Internet of things and Precision Livestock Farming

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Overview

• Challenges for Livestock Production
• What is Precision Livestock Farming (PLF)?
• Where is PLF today: Examples of PLF
• Conclusions
M3-BIORES team

253 A-Publications  16 products  15 patents
359 Conf. papers  2 spin-off companies
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Challenges for livestock production
Problem of monitoring animals

- Livestock farming in the past ...

Farmer had the time to use audio-visual scoring

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Worldwide Individual Meat Consumption

Source: FAO (2010)
Numbers of animals

Number of farmers

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Resulting in

- High number of animals per farm
- Less available time per individual animal
- More welfare and other problems
Challenges for livestock production

- Over 60 billion animals are slaughtered every year, increase with up to 40%?
- **Health**: Relationship between animal health and healthy food
- **Animal welfare** (e.g. EU)
- Environmental Issues
- Social importance
- **Economic importance** including Valorisation of knowledge
3 approaches in European focus on animal behaviour
First approach: Welfare Quality (1)
Europe has invested in a methodology to quantify Animal Welfare “Welfare Quality”

Procedure: Experts do audio-visual scoring by visiting farms and looking to (behaviour) of animal.
Second approach: Iceberg Indicator (2)
Technology can help to quantitatively measure **behaviour, health and performance** of animals.
Third approach: Precision Livestock Farming (3)

Management of livestock by continuous automated real-time monitoring of production/reproduction, health and welfare of livestock and environmental impact.
Welfare Scoring/Monitoring

Welfare Quality once a year (1)

Iceberg indicators (2)
slaughterhouse

PLF-Continuous animal based management during growth period (3)
A living organism:

Complex

Individual

[Graph showing heartbeats over time for different individuals]
A living organism:

Complex

Individual

Time

N

Individual

δ population

Δ individual

Response variable

Av. population

19

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A living organism:

Identical

Individually different
A living organism:

Complex  Individual  Time-Varying

Example: Heat production of broiler chickens

5 days old

30 days old

Example: Heat production of broiler chickens
A living organism:

- Complex
- Individual
- Time-Varying
- Dynamic

Living organism = CITD - system

1. Measure
2. Model
3. Manage & Monitoring

In an on-line way

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Examples of PLF Technology: What is possible today?

Fully automated monitoring
Example on Pigs: Infection Monitoring by On-line Pig Sound Analysis

i.c.w. University of Milan, SoundTalks NV, Fancom BV
Health monitoring by on-line sound analysis:

On-line cough recognition algorithm in pig stables
PCM: Results

Animals treated

Animals ill again

Pigs ill upon entering

Animals again ill

Cough Index (# coughs / 24h)

Oct 21 2014
Oct 28 2014
Nov 04 2014
Nov 11 2014
Nov 18 2014
Nov 25 2014
Dec 02 2014
Dec 09 2014

Time (day)
22,050 samples/sec
Analyses every 5 min.
Analyses of 6,615,000 samples/5 min

1 number/5 min
Less than 1 KB/day

INTERNET

Server SoundTalks
Example on pigs: Monitoring of drinking behaviour of pigs (health!)
Monitoring of drinking behaviour in pigs
(i.c.w. Ughent, Fancom BV)

• Monitoring water usage as indicator for health status

• Estimate hourly water use in a pig pen by analysing hourly duration of drink nipple visits
Model-based monitoring of water use

Water flow measured

Water use from water meters

Images

Detection of visits

Duration of visits

Water use estimated from image

Transfer function modelling

Compare

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Model-based detection of visits

$\Delta T = \text{duration of the visit}$
Results

Hourly water use can be estimated with an accuracy of 92% or 200 ml over 13 days
1 camera/pen

Video = 2 GB/hour

Analyses of: 1 image/sec x 3600 sec/hour x 24 hours/day

= 43,200 images/day, pen

X10 pens/compartment = 432,000 images/day, compartment analysed

1 number/30 min or 48 numbers/day

INTERNET
Example on broilers: Real time monitoring of problems in a broiler house

i.c.w. Fancom BV
eYeNamic monitor tool

Farm manager

Farm network

Camera network

Image pre-processing

Monitoring software
Vision-based Early Warning System for Broiler Houses

- Solution?
- Farmers can use automatic tools to continuously monitor the welfare and health of their broilers
Experiment’s ground plan
- Detecting malfunctioning in broiler houses
- Produce alarms in real-time when malfunctioning happens
  (in feeder or drinker lines, light, climate control, etc.)
Birds and housing

- Experiment rounds: 42 days
- Initial broiler weight: weight of 40±5 grams
- Broiler type: ROSS 308 broilers
- House capacity: 28000 broilers
- Climate control: Fancom FUP1EA2
Farmer logbook and manual video observation as references
Measuring vs. modelled animal distribution

Measured vs. modelled animal distribution

Date (dd/mm):
26/10  30/10  03/11  07/11  11/11  15/11  19/11  23/11  27/11  01/12  05/12

Distribution (%)

Prediction window: 1 light period = 5 hours

Measured distribution
Predicted distribution
Event detection

Feeder line

Defect Feeder line

Measured values
Smoothed values within 25% range
Smoothed values out of 25% range
Predicted values

Normal situation

Problem in feeding lines

Distribution

Date(dd/mm)
Detected events in the validation experiment over 42 days

**Conclusion**: Events in a broiler house could be detected using top-view image analysis with an accuracy of 95.24%
4 cameras

3 images/sec per camera analysed

1MB/image

12 MB/sec is analysed

1 image/min is stored per camera

= 4 MB/min per compartment

4 MB x 24 h x 60 min
5.76 GB/day
Broilers’ fee intake

Scratching behaviour: Ughent, ILVO

Aggression monitor: Umil, TIHO, Fancom BV

Weight estimation: Fancom BV, Agrifirm
Example cows: Automated Lameness Monitor

(i.c.w. ARO Israel, WUR, DeLaval)
Commercial farm layout

- Waiting area
- Alley
- Pen Group 1
- Pen Group 2
- Treatment
Results: Active Appearance Model
Aim of research

3D Video

Cow segmentation

Back detection

Back spine extraction

Curvature parameters extraction

Classification
Cow traffic: crowding in alley

Cow 2

Cow 1
Algorithm: performance per cow

About 80% has enough scores

Aim: at least 5 BPM-scores per week
Value Creation through Precision Livestock Farming
Value for farmer:

- Welfare
- Health
- Environmental Impact
- Consumer
- Social Recognition
- Labour and Time
- Euros
PLF is a tool that helps farmers and stakeholders
The PLF Business Model

Cost of PLF investment & operation shared along the value creation chain by payment for access to data pool
General Conclusions

• PLF offers fully automated continuous real time detailed management of animals.

• PLF brings the farmer to the individual animals that need his/her attention, active management tool.

• Efficient implementation of PLF needs low cost and reliable internet connections.
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Organiser: Dr. Marcella Guarino
Thank you for your attention
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Questions
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