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Automated gait analysis with a deep learning key point detection model

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Background and purpose: Lameness is a frequent and costly problem among dairy cows, negatively affecting their welfare and productivity. Currently, lameness is evaluated by visually observing the animal's gait, a subjective and time-consuming method that can overlook cows in the early stages of this abnormal behavior disease. Early treatment of lameness, such as through hoof trimming, can prevent the development of more severe cases that may require antibiotic treatment or even culling. By promoting higher longevity and improved welfare, these measures can have a positive impact on the sustainability of dairy farming. Over the past few decades, there has been a significant emphasis on automating the detection of lameness in animals. Various technologies, including pressure mats and the analysis of behavioral parameters indirectly linked to lameness (such as activity and lying behavior), have been investigated. More recently, advances in machine vision and the greater availability of computational resources have led researchers to the adoption of deep learning-based solutions for animal monitoring. The aim of our study is to automate gait assessment which allows for continuous monitoring of locomotion and detecting lameness at an early stage. This study consists of four steps: (1) Automated cow detection; (2) Automated key point detection; (3) Defining and extracting gait features; (4) Validate the repeatability and individuality of key point-derived gait features.

Materials and methods: One camera (frame rate = 25 fps) was installed at the Dairy Campus research facility of Wageningen University and Research, Leeuwarden, the Netherlands. These cameras collect side-view footage of110 Holstein Friesian dairy cows after they exit the milking parlor.

In the current study, (1) we trained and validate the You Only Look Once (yolov7) object detection [1] with BoT-SORT tracking [2] on 200 frames; (2) we've adapted a previously developed key-point detection model (T-LEAP) [3] to work in an indoor environment to detect 17 key points. For this, we used video footage of 44 cows to train, validate and test the automatic key point detection model.

Results and the next steps: The object detection and tracking algorithm achieved the mean average precision of 0.95 with a threshold of 0.5 in the validation set. The key points detection model's performance on the test set reached an average Percentage of Correct Key points (PCKh@0.2) of 0.89 on all key points together, with the poorest performance on the back key points. As the direction of the error matters for different key points, some post-processing is applied before the gait feature calculation. In the next steps, we will investigate the definition and extraction of the gait features from the detected key points on more videos and the repeatability and individuality of these features for automated lameness detection.

References

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