Automatic detection of oestrus and health disorders using data from Electronic Sow Feeders

Cécile Cornou, Jens Vinther and Anders Ringgaard Kristensen
Copenhagen University, Faculty of Life Sciences, Dept. of Large Animal Sciences, Groennegaardsvej 2, 1870 Frederiksberg C, Denmark

Introduction

Group housing for sows results in difficulties monitoring an individual among a group; concomitantly, the increasing herd size implies a reduction of the time spent by animal. New automatic tools need to be developed to help farmers focusing on specific individuals, which need particular attention at a given time, for instance at the onset of oestrus or when health problems occur. Eating behaviour is influenced by the onset of oestrus (Friend, 1973) and diseases (Forbes, 1995). For group housed sows fed by Electronic Sow Feeders (ESF), it is possible to collect sufficient information to characterize the eating behaviour of individual animals. At the present time, the information available to the farmer is restricted to a *list of sows* that have not eaten. Selecting and processing the relevant information from ESF, over a sufficient period of time and for a larger number of sows should allow developing a method for monitoring oestrus and health disorders.

Material and methods

Data was collected over a period of 12 months (January 2005 to January 2006) in three production herds, in Denmark. Data collection includes 1) registration of visit at the ESF for the individual sows by a central computer, 2) registration of oestrus, lameness and other health disorders by visual inspection performed by the herds' employees.

Modelling of the individual eating behaviour

The individual eating rank is selected as the response variable: it includes the order (o_{it}) in which sow *i* enters the ESF and eats more than 300 g and the group size (N_t) at day *t*. To obtain an approximately normal distribution, the individual eating rank is logistically transformed as:

$$O_{it} = \log\left(\frac{o_{it}}{1 + N_t - o_{it}}\right) \tag{1}$$

When a sow has not eaten at the end of a daily feeding cycle, the individual eating rank o_{it} is set to N_t, so that O_{it}= log(N_t). Time series of daily eating ranks are generated for each experimental sow, for their whole gestating period. Thereafter, the individual eating rank is modelled using a Dynamic Linear Model (DLM) combined with a Kalman Filter (KF) as described in West and Harrison (1997). External information is included into the model: *intervention* is performed each time a subgroup enters, exits or both.

Detection method

The detection method consists in applying a *V-mask* (Montgomery, 1997) on the cumulative sum (cusum) of the standardized forecast errors (deviations between the model forecasts and the observations). It is expected that when a sow presents a specific condition (oestrus, lameness or other health disorders), the cusum tends to drift upwards or downwards. The parameters of the V-mask are optimized for the 3 herds and the 3 conditions, using 300 sows chosen at random but including individuals presenting oestrus, lameness and other health disorders.

Results and discussion

Results presented in Table 1 indicate that the detection method allows detecting sows in oestrus with a sensitivity ranging from 59 to 75%. As compared to other results obtained with either the list of sows that have not eaten obtained by the ESF (currently the only kind of alarm system for the farmer) or with a Multi Process Kalman filter (MPKF) as tested by Søllested (2001), the performance of the automatic detection method developed in this paper appears satisfying; the sensitivity for those other methods were 9 to 20%, and below 2% respectively. The detection method for lameness and other health disorders shows a sensitivity ranging from 41 to 70%, as compared to 22 to 39% when the list of sows from the ESF is used as alarm.

Table 1. Performance of the automatic detection method for detecting oestrus, lameness and other health disorders, using the corresponding V-mask parameters for the three herds

	Herd 1			Herd 2			Herd 3		
	oestrus	lameness	other	oestrus	lameness	other	oestrus	lameness	other
Sensitivity	0.588	0.556	0.000	0.700	0.703	0.750	0.750	0.413	0.385
Specificity	0.935	0.923	0.923	0.810	0.803	0.790	0.954	0.954	0.954

However, the major drawback of the detection method is a too high number of false alarms; for oestrus detection, the number of false positives observed in herd 1, 2 and 3 is 3634, 21291 and 6466, vs. 1354, 6884 and 3609 when the list of sows is used. A possible explanation for the high number of false alarms is the fact that oestrus is a rare event to monitor: during the implementation of the method in the three herds, only 81 sows showed oestrus, out of the 308836 days of monitoring. Suggestions for improvement of the method include a reduction of the period for automatic oestrus detection and broadening the reference periods in which sows with lameness and other health disorder were observed at the herd; the reference periods used in this experiment were from 6 days before up to the day of observation (lameness), and from 3 days before to 3 days after the observation (other health disorders). Besides, it can be argued that a sow presenting health disorders is expected to decrease in eating rank; detection of the cusum deviations in one side only, i.e. downward drift of the eating rank, may help reducing the number of false positives. A control chart such a *Tabular Cusum* (Montgomery, 1997), which allows monitoring separately upwards and downwards drifts of model deviations, may be used for this purpose. To improve both the sensitivity and the specificity of the detection method, it is suggested to include more variables such as daily feed consumption, body activity or temperature into a multivariate model.

References

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