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Using automated image analysis in pig behavioural research: Assessment of the influence of enrichment substrate provision on lying behaviour

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ABSTRACT

Visual monitoring of pig behaviours over long periods is very time consuming and has possibility for observer bias. Automated image processing techniques now give the potential to carry out behavioural research in a more effective way. To illustrate this, an image processing technique was applied to identify whether any changes in pig lying behaviour which might be detrimental to welfare resulted from an enrichment provision treatment. The lying patterns of pigs in 6 enriched pens were compared with those of 6 control pens, which had only a suspended enrichment toy, to determine whether daily provision of a rooting material (maize silage) onto a solid plate in the lying area of a fully slatted pen resulted in changed lying time and location. Pigs were monitored by top view CCTV cameras and animals were extracted from their background using image processing algorithms. An ellipse fitting technique was applied to localize each pig and the centre of each fitted ellipse was used in x–y coordinates to find the lying positions after use of an algorithm to remove images in motion preceding the scan. Each pen was virtually subdivided into four zones and the position of each lying pig obtained at 10 min intervals over a series of 24 h periods. Results of a validation study showed that the image processing technique had an accuracy of 93–95% when compared to visual scoring. Results from image processing indicated that once daily provision of rooting material significantly changed the diurnal activity pattern ($p < 0.001$) and resulted in a modified diurnal pattern of resting location. The study demonstrates that machine vision can be used as a precise and rapid method for quantifying pig lying behaviour for research or practical applications.

1. Introduction

Studies of animal welfare or housing design frequently employ behavioural measures. Visual monitoring of animal behaviour over long periods is very time consuming and has the possibility for subjective interpretation and hence observer bias (Tuyttens et al., 2014). Automated image processing techniques now give the potential to carry out behavioural research in a more effective way (Nasirahmadi et al., 2017a). A number of such techniques have recently been published to capture a range of different behaviours in pigs, for example group activity pattern (Gronskyte et al., 2015, 2016), locomotory behaviour (Stavrakakis et al., 2015), aggressive interactions (Viazzi et al., 2014; Lee et al., 2016) and mounting behaviour (Nasirahmadi et al., 2016). The automated capture of the lying behaviour of pigs was one of the first techniques to be explored (Shao et al., 1998; Shao and Xin, 2008). More recently, Nasirahmadi et al. (2015, 2017b) used binary image data and the Delaunay triangulation method for automatic detection and modelling of the group lying pattern of pigs in commercial farm conditions. Despite the existence of these techniques, they have as yet seldom been applied as a tool in behavioural research in pigs.

Access to enrichment materials can improve pig welfare by allowing the animals to express behavioural elements such as feeding and exploring (Bracke et al., 2007; Vanheukelom et al., 2012) and thus reducing the level of aggression (Day et al., 2002) and the biting of tails, ears and other body parts (Van de Weerd et al., 2006; Zonderland et al., 2008; Jensen et al., 2010). European legislation states that pigs must have permanent access to a sufficient quantity of material to enable manipulation behaviours (Commission Directive, 2008/120/EC). Observations of the use of different enrichment materials for pigs have already been made in numerous studies, and it has been shown that substrates in which pigs can root are more attractive than hanging toys (Scott et al., 2006), with edible substrates particularly effective (Jensen et al., 2010). Limited accessibility of rooting materials may lead to aggression and restlessness by causing competition in groups of pigs (Van de Weerd et al., 2006). Therefore, pigs should have enough material and space to allow several pigs to explore and manipulate the material simultaneously (Zwicker et al., 2012). This suggests that distribution onto the flooring would be preferable to a localised substrate

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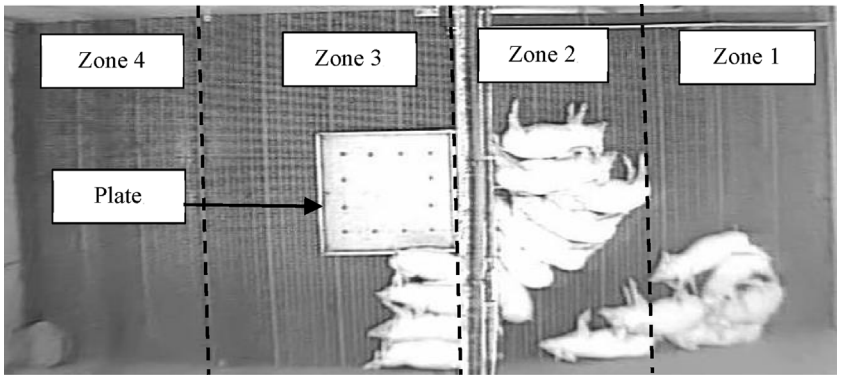

Fig 1. Top view of the research barn with the enrichment plate and showing zone numbers.

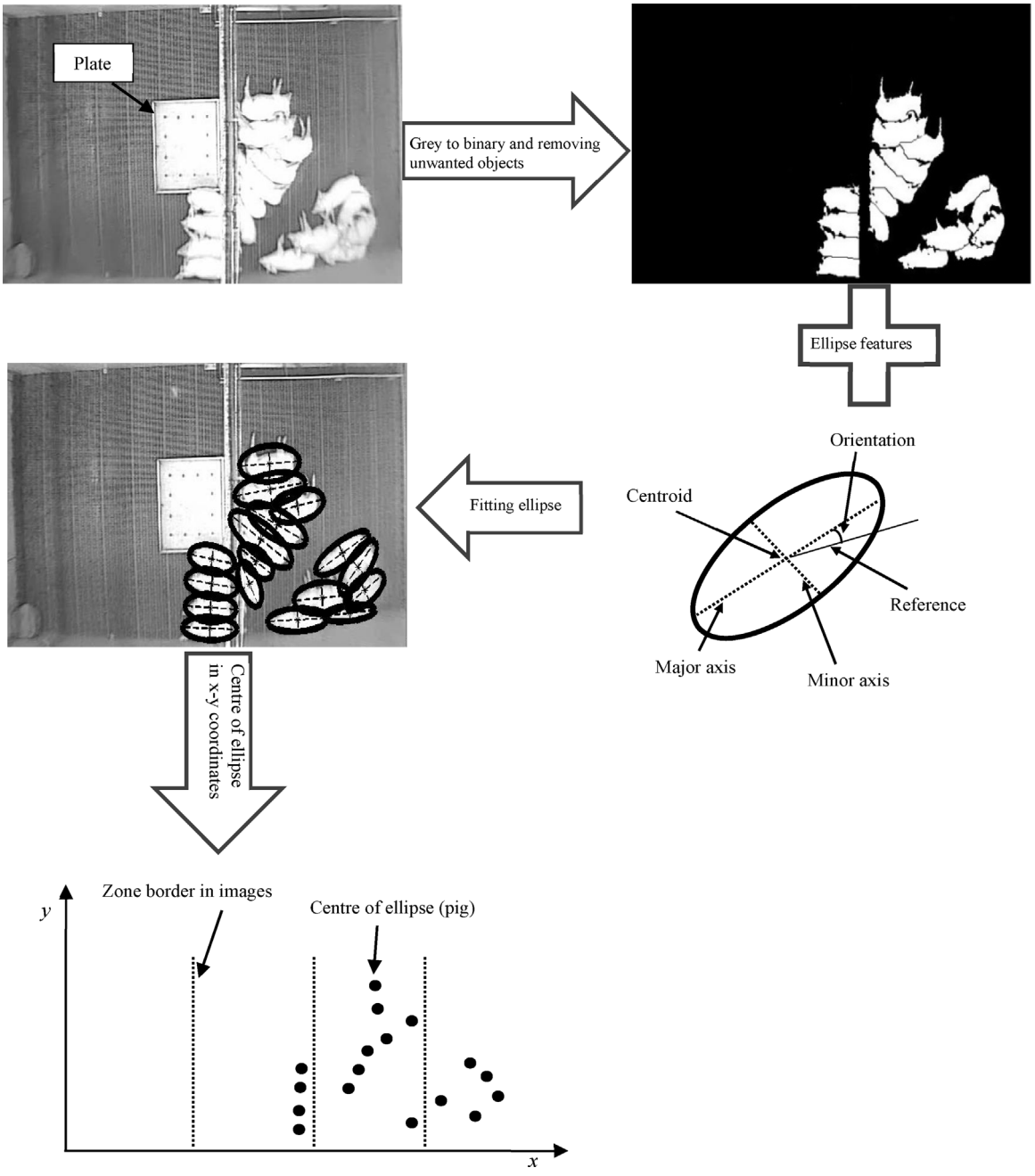

Fig. 2. Different steps used for lying position detection.