Peer review: Detecting dairy cows' lying behaviour using noisy 3D ultra-wideband positioning data

Overview

This study aims to develop a methodology to classify the lying behaviour of dairy cows using noisy positioning data. This is achieved by preprocessing the data then applying changepoint analysis and bagged decision trees. The authors successfully classify lying behaviour to a high accuracy, which has not been done using spatial positioning data in an automated non-invasive way to date. This could help refine farm management to improve dairy cow health and welfare.

Additional details and justification in the methodology would strengthen this manuscript, such as outlining the amount of data lost after each pre-processing step and demonstrating the minimal change in accuracy with different splits in the data between the training and test sets.

Major

1. Section 3.3. The authors have clearly outlined the data editing steps. Outlining the amount of data lost during each data editing step would be useful, to show the reader specifically how much data was excluded within the average of 43% lost per day (including 'correct' data during milking). The use of a flow chart may help.
   Furthermore, it would be beneficial if the details of the data exploration, which the management of missing data was based on, were included (L182-184), perhaps as Supplementary Material).
2. L177-179. It is not clear whether the data points either side of these instances were always close to the edge value. If not, why were these instances replaced by the edge value rather than excluded, as was done with successive data points out of the barn edges?
3. Section 3.4. The authors explain that the (z)-position was found to be the most unreliable and noisy of all three coordinates (L213-215). Is it not clear why the (z)-coordinate was therefore used in the classification at all, apart from because it is straightforward (L226-227). Would a measure derived from the coordinates have been useful? e.g., VeDBA and SCAY (see Vázquez Diosdado *et al.,* 2015).
4. Section 3.5. The data-split approach could do with further justification. Was the use of a validation dataset or K-fold cross validation to increase robustness considered?
5. L267-269. Please provide results to demonstrate increasing the data used for training did not increase the accuracy. It would be useful to see the results of different combinations.
6. L271-277. The division between training and test data is set to be different for the cow identify-based data split and the time-based data split, but why this was done is unclear. In Section 4.4, please state the final division as a percentage, as in Section 4.3 (35% training).
7. L286-288. It is explained that this classification algorithm performed best- is this in relation to other algorithms and can you provide evidence?

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Minor

8. L50. Good explanation- please briefly expand on how they are much less homogenous.
9. L57-61. Please add references here e.g., Boyland et al. (2015) and Chopra et al. (2020).
10. L57-81. The authors could mention other indoor positioning systems that have been used to monitor behaviour over time, such as local positioning systems (LPS), and compare these to uwb-based positioning systems.
11. L72-73. Add references(s) showing findings of changing lying behaviour in relation to lameness e.g., Barker et al. (2018).
12. L93-95. Has research on uwb with a view for livestock applications been conducted previously? If so, please provide a brief overview and references.
13. L99-103. 'previous research' regarding these limitations needs a citation.
14. L127-131. Please give the accuracy of the uwb-positioning tags and the accelerometers.
15. L133. Please check- is the latter meant to read (y)-position?
16. L171-173. Were there not any instances when cows were lying down in the feeding area? Was the data filtered to y > 11.5m? This is unclear.
17. L202-203. Perhaps include why this was done i.e., to reduce noise.
18. Figure 1. The visualisation of the barn layouts is useful. Please move the figure so it is directly under Section 3.3, and please move the figure legend so it is directly under the figure. It may help to stick to one unit or measurement in the main text and figure e.g., m (see L166-173). In the main text, the minimum and maximum x and y coordinate values do not match those in the figure (see L166-173). Please ensure you are consistent with which sides of the barn layouts were considered x and y too.
19. The positioning of most figures and tables needs improving- please place directly under associated text. E.g., I suggest moving Fig 3-5 to the results section. Please also state when a table/figure is in the Appendix.
20. Figures and tables are often not interpretable independent to the main text- this could be improved by providing additional details in the figure/table legends.

Note to editor

Reviewer lacks expertise in changepoint analysis i.e., L240-261.