Evaluation of strategies for summarizing acceleration data to monitor calving in rangeland systems

Ana Bugueiro-Domingo[1], Jorge Navarro-García[2], Ignacio Gómez-Maqueda[1], Marie Gaborit[3], Frédéric Launay[3], Dolores C. Pérez-Marín[4], Carlos C. Pérez-Marín[4] and Francisco Maroto-Molina[4]

[1]Digitanimal SL, San Fernando de Henares, Spain; [2]Data Science Laboratory, Rey Juan Carlos University, Móstoles, Spain; [3]Domaine Expérimental du Pin, INRAE, Gouffern-en-Auge, France; [4]Department of Animal Production, ETSIAM, University of Cordoba, Córdoba, Spain

fmaroto@uco.es

EAAP 72nd Annual Meeting (DAVOS)

INTRODUCTION

- Calving is an important event for farmers, both in terms of animal production and welfare.
- Several PLF devices to monitor calving are available, most of them designed to be used indoors. Generally, they are not valid for rangeland systems due to connectivity constraints (data need to be transmitted wirelessly over long distances to allow real-time monitoring).
- Low Power Wide Area (LPWA) networks have been deployed for the Internet of Things, allowing long-range data transmission, but the number and size of data packages that can be sent through LPWA networks are limited. Thus, acceleration data with a high time resolution cannot be directly transmitted using LPWA networks.

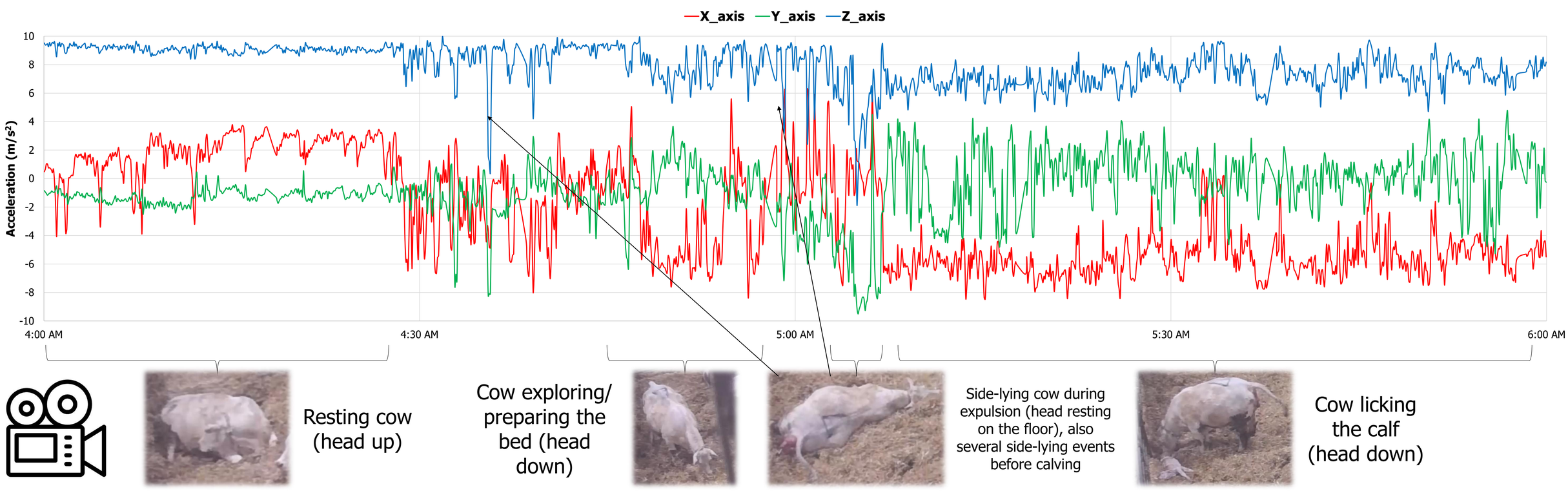
Objective: to evaluate different data summarization strategies to build simple and meaningful indicators for calving detection that can be transmitted through LPWA networks.

MATERIALS AND METHODS

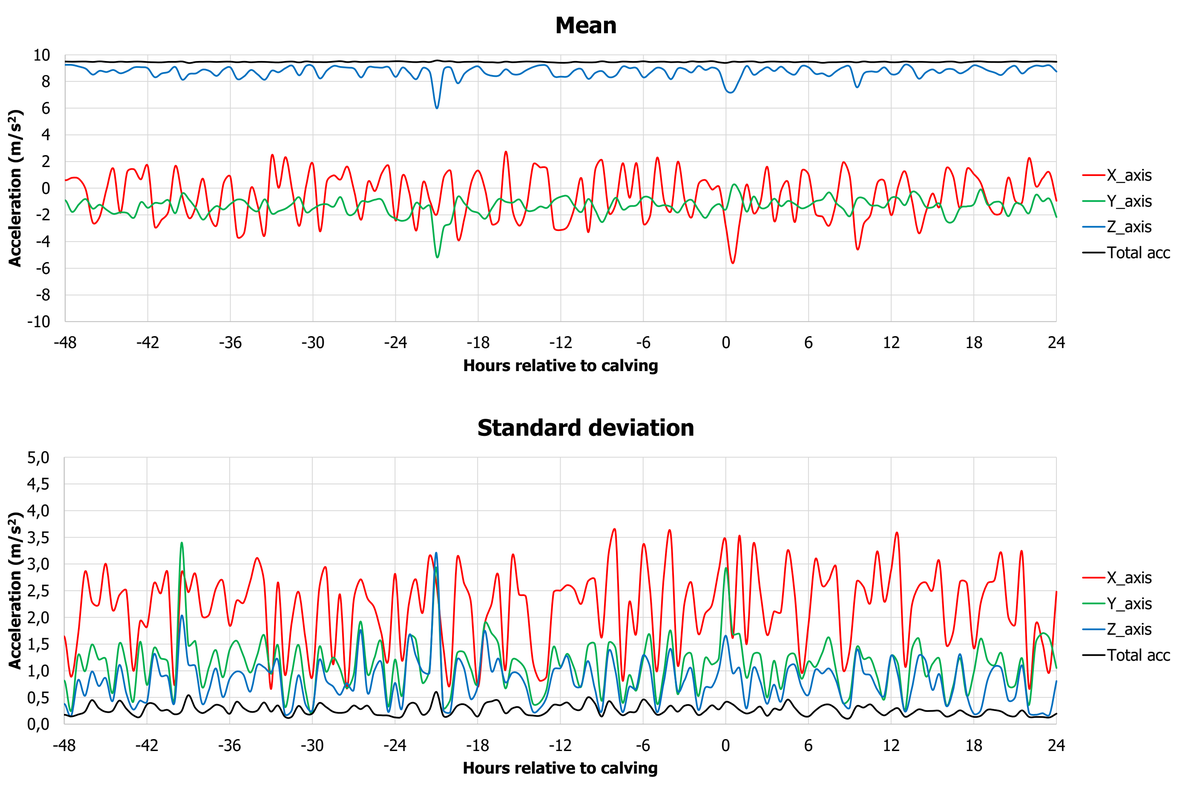
- Monitorization of 15 dairy and beef cows at INRA Le Pin (from 7 days before expected calving date t0 24 h after actual calving date).
- Digitanimal® collars: 3D acceleration data with a time resolution of 10 ms.
- Cow behavior around calving videorecorded and labelled.
- Acceleration features calculated for each period of 30 min (typical time resolution of commercial Digitanimal® collars connected to LPWA networks):
  1. Mean (for each axis and total acceleration).
  2. Standard deviation (for each axis and total acceleration).
  3. Average difference between each pair of axes.
  4. Sum of absolute deviations from 30-min mean (static window) (for each axis and total acceleration).
  5. Sum of absolute deviations from 3-h rolling mean (moving window) (for each axis and total acceleration).

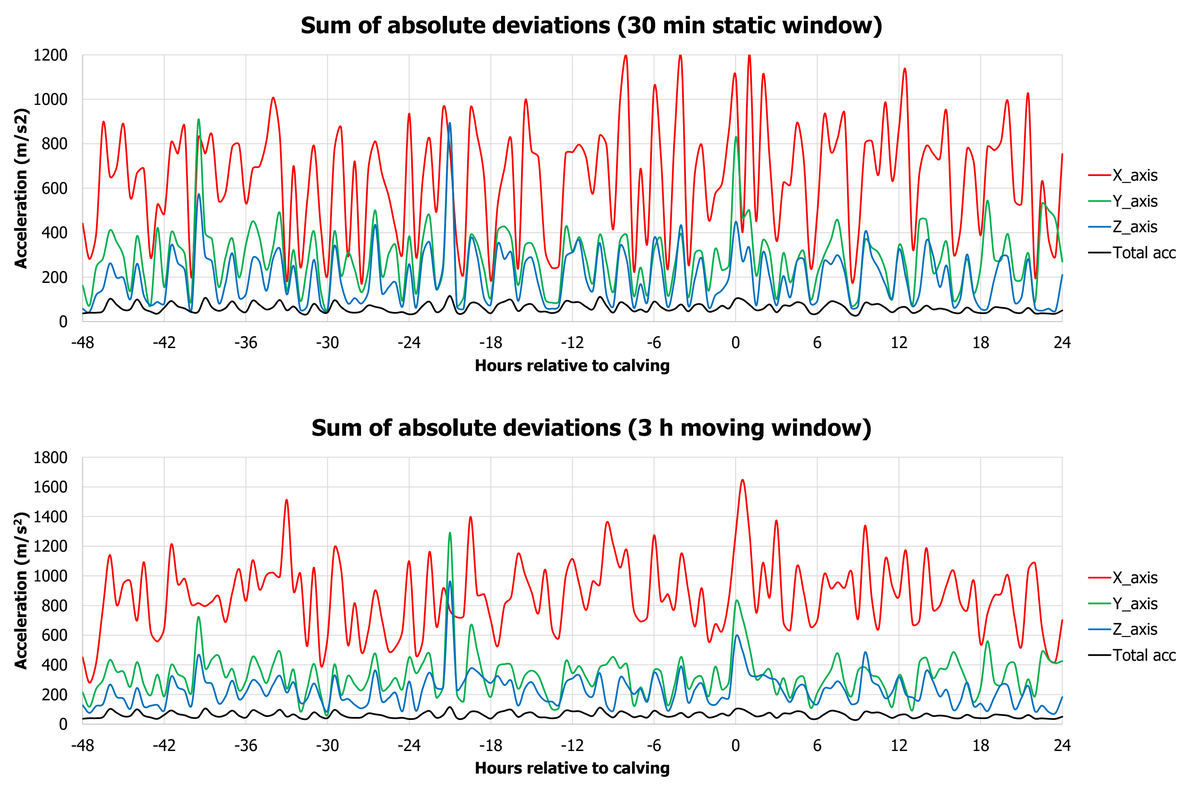
RESULTS AND DISCUSSION

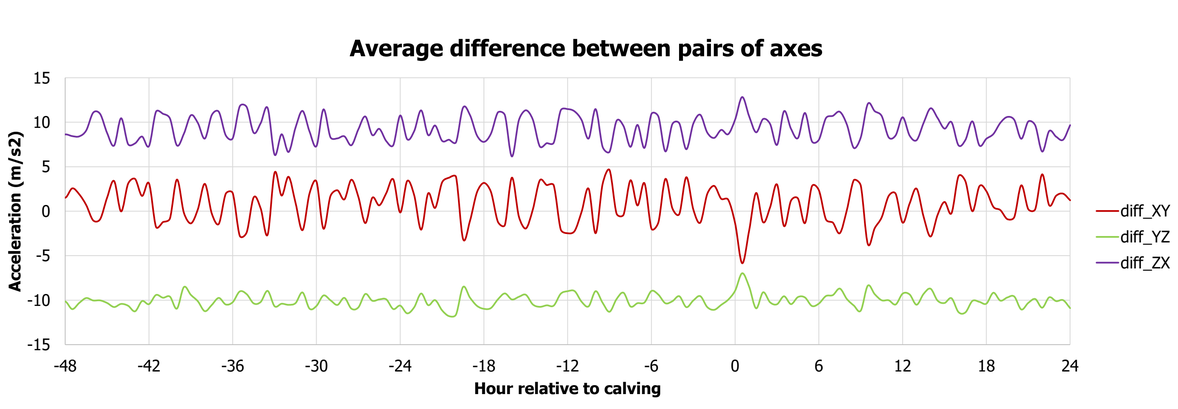
Typical pattern of acceleration data (time resolution = 10 ms) around calving

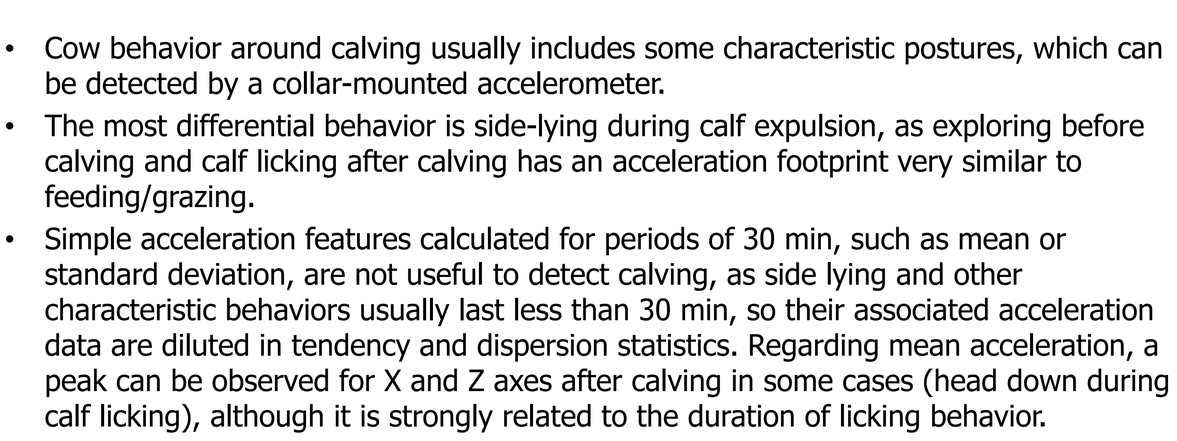


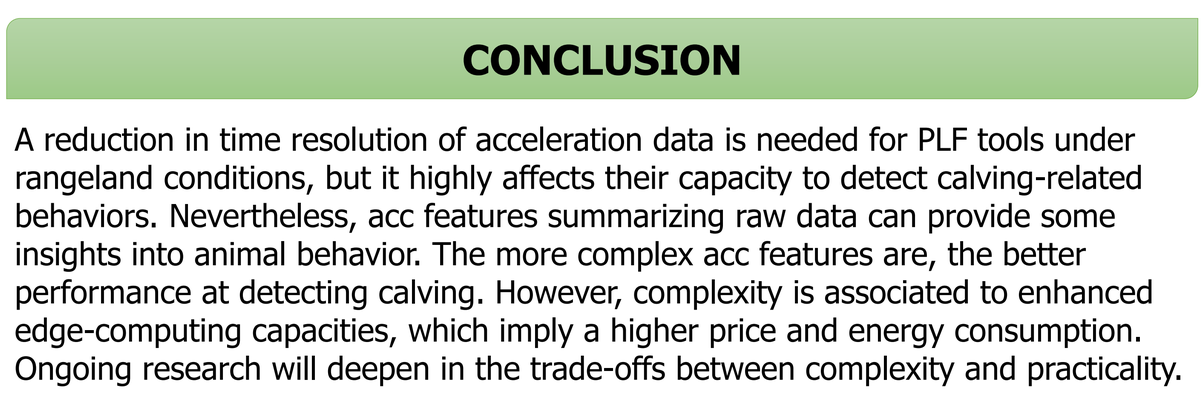
30-min acceleration features











- Cow behavior around calving usually includes some characteristic postures, which can be detected by a collar-mounted accelerometer.
- The most differential behavior is side-lying during calf expulsion, as exploring before calving and calf licking after calving has an acceleration footprint very similar to feeding/grazing.
- Simple acceleration features calculated for periods of 30 min, such as mean or standard deviation, are not useful to detect calving, as side lying and other characteristic behaviors usually last less than 30 min, so their associated acceleration data are diluted in tendency and dispersion statistics. Regarding mean acceleration, a peak can be observed for X and Z axes after calving in some cases (head down during calf licking), although it is strongly related to the duration of licking behavior.
- More complex features (average difference between axes and sum of absolute deviations) perform better at detecting calving, showing clear peaks in X and Y axes (or their difference) during and/or after calving (side lying and licking, respectively).
- The sum of absolute deviations for a 3 h rolling average showed the best detection capacity, with a clear peak in Y axis during calving and an absolute maximum in X axis after calving. However false positives associated to Y maximum values were found, responding to side-lying resting behavior. It is expected that this behavior in not as usual in rangelands as it was in INRA Le Pin experimental farm, due to the availability of a comfortable bedding system for cows.

CONCLUSION

A reduction in time resolution of acceleration data is needed for PLF tools under rangeland conditions, but it highly affects their capacity to detect calving-related behaviors. Nevertheless, acc features summarizing raw data can provide some insights into animal behavior. The more complex acc features are, the better performance at detecting calving. However, complexity is associated to enhanced edge-computing capacities, which imply a higher price and energy consumption. Ongoing research will deepen in the trade-offs between complexity and practicality.