Automatic detection of atypical head lunge movements of dairy cows in free-stall cubicles using accelerometers and machine learning

Thursday, 3rd August - 12:15: PLF and Other New Techniques for Measuring Animal Behaviour (Ruminants) (Bolero hall) - Oral

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Dairy cows stand up by thrusting their head forwards and using it as a counterweight to gain enough momentum to rise up. In confined spaces like lying cubicles, cows may not be able to perform the head lunge in a natural manner and can have difficulties standing up. Current free stalls where head space cannot be increased may be improved by installing cubicle partitions that facilitate space sharing to the side, so the head lunge can be performed sideways. However, the only method to assess the effect of partition shape on cow welfare is through direct observations. Not only is this labour intensive, assessors can also be influenced by other factors, such as stable cleanliness. Since motion sensors are now commonly used to detect dairy cow behaviours, we aimed to investigate how well the direction and fluency of the head lunge can be detected using accelerometers and machine learning. Data was collected using triaxial accelerometers recording at 20 Hz attached to the left side of the head of 48 lactating cows (Brown Swiss and Holstein × Swiss Fleckvieh). A total of 569 standing up events were recorded. We used a recently proposed time series classification algorithm, MiniRocket, for machine learning model development and employed a cross-validation strategy. Balanced accuracy was used as primary performance metric as it is insensitive to class imbalances. We considered video observations as the ground truth. Head lunge direction (right/left/straight) and head lunge fluency (repeated movements/one fluent motion) were predicted with balanced accuracies of 0.67 and 0.69, respectively. Although this is not yet satisfactory for standalone use, it is a clear increase over a baseline classifier always predicting the most frequent class in the training dataset (0.33 and 0.50, respectively). Plotting learning curves indicated that the performances of these classification models are likely to improve with additional data. The results of this study suggest that the use of motion sensors and machine learning could improve the efficiency and objectivity of assessing dairy cow housing installations by regulatory authorities. Further research is needed to collect more data and improve the reliability and generalisability of these models.