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Automatic detection of mounting behaviours among pigs using image analysis

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ABSTRACT

Excessive mounting behaviours amongst pigs cause a high risk of poor welfare, arising from skin lesions, lameness and stress, and economic losses from reduced performance. The aim of this study was to develop a method for automatic detection of mounting events amongst pigs under commercial farm conditions by means of image processing. Two pens were selected for the study and were monitored for 20 days by means of top view cameras. The recorded video was then visually analysed for selecting mounting behaviours, and extracted images from the video files were subsequently used for image processing. An ellipse fitting technique was applied to localize pigs in the image. The intersection points between the major and minor axis of each fitted ellipse and the ellipse shape were used for defining the head, tail and sides of each pig. The Euclidean distances between head and tail, head and sides, the major and minor axis length of the fitted ellipse during the mounting were utilized for development of an algorithm to automatically identify a mounting event. The proposed method could detect mounting events with high level of sensitivity, specificity and accuracy, 94.5%, 88.6% and 92.7%, respectively. The results show that it is possible to use machine vision techniques in order to automatically detect mounting behaviours among pigs under commercial farm conditions.

1. Introduction

Mounting behaviours in pigs can be defined as when a pig lifts its two front legs and puts the two legs or its sternum on any part of the body or head of another pig; the mounted pig may stand or sit down during the mounting or move away to avoid being mounted (Hintze et al., 2013). Both male and female pigs perform mounting behaviour, with different frequencies (Rydhmer et al., 2006; Hemsworth and Tilbrook, 2007), and the behaviour occurs more frequently in overcrowded conditions (Faucitano, 2001). Mounting behaviour amongst pigs can increase the risk of injuries, such as bruises and damage to the skin when pigs mount one another and scratch the back with the claws of the forelimbs (Faucitano, 2001; Harley et al., 2014), and lameness or leg fractures (Rydhmer et al., 2004). These injuries and the general unrest in the group can have considerable negative economic consequences (Rydhmer et al., 2006). Although the level of activity declines with increasing weight, mounting behaviour (Thomsen et al., 2012), and skin lesions and lameness (Teixeira and Boyle, 2014), happen during the entire growing period of pigs. Investigations of the mounting behaviour of pigs have already been made in different studies. However, these have generally been carried out using direct visual observations to sample behaviour under experimental conditions, reflected by a small number of pigs in the pen. Hintze et al. (2013) developed an ethogram of different types of mounting behaviours and their consequences. According to their classification, sexual mounts were longer than non-sexual mounts and were associated with more screaming, which is an indicator of stress and reduced welfare in pigs, by the mounted animal.

Image processing techniques have increasingly been applied to pig farm management in recent years and different studies have been carried out on the development of machine vision tools for pig production. By using a CCD camera the amount of pigs' water usage was estimated automatically with an accuracy of 92% based on their head distances to the drinking nipples in the images (Kashiha et al., 2013). Pig herds have been monitored using the optical flow method developed by Gronskyte et al. (2015) for obtaining undesirable events in the slaughterhouse with high overall sensitivity and specificity. Lu et al. (2016) proposed automatic

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weight estimation of pigs using image processing systems. In order to identify aggressive behaviours among pigs, motion history features have been applied (Viazzi et al., 2014) resulting in an overall high accuracy and sensitivity. Thermal comfort and lying patterns of groups of pigs have also been investigated with a high degree of accuracy by applying image processing techniques (Shao and Xin, 2008; Costa et al., 2014; Nasirahmadi et al., 2015). Recently some more state-of-art image capture methods have been applied in farms in order to improve animal welfare and monitor performance. A Vicon 3D optoelectronic motion analysis system and a Kinect motion sensor have been used for pig lameness detection (Stavrakakis et al., 2015) and the proposed method could distinguish the sound from lame pigs. For estimation the weight of pigs (Kongsro, 2014) and broilers (Mortensen et al., 2016) 3D Kinect cameras have been used. Furthermore, backfat thickness of Holstein-Friesian cows was estimated using a time-to-flight camera by Weber et al. (2014).

Every year approximately 100 million male piglets are castrated in the EU countries to control risk of boar taint and undesirable male behaviours. Surgical castration is a painful and stressful event (Prunier et al., 2006; Hintze et al., 2013), and its abolition is currently being proposed. If systems with entire male pigs are adopted in consequence, employing an automated machine vision method as a non-contact way for monitoring mounting behaviours in pig farms could help to inform farm managers about the number of mounting events and identify pens requiring intervention. It would also facilitate large scale research into methods to reduce this behavioural problem. A method using low cost CCTV cameras would be more economically acceptable for farm mangers than one requiring investment in expensive high resolution cameras. However, no studies have yet been done on the topic of automated detection of mounting and the feasibility of a low-cost system for this requires evaluation. Hence, the main object of this research was to develop an automatic method for detection of mounting behaviours among pigs under commercial pig farm conditions by means of machine vison techniques and development of image analysis algorithms.

2. Material and methods

2.1. Animal and data collection

The study was carried out at a commercial pig farm in the UK and started after placement of pigs in the pen at about 30 kg live weight. A 20 day period of data collection was used to generate sufficient occurrences of mounting behaviour. Each pen had a dimension of 6.75 m wide × 3.10 m long, with a fully slatted floor, and contained 22–23 pigs of mixed gender (entire males or females). All pens were equipped with a liquid feeding trough and one drinking nipple. During the experiment lights were switched on and video recording of the pigs in two of the pens were made. Each research pen was equipped with a CCVT camera (Sony RF2938, EXview HAD CCD, Board lens 3.6 mm, 90°, Gyeonggi-do, South Korea) which was located centrally at 4.5 m above the ground and pointing directly downward to get a top view. Video images from the cameras were recorded simultaneously for 24 h during the day and night and stored in the hard disk of a PC using Geovision software (Geovision Inc. California, USA) with a frame rate of 30 fps, at a resolution of 640 × 480 pixels. After downloading the recorded data, the video files were directly observed and labelled in order to evaluate peak times of mounting activity (Hintze et al., 2013). A sufficient number of occurrences of the behaviour for testing the automated approach were obtained using five days of 24 h activity selected from the available sample. Two periods were selected (2 h between 09:30 and 11:30 AM; 3 h between 14:30 and 17:30 PM) for each day and pen, during which the number of mounting events was increased compared to other

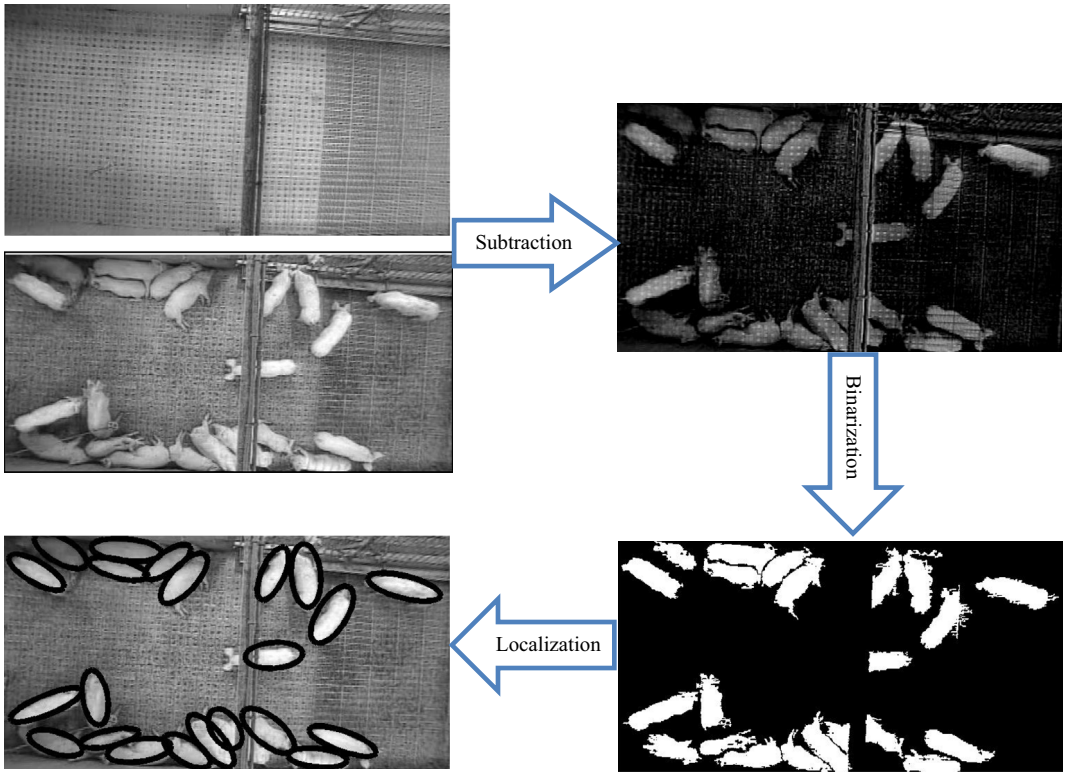

Fig. 1. Image processing steps in this study; background (top left), grey image (middle left), subtracted image (top right), binary image (down right) and fitted ellipse (down left).