Snapshot Report

Box Label Verification

Computer Vision verification technologies to reduce labelling errors in the red meat processing industry

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Project Description

Quality control is a vital aspect of the red meat processing industry, particularly regarding the packing and labelling of meat into boxes. The industry has previously faced issues in this area, with human error leading to labelling inconsistencies and subsequent export bans. These errors have significant consequences for individual processors and the entire Australian meat processing industry, resulting in significant financial loss, damaged reputation, and loss of market share.

To address these issues, the project builds upon earlier AMPC-funded research (2021-1113) which in-part, explored development of a prototype computer vision-based solution capable of detecting box label errors found in meat processing factories. While the previous project was able to demonstrate that computer vision systems employing artificial intelligence (AI) could detect several cuts of meat, and that a combination of traditional computer vision and AI could extract information on external box labels, it concluded that further development of a box label verification solution for use by Australian meat processors required further investigation.

Moving from a prototype box label verification solution to a robust commercial solution that could be deployed into a meat processing facility requires addressing several challenges. One of the challenges is ensuring that the solution is robust and reliable enough to work in a real-world meat processing environment, which involves various operating conditions such as a requirement to withstand harsh, end-of-shift cleaning regimes involving high pressure water jets within boning rooms.

Commercial vendors of industrial automation technology can bring several capabilities to the solution, such as expertise in designing and implementing automation systems, knowledge of industry best practices, and access to a wide range of technologies and components. They can also provide support for maintenance and troubleshooting, as well as ongoing training and education to ensure that the solution is used effectively. Consequently, this project aimed to work closely with several vendors of industrial computer vision solutions to explore if “off-the-shelf” technology could be deployed into meat processors to address the label verification challenge.

Project Content

Objectives of the project:

- Consult industry about their direct needs for label verification.
- Conduct staged comparative experiments of existing off the shelf solutions which could solve this issue.
- Field trial at least one label verification system which has passed prior evaluation steps.
- Conduct staged experiments of “What was put in the box” computer vision solution to detect meat cuts placed into a carton.
- Field trial prototype of “What was put in the box” computer vision solution in a meat processing facility that links with a label verification system.

Activities undertaken:

This project pursued a sequential staged approach involving research, design, development and testing. Each of these stages had their own sub objectives and outcomes. To summarise, the stages were:

- Research: Further understand the challenges faced by the meat processing and inspection industry
- Design: Experimentation design, installation, rollout procedures for the labelling solutions. Data capture in the field used for training AI model.

- Develop: Develop additional experiment materials and software to support the use of these camera systems in a meat processing environment. Develop AI models to be used with these systems.
- Test the use of the technology being applied to challenges in food safety inspection, data capture.

Project Outcome

Outcomes from the project included:

- while many meat cuts are relatively easy for humans to discriminate, several cuts, especially when shrink wrapped, are difficult for even “expert” human observers to tell apart.
- while packing a box with meat cuts, and then placing an external trade label on each box of meat, is uniform across the sector, each processor adopts a different approach to this task.
- Commercial off-the-shelf computer vision solutions are currently not sufficiently advanced to recognise individual cuts of meat, recognise the packing of meat into boxes nor able to adequately process external label data at production speed.
- Relatively inflexible positioning requirements for commercial off-the-shelf camera systems to ensure coordinate frame of the camera closely matches the coordinate frame of the label on box.
- Existing “smart” cameras need templates for each label type and pre-identification of label type as a box moves along a conveyor, requiring slowed production speeds.
- Existing “smart” cameras cannot translate Mandarin or other languages at production speed.
- Approach to engaging meat processors in research trials where they are required to answer questionnaire needs refinement.

Benefit for Industry

While the project was unable to finalise an in-processor evaluation of a commercial, off-the-shelf industrial computer vision solution for addressing the issue of box label verification, research conducted better identified the challenges involved for design and implementation of such as system. These include the need to:

- Define environmental conditions: Investigate the environmental conditions in typical red meat processing facilities, such as temperature, humidity, dust, and moisture levels. This information will help specify the necessary protection levels for the image acquisition technology.
- Determine conveyor speed range: Determine the range of conveyor speeds typically found in Australian red meat processing facilities to ensure the image acquisition system can handle the highest possible speeds without compromising image quality.
- Define label position and orientation: Identify the standard positions and orientations of labels on boxes, as well as the acceptable variations in label placement. This information will be crucial for designing the camera and lighting setup.
- Specify camera requirements: Based on the gathered information, specify the camera requirements, including resolution, frame rate, shutter type (global shutter), and interface (GigE, USB3, or Camera Link, for example). Camera selection should ensure delivery of clear, high-quality images at the required conveyor speeds.

- Specify lens requirements: Define the lens requirements, such as focal length, field of view, and aperture, based on the label size, conveyor speed, and camera sensor size. Ensure the lens is compatible with the chosen camera.
- Specify lighting requirements: Specify the type and arrangement of lighting that provides consistent, even illumination of the labels, considering factors like label position, conveyor speed, and environmental conditions. LED light bars, ring lights, or backlights may be suitable options.
- Specify mounting and enclosure requirements: Define the necessary mounting and enclosure requirements to ensure proper positioning, alignment, and protection of the camera system. Consider adjustable mounts and IP-rated enclosures suitable for the environmental conditions in red meat processing facilities.
- Integration and communication: Specify the required integration and communication protocols for the image acquisition system to work seamlessly with the facility's existing infrastructure, such as industrial controllers, alert systems, and conveyor synchronization.

In addition, the project identified that Australian meat processors currently do not have a standardised or systematic method for responding to customer complaints/queries about shipments of meat to overseas destinations. In particular, the is no current means for meat processors to easily search a database containing images box label and box contents. It is proposed that a box search tool should be a minimum feature for any box verification tool. A search function is currently being developed by Bondi Labs.