SNAPSHOT

AUTOMATED VISUAL INSPECTION AND PREPARATION OF LIVE ANIMALS FOR MEAT PROCESSING

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Project Description

The overarching purpose of this research project was to design and develop an automated cattle inspection and washing station that improves the cleanliness of cattle prior to entering the knocking box. This included the development and testing of an appropriate image classification methodology to classify animals in terms of cleanliness for slaughter. The methodology was designed to replicate the common industrial inspection practice across different Australian processing facilities. The objective also included the development and evaluation of possible designs that implement the required washing action as well as performing additional measurements related to cattle in tandem with the developed automated cattle cleanliness inspection and washing prototype.

Figure 1. Manufactured prototype of the system.

Project Content

Our extensive patent search of the prior art that described livestock washing/cleaning systems showed that the existing methods appear to have not incorporated computer vision-based technology for inspecting the external appearance of livestock for cleanliness prior to slaughtering. Also, the scope of automatic computer vision-based livestock monitoring systems does not appear to include inspection of livestock for cleanliness (except for cow teats) and those are largely limited to the measurement of animals' physical attributes.

Different cleanliness scoring systems were investigated, analysed and compared with Australian meat processing practices in seven major meat processing plants in three different states (Victoria, Queensland and South Australia). Our discussions with QA managers during meat processing plant visits confirmed that the current cleanliness inspection at the pre-slaughter stage is a classification problem in which the visually inspected animal should be categorised into different classes of cleanliness.

Different designs for implementation of the visual inspection and cleaning actions in one location were investigated, and two different designs were considered for prototype testing; a design that involved a rack of nozzles that is actuated parallel to the side of the cattle and a design that consists of a fixed matrix of nozzles that cleans the same area. We concluded that the nozzle matrix design would realise non-invasive cleanliness inspection, pose minimum stress to cattle, reduce potable water consumption as well as wash time and is also estimated to be cheaper compared to the other considered design.

We developed and manufactured a prototype (based on the nozzle matrix design) that utilises optical cameras to detect possible contamination on livestock hides and applies water to clean visually contaminated sections. To automate the cleanliness inspection process, we devised an image classification framework that enables classification of different sections of animal hide into clean, dirty and dagged categories. Each section is analysed by an image classification algorithm to determine its cleanliness status (clean or dirty) from the texture information of the animal skin. Once a section is identified as dirty by the image classification software, targeted washing of the associated area on the animal hide would commence. The automated washing system sprays potable water via specific nozzles that are associated with dirty sections.

We tested the performance of the targeted washing system on live cattle. Results of the field experiments verified the system performance, and showed that the system is capable of significantly reducing the visible dirt on the animal skin. Finally, we integrated multi-dimensional data from advanced sensors such as Kinect into the overall system to enable assessing important measurable characteristics of livestock in tandem with the developed cattle cleanliness inspection and washing system.

Project Outcome

The major outputs of this project are threefold:

1. Effective automated visual inspection technology, specifically developed for live animal inspection applications in the Australian red meat processing industry: the technology not only entails the computer science behind the methodologies developed for processing the images and arriving at detection and classification results, but also the devising and integration of the hardware and software in practice.
2. Flexible yet efficient automated cleaning technology, specifically developed for working in tandem with the above mentioned automated inspection technology, for cleansing the animals off their possible faecal contamination and external hygiene of hides. This technology needs to be able to rapidly communicate with the inspection outcomes and lead to decision of cleaning/marking of the animals in real-time and with a high throughput. It also has to be sufficiently flexible to be tailored to the specific Australian environmental and climate conditions and logistic and operational constraints of the end-user industries.
3. A complete working prototype for automated cattle inspection/cleaning before slaughter: This provides the main drive for the industries to embrace the new technology by seeing an actual example of how the animals are inspected then cleaned in a fast rate.

Benefit for Industry

In terms of development of an automated animal inspection/cleaning station, the priorities of all of the visited processing facilities can be summarized as follows:

1. Inspection and cleaning actions must be carried out in such a way that the animal stress is minimized.
2. Use of portable water is a significant expense and therefore they seek to minimize the potable water consumption. Excessive use of portable water is also affecting the plants sustainability. Efficient (controlled) use of potable water is a high priority for the industry.
3. The animal inspection/cleaning is an arduous task and has to be manually performed outdoor in all weather conditions. Automation of inspection and cleaning processes reduces manual labour and improves productivity.
4. Record keeping in the harsh outdoor environment of a processing facility is difficult and error prone. Improvements in communication and record keeping practices appear to be highly valued by the industry.

Common RGB cameras enable capturing the dirt properties for classification purposes and would not stress animals. The developed cattle inspection/ washing station realizes automated cleanliness assessment of individual animal and provides a possibility to efficiently use potable water. Possibility of keeping record of each and every slaughtered cattle in the harsh outdoor environment of a processing facility is another advantage of the proposed system which would automate as well as improve current communication and record keeping practices. The system would realise non-invasive cleanliness inspection, pose minimum stress to cattle, and reduce potable water consumption.

With the help of relatively cheap RGB-D cameras that also provide depth information, it has become possible to integrate a multitude of measurements in a single integrated system. The proposed integrated measurement system in this project provides an opportunity to assess important characteristics of livestock in tandem with the developed cattle cleanliness inspection and washing system. This potentially enables measurement of physical attributes of cattle, leading to improved record keeping capability at the pre-slaughter stage.

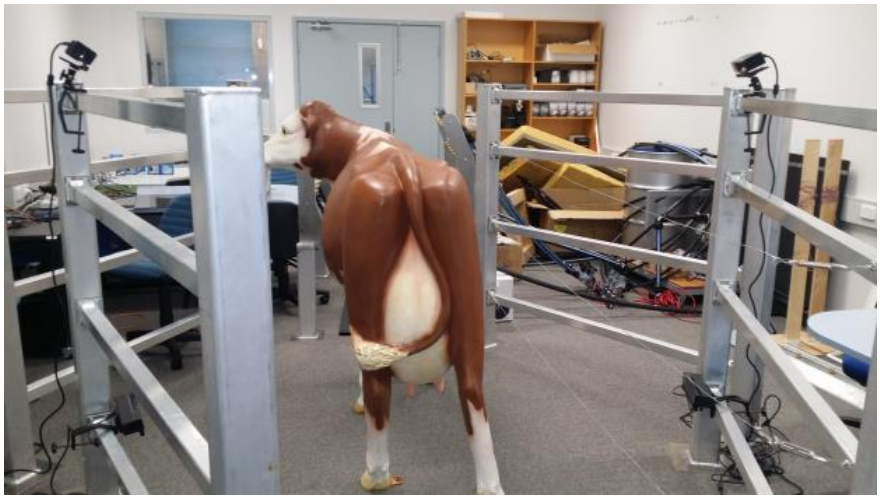

Figure 2. Manufactured prototype of the integrated system.