

Oestrus detection in dairy cattle using ALT-Pedometer and Fuzzy-Logic

A project together with Saxon State Institute for Agriculture in cooperation with the Institute of Agricultural Engineering Bornim and the Agricultural Faculty of the Martin-Luther-University Halle for using new indications for the automatic health and fertility supervision in precision dairy farming

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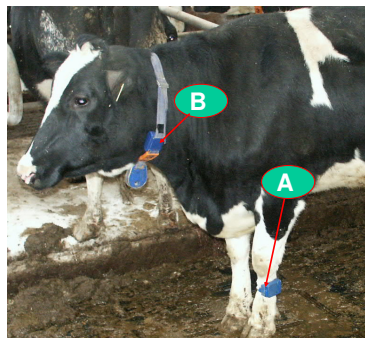


Fig. 1: Cow with an ALT-pedometer (A) and a neck belt actiometer from DeLaval (B)

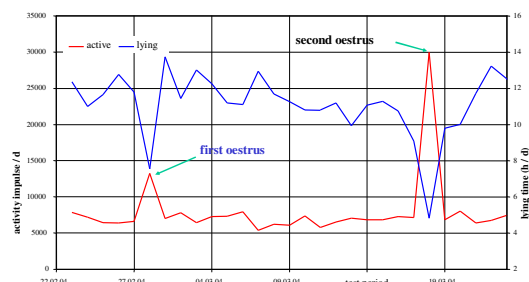


Fig. 3: Run of lying and activity impulse from the ALT-pedometer for a cow with two oestrus

Input variables	Steps	Lying behavior	Days since last oestrus	% cows with an increased activity
model 1	X			
model 2	X	X		
model 3	X		X	
model 4	X	X	X	
model 5	X	X	X	X

Fig. 4: Table for combinations of the input variables to the Fuzzy Logic models for oestrus forecast

Results

- Seven variants to forecast the oestrus were compared. The quality of the models was evaluated with the rate of oestrus detection and the error rate (figure 5).
- The neck belt actiometer system with the application ALPROwin signalled 72% of the oestrus, but the wrong detection rate was at a high level (55%).
- With the ALT-pedometers the detection rate improved by 11% and the error rate reduced by 32%.
- With the application of adopted Fuzzy Logic models using activity and lying information of the ALT-pedometers and other traits (days since last oestrus or level of activity in the herd) the error rate could be further reduced up to 0%.
- The best results regarding the oestrus detection were 84% but with a maximum error rate of 17% (models 2 or 3 - the lying behavior or the days since last oestrus was taken into account).
- From a practical point of view we prefer the model 2 with the input variables number of steps and lying periods.

Introduction

- Oestrus intensity, oestrus duration and cycle length are negative correlated to the milking traits. In order to support the oestrus detection a new developed four channel pedometer system from the Institute of Agricultural Engineering Bornim (ALT-Pedometer in figure 1) was tested in practice which measures the number of steps, the lying position and lying duration as well as the temperature.
- The task was to test the ALT-Pedometer in comparison with the neck belt actiometer from DeLaval and developing an evaluation algorithm to the oestrus forecast by means of Fuzzy Logic with the aim to improve the detection as well as the error rates.

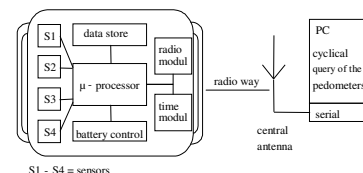


Fig. 2: Block circuit diagram of an ALT-pedometer systems

Material and Methods

- Ten cows were sampled after calving and equipped with the so called ALT-pedometers in addition to the neck belt actiometers which were used in this herd. These cows were observed for a period of 6 month.
- The freely programmable ALT-pedometers collected the number of steps and the lying periods as well as the environmental temperature every quarter of an hour from each cow.
- The records were transferred by means of a radio modem to the PC in a four-hour cycle (figure 2).
- The levels of activity signalled by the neck belt actiometers and the results of the oestrus observation were recorded daily.
- All together 18.432 records were collected per cow for the traits "number of steps" and "lying duration" (ALT-pedometer, figure 3) as well as 193 day values for the traits "level of activity", "oestrus observation", "insemination" and "conception" (neck belt actiometer).
- Five different models were adapted for the oestrus detection by means of Fuzzy Logic with up to four different combinations of the input variables (Table in figure 4).
- The validation of the models was based on observations of the oestrus traits and on the date of conception.

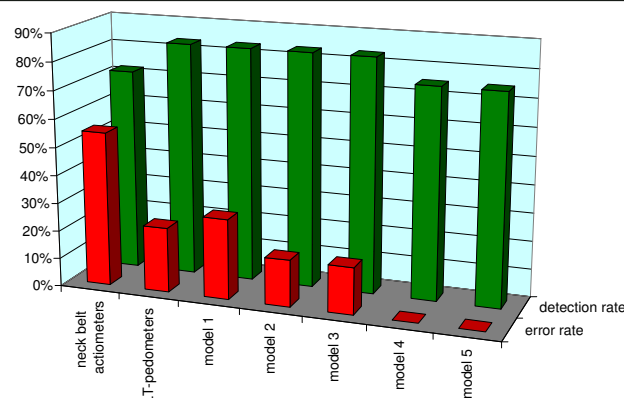


Fig. 5: Variant comparison at the quality for the oestrus forecast to hand of the detection and error rate

Conclusions

- Compared with commercial solutions the oestrus detection rate could be improved by 12% using further parameters of the ALT-pedometer and the Fuzzy Logic methodology. The error rate could be reduced by 38%.
- Fuzzy Logic is an appropriate methodology to aggregate information to support management decisions in milk production.
- Further applications of the system to support other management fields (health detection, expected calving etc.) are possible.