



Camera-Based Gait Scoring Procedure for Early Detection of Lameness in Commercial Broilers

Noah Osborne^{1*}, Aurelie Nwosu², Hiroshi Berg³

¹Department of Agri, Orinoco Institute for Advanced Agri, Mexico

²Department of Agri, Baikal University Centre for Agri, Cote d'Ivoire

³Department of Agri, Patagonia Institute for Advanced Agri, Brazil

Article Info

Volume 1, Issue 1, 2026

[doi: 10.62715/ijpsf.2026.v1.i1.pp24-29](https://doi.org/10.62715/ijpsf.2026.v1.i1.pp24-29)

Received: 15 April 2026

Accepted: 04 June 2026

Published: 30 July 2026

Abstract

Lameness is among the most serious welfare problems of fast-growing broilers, and it is usually discovered late, when a trained assessor walks the house and scores a sample of birds by eye. Visual gait scoring is slow, depends on the observer and disturbs the flock, so it is done seldom and near slaughter age. Cameras fixed above the litter can watch the same birds continuously, and published work shows that image-derived measures of activity and movement are related to gait score. This article sets out a procedure for turning overhead video into a flock-level gait indicator that can be followed from the third week of life. The procedure has six parts: camera placement and calibration, a recording schedule, detection and tracking of individual birds, selection of usable walking bouts, calculation of a small set of gait features, and conversion of those features into a daily index with an alert rule. A plan for checking the index against trained human scorers is included, with the agreement statistics to report. The procedure is a proposal built from the published literature on broiler gait and on computer vision. It has not been validated on farm data here, and the article is explicit about what a validation would have to show.

Keywords: Broiler lameness, Gait scoring, Computer vision, Precision livestock farming, Animal welfare, Automated monitoring

© 2026 Noah Osborne et al. This is an open access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made.

1. Introduction

Modern broilers reach market weight in a few weeks, and their skeleton and gait bear the cost. A large survey of commercial flocks in the United Kingdom found impaired walking to be widespread, with risk rising with age and differing with genotype and stocking density (Knowles *et al.*, 2008). The causes range from developmental disorders of the growth plate to bacterial infection of bone and joint and contact dermatitis of the foot (Bradshaw *et al.*, 2002). Lameness change their behaviour: they lie for longer and visit the feeder less often (Weeks *et al.*, 2000). They also select feed containing an analgesic when given the choice, which is evidence that the condition is painful (Danbury *et al.*, 2000).

Detection depends on people. A stockworker removes birds that cannot reach feed or water, and

* Corresponding author: Noah Osborne, Department of Agri, Orinoco Institute for Advanced Agri, Mexico. E-mail: noah.osborne@orinoco.edu

welfare audits score the gait of a sample of birds late in the cycle. By then there is little that management can do for the flock in the house. An indicator that showed, in the third or fourth week, that walking ability was deteriorating faster than usual would allow lighting, feeding and litter management to be adjusted while they could still have an effect.

This article proposes a procedure for obtaining such an indicator from fixed overhead cameras. It describes the method and the reasoning behind each choice. It does not report an application to a flock, and the procedure remains to be validated.

2. Background

Two bodies of work underlie the design: the visual scoring systems that define what is meant by a gait score, and the attempts made so far to automate the assessment.

2.1. Visual gait scoring and its limits

The reference method is the six-point scale of [Kestin *et al.* \(1992\)](#), which runs from 0 for a bird that walks normally to 5 for a bird that cannot walk. [Garner *et al.* \(2002\)](#) tightened the category definitions to improve agreement between observers, and [Webster *et al.* \(2008\)](#) proposed a three-point version for use in the field. The six-point scale is the one adopted in the Welfare Quality protocol for broilers ([Welfare Quality, 2009](#)). All of these require an observer to make each bird walk and to judge it against a verbal description. Training is needed, scores drift between assessors and over time, and only a small sample can be scored in a house of many thousands of birds.

2.2. Automated approaches to date

Three lines of automation have been explored. The first treats the flock as a moving texture. [Dawkins *et al.* \(2009\)](#) computed optical flow from overhead video and found that the statistical distribution of flow across the image was related to the gait scores of the flock, without any bird being identified. The second measures activity. [Aydin *et al.* \(2010\)](#) showed that image-based activity differed between groups of birds with different gait scores, and [Silvera *et al.* \(2017\)](#) related the output of a commercial camera system to gait score in commercial flocks. The third follows individuals: [Aydin \(2017\)](#) derived step and speed variables from images of single birds, and kinematic studies have quantified how the gait of lame birds differs in velocity and stride characteristics ([Caplen *et al.*, 2012](#)).

Flock-level methods are robust and cheap but say nothing about which birds are affected or how severely. Individual-level methods describe gait directly but have mostly been developed in corridors or pens with one bird in view. The procedure proposed here takes a middle course. It follows individual birds for short bouts in the ordinary house and reports a summary for the flock.

3. The Proposed Procedure

Table 1 lists the six parts of the procedure with the output of each. Figure 1 shows the processing chain and the check attached to each stage, since an automated measure is only as trustworthy as the controls on its inputs.

3.1. Part 1: Camera placement and calibration

Cameras are mounted on the roof structure looking straight down at areas of open litter between feeder and drinker lines, where birds must walk to reach resources. A vertical view avoids most occlusion of one bird by another and keeps the scale nearly constant across the image. Each camera is calibrated for lens distortion with a planar target, following the standard method of [Zhang \(2000\)](#), and a target of known size laid on the litter gives the conversion from pixels to distance. Because litter depth changes and cameras are knocked during cleaning, the scale check is repeated weekly.

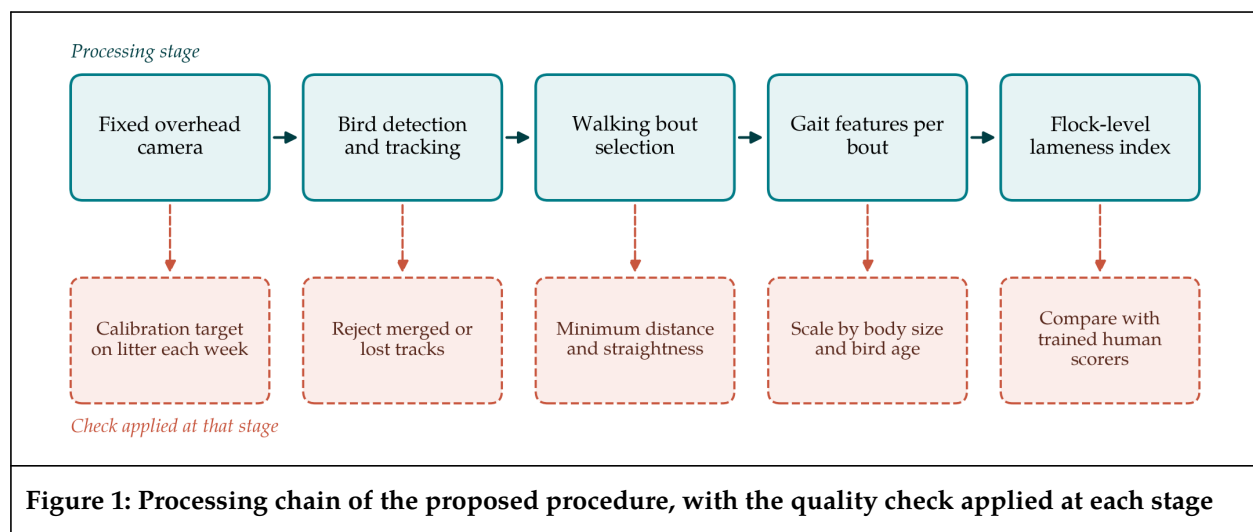
3.2. Part 2: Recording schedule

Broiler activity varies with the lighting programme, feeding and the presence of staff. Segments are therefore recorded at fixed times in the light phase, away from routine inspections, and for long enough to

yield an adequate number of walking bouts. A short period following the daily walk-through is recorded as well, since birds made to move by a passing person provide bouts comparable to those elicited in manual scoring.

Table 1: Parts of the proposed procedure, what is done and the output passed to the next part

Part	What is done	Output
1. Camera set-up	Mount cameras vertically above open litter; calibrate image scale	Calibrated field of view
2. Recording schedule	Record fixed periods daily under the same light phase	Comparable video segments
3. Detection and tracking	Locate each bird in each frame and link positions over time	Tracks with identity and position
4. Bout selection	Keep tracks in which a bird walks far enough in a nearly straight line	Usable walking bouts
5. Gait features	Compute speed, bout length, lateral sway and tendency to sit	Feature values per bout
6. Index and alert	Summarise features per day; compare with the expected course for age	Daily flock index and alert



3.3. Part 3: Detection and tracking

Birds are located in each frame with a convolutional object detector of the single-stage kind introduced by Redmon et al. (2016), trained on annotated frames from the house type and ages concerned. Detections are linked from frame to frame into tracks. White birds on pale litter at high density are a hard case, and tracks that merge or break are frequent late in the cycle. The procedure does not attempt to repair them. Any track in which two detections overlap or the identity is uncertain is discarded, on the principle that fewer clean bouts are preferable to many doubtful ones. Where finer description is wanted, markerless pose estimation can place points on the head, body centre and tail (Mathis et al., 2018).

3.4. Part 4: Selecting walking bouts

Most of what a broiler does is not walking. A bout is accepted when a tracked bird moves from rest, travels at least a set number of body lengths and does so without sharp turns. The thresholds are fixed before recording begins and expressed in body lengths, so that they scale with the growth of the bird.

3.5. Part 5: Gait features

Four features are computed for each bout, chosen because each corresponds to something a human scorer looks for in the scale of [Kestin et al. \(1992\)](#) and has support in the kinematic literature ([Caplen et al., 2012](#)). They are walking speed in body lengths per second, the distance covered before the bird stops, the side-to-side sway of the body centre about the line of travel, and whether the bout ends with the bird sitting down. Speed and distance fall, and sway and sitting increase, as gait worsens. Body length measured in the image serves to normalise the features and gives a rough check on growth.

3.6. Part 6: Flock index and alert rule

The features are standardised and combined into one value per bout, and the daily index is the proportion of bouts beyond a chosen cut-off together with the median. Gait deteriorates with age in every flock, so the index is read against a reference course for the genotype and house, built from earlier flocks. An alert is raised when the index departs from that course for several consecutive days. The weights, the cut-off and the alert rule are all quantities to be estimated in a validation study and cannot be stated in advance.

4. Checking the Index Against Human Scorers

The procedure can be trusted only to the extent that it agrees with competent visual scoring. The check proposed is simple in outline. On set days, two trained assessors independently score a sample of birds in the camera's field of view by the six-point scale, and the same birds are identified in the video by temporary marks. Agreement between the assessors is reported first, because it sets the ceiling for any automated method. Agreement between the bout-level value and the human score is then reported with weighted kappa ([Cohen, 1968](#)), which gives partial credit for near misses on an ordered scale. The ability of the daily index to distinguish flocks that later show a high prevalence of poor gait is a question of diagnostic accuracy and should be reported according to the STARD guidance ([Bossuyt et al., 2015](#)). Houses used to set the weights must be kept separate from those used to test them.

5. Fitting the Procedure to a Commercial House

Commercial houses are dusty, humid and dim. Cameras need sealed housings and lenses that can be wiped down, and light levels in many programmes are low enough that near-infrared illumination may be required. Processing on a small computer at the house avoids sending video over poor rural connections. A few cameras cover only a small part of the floor, and lame birds may avoid the open areas where the cameras look, so placement near resources matters. The procedure is intended to support the stockworker's daily inspection and the assessments required by welfare schemes. It is no substitute for either.

6. Limitations and What Remains to Be Shown

This is a proposed procedure and nothing in it has been validated here. It is not yet known whether clean tracks can be obtained in sufficient numbers at commercial density in the last weeks, when lameness is most prevalent and birds are most crowded. Birds that walk least contribute fewest bouts, so the index may understate severe lameness; the sitting and distance features are meant to offset this, but whether they do is an empirical matter. An overhead view cannot see the legs, and conditions that alter leg placement without changing speed or sway will be missed. A detector trained in one house type may fail in another. Finally, earlier warning is useful only if there is an effective response, and that link also needs to be demonstrated.

7. Conclusion

Overhead cameras offer a way to follow the walking ability of a broiler flock every day instead of once near slaughter. The procedure proposed here selects short, clean walking bouts from ordinary house video, describes them with four features tied to the established gait scale, and reports a daily index against the expected course for age. Each stage carries its own check. The value of the index for early detection is an open question that only a validation against trained scorers, across several houses and

flocks, can settle.

Conflict of interest

To be declared by the author(s) before publication.

Funding

To be declared by the author(s) before publication.

References

- Aydin, A. (2017). [Development of an early detection system for lameness of broilers using computer vision](#). *Computers and Electronics in Agriculture*, 136: 140-146.
- Aydin, A., Cangar, O., Ozcan, S.E., Bahr, C. and Berckmans, D. (2010). [Application of a fully automatic analysis tool to assess the activity of broiler chickens with different gait scores](#). *Computers and Electronics in Agriculture*, 73(2): 194-199. <https://doi.org/10.1016/j.compag.2010.05.004>
- Bossuyt, P.M., Reitsma, J.B., Bruns, D.E., Gatsonis, C.A., Glasziou, P.P., Irwig, L., Lijmer, J.G., Moher, D., Rennie, D., de Vet, H.C.W., Kressel, H.Y., Rifai, N., Golub, R.M., Altman, D.G., Hooft, L., Korevaar, D.A. and Cohen, J.F. (2015). [STARD 2015: an updated list of essential items for reporting diagnostic accuracy studies](#). *BMJ*, 351: h5527. <https://doi.org/10.1136/bmj.h5527>
- Bradshaw, R.H., Kirkden, R.D. and Broom, D.M. (2002). [A review of the aetiology and pathology of leg weakness in broilers in relation to welfare](#). *Avian and Poultry Biology Reviews*, 13(2): 45-103.
- Caplen, G., Hothersall, B., Murrell, J.C., Nicol, C.J., Waterman-Pearson, A.E., Weeks, C.A. and Colborne, G.R. (2012). [Kinematic analysis quantifies gait abnormalities associated with lameness in broiler chickens and identifies evolutionary gait differences](#). *PLoS ONE*, 7(7): e40800. <https://doi.org/10.1371/journal.pone.0040800>
- Cohen, J. (1968). [Weighted kappa: nominal scale agreement with provision for scaled disagreement or partial credit](#). *Psychological Bulletin*, 70(4): 213-220. <https://doi.org/10.1037/h0026256>
- Danbury, T.C., Weeks, C.A., Chambers, J.P., Waterman-Pearson, A.E. and Kestin, S.C. (2000). [Self-selection of the analgesic drug carprofen by lame broiler chickens](#). *Veterinary Record*, 146(11): 307-311.
- Dawkins, M.S., Lee, H.-J., Waitt, C.D. and Roberts, S.J. (2009). [Optical flow patterns in broiler chicken flocks as automated measures of behaviour and gait](#). *Applied Animal Behaviour Science*, 119(3-4): 203-209. <https://doi.org/10.1016/j.applanim.2009.04.009>
- Garner, J.P., Falcone, C., Wakenell, P., Martin, M. and Mench, J.A. (2002). [Reliability and validity of a modified gait scoring system and its use in assessing tibial dyschondroplasia in broilers](#). *British Poultry Science*, 43(3): 355-363. <https://doi.org/10.1080/00071660120103620>
- Kestin, S.C., Knowles, T.G., Tinch, A.E. and Gregory, N.G. (1992). [Prevalence of leg weakness in broiler chickens and its relationship with genotype](#). *Veterinary Record*, 131(9): 190-194. <https://doi.org/10.1136/vr.131.9.190>
- Knowles, T.G., Kestin, S.C., Haslam, S.M., Brown, S.N., Green, L.E., Butterworth, A., Pope, S.J., Pfeiffer, D. and Nicol, C.J. (2008). [Leg disorders in broiler chickens: prevalence, risk factors and prevention](#). *PLoS ONE*, 3(2): e1545. <https://doi.org/10.1371/journal.pone.0001545>
- Mathis, A., Mamidanna, P., Cury, K.M., Abe, T., Murthy, V.N., Mathis, M.W. and Bethge, M. (2018). [DeepLabCut: markerless pose estimation of user-defined body parts with deep learning](#). *Nature Neuroscience*, 21(9): 1281-1289. <https://doi.org/10.1038/s41593-018-0209-y>
- Redmon, J., Divvala, S., Girshick, R. and Farhadi, A. (2016). [You only look once: unified, real-time object detection](#). *Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition*, 779-788. <https://doi.org/10.1109/CVPR.2016.91>
- Silvera, A.M., Knowles, T.G., Butterworth, A., Berckmans, D., Vranken, E. and Blokhuis, H.J. (2017).

- Lameness assessment with automatic monitoring of activity in commercial broiler flocks. *Poultry Science*, 96(7): 2013-2017.
- Webster, A.B., Fairchild, B.D., Cummings, T.S. and Stayer, P.A. (2008). Validation of a three-point gait-scoring system for field assessment of walking ability of commercial broilers. *Journal of Applied Poultry Research*, 17(4): 529-539. <https://doi.org/10.3382/japr.2008-00013>
- Weeks, C.A., Danbury, T.D., Davies, H.C., Hunt, P. and Kestin, S.C. (2000). The behaviour of broiler chickens and its modification by lameness. *Applied Animal Behaviour Science*, 67(1-2): 111-125. [https://doi.org/10.1016/S0168-1591\(99\)00102-1](https://doi.org/10.1016/S0168-1591(99)00102-1)
- Welfare Quality (2009). Welfare Quality Assessment Protocol for Poultry (Broilers, Laying Hens). Welfare Quality Consortium, Lelystad.
- Zhang, Z. (2000). A flexible new technique for camera calibration. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 22(11): 1330-1334. <https://doi.org/10.1109/34.888718>