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Evaluation of retinal imaging technology for the biometric identification of bovine animals in Northern Ireland

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Abstract

Animal identification is a major requirement for government agricultural authorities, facilitating registration of animals, recording of authorised animal movements, national herd management, payment of appropriate grants and subsidies and as a vital tool in tracing diseases of public and animal health concern. Most schemes are based on a computer database of ear-tag numbers. A potential limitation of such systems has been their tracking of a device attached to the animal, rather than tracing the animal itself. This becomes problematic when accidental loss or fraudulent switching of tags occurs, as preserving correct identification is difficult. Biometric identification offers considerable advantages since the indices used to construct identifiers are unique, unalterable biological properties. We have evaluated a novel technology in bovine animals as a means of scientifically verifying tag-based identity. This system records the unique retinal vascular pattern at the back of an animal's eye as a means of corroborating ear-tag information. 869 animals were imaged to create a retinal identification. Each of these 1738 retinal patterns were compared computationally and visually against each of the remaining 1737, a total of 1,509,453 comparisons. None of these comparisons yielded an identical retinal pattern, indicative that each is unique within this dataset and that the chances of finding two different eyes with an identical pattern is at least 1 in 1.5 million. A further 2266 images taken from the registered animals at later dates were used for successful identification verification with 2227 (98.3%) being successfully computationally matched to the initial images. The remaining 39 (1.7%) were successfully matched by visual inspection. A simulated tag switch involving alteration of ear-tag number for 115 animals, after their initial imaging, was detected for all participants by subsequent imaging and computational comparison. These data indicate that this system could be deployed as a stand-alone technology for animal identity verification. It also has the potential to improve the performance of ear-tag-based identification systems in cattle and could be deployed in support of identification, registration and movement requirements and as a counter-fraud measure.

Keywords: Cattle; Identification; Retinal

1. Introduction

Accurate identification and registration of farm animals and recording of their authorised movements has been a major concern of national governments for many years, aiding control of diseases like bovine tuberculosis, grant

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and subsidy management and protecting public and animal health. Many countries have adopted national databases, based on numbered ear-tags, to monitor cattle movements (Houston, 2001; Buick, 2004).

Recent globalisation of trade and the formation of the European Common Market (McGrann and Wiseman, 2001) has strengthened the case for improved animal tracking systems. Consumers are presented with increased choice, but also increased risk from chemical/pathogenic contamination in foodstuffs (Caporale et al., 2001; McKean, 2001). The BSE crisis also demonstrated that the actions of one state can impact negatively on the public health of others (McGrann and Wiseman, 2001).

Consequently, European Union (EU) Council Directive 92/102/EEC dictated that all bovine animals in Member States should be identified with an ear-tag bearing a unique identification code shortly after birth (Ammendrup and Fussel, 2001). Council Regulation 1760/2000 (Commission of the European Communities, 2000–Commission Regulation No. 1760/2000), established the need for Member States to control registration and tracking of bovine animals through a computerised database based on a two ear-tag system.

In Northern Ireland, computer database monitoring of the national herd had been in existence since 1988. The original system was designed to facilitate the eradication of brucellosis and tuberculosis (Houston, 2001). However, in 1998 this system was superseded by the Animal and Public Health Information System (APHIS), which had increased functionality to manage identification, registration, movement and general traceability of animals. To date, APHIS facilitates the registration of all animal births, movements, test histories and slaughter, based on the two ear-tag system (Houston, 2001).

Future development of tag schemes may include the use of electronic identification devices such as radio frequency transmitter (RFID) ear-tags, ruminal boluses and injectable transponders which can improve existing practices by automating the reading of animal identifications and reducing transcription error (Ribo et al., 2001).

The EU recently funded a trial on the effectiveness of electronic identification called the 'Identification Életronique des Animaux' project. In total, this project investigated the application of RFID ear-tags, ruminal boulses and subcutaneous transponders to 370,000 cattle. The final report (Report from the Commission to the Council and the European Parliament, 2005) indicated that whilst boluses and transponders offered superior retention and read rates, recovery at time of slaughter was not as good as that observed for RFID ear-tags. Therefore, the report recommended that Member States should have the option of applying these ear-tags in place of the second conventional ear-tag required by EU law. Whilst lauding the ability of such a system to improve farm management, the report confirmed that RFID ear-tags still suffered from the same tag loss and switching problems which afflict conventional schemes. A recent study in intensively farmed buffalo has revealed mean conventional ear-tag retention time to be 272 days (Fosgate et al., 2006) and highlights the herd management and epidemiological problems this causes owing to difficulties in re-assigning correct identification.

Next-generation identification devices, such as RFID tags, boluses and transponder chips, whilst making animal management easier, still suffer many of the same constraints as conventional devices. Conventional and electronic identification systems rely on tracking devices (ear-tags, boluses, transponders etc), which are attached to animals, but not the animals themselves. However, biometric identification, which utilises unalterable biological properties of individual animals to produce a unique identifier, offers a potential solution.

Two biometric technologies, which can produce secure, unique identifiers are DNA profiling and retinal imaging (Pettitt, 2001). DNA profiling, whilst being a powerful tool for scientifically verifying animal identity, is currently limited by the fact that verification results cannot be generated in real-time i.e. beside animal, for most applications. It is unlikely therefore to become the primary identifier for live animals. It can be used effectively in retrospective audits, meat tracing and parentage verification (Caporale et al., 2001; Cunningham and Meghen, 2001; Houston, 2001; Raspor, 2004) as a traceability technology and counter-fraud measure.

Retinal vascular patterns (RVPs) appear to offer considerable advantages as biometric identifiers, not least because modern technology, such as the Optibrand system assessed in this study, is designed to facilitate the secure capture and analysis of RVP images beside the animal as a means of verifying identity. This function is linked, uniquely and securely, to GPS-based positioning.

The aims of this study were to assess:

1. The practicality of using the Optibrand system to capture and analyse good quality initial registration RVP images from bovine animals.
2. The capability of the system to capture and use subsequent RVPs from the same animals for the purposes of verifying correct APHIS identity and detect switched APHIS identity by comparison to initially captured images.