

Assessing individual activity levels in two broiler lines using an ultra-wideband tracking system

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Abstract

Individual data on activity of broilers is valuable for breeding programmes, as activity may serve as proxy for multiple health, welfare and performance indicators. However, in current husbandry systems, broilers are often kept in large groups, which makes it difficult to identify and monitor them at the individual level. Sensor technologies, such as ultra-wideband (UWB) tracking systems, might offer solutions. This paper investigated the recorded distances of an UWB tracking system that was applied to broilers, as a first step in assessing the potential of an UWB tracking system for studying individual levels of activity in broilers housed in groups. To this end, the distances moved as recorded by the UWB system were compared to distances recorded on video, using Kinovea video tracking software. There was a moderately strong positive correlation between the output of the UWB system and video tracking, although some under- and over- estimations were observed. Even though the recorded distances from the UWB system may not completely match the true distances moved, the UWB system appears to be well-suited for studying differences in activity between individual broilers when measured with the same system settings.

Keywords: tracking, broilers, activity, ultra-wideband

Introduction

Animals are kept in large groups in husbandry systems, which makes it difficult to identify and monitor individual animals. Still, there is an interest in quantifying individual behaviours of group-housed animals to study the link between individual behaviour and performance in more detail. Broilers are an example of a livestock species for which data on individual behaviour could prove to be valuable. Commercial selection of broilers has resulted in fast growth (Zuidhof *et al.*, 2014). At the same time, broilers may show different activity levels. For example, Weeks *et al.* (2000) found that broilers between 39–49 days of age spent on average 76 - 86% of the time lying, depending on whether the birds were sound or showed varying degrees of lameness. Additionally, with increasing age of broilers, decreases in activity are seen (e.g. Weeks *et al.*, 2000; Tickle *et al.*, 2018). The relationship between individual level of activity and leg health, welfare and performance is valuable for broiler breeders. This requires detailed information on activity of individual broilers. Sensor technologies may aid in obtaining this information. In this study, an ultra-wideband (UWB) tracking system was implemented and its suitability for individual tracking of broiler activity was investigated. The main objective was to validate the recorded distances moved of the UWB system, by comparing these to distances recorded on video, where it was assumed that the distances recorded on video were the true distances moved by the broilers.

Material and methods

Population

Data were collected at a broiler farm, under control of Cobb Europe. In total, 24 male broilers from two genetic crosses were housed in a pen with a size of 6.4 m² with feed and water provided ad libitum. These birds were taken from a larger group, selecting the lowest and highest body weights. From each cross, three heavyweight and three lightweight birds were selected for UWB tracking. The average weight of the light birds was 0.42 kg, while the heavy birds weighed on average 0.63 kg, as measured on day 15 of life. These six broilers per cross were fitted with an UWB tag and were tracked with the UWB system.

Ultra-wideband tracking system

A Ubisense UWB system with Series 7,000 sensors and compact tags (Ubisense Limited, Chesterton, United Kingdom) was used, in combination with TrackLab software (Noldus Information Technology, Wageningen, the Netherlands). Broilers were fitted with a Ubisense tag with a size of around 3.5 × 3.5 cm and a weight of around 25 grams on their backs, using elastic bands around their wing base. Every 6.91 seconds, these tags sent out a signal. Four Ubisense beacons, which could receive these signals, were placed in a square above the broilers' pen. Using the time of arrival of the signal, the location of the tags could be determined. The 12 broilers were tracked from day 15 to day 33 of life (n = 19 days), for approximately one hour each day, at different times. This one-hour sample per day was deemed sufficient as the main interest here was validating UWB recordings and not studying individual activity patterns over time. The resulting UWB output used in this study was the total distance moved in meters per individual per tracking session.

Video analysis

Video recordings were made from above the pen, at the same time as the UWB recordings were made. A Zavio B6210 2MP (Zavio Inc., Hsinchu City, Taiwan) video camera was used and the recordings were analysed using Kinovea video analysis software version 0.8.25 (<http://www.kinovea.org/>). Using Kinovea, individual broilers could be tracked throughout the pen to assess the moving distance. The length of one side of the octagonal pen was used for calibration. Manual corrections were applied when necessary, for example, when the bird was flapping its wings or was very close to other birds. The output used here was the total distance moved in meters per individual per session.

Statistical analysis

For one bird, no data were available for day 29–33, resulting in a total of 223 samples of recorded distances from both the UWB system and video tracking. Statistics were performed using R version 3.5.2 (R Core Team, 2018). The correlation between the distance moved, per individual and per session, as recorded with the UWB system and using video tracking was studied using a repeated measures correlation (package rmcrr; Bakdash & Marusich, 2018) and a Pearson correlation. The level of statistical significance was set at 0.05. Reported results are rounded to two decimals.

Results and discussion

The data were not normally distributed. However, when comparing square root-transformed data and untransformed data, the results were very similar. Therefore, the untransformed data and results are presented here. The repeated measures correlation was used to correct for the repeated measures on the same individuals and tags. However, the results of the Pearson and repeated measures correlation were virtually the same, so only the results of the Pearson correlation are reported here. A moderately strong positive correlation between video tracking and UWB tracking was found (Pearson correlation, r

= 0.71 (95%-CI: 0.64-0.77), $df = 221$, $P < 0.001$; Figure 1). This correlation indicates that the UWB system can provide reliable information on distances moved by broilers. However, it does appear that when broilers move less, the distance moved according to the UWB system is generally an overestimation of the distance determined by video analysis (Figure 1). Furthermore, it appears that the UWB system underestimates the distance moved when broilers move more (Figure 1). This may be the result of the implemented sampling rate of 6.91 seconds. With each sample that is received, there can be some noise, i.e. the triangulation-based location of the tag may deviate slightly from the actual location. Consequently, if an animal moves very little, this noise can make up a relatively large part of the total registered distance, which could explain the overestimation by the UWB system. Alternatively, if an animal is very active, some of the movement of the animal between samples might be missed by the system. However, a previous study in which different sampling rates were compared for agreement between distances moved with the UWB system and on video indicated that the sampling rate used in the current study was the best fit for the current implementation (personal communication Hijink, 2018).

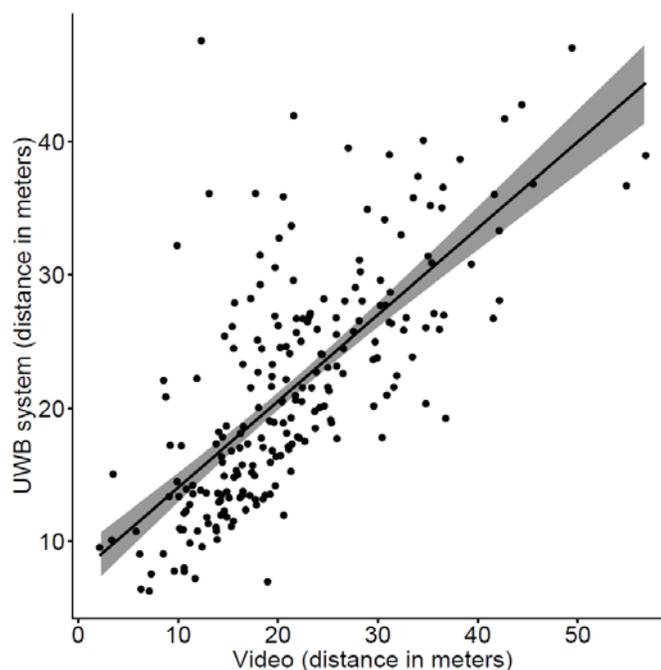


Figure 1. Plot of the correlation between the distances found with the UWB system and the distances found in video observations using Kinovea. The grey area represents the 95% confidence interval of the correlation

It is currently being investigated whether the UWB system is capable of detecting differences in level of activity over time between individual broilers of four crosses and of different weights. Preliminary results indicate that the UWB system can detect decreases in activity over time and that birds with a lower weight at about 14 days of age are on average more active than heavier birds, but further analysis is required to confirm these findings.

Conclusions

This paper showed the first step in investigating the potential of an UWB tracking system to study individual levels of activity in broilers. The main focus was on validation of the distances recorded by the UWB system. There was a moderately strong positive correlation between the recorded distances from the UWB system and from video. Although the

distances that are recorded with the UWB system may not fully match the distance moved in reality, likely due to the implemented sampling rate, the UWB system appears to be well-suited for studying activity differences between individual broilers when measured with the same system settings. Longitudinal information on activity can provide insight into what the activity levels of individuals can indicate about leg health, welfare and performance, but further research into this relationship is required.

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