Industrial robots for the meat industry

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The potential applications of robots in the food industry, particularly in meat, have been investigated for several years. The main aim of using an industrial robot is to reduce production costs and occupational injuries while improving process efficiency and hygiene. The strength of robotics, particularly in boning rooms where labour costs are inherently high, is in their ability to perform the required repetitive tasks more efficiently and consistently than is currently possible.

Figure 1. Prototype robotic installation.

Industry is interested because the benefits are improved product yield through better efficiency and repeatable boning methods at lower long-term costs. Beef processing costs for Australia's best-in-class meat processors are generally higher than any of its international competitors and 2.5 times higher than US best-in-class, on a direct comparison AUD$ per kg basis (2001 figures). With increased personnel and OH&S injury costs, industry realises robots and automation are going to be important tools in remaining commercially viable in a competitive future. The current emphasis in industry is on innovative automation procedures, but the need for smart, novel sensing is likely to increase.

Robots have been widely adapted into many of the labour-intensive industries, such as manufacturing, but in the meat processing industry there has been minimal uptake in the use of commercial robots. This has been due to automation being unable to cater for the variability in the products being processed. Apart from picking, placing and palletising cartons, there have been few applications of robotics on meat processing lines.

Food Science Australia is currently investigating several robotic systems for meat production applications. The basic components of these systems are:

- an industrial robot and controller,
- a material handling unit, and
- a sensing or detecting system.

Commercial industrial robots have been used, rather than purpose-built machines because industrial robots possess proven positioning performance, sound safety records, operational reliability and have replacement parts and service technicians readily available. Compared with customer-specific designed manipulators, it has been found that the development of an application that integrates an industrial robot reduces development cycle time significantly. Direct integration of commercial robots is more economical, especially as a single robot can be used in the development of multiple applications.

Robotic dynamic performance (response time, communication and positioning accuracy) will determine the acceptance of industrial robots in the meat industry for automated applications. The areas that need to be addressed when considering industrial robots for meat industry applications are:

Accuracy: To perform a task what level of accuracy is required? When operating under 'fine' positioning control, the robot should

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be capable of achieving a linear accuracy of ± 0.1 mm; however the more precise the positioning required the longer the robot requires to perform the task.

Response time: A robot needs to respond quickly to achieve the production speeds that meat processing requires. What is the cycle time for the proposed task?

Sensing: Information about the carcase / task environment is required to perform the operation. What type of sensor is appropriate or what is trying to be sensed? Is sensor orientation important?

Tool/end effector: Is a tool required to perform the task? Possibly an existing manual tool could be adapted or a purpose built tool may need to be developed. What kind of compliance and feedback is required? Can the tool undergo maintenance easily?

Space/layout: Can the robot operation be carried out in its present location or does the processing line need to be revised? Note that allowances must be made to fulfil all requirements of safety legislation.

Materials handling: Is carcase stabilisation required? The product may require a particular orientation or consideration as to how it is delivered and further processed.

Product quality: The final product finish and specification needs to be considered.

Process analysis: The current process or task needs to be reviewed and efficiencies / requirements of proposed system confirmed.

Product variability: Allowances need to be made for the carcase variability in the Australian meat industry.

Control: The way the system will be operated has to be considered. If sensor information can be processed prior to execution of operation instructions, then the robot can be commanded with off-line programs which allow pre-movement calculation and path planning. When the data is processed externally, the planning process for the next move can be carried out in parallel with the execution of the current instruction. The resultant path is both faster and more accurate.

Operator: Is the proposed system only semi-automatic and if so what operator feedback is required? Will the system require only start up, shut down and problem shooting procedures?

Sterilisation: Does the tool/robot need to be sterilised or washed? Is the task performed pre or post final inspection?

There is great potential to incorporate industrial robots into the meat industry, particularly as improved productivity and cost reduction become more essential. To take advantage of the benefits of robot integration such as low cost, quick development and high system durability, industrial robots must be adapted to include features such as food-grade housings and improved response times while maintaining currently available accuracy.

"The processing sector is critical to the overall viability of our industry. ….. Processors are facing many tough issues including shortage of skilled labour, … the high cost of workers' compensation.

The research we undertake in the meat processing sector is funded solely by processors and the Federal Government matching funds and we now have a comprehensive strategy that covers the development of new automation technologies, OHS best practice…"

Christine Rawards, Meat and Livestock Australia's Client and Innovation Services General Manager; Meatnews.com - November 20, 2003.

Food Science Australia has considered industrial robot operations and is working to develop control programs to optimise performance in commercial meat applications. Innovative automation-based technologies will enable a reduction in meat processing costs and the realisation of potential benefits to Australian meat processors of millions of dollars per annum. As long as the appropriate processing task is selected and evaluated the introduction of automation in the meat industry will be successful.

Further Information

Li, Z and Hinsch, A (2003). A new approach to detect the cutting positions for a robotic beef carcase scribing system. Proc. of the 2003 Australasian conference on robotics and automation, December, 2003 Brisbane Australia. www.araa.asn.au.

Li, Z, Ring, P, MacRae, K and Hinsch, A (2003). Control of industrial robots for meat processing applications. Proc. of the 2003 Australasian conference on robotics and automation, December, 2003 Brisbane Australia. www.araa.asn.au.

For further information, please contact Ray White or Darryl Heidke at Food Science Australia, Ph. 07 3214 2000.

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