AUTOMATIC MEASUREMENT SYSTEM FOR COW LEG DISORDER DETERMINATION

Väino Poikalainen[1], Jukka Ahokas[2], Jaan Praks[1], Mikko Hautala[2], Andres Aland[1], Imbi Veermäe[3]
[1] – Faculty of Veterinary Medicine, Estonian Agricultural University, Tartu, Estonia; [2] – Faculty of Agriculture and Forestry, University of Helsinki, Helsinki, Finland; [3]– Institute of Animal Science, Estonian Agricultural University, Tartu, Estonia

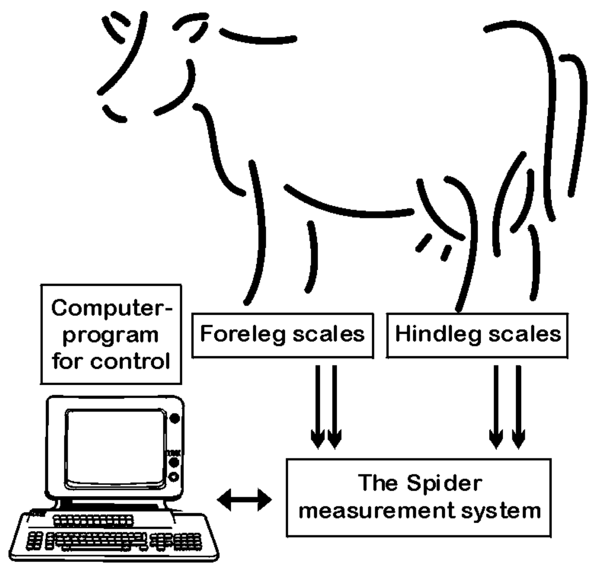
Introduction

Limb disorders cause serious welfare, health and economic problems at the loose housing cattle keeping (Klaas et al, 2003; Juarez et al, 2003). In bigger herds it is very complicated to track the early stages of lameness and other disorders. Therefore, the automation of relevant procedures is needed. Walkthrough scales for lameness detection are under development at present (Rajkondawar et al, 2002). The automatic measurement of static load of each leg is quite a suitable means for this purpose as well. It could be carried out when the cow is in some of the self-service units (concentrate feeder, milking robot etc). The objective of this study is to estimate the leg load distribution of cows.

Material and Methods

The Interrobo co-operation project between the University of Helsinki and the Estonian Agricultural University has developed a four-scale measurement system at a milking robot (AMS) in Suitia experimental cowshed in Finland (Figure 1).

Figure 1. Measurement systems for the investigation of the leg load distribution of cows



Four strain gauge scales were installed taking into account the point of support of each leg. Prior to this study it was ascertained that the application of scales with the area of 30×40 cm would guarantee that all four legs are situated on the scales with 95% probability (Hämälainen, 2003). The Spider measurement system (HBM, Germany) consisting of an amplifier, an analogue-digital converter and a controller were connected to the scales. Special software was created to ensure the data flow from the Spider to a PC and to control the measurement cycles. The load measurement had an accuracy of ± 1.0 kg and the measurement frequency was 10 Hz. When a cow entered the AMS, leg load measurements started automatically. Measurements were stopped and written into hard disc also automatically after the cow left the AMS. The data files were later downloaded from the PC via a network of the Helsinki University. Leg load index (LLI) that indicates the partial load of a leg in relation to the body weight was created for each leg:

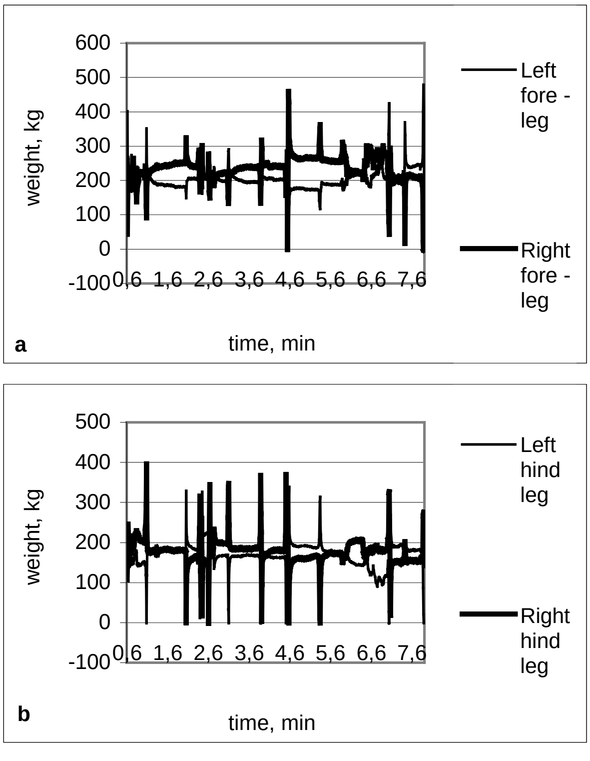
$$LLI_n=L_n/W,$$

whereas L_n is the leg load (n=1-4), and $W = \Sigma L_n$ is the body weight. These indexes were used to evaluate the leg load distribution during the study. For the experiments, 42 dairy cows were chosen as focal animals who regularly visited the AMS. Altogether 1 055 AMS visits were analysed with the EXCEL software package.

Results and discussion

An example of leg load changes during the milking is presented on figure 2. Typically the forelegs' load is higher (54%) than for hind legs (46%). The peaks on the graphs indicate kicks .

Figure 2. Forelegs (a) and hind legs (b) load during the milking



The results of the study showed that there are static and dynamic differences in LLIs between different legs and cows (Figures 3-7). Cows A and B on figure 3 have normal pattern of LLIs, cow C has a considerably smaller left hind leg LLI, and cow D has a much smaller right foreleg LLI. The results of the whole study showed that the mean values of the hind legs load were unevenly distributed: the LLI of the left hind leg was 0.206 and for the right hind leg 0.253 (Figure 4). This was obviously caused by the cows' behaviour in connection to the AMS.

Figure 3. LLIs of four cows

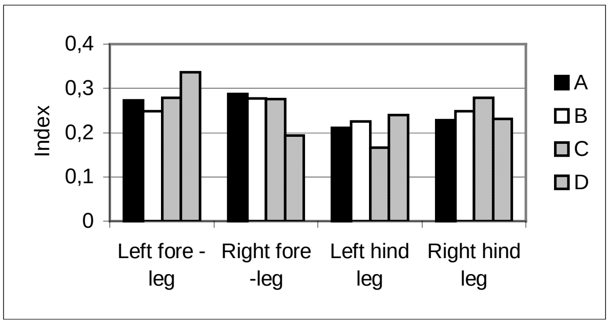
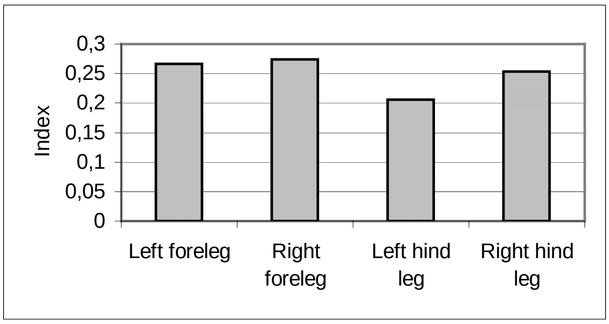


Figure 4. Mean LLIs during the study



LLIs of different cows had quite a specific dynamic pattern during the study. The appearance and duration of the differences in LLIs between the neighbouring legs can be used as parameters for the evaluation of abnormalities (Figures 5-7).

Figure 5. The dynamics of forelegs (a) and hind legs (b) LLIs of cow A

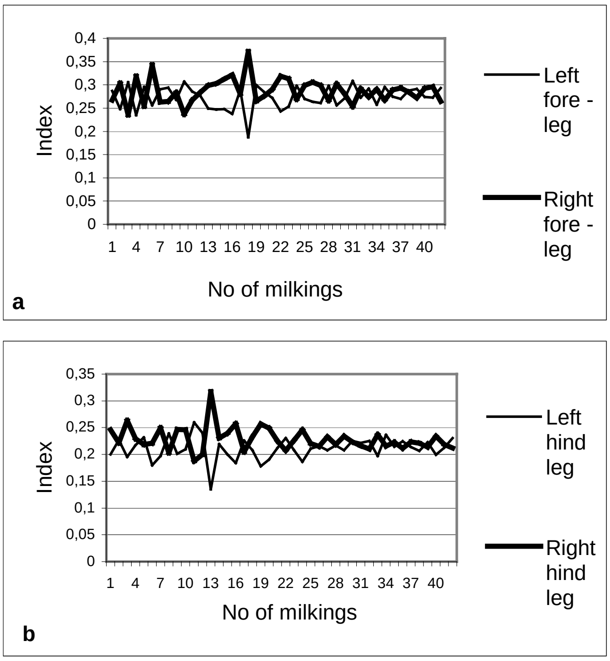
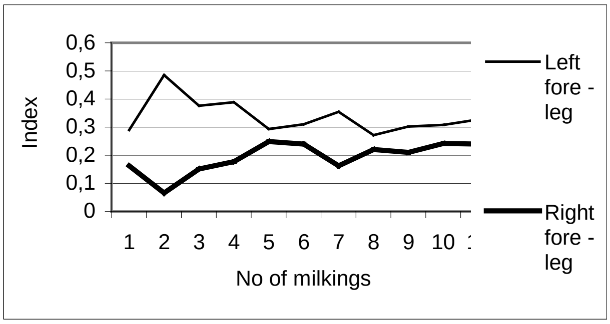


Figure 6. The dynamics of hind legs LLIs of cowC

Figure 7. The dynamics of forelegs LLIs of cow D



Conclusion

The static distribution of leg load indexes (LLIs) and their dynamics in time can provide a basis for the detection of leg disorders. To a certain extent the cow's behaviour influences the leg load distribution. An automatic system for the estimation of LLIs can be used to monitor the health status of animals.

Acknowledgements

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