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# Assessing lactating sow behaviour using sensor technology and machine learning

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for Swine  
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des Porcs inc.



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du porc du Québec inc.

# BACKGROUND

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- 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

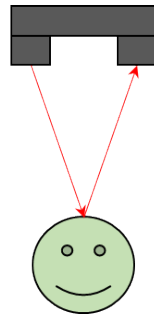
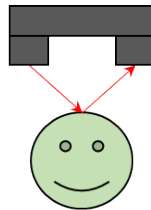
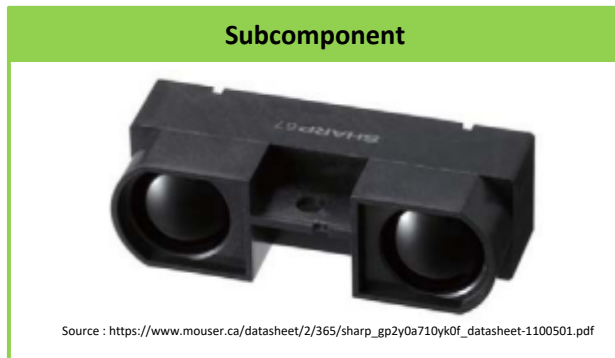
# CDPQ RESEARCH AND TRAINING SOW BARN

- 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



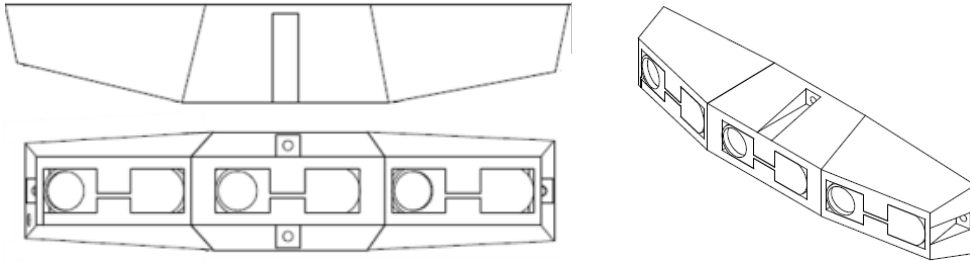
# THE SOW SENSOR

- 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

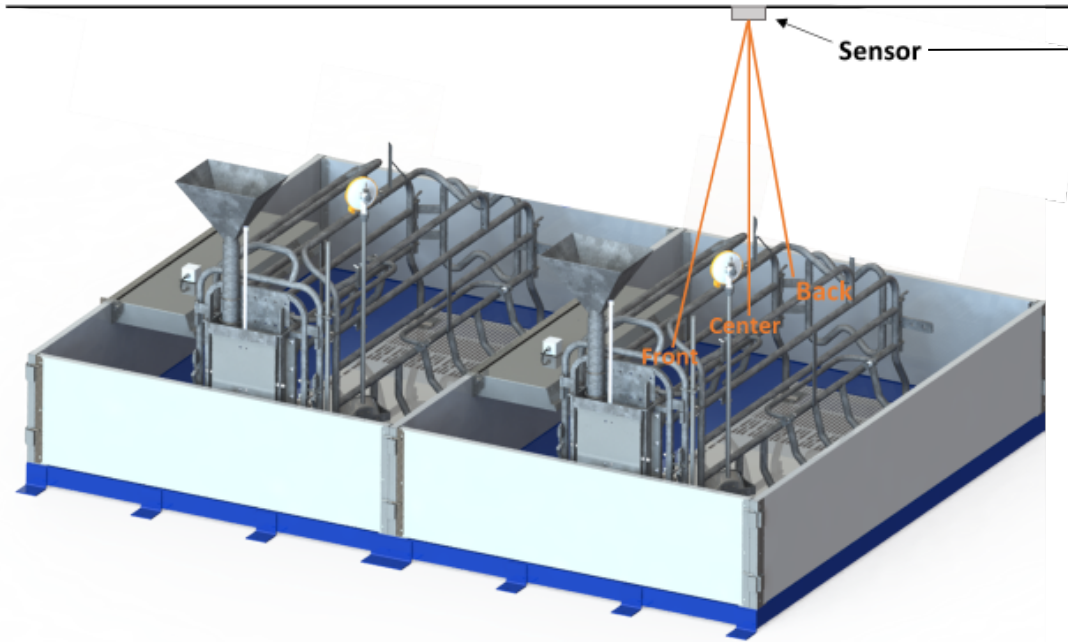


# THE SOW SENSOR (CONT'D)

- 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

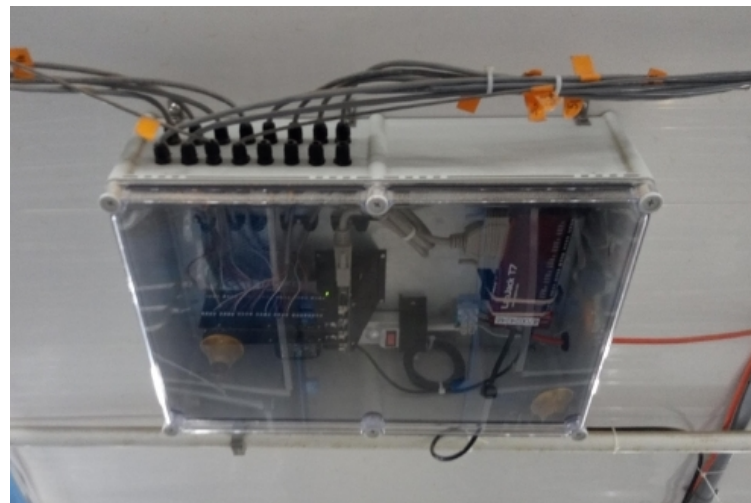




# DATA ACQUISITION

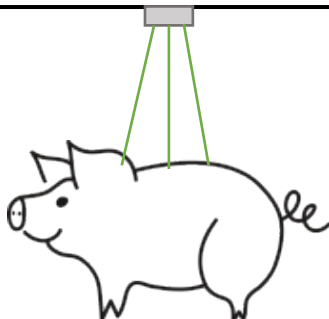
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- Analog output
- Labjack T7 analog/numeric converter + MUX80 extension
- Data acquisition code (Python) developed by CDPQ
- 1 reading every 12 seconds, 24/7
- Data collected from entry into the farrowing pen to about 2 weeks post farrowing

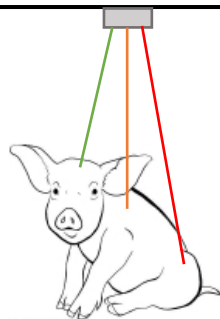
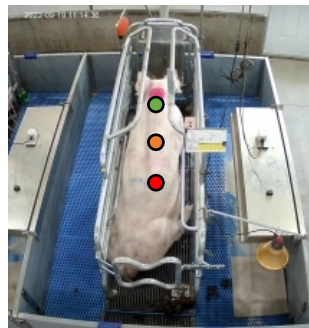


# POSTURES

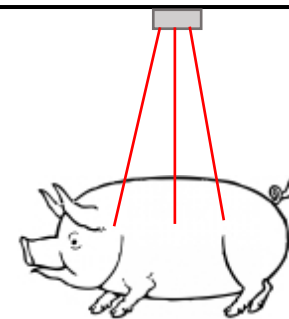
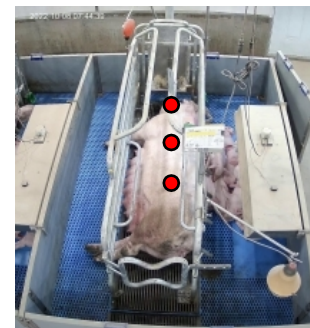
Standing



Sitting



Laying down





# METHODOLOGY

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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

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- 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

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For all questions:  
[gdumas@cdpq.ca](mailto:gdumas@cdpq.ca)  
[laurence@ccsi.ca](mailto:laurence@ccsi.ca)



## Évaluation du comportement de la truie en lactation via les nouvelles technologies et l'apprentissage automatique

### Auteur

Gabrielle Dumas, agr., M. Sc., chargée de projets (CDPQ)

### Collaborateurs

Patrick Gagnon, Ph. D., Responsable - Analyse et valorisation des données (CDPQ)

Laurence Maignel, M. Sc, généticienne (CCAP)

Jean-Gabriel Turgeon, chargé de projets (CDPQ)

## Research Project

### *New selection tools to improve piglet pre-weaning survival*

## Acknowledgements

- **Research team**

- Canadian Centre for Swine Improvement
- Centre de développement du porc du Québec



- **Industry partners**



Ferme  
R.Coutu

- **Financial Support**

- Agri-Science Program



# COSTS

Équipement	Qté	Coût ind.	Total
<b>Capteurs</b>			
Sous-composantes GP2Y0A710K0F (3/capteur)	84	20 \$	1680 \$
Impression 3D de la coque en plastique ABS	28	14,40 \$	403,20 \$
Fil 3 brins (1000')	2	280 \$	560 \$
Silicone	7	13 \$	91 \$
Mini connecteurs pour fils 3 brins (paquet de 200)	1	25 \$	25 \$
<b>Boîtier pour le système d'acquisition des données</b>			
Boîtier en plastique et plaque métallique	1	250 \$	250 \$
Rallonge électrique	1	75 \$	75 \$
Système d'alimentation UPS	1	100 \$	100 \$
Connecteur safetouch pour la rallonge	1	5 \$	5 \$
Barre multiprises	1	20 \$	20 \$
Connecteurs électriques PG (paquet de 100 PG7)	1	25 \$	25 \$
Labjack T7	1	860 \$	860 \$
MUX 80	1	290 \$	290 \$
CB37	4	90 \$	360 \$
Impression 3D des supports pour le boîtier	1	28,80 \$	28,80 \$
<b>Matériel divers</b>			
Tie wraps (paquet de 1000)	1	40 \$	40 \$
Quincaillerie générale	1	100 \$	100 \$
Câble ethernet reliant la MB à l'ordinateur (env 250') <sup>1</sup>	1	100 \$	100 \$
Commutateur réseau	1	50 \$	50 \$
<b>TOTAL</b>			5063 \$
<b>TOTAL/CAPTEUR</b>			180,82 \$

Équipement	Qté	Coût ind.	Total
<b>Enregistreur et caméras</b>			
1 enregistreur 16 ports + 16 caméras (modèle Swann)	1	2600 \$	2600 \$
Extension câble Swann 100' <sup>1</sup>	3	60 \$	180 \$
<b>Boîtier pour l'enregistreur</b>			
Boîtier métallique	1	250 \$	250 \$
Tablette pour enregistreur (dans boîtier métallique)	1	50 \$	50 \$
Système d'alimentation UPS	1	100 \$	100 \$
Rallonge électrique	1	75 \$	75 \$
Connecteur électrique pour rallonge	1	10 \$	10 \$
Contre écrous 2"	2	3 \$	6 \$
Adaptateur 2"	2	10 \$	20 \$
Boîte électrique 8" x 8" x 4"	1	100 \$	100 \$
Connecteurs électriques 1/2	20	9 \$	180 \$
<b>Matériel divers</b>			
Tie wraps (paquet de 1000)	1	40 \$	40 \$
Quincaillerie générale	1	100 \$	100 \$
Câble ethernet reliant la MB à l'ordinateur (env. 250') <sup>1</sup>	1	100 \$	100 \$
Commutateur réseau	1	50 \$	50 \$
<b>TOTAL</b>			3861 \$
<b>TOTAL/CAMÉRA</b>			241,31 \$

# CONFUSION MATRIX – M510 SENSOR

Actual Class	Predicted Class		
	Sitting	Laying down	Standing
Sitting	287	40	59
Laying down	175	13047	65
Standing	111	124	865