CONTROL OF WATERING POINT ACCESS USING MACHINE VISION CLASSIFICATION OF ANIMALS

NEAL A. FINCH,[1] School of Animal Studies, University of Queensland, Gatton, Queensland, 4343, Australia

PETER J. MURRAY, School of Animal Studies, University of Queensland, Gatton, Queensland, 4343, Australia

MARK T. DUNN, Faculty of Engineering and Surveying, University of Southern Queensland, Toowoomba, Queensland, 4350, Australia

JOHN BILLINGSLEY, Faculty of Engineering and Surveying, University of Southern Queensland, Toowoomba, Queensland, 4350, Australia

***Abstract*:** Invasive and overabundant native vertebrates cause significant economic and environmental damage in the Australian rangelands. Access to artificial watering points, created for the pastoral industry, has been a major factor in the spread and survival of these pests. Existing methods of controlling watering points are mechanical and cannot discriminate between target and nontarget species. Therefore, we developed an intelligent system of controlling vertebrate access to watering points. The project combined an intelligent camera, using machine vision technology, with enclosure design to successfully classify animals on a small scale. Future work will involve field trials of all large vertebrate species living on the Australian rangelands. The system has application in any habitat throughout the world where a resource is limited and can be enclosed for the management of livestock or wildlife.

TRANSACTIONS OF THE WESTERN SECTION OF THE WILDLIFE SOCIETY 42:16–19; 2006

Key words: Australia, invasive species, machine vision technology, videos, watering sources.

The Australian rangelands cover >70% of the continent. The majority of the large vertebrates in these ecosystems are invasive species. Pigs (*Sus scrofa*), goats (*Capra hircus*), camels (*Camelus dromedarius*), horses (*Equus caballus*), donkeys (*Equus asinus*), dogs (*Canis familiaris*), and cattle (*Bos taurus*) are now widely dispersed in feral populations. With overabundant native vertebrates, invasive vertebrates contribute to significant economic and environmental damage on a landscape scale (Braysher 1993, Choquenot et al. 1996, Parkes et al. 1996). Access to water, principally from free-flowing bore drains, has been a major factor in the spread and continued survival of these introduced species in arid and semiarid Australian environments. Despite considerable efforts from producers and government agencies, invasive species remain widespread.

The Great Artesian Basin Strategic Management Plan is a joint Australian federal/state government and landowner initiative that aims to replace free-flowing bore drains with pipe and trough systems (Great Artesian Basin Consultative Council 2000). The widespread implementation of this plan provides an opportunity to control invasive species at an ecosystem level. The concept is simple: control the water and you control the animals.

There are many existing methods to control animals at watering points, some of which are widespread and recommended by government agencies throughout Australia (Connelly et al. 2000). Essentially, all current trap systems rely on mechanical or physical 1-way barriers. These existing methods cannot discriminate between target and nontarget species and do not allow access to water by nontarget species. We developed an intelligent system of controlling watering points that relies on the ability to accurately identify any large animal accessing a

---

[1] E-mail: naf@sas.uq.edu.au

watering point through the use of machine vision technology. Using this ability, together with specifically designed fencing and gates, any large animal can be excluded, trapped, or allowed to access water.

MACHINE VISION TECHNOLOGY

Because of advances in technological capabilities and reductions in the cost of technology, machine vision systems are becoming more common in remote-sensing applications in all aspects of the agricultural domain (Davies 2000) and many areas of wildlife management (Laliberte and Ripple 2003). For this project machine vision technology must accurately classify any large animal to species level. Of the large vertebrates in the Australian rangelands, sheep and goats are most similar in size and shape and are the most difficult to classify. To test the feasibility of using machine vision technology for this application, a trial was set up at the University of Queensland's Gatton Campus.

Six merino sheep and 6 goats of different breeds were fenced within a paddock where the only access to water was through a laneway. A camera captured video footage of the animals as they entered the laneway. Because of the size of the laneway, only 1 animal can usually pass in front of the camera at any given time. Animals randomly passed in front of the camera for 2 days. Specifically designed software processed the data using edge detection and template matching. In all cases where the animals passed singly in front of the camera, they were identified as the correct species. In 2 occurrences, an object was identified, but species could not be determined with high enough probability because multiple animals bunched together as they tried to pass the camera.

The software processes video input in real time by comparing processed frames to a database (Fig. 1). The images on the left are the original video frames being processed, while the images on the right show the digitized detected edges, the boundaries of the animals, and the matched templates underneath. In the initial trial, a blue tarpaulin was fixed to the rear of the laneway to provide a contrasting background. Other methods of separating the image of the animal from the background have also been developed. Further improvements in laneway design should ensure all animals are presented to the software in single file. Dunn (2003) provides a full description of the software developed for this application.

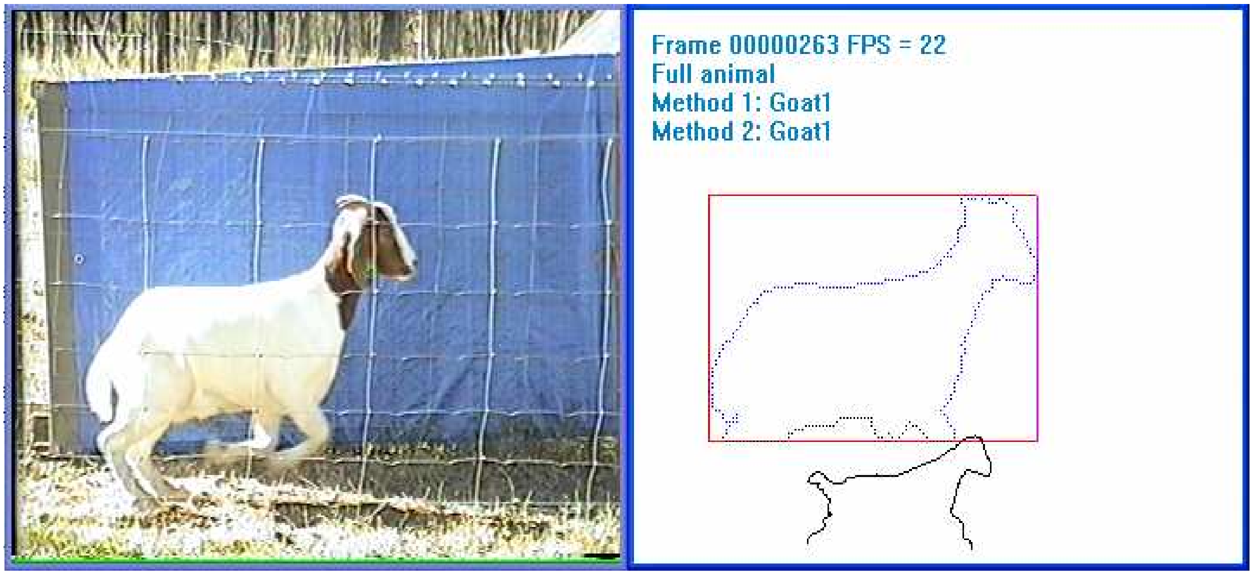
ENCLOSURE DESIGN

Fencing to keep animals in or out of an area is widely used throughout the Australian rangelands for both domestic stock and wild animals. Wild animals, both native and introduced, require more elaborate fencing than domestic stock (Braysher 1993). Using the proposed system to control a watering point, the animals in question must access enclosed water through a laneway and gate system (Fig. 2). Once an animal has entered the laneway and has been successfully identified, an automated gate can control its access to water (Fig. 2). The system will allow the gate to remain open and close only when undesirable animals enter the laneway. The gate would reopen after a predetermined period of time, and the basic design of an enclosure can also be used as a trap (Fig. 2).

CONCLUSIONS

The project combined an intelligent camera using machine vision technology and an enclosure to successfully classify animals on a small scale. Field trials of enclosures have successfully directed wild animals and domestic stock to access water through a laneway. Future work will involve field trials of the machine vision software with multiple species and, ultimately, all large vertebrate species living in the Australian rangelands. The final experiment planned for this project involves installing the complete system (e.g., enclosure, automated gate, and intelligent camera) at 12–15 watering points in national parks and on pastoral land within the Australian rangelands. Although developed for use in the Australian rangelands, the system has application in any habitat throughout the world where resources are limited and can be enclosed for management of livestock or wildlife.

A.



B.

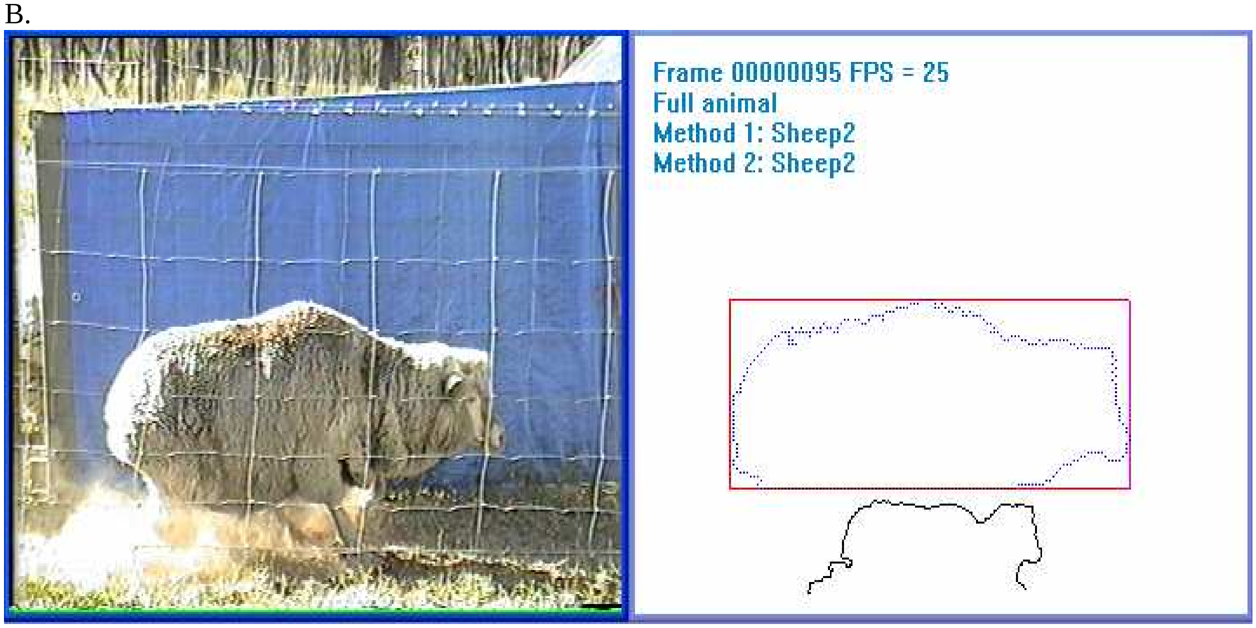


Fig. 1. Video and processed images of (A) a goat and (B) a sheep from the software.

A. B.

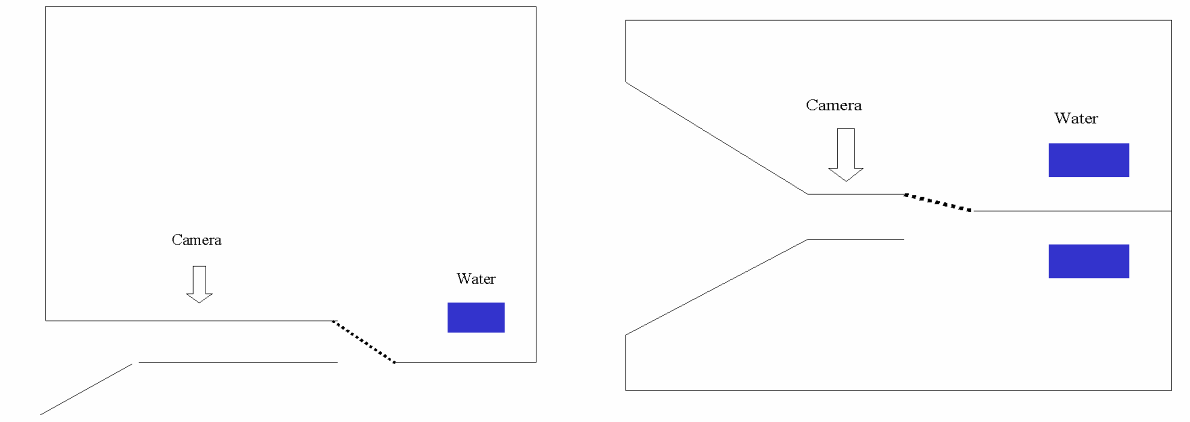


Fig. 2. Basic design for a watering point enclosure suitable for (A) excluding undesirable animals, and (B) suitable for use as a trap. Access is only through the laneway, and the gate normally remains open.

LITERATURE CITED

BRAYSHER, M. 1993. Managing vertebrate pests: principles and strategies. Australian Government Publishing Service, Canberra.

CHOQUENOT, D., J. MCILROY, T. KORN, AND M. BOMFORD. 1996. Managing vertebrate pests: feral pigs. Australian Government Publishing Service, Canberra.

CONNELLY, P., D. HORROCKS, L. PAHL, AND K. WAMAN. 2000. Cost effective and multipurpose self-mustering enclosures for stock. Department of Primary Industries, Brisbane, Australia.

DAVIES, E. R. 2000. Image processing for the food industry. Series in Machine Perception and Artificial Intelligence. Volume 37. World Scientific, Singapore, Indonesia.

DUNN, M., J. BILLINGSLEY, AND N. FINCH. 2003. Machine vision classification of animals. Mechatronics and machine vision 2003: future trends. Research Studies Press, Baldock, UK.

GREAT ARTESIAN BASIN CONSULTATIVE COUNCIL. 2000. Strategic Management Plan. <http://www.gab.org.au/about/management.html>. Accessed 2003 Oct.

LALIBERTE, A. S., AND W. J. RIPPLE. 2003. Automated wildlife counts from remotely sensed imagery. Wildlife Society Bulletin 31:362–371.

PARKES, J., R. HENZELL, G. PICKLES, AND M. BOMFORD. 1996. Managing vertebrate pests: feral goats. Australian Government Publishing Service, Canberra.