focused on identifying the spine cuts only, while the second trials focused on identifying the rib scribing cuts while building upon the results from the first trials to further examine spine cut positioning. Once the data were acquired a number of neural networks were then trialled to find the optimal setup for accurately predicting these features.

The results obtained suggest that neural networks offer a feasible sensing alternative for beef scribing to x-ray sensing. With respect to the spine cuts, the ability to accurately identify the required features using the neural networks as a first pass for the vision analysis is feasible and will increase in performance with greater training. Regarding the vertical rib cuts, the neural network already operates at a level similar to a highly trained operator in identifying the key features. The networks also operate very successfully at correctly identifying features which have been historically challenging to identify reliably in previous attempts at vision-based scribing.

This project has therefore shown it is possible to identify the key features required to characterise the beef scribing cuts without using x-ray sensing. The next phase of development in both instances would be to now develop the further post-processing vision algorithms to transform these features into actual cut paths, as well as adding further refinement and error checking tools to ensure robust performance.

While there is still a significant amount of vision code to be developed to produce robust, production-quality software, the key risks for AI-based scribing have been examined within this project and the optimal methodology identified to achieve the desired results. It is therefore envisioned that this work would continue under a project for a commercial AI-driven beef scribing system with an Australian beef processing facility.

Benefit for Industry

This project involved understanding what an AI enabled “non-x-ray automated cutting system” may look like, with particular emphasis on the sensing technology. X-ray has been used in a large range of meat cutting projects in the past, and it is a proven technology for the automation of meat cutting systems to a reasonable degree of accuracy. Unfortunately, there are drawbacks to the use of X-ray for this purpose, that include:

1) Required size
    a. The required size of an automation cell to build a labyrinth of x-ray shielding is too much for many sites
2) Cost
    a. Addition of X-ray introduces significant costs, including the technology itself and the shielding required to make it safe
3) Complexity
    a. Component complexity increases when having to use high voltage components
4) Risk
    a. There is an increased risk due to radiation exposure

Due to the reasons above, there are numerous of benefits to the development of an AI powered automated cutting system. This project has also been identified to be in line with AMPC’s 2020-2025 strategic plan, with benefits including:

1) Removing staff from dangerous operations, via hands-off processing.
2) Increasing safety and wellbeing, by reducing the high-risk nature or certain processing operations.
3) Attraction of people to the industry via demonstrating a wide range of technological operations.
4) Retention of people within the industry by improving working conditions.
5) Development, via developing tasks that require higher skills and intellect.
6) Increasing carcase primal profitability through optimisation
7) Enabler for acquiring product and processing formation in order to leverage data insights.

Intelligent Robotics and AMPC are currently working with Australian beef processors to further develop the technology in production beef scribing systems.