Dipartimento di Agraria
Università di Sassari

19th Symposium of the European Grassland Federation

Agris
Agentzia pro sa chirca in agricoltura
Agenzia regionale per la ricerca in agricoltura

Precision Farming
New technologies for grazing management of ruminants

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BEHARUM Project

Use of Information and Communication Technology (ICT) to monitor feeding behaviour in grazing ruminants

Project funded by Regional Government of Sardinia, (Projects CRP-17287 PO Sardegna, FSE 2007-2013 LR 7/2007).

Partners

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Electronic Systems

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Why BEHARUM project?

- Accurately monitoring of feeding behavior and nutrition of herbivores is still a challenge.
- Monitoring the feeding behavior in the pasture is important to take management decisions in grazing systems.
- Grazing, ruminating and resting are the main daily activities of ruminants and play a key role in regulating their **herbage intake**.

Daily herbage intake

Resting time

Ruminating time

Grazing time

x

Bite rate

x

Bite weight

Long-term

Pasture conditions

Short-term

Controlled conditions
micro-swards

Methods for monitoring feeding behaviour

1) Direct observation

2) Automatic recording

Acoustic system

IGER Behaviour Recorder

BEHARUM 1.0

Minimum impact on animal

850 g

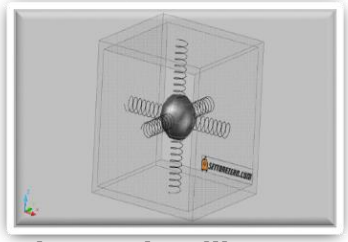
40 g

Transmits reliable data from animal to a remote computer

Long recording sessions – easy battery recharge

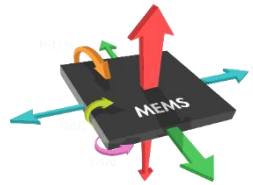
Upgradable system

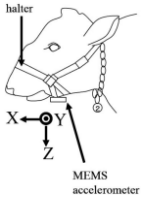
BEHARUM 1.0



It is a spring-like sensor

The tri-axial (x, y, z) **accelerometer sensor** (ADXL335) is inserted in a micro-electromechanical compact system (**MEMS**) with lots of on-board peripherals.



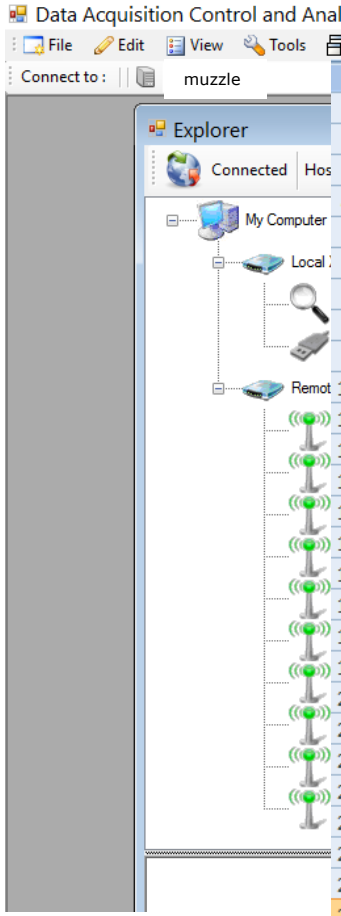


When deformed, it generates a voltage signal that is proportional to the acceleration it experiences.
It is affected both by **static acceleration of gravity** as well as **dynamic acceleration** due to movement.

The central part of the system is a **microcontroller** (16F1825) that samples the row acceleration data at a frequency of **62.5 Hz** and encodes them into levels ranging from 0 to 255, then selects only three acceleration converted values per second and axis. The power supply of the system is guarantee by a Li-Polymer **battery**.

ZigBee wireless communication technology (IEEE 802.15.4) operates on 2.4 GHz bands, can cover distances up to 1500 meters.

DACAS 2.0



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Recording Data	17/01/2015	Time 10.03										
2	Time	Z Counter	Z Peak 1	Z Peak 2	Z Peak 3	Y Counter	Y Peak 1	Y Peak 2	Y Peak 3	X Counter	X Peak 1	X Peak 2	X Peak 3
3	10:21:54	2	4	12	0	1	4	0	0	1	6	0	0
4	10:21:56	1	7	0	0	1	7	0	0	0	0	0	0
5	10:21:57	1	4	17	47	2	12	17	0	2	5	11	0
6	10:21:58	2	3	26	0	1	4	0	0	1	6	0	0
7	10:21:59	2	4	13	0	0	0	0	0	1	10	0	0
8	10:22:01	0	0	0	0	0	0	0	0	0	0	0	0
9	10:22:02	0	0	0	0	0	0	0	0	0	0	0	0
10	10:22:03	1	4	0	0	1	3	0	0	0	0	0	0
11	10:22:05	3	26	33	63	1	3	4	5	1	10	15	40
12	10:22:06	1	3	0	0	0	0	0	0	0	0	0	0
13	10:22:07	2	5	11	0	2	5	14	0	2	4	6	0
14	10:22:08	1	4	0	0	1	5	0	0	1	3	5	0
15	10:22:10	1	4	0	0	1	5	0	0	0	0	0	0
16	10:22:11	1	4	0	0	2	5	11	0	1	5	0	0
17	10:22:12	0	0	0	0	1	4	5	0	1	3	0	0
18	10:22:13	0	0	0	0	1	4	0	0	1	3	0	0
19	10:22:15	3	4	7	12	3	4	7	15	3	3	5	12
20	10:22:16	0	0	0	0	0	0	0	0	2	3	10	0
21	10:22:17	0	0	0	0	0	0	0	0	0	0	0	0
22	10:22:19	0	0	0	0	2	4	7	0	1	3	0	0
23	10:22:20	0	0	0	0	1	3	0	0	0	0	0	0
24	10:22:21	0	0	0	0	1	8	0	0	0	0	0	0
25	10:22:22	0	0	0	0	1	7	0	0	0	0	0	0
26	10:22:24	1	3	0	0	1	4	0	0	1	3	0	0
27	10:22:25	1	4	0	0	1	7	0	0	1	4	0	0
28	10:22:26	0	0	0	0	1	4	0	0	0	0	0	0
29	10:22:27	1	3	6	0	2	5	14	0	1	4	0	0
30	10:22:29	1	4	0	0	0	0	0	0	0	0	0	0
31	10:22:30	0	0	0	0	0	0	0	0	0	0	0	0

60 s

Mean
Variance
Inverse Coefficient of Variation

X, Y, Z axis and the resultant

Italian ryegrass – Sulla – Alfalfa - Chicory

1. We classified the video-recorded behavior of the animals into three simplified activities at **60 s** intervals as:
   Grazing, **Ruminating**, **Resting**

2. Datasets by combining the **three behaviours** and **number of bites** with the variables concerning accelerations

3. Multivariate statistical approach: **Stepwise**, **Canonical**, **Discriminant analysis**

Livestock Science 196 (2017) 42–48

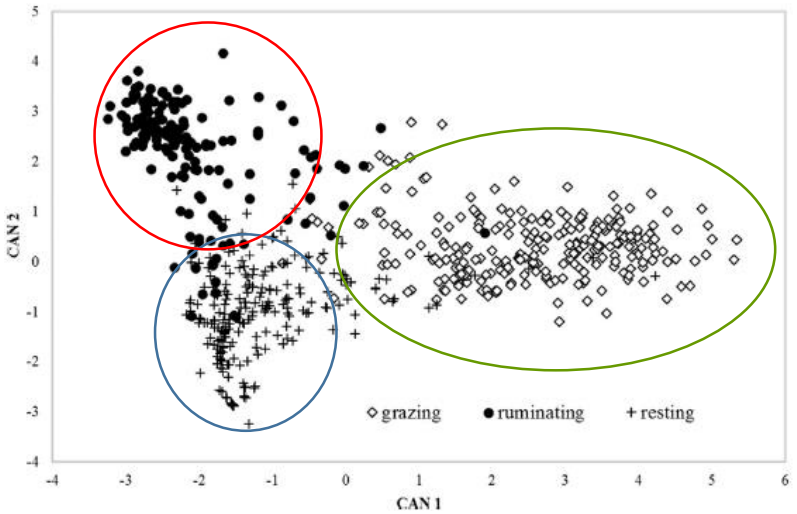
Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Automatic classification system for grazing, ruminating and resting behaviour of dairy sheep using a tri-axial accelerometer

V. Giovanetti[a,*], M. Decandia[a], G. Molle[a], M. Acciaro[a], M. Mameli[c], A. Cabiddu[a], R. Cossu[b], M.G. Serra[a], C. Manca[a], S.P.G. Rassu[b], C. Dimauro[b]



Observed behaviour	Predicted behaviour			
	Grazing	Ruminating	Resting	Total
Grazing	234	8	6	247
Ruminatin;	1	133	15	149
Resting	9	9	261	279
Total	244	149	282	675
Sensitivity (%)	96	89	93	
Specificity (%)	97	97	95	
Precision (%)	95	89	94	
Accuracy (%)	96	95	94	93[a]
k	0.92	0.86	0.89	0.89[$]

The total error in minutes assignment was around 7%

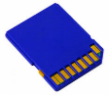
The sum of accelerazione in the X-axis represented a good proxy of number of bites (r2=0,65)

BEHARUM 2.0

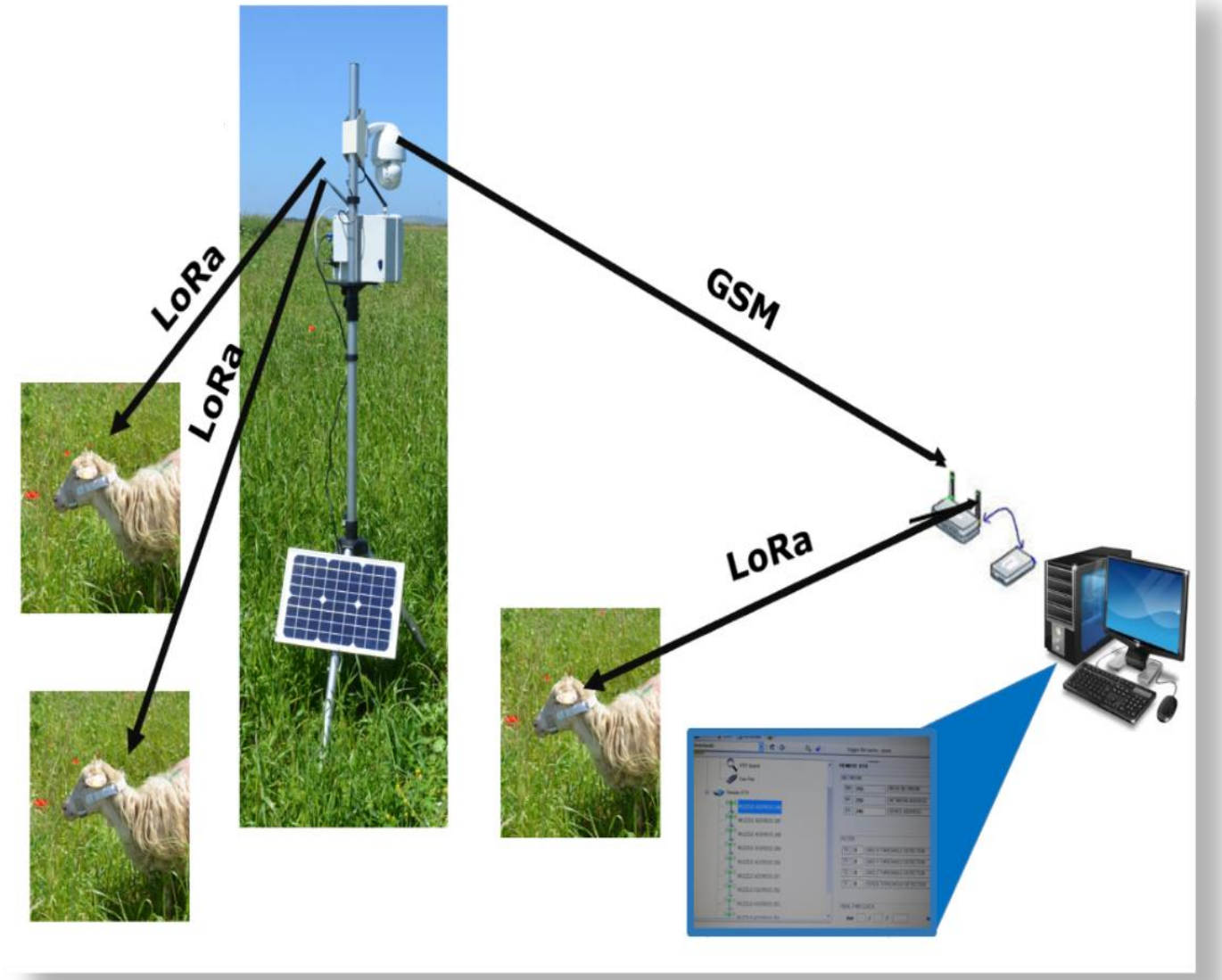
Halter

microchip
(PIC18F87J50)

SD card



LoRa SSM



Server

Mother Board
- CPU Intel Atom quad core Z3736F, 1.83GHz
- Operating System Windows 10
- RAM 2Gb
- Micro SD up to 64Gb

Transceiver
LoRa XTR-8LR100

Router
3G RUT500

Solar Charger Controller
SC-LI11V

4 days, 8 animals. Video recording and direct observation.

• space mixed sward	berseem clover & italian ryegrass: 6 hours
• time mixed sward	berseem clover + italian ryegrass: 3+3 hours

Short-term: micro-swards (Orr et al., 2005)

To calibrate the BEHARUM device for **bite/chew bite** number in Sarda dairy ewes

6 minutes

BEHARUM 2.0

Cichorium Intybus (**C**)

Lolium multiflorum (**L**)

Medicago sativa (**M**)

Avena sativa (**A**)

L+M

5x5 Latin square design: 5 forage specie, 2 replicates

Calibration of **BEHARUM** to measure feeding behaviour of grazing cattle raised on natural pasture

60 s

Decandia et al., 2017 Poster session - EGF Proceedings

….on going

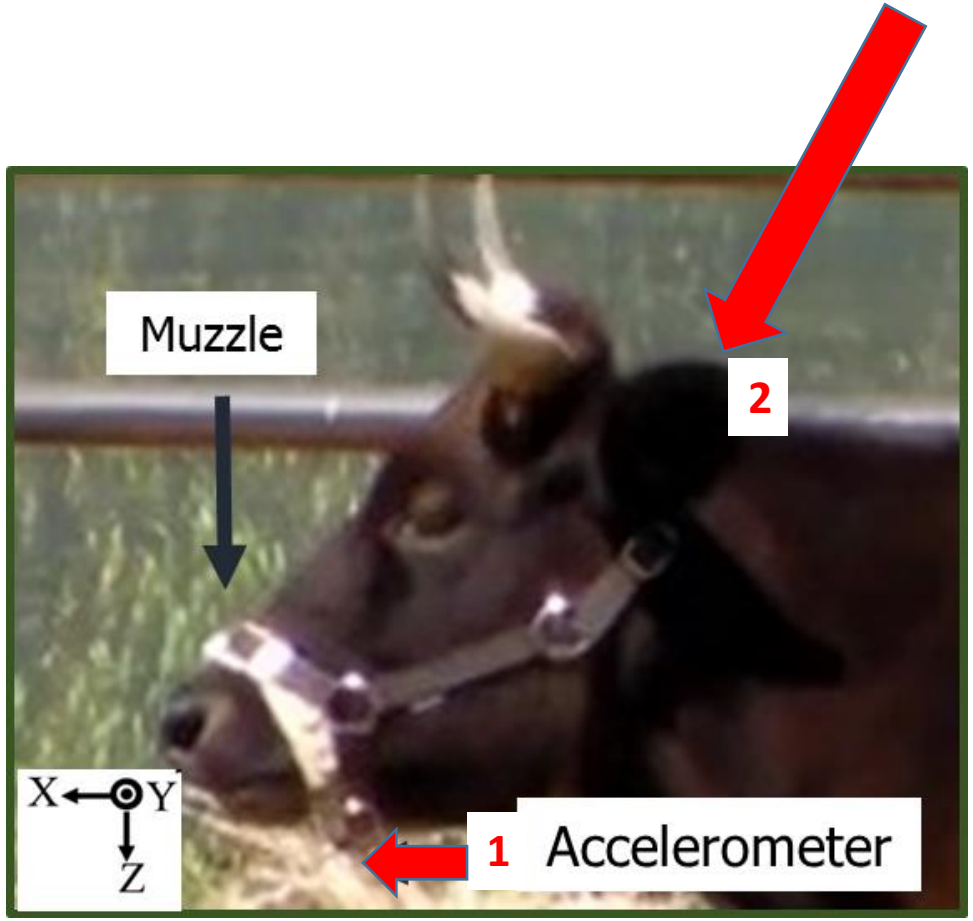
Is **60 s** the best aggregation window to process acceleration data?

Correct classification rate (%)

Epoch setting	Sheep	Cattle
5 s	79	78
10 s	87	83
30 s	93	89
60 s	89	91
120 s	87	92
180 s	86	93
300 s	79	93

….on going

Is the under lower jaw (**1**) the best sensor position?



……future purposes

To upgrade the device with other sensors (GPS, heart rate)

On farm long recording sessions with sheep and cattle

Thank you