THE PERFORMANCE OF MOBILE DEVICES' INERTIAL MEASUREMENT UNIT FOR THE DETECTION OF CATTLE'S BEHAVIORS ON PASTURE

A.L.H. Andriamandroso, B. Dumont, F. Lebeau and J. Bindelle

AgricultureIsLife Platform, Precision Agriculture and Animal Science units
Gembloux Agro-Bio Tech, University of Liège
Belgium

ABSTRACT

Over the past decade, the Precision Livestock Farming (PLF) concept has taken a considerable place in the development of accurate methods for a better management of farm animals, as Precision Agriculture has done for crop production. Mass consumption mobile devices have nowadays the possibility to record accurately user movements with their Inertial Measurement Unit (IMU). We used iPhone 4S to detect accurately cattle behaviors such as grazing and ruminating with the aim of performing a precision grazing management on the near future. Results showed accuracies ranging between 84% and 100% when detecting these two major behaviors by analyzing recorded raw signals in the time-domain. Ongoing research tries to link these behaviors to different pasture characteristics and performs a refined signal processing analysis for a better monitoring of some possible behavioral changes.

INTRODUCTION

PLF is not anymore an utopia when looking at recent progress in technology. For cattle, starting with robotic milking and some physiological and health status monitoring like a GPS-GSM based system for estrus and parturition alert (Calcante et al., 2014), numerous researchers are now focusing in individual behavior monitoring and try to classify some cattle behaviors using GPS, accelerometer or both and "black-box" statistical methods. Using accelerometers provides the classification of several behaviors with an accuracy ranging between 29% and 98% (Martiskainen et al., 2009). Knowing the state-of-the-art answers about cattle behavioral monitoring, this study purposes a "white-box" approach to analyze and detect the most important cattle behaviors using iPhone 4S sensors grouped in its IMU. Even if this smartphone is already used for some medical purposes using downloadable applications, its IMU is not well-exploited but is a promising powerful measurements instrument.

MATERIAL AND METHODS

Six different recording sessions in Belgium in Gembloux Agro-Bio Tech farm (50°33'52''N 4°42'08''E) with two dry cannulated red-pied cows (RP1 and RP2) fitted with an halter where the iPhone 4S was fixed on its neck. Sensor Data

application (Wavefrontlabs) was installed on the smartphone to allow the recording of signals from its IMU with a frequency of 100Hz. Data were divided in two sets, one for calibration and one for validation. Cows activities were also video recorded. Raw data were analyzed in time-domain by observing sets of movements performed during grazing and ruminating behaviors. The most discriminant signals were chosen and statistical criteria were fixed to elaborate the final detection algorithm. Detection accuracies were finally determined by comparing observed behaviors from video and the detected from algorithm.

RESULTS

For validation data it was shown that ruminating behaviors were detected correctly for up to 91% when grazing behaviors showed an accuracy of 84% in one data. This is probably due to the different unconsidered situation (pasture height and use of another animal).

Table 1. Detection accuracies of grazing and ruminating behaviors

Data	Calibration			Validation		
Season	Summer	Summer	Summer	Spring	Spring	Fall
Cow	RP 1	RP 1	RP 1	RP 2	RP 2	RP 2
Grazing	100%	-	97%	84%	100%	-
Rumination	-	98%	-	-	100%	91%

CONCLUSION

The iPhone 4S could record user movements into accelerometric signals through its IMU. It allows the detection of specific behaviors knowing the sets of movements performed when the animal is doing them. Refined signal processing will be also involved in our research to improve the detection accuracies and to reach the precision bite monitoring for a better pasture management.

REFERENCES

Calcante A., Tangorra F.M., Marchesi G. and Lazzari M., 2014. A GPS/GSM based birth alarm system for grazing cows. Comput. Electron. Agric. 100: p.123-130.

Martiskainen P., Järvinen M., Skön J.-P., Türikainen J., Kolehmainen M. and Mononen J., 2009. Cow behaviour pattern recognition using a three-dimensional accelerometer and support vector machines. Appl. Anim. Behav. Sci. 119: p.32-38.