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Computational challenges in deriving dairy cows' action patterns from accelerometer data

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Information on animals' behaviour is an essential feature of any Precision Livestock Farming (PLF) system. Animal behaviour is basically movement in space and time, and high frequency three-dimensional (3D) accelerometers can be utilised to measure this movement. Thus, accelerometer data, combined with sophisticated computation, is a putative method for recognising animals' action patterns. We describe an attempt to build a computational model for deriving dairy cows' action patterns automatically from accelerometer data.

3D accelerometer data (10 Hz) and video-data were collected from 21 dairy cows. The accelerometers were placed over the neck in collars of the cows. The postures and movements of the whole body, and the movements of the head and mouth were analysed from the videos in 5 or 6 s time windows. The postures and movement categories used in building the behaviour pattern recognition model were: lying or standing with only minor head movements (LS), lying or standing with marked head movements (LSH), walking (WALK), lying down (LYD), standing up (STU), and rumination (RUM) or eating (EAT) during lying and standing. The data set included altogether 2061 observations. The model was based on features, which reflected the changes in the intensity and direction of accelerations. The actual classification was done with the decision trees. The accuracy of the classification (the percentage of correct classifications in each class) was estimated by the ten-fold cross-validation.

The first classification including only three rough action pattern classes gave rather good accuracies: LS+LSH 94 %, WALK 85 % and LYD+STU 83 %. Increasing the number of classes lead to the following results: LS 98 %, LSH 38 %, WALK 85 %, LYD 53 %, STU 70 %, and HEAD 38 %. RUM and EAT, while LS or LSH, could be classified with accuracies 71 % and 81 %, respectively.

These preliminary results show that accelerometers can be used to recognise dairy cow's action patterns. The placement of the accelerometer on the neck of a cow enables the recognition of rumination and eating, but on the other hand, sudden, and sometimes very violent, head movements may disturb the recognition of other behaviour patterns. The collars move rather freely, and the position of the accelerometer is not necessarily always the same although the posture of an animal would be exactly the same. Thus, the computational methods used to recognise, for example, human behaviour are not necessarily suitable, but new methods are needed. Another solution would be a second accelerometer attached so that the posture of an animal could be interpreted more reliably, but avoiding excess "instrumentation" of the animals may also be important. We aim to improve our cow action pattern recognition model by altering the time windows to suit better various behaviours. We also want to emphasise the importance of the accuracy and detailed description of the gold standard, i.e. the reliability of the behavioural observations.