Boundary Detection of Pigs in Pens Based on Adaptive Thresholding Using an Integral Image and Adaptive Partitioning

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ABSTRACT

Boundary detection of pigs is important to pig weight estimation, pig feeding behavior analysis, and thermal comfort control. This research proposes a boundary detection method for pigs in a feeder zone with a high-density pen under insufficient and varied lighting, a dirty pen scene, and small field of view. The method is based on adaptive thresholding using an integral image and adaptive partitioning. First, we segment an original grayscale image with adaptive thresholding using an integral image, and then apply adaptive partitioning with connected components. Afterwards, we utilize the maximum entropy threshold of each partition and merge the results. Our experimental results using 230 images showed that the proposed method led to a high average detection rate in a short execution time. Moreover, to the best of our knowledge, our study is the first attempt to investigate pig boundary detection in a practical farm environment, which involved dirty pen scenes with insufficient and varied lighting.

Keywords: Pig boundary detection, Image segmentation, Adaptive partitioning, Adaptive thresholding

INTRODUCTION

Several studies (Shao and Xin, 2008; Wang et al., 2008; Tu et al., 2013, 2014; Guo et al., 2014, 2015; Kashiha et al., 2014; Khoramshahi et al., 2014) have investigated boundary detection, identification, and behavior analysis of pigs from above (top-view) the pen. Research on the efficiency of methods for boundary detection of pigs is primarily to improve subsequent tasks, such as identifying pigs. Several applications require pig boundary detection, including estimating pig weight (Brandl and Jørgensen, 1996; Wang et al., 2008; Kashiha et al., 2014; Kongsro, 2014; Li et al., 2015; Wongsriworaphon et al., 2015), feeding behavior analysis (Bigelow and Houpt, 1988; De Haer and Merks, 1992; Young and Lawrence, 1994; Pourmoayed et al., 2016), and thermal comfort control for group-housed pigs (Shao and Xin, 2008). Some current machine vision systems for pig detection use either a general method, such as Generalized Hough Trans-