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DEVELOPMENT OF AN AUTOMATIC LAMENESS DETECTION SYSTEM FOR DAIRY CATTLE

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Abstract

Lameness in dairy cattle negatively effects the welfare of affected cows and is the third biggest cause of economic loss to the dairy industry in New Zealand. As the cost and frequency of lameness continues to increase, profitability will further decrease, unless a more effective and efficient method of detecting cattle lameness is found.

The main objective of this study was to investigate whether differences between healthy and lame cattle could be identified by capturing ground reaction forces when the dairy cattle walked over the designed platform. The designed walkover platform (WoP) has four independent platform segments, with each segment containing four ASB1000 shear beam load cells, a 24 bit sigma-delta analogue-to-digital converter and an ATmega328 microcontroller. Software was developed in Python 2.7 to record the captured load cell signals and process them to determine the three basic kinematic variables associated with lameness: force, position and duration. Based on these variables a wide range of typical gait parameters such as stride length, abduction, stance time, etc. were calculated. Laboratory testing of the positional and weight accuracy of a platform segment found a maximum weight error of 0.4%, a X-position mean error of 1.0 ± 2.2 mm and a Y-position mean error of 0.8 ± 1.8 mm.

The WoP was tested on two farms during the winter of 2015. During this period approximately 9500 hooves landed on the platform from 200 cows. 95% of all hoof falls were captured implying that the segment length and lead on platform were the correct dimensions for an averaged sized herd of dairy cattle. The dynamic weighing of the cattle on the WoP showed a mean deviation of -13.7 ± 7.5 kg. On farm and video analysis lameness scoring was conducted by a trained observer. The lame and healthy cows were compared to see the differences in variable values and signal signatures. Two-sample t-tests proved that the most significant variables are a combination of weight, position and duration parameters with these being: asymmetry in front limb weight, asymmetry in rear limb weight, asymmetry in diagonal weight, asymmetry in side weight, average step overlap left-side, average step overlap right-side, asymmetry in step overlap L Vs R, average step overlap, average abduction left-side, average abduction, asymmetry in stance time left-side, asymmetry in stance time L vs. R, asymmetry in stance time front hoof and asymmetry in stance time hind hoof. Statistical techniques were used to build classification models based on significant variables associated with lameness. The model that demonstrated the most promise is logistic regression using six predictor variables; this technique correctly classified all 86 cow trials in relation to the observer score. Although there is still much work to be done to provide an automated solution to lameness detection, this research provides novel contributions towards the architecture of a commercial low cost system that can determine cattle lameness in any limb.

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List of Abbreviations

NGRF	Normalised ground reaction force
RF	Right front hoof
LF	Left front hoof
RH	Right hind hoof
LH	Left hind hoof
StDev	Standard deviation
DA	Discriminant analysis
LS	Locomotion scoring
WoP	Walkover platform
PCB	Printed circuit board
COP	Centre of pressure
BLG	Binary logistic regression

Platform background – one main platform called WoP separated into four individual platform sections/segment