

Tracking and monitoring of individual chickens housed in groups using passive radiofrequency identification

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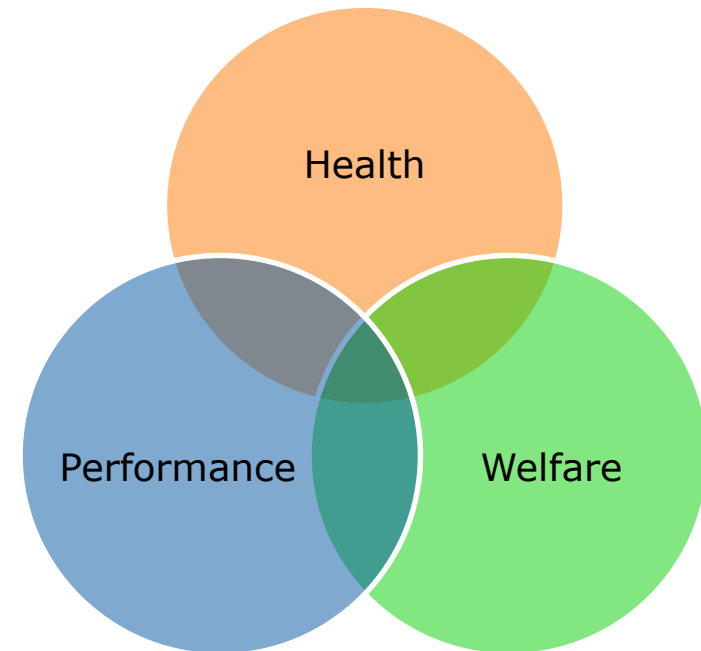


Why monitor in groups?

- ✓ Individual information
- ✓ For breeders: relation to performance in groups

✗ Monitoring difficult → video analyses

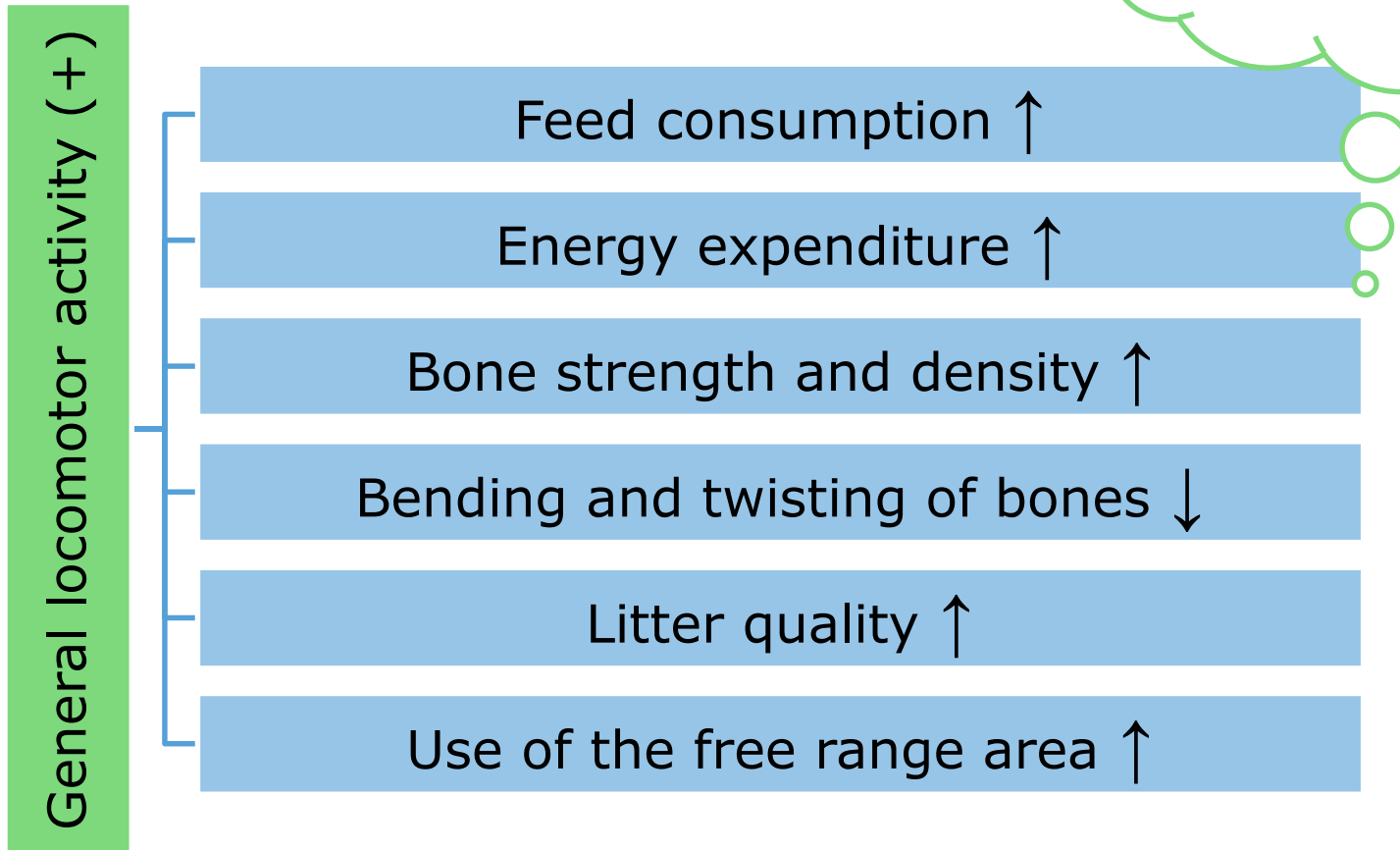
- Homogeneous appearance (Dawkins et al., 2012)
- Time-consuming, error prone (Catarinucci et al., 2014; Howerton et al., 2012)



Overview of the project

Automatically collect data on health, welfare and performance of individual animals that are kept in groups, using sensor technologies

Activity in poultry

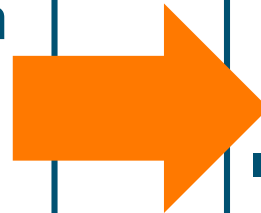


Based on Kjaer (2017)

Sensor technologies

Requirements

- Individual level
- Multiple animals
- Fast processing of data
- Determine:
 - **Activity**
 - Location
 - Proximity



Possible systems

- **Radiofrequency identification**
 - Passive
 - Ultra-wideband
 - Video tracking
 - Accelerometers
 - ...
- **Combinations**

Radiofrequency identification systems

- Wireless communication systems using radiofrequency fields (Debouzy & Perrin, 2012)
 - Tags – attached to animal
 - Antennas and readers

(Finkenzeller, 2010)

Different RFID systems

- Different systems can be distinguished based on:
 - Memory type of tags (Ilie-Zudor et al., 2006)
 - Reader type (Ilie-Zudor et al., 2006)
 - Communication method & range (Finkenzeller, 2010)
 - Linked to operating frequency
- Operating frequency (Finkenzeller, 2010)
 - Power supply (Ilie-Zudor et al., 2006)

FOCUS

Power supply of the tags

Active



With battery - continuous exact location determination

Passive



No battery - registered when an antenna is passed

Operating frequency

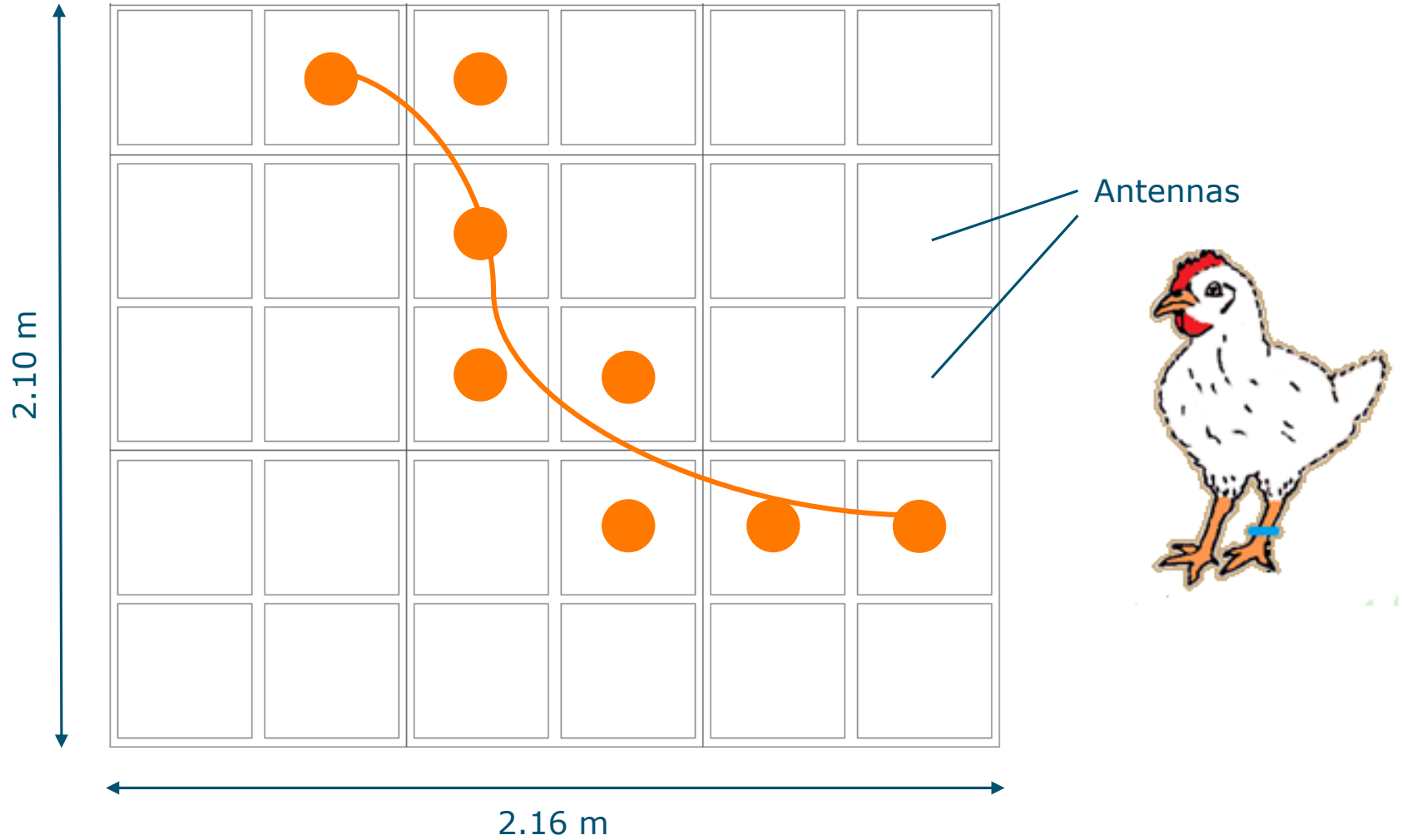
- Three basic operating frequency classes
 - Low frequency (LF): ± 134.2 kHz
 - High frequency (HF): ± 13.56 MHz
 - Ultra-high frequency (UHF): 866-868 MHz (EU)

- Additional:
 - Microwave: >3 GHz (Finkerzeller, 2010) ~ 2.45 GHz
 - Ultra-wideband (UWB): low-power signals on a range of frequencies (Weis, 2007)

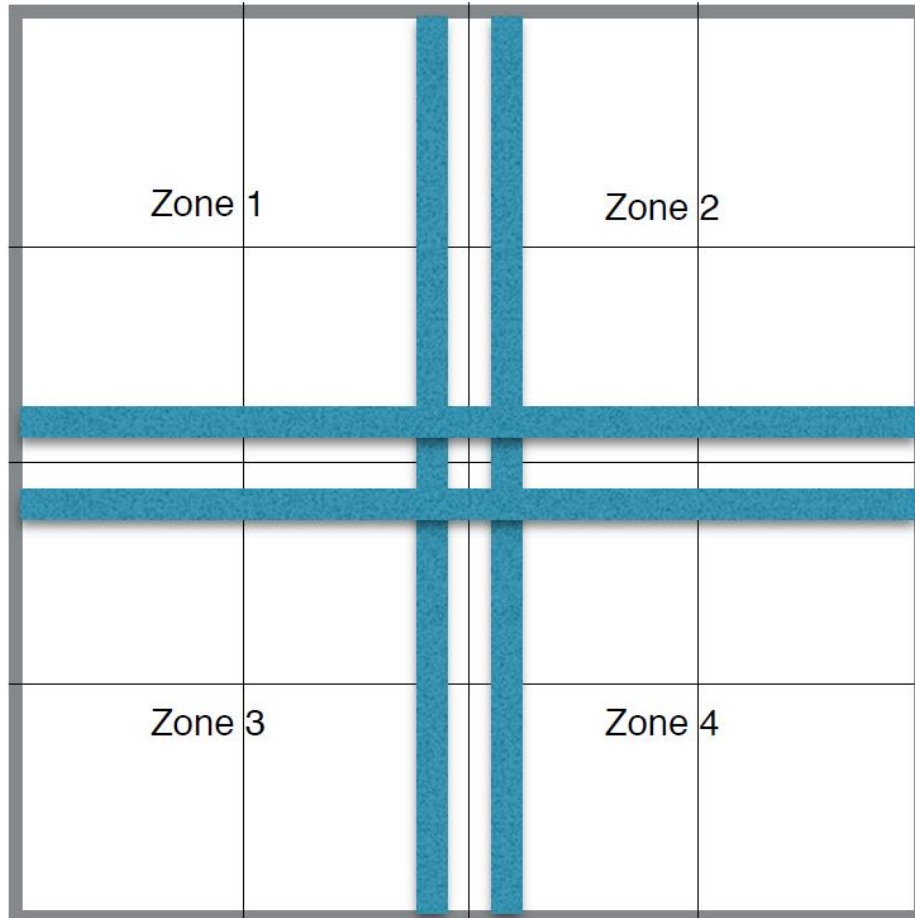
What type to use?

Low frequency (P)	One tag X No interference of water and metals 0-80 cm
High frequency (A/P)	Multiple tags Low interference of water and metals ✓ 10 cm – 1 m
Ultra-high frequency (A/P)	Multiple tags Strong interference of water and metals X Up to 12 m
Microwave (A/P) X	Multiple tags Can interfere with WiFi, water, metals X Up to 12 m or higher
Ultra-wideband (A) X	Multiple tags No interference of water and metals Long reading range

Passive HF RFID



Passive HF RFID – larger scale



Antenna



Output

RFID system

Time	Animal ID	Antenna number
00:01	42	8
00:47	42	9
00:53	42	14
03:41	42	9

Video observation

- EthoVision
- **The Observer XT**

Other tracking methods

- UWB tracking

→ Assess agreement between the methods

Validation

- **Sensitivity** = $\frac{TP}{P}$
 - Likelihood that a present animal is detected
- **Specificity** = $\frac{TN}{N}$
 - Likelihood that a not present animal is not detected

TP = number of true positives (both video and tracking system find positives)
 P = number of positives (video identifies positives)
 TN = number of true negatives (both video and tracking system find negatives)
 N = number of negatives (video identifies negatives)

(Maselyne et al., 2014)

Validation

Aim: 90%

■ **Sensitivity** = $\frac{TP}{P} = \frac{9}{10}$

- Likelihood that a present animal is detected

■ **Specificity** = $\frac{TN}{N} = \frac{9}{10}$

- Likelihood that a not present animal is not detected

TP = number of true positives (both video and tracking system find positives)

P = number of positives (video identifies positives)

TN = number of true negatives (both video and tracking system find negatives)

N = number of negatives (video identifies negatives)

(Maselyne et al., 2014)

Validation

■ **Accuracy** = $\frac{TP+TN}{P+N}$

- Likelihood that an animal's status is correctly identified by the system

■ **Precision** = $\frac{TP}{TP+N-TN}$

- Likelihood that a detected animal is actually present

TP = number of true positives (both video and tracking system find positives)

P = number of positives (video identifies positives)

TN = number of true negatives (both video and tracking system find negatives)

N = number of negatives (video identifies negatives)

(Maselyne et al., 2014)

Validation

■ **Accuracy** = $\frac{TP+TN}{P+N} = \frac{9+9}{10+10} = \frac{18}{20} \rightarrow 90\%$

- Likelihood that an animal's status is correctly identified by the system

■ **Precision** = $\frac{TP}{TP+N-TN} = \frac{9}{9+10-9} = \frac{9}{10} \rightarrow 90\%$

- Likelihood that a detected animal is actually present

TP = number of true positives (both video and tracking system find positives)

P = number of positives (video identifies positives)

TN = number of true negatives (both video and tracking system find negatives)

N = number of negatives (video identifies negatives)

(Maselyne et al., 2014)

Validation

- Desired values depend on the goal and traits to be measured
 - E.g. for early warning system

TP = number of true positives (both video and tracking system find positives)

P = number of positives (video identifies positives)

TN = number of true negatives (both video and tracking system find negatives)

N = number of negatives (video identifies negatives)

(Maselyne et al., 2014)

Topics: overview

- ❖ Activity differences between different genetic lines or treatments
 - ❖ E.g. High feather pecking vs Low feather pecking lines
 - ❖ Estimating genetic parameters for activity
 - ❖ ...
- ❖ Correlations between activity and gait score

Topic: Gait

- Lameness common in broilers and turkeys (Kestin et al., 1992; Martrenchar et al., 1999)
 - Problem for welfare (SCAHAW, 2000)
 - Affects performance and economic output (Weeks et al., 2002)
- Links between activity and gait in poultry (Aydin et al., 2013; Van Hertem et al., 2017)

Can we automatically score gait when GLA is monitored?

Topic: Gait

HF RFID tracking results

Manual gait scoring
(Garner et al., 2002)



Novel, automated method of gait scoring

+ Continuous measurements

+ Non-invasive

Relevance

- Improved understanding of animals
- Health and welfare monitoring
 - Early identification of disease → prevent welfare impairments and save costs (Hammer et al., 2017)
- Precision phenotyping in breeding programmes

Breeding healthy animals that perform well in group housed systems

Discussion points

- What other sensors could we use?
 - Combinations of sensors?
- Proximity: social interactions
- Machine learning

Thank you

Project: Tracking and monitoring of individual animals kept in groups

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Discussion points

- What (minimum) validation values should we adhere to?
- How to apply this in large groups?
 - What information can we still obtain?
 - How to implement this in commercial situations?