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Assessing lactating sow behaviour using sensor technology and machine learning

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BACKGROUND

- R&D project on '*New selection tools to improve piglet pre-weaning survival*'
- Pilot studies on novel technologies to automate the collection of new phenotypes:
  - piglet traits (maturity at birth and birth-weaning growth)
  - sow traits (behaviour around farrowing and during lactation)
- Frequent postural changes during lactation are linked to sow stress, leading to higher piglet mortality by crushing.
- Video analysis can be used to monitor sow postural changes over time, but in large sow operations in North America, it is challenging to manage many cameras in farrowing units

CDPQ RESEARCH AND TRAINING SOW BARN

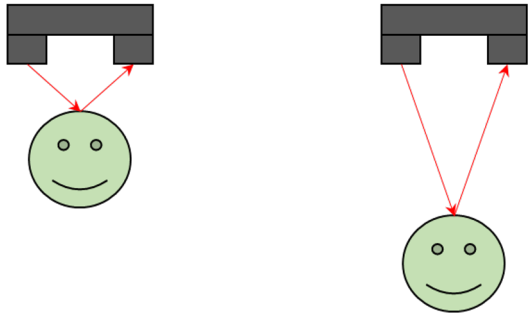
- Located in Armagh (Quebec)
- Inaugurated in 2020
- 675 head sow barn – farrow to wean
- 4-week batch management
- 1 large farrowing room with 135 crates
- Novel technologies in all sections

THE SOW SENSOR

- Infrared technology (motion sensors)
- Triangulation method
  - ➢ Distance between ceiling and sow
- Output voltage converted to distance
- 1 sow sensor = 3 subcomponents in a custom box

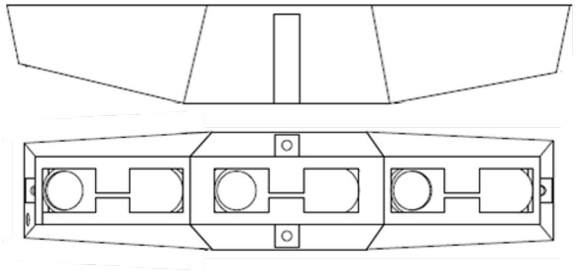
Subcomponent

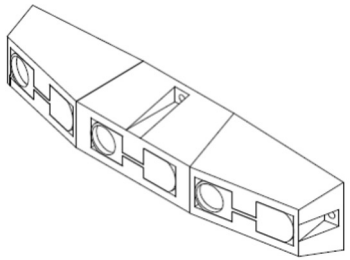
Source : https://www.mouser.ca/datasheet/2/365/sharp_gp2y0a710yk0f_datasheet-1100501.pdf



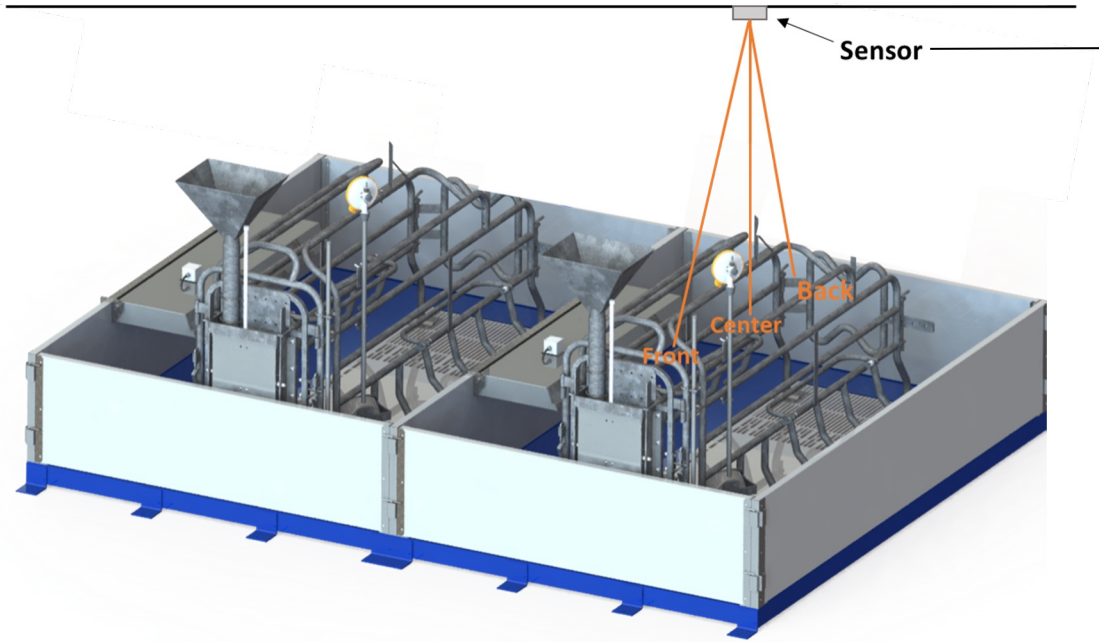
THE SOW SENSOR (CONT'D)

- Homemade design and 3D printing (CDPQ)
- Specific angles for each component to maximize the coverage of the crate (10.5 degrees for the front angle and 13.5 degrees for the back angle)



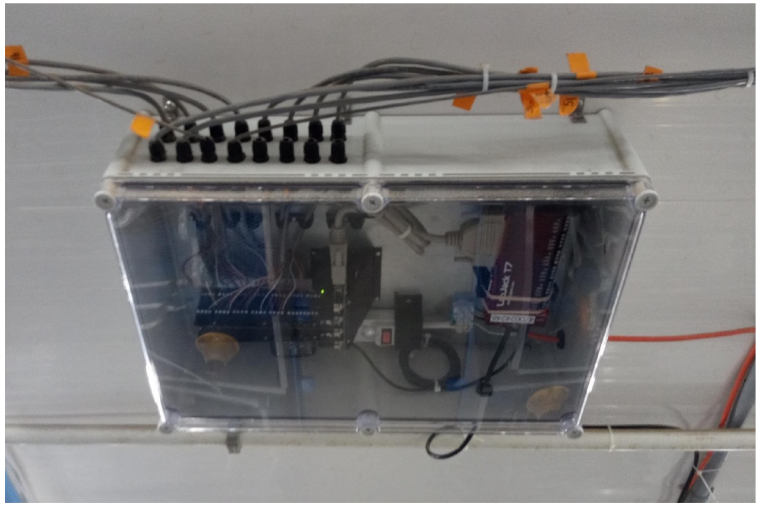


BARN SETUP



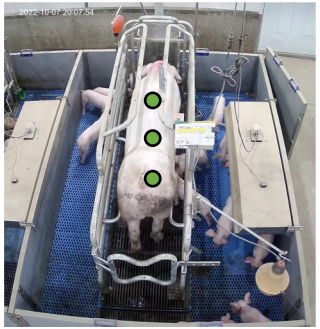
DATA ACQUISITION

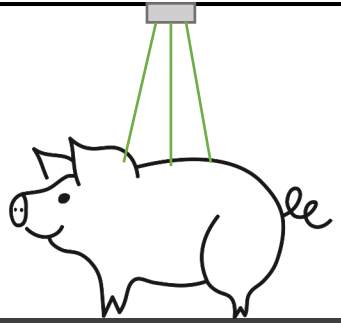
- Analog output
- Labjack T7 analog/numeric converter + MUX80 extension
- Data acquisition code (Python) developed by CDPQ
- 1 reading every 12 seconds, 24/7
- Data collected from entry into the farrowing pen to about 2 weeks post farrowing



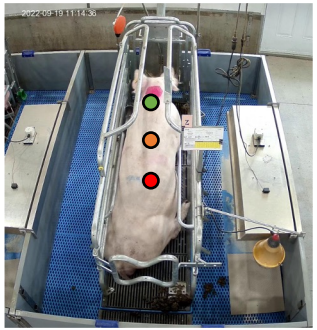
POSTURES

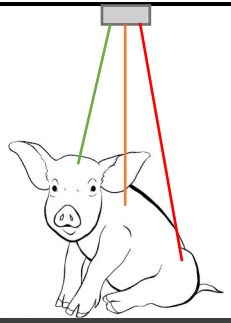
Standing



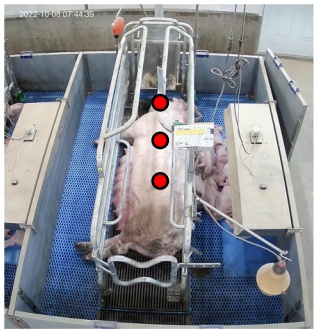


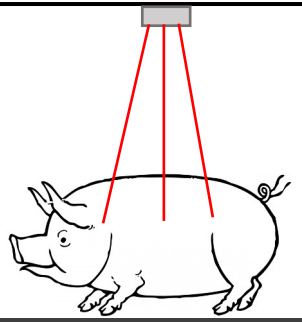
Sitting





Laying down





METHODOLGY

1. Posture database: manual annotations of selected 1-hour video sequences during specific days:
   - 2:00 to 3:00 AM (overnight)
   - 10:30 to 11:30 AM (feeding phase)
   - 4:00 to 5:00 PM (sow awake)

2. Matching manual annotations to sensor data

3. Approach: machine learning (Random forests)
   - Goal: automatically predict sow postures and transitions

MACHINE LEARNING

- Random Forests (Python)
  sklearn.ensemble.RandomForestClassifier

- Training set : all other sensors
  - 550 to 2240 records
- Validation set : sensor data
  - 9,111 to 14,773 records
- Balancing training data:
  - Standing: 30 %
  - Sitting: 30 %
  - Laying down: 40 %

Model

- Nb seconds since the beginning of the day
- Distance between the ceiling and the sow for each subcomponent (x 3)
- Difference between the present value and the subsequent value (Diff_i)

RESULTS - POSTURE DETERMINATION

- Variation between sensors – prediction accuracy

Sensor	Global	Standing	Sitting	Laying down
M409	77.0	58.7	58.9	80.2
M411	74.1	56.7	31.5	76.9
M412	90.6	97.9	67.5	90.3
M413	94.6	68.4	64.9	98.6
M508	77.5	72.0	78.0	78.3
M509	50.3	90.4	51.8	45.5
M510	96.1	78.6	74.4	98.2
M513	89.0	48.9	50.1	96.2
MEAN	81.2	71.4	59.6	83.1

POSTURAL CHANGE

- Tends to overestimate the actual number of postural changes

Sensor	Postural change				
	Actual	Predicted	Exact	% exact	% good prediction
M409	191	2531	90	47.1	52.2
M411	162	2210	78	48.2	44.9
M412	175	991	80	45.7	75.0
M413	90	412	29	32.2	72.4
M508	143	1956	71	49.7	67.6
M509	107	2159	45	42.1	44.4
M510	148	578	63	42.6	71.4
M513	152	923	59	38.8	67.8
MEAN	146	1470	64	43.3	62.0

The Sow Sensor – Pros and Cons

Benefits

- Easy to use
- Data acquisition can be done on any computer
- Requires less manipulation than cameras
- Low maintenance
- Low storage space requested (616 Mo vs 75 To with cameras)
- Low cost (122 euros/sensor vs 164 euros/camera)

Limitations

- Less information than cameras (laying postures)
- Information exclusively on sows; no information on piglets
- Still under development

TAKE HOME MESSAGE

- Preliminary results on only 59 litters tracked
- Sow posture recognition: promising results but large variability in accuracy between sensors and between sows
- Postural changes: limited accuracy so far – more data needed to improve the approach
- Overall, limited information compared to video analysis but maybe enough for management and breeding purposes?
- Next project will involve more litters and a comparison with video analysis

REPORT AVAILABLE

For all questions:
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CDPQ

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Research Project
New selection tools to improve piglet pre-weaning survival

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