Measuring the behaviour of lambs in isolation using artificial intelligence methods

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Objectives and background

Artificial intelligence and
and image processing tools ⟹ Automatic measurement of lamb behaviour
Continuously over long periods
in delayed time or in real time

- Measurements :
Positioning, speed of movement, body and head orientation, etc.

- Context: Enrisheep* project (comparison of lambs reared with and without environmental enrichment)
* coordinated by R. Botreau, A. Favreau-Peigné et N. Aigueperse

- 39 lambs (19 control and 20 enriched)

Analysis of videos recorded during a reactivity test:
- Day 1   : isolation test and new environment
- Days 2 & 3 : habituation
- Day 4   : new object test

enriched environment (ball, plateform, brushes,...)

Post-weaning emotional reactivity test

128 videos automatically analysed by image processing and artificial intelligence

- 4x4m arena,

- Unfamiliar container fixed to the wall and containing 100g of concentrate,

- New object test: traffic cone placed above the container

- Camera overlooking the entire test area (non-zenith position)

- Test duration for each video = 5 minutes

trafic cône

the door through which the lamb enters and leaves

container containing concentrates
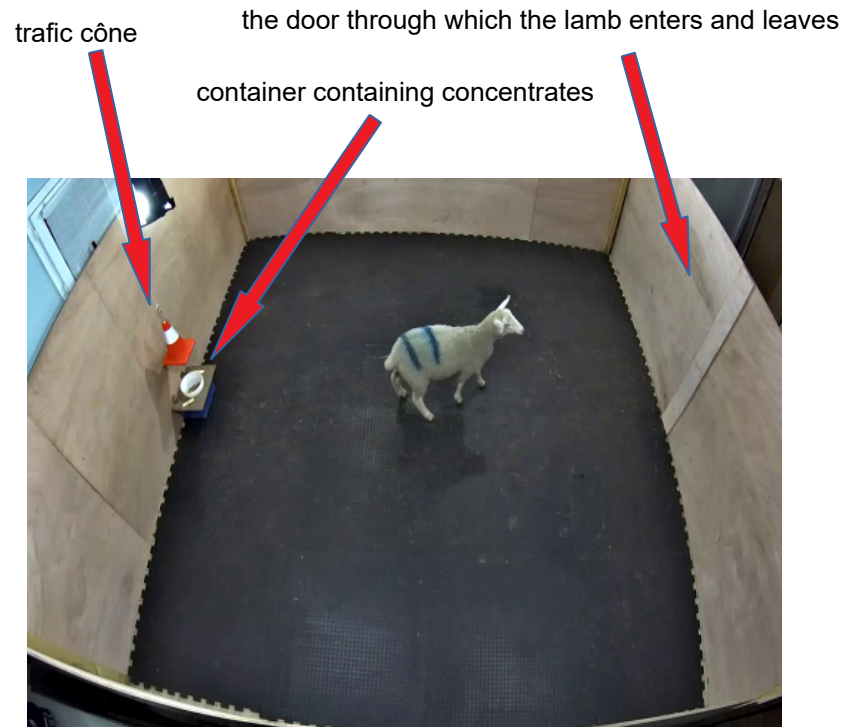
The pen for studying the lamb behaviour

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Measurements obtained for each lamb

Objectives: to analyse the time spent by the lamb in each area of the test pen and in areas of interest, using image processing and artificial intelligence applied to the videos.

Measurements over time:
→ Location of the lamb in the pen
(in each area of the pen) (body and head)

→ Identification of areas of interest for the lamb

→ Movement speed

→ Body orientation

16 areas in the pen

Step 1: Identifying the lamb in the image

Detecting the lamb in the image (tracking)

Two operations:

- **Image processing** (colour segmentation, morphology operations, labelling)

Original image

Animals and noises

- **Artificial intelligence**: two neural networks (NN) used (OpenCV DNN and YOLO network) trained with a GoogleNet image database (1000 animal species (mammals, farm animals, fish, etc.)).
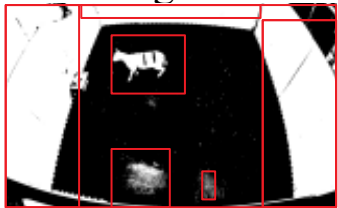
N rectangular thumbnails

If both RNs give a positive result for a thumbnail, then that thumbnail contains an animal.
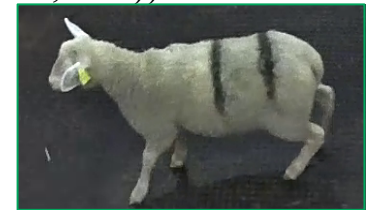
Identification of the area of the image containing the lamb

Lamb detection (Image processing + AI): **Sensitivity = 95 %**   **(5000 images tested)**   **S= (TP/TP+FN)**
Taking into account different lamb orientations, profiles and postures

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# Step 2: Identifying the lamb's head in the image

Detection of the lamb's head in the area of the image containing the lamb

Artificial intelligence: neural network (Inception model) created with a customised image database

Images of lamb's head (4000 images)

Images of other parts of the body (legs, back...) (4000 images)

Identification of the area of the image containing the lamb's head

AI

Head detection (AI): **Sensitivity = 85% (5000 images tested)   S= (TP/TP+FN)**
Taking into account the different orientations, profiles and postures of the lambs

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Step 3: Identification of the centres of gravity of the lamb's body and head

Determination for each image of the video the position of the centres of gravity of the lamb's body and head

Head centre

Head zone detected

Body centre
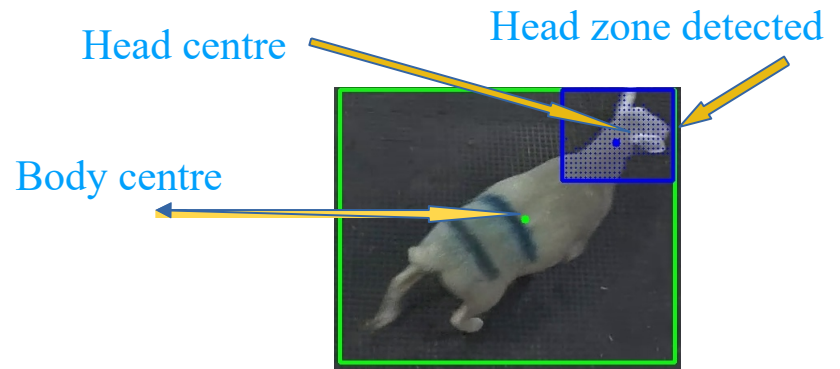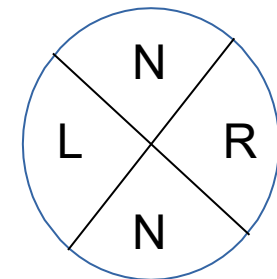
This positional information can be used to make a number of measurements:
-Measurement of the location of the lamb and its head in the pen
-Measurement of the lamb's speed of movement: V= distance (t1→t2) / (t2-t1)
-Measurement of the orientation of the lamb's body in relation to the arena (Left / Right / Neutral)
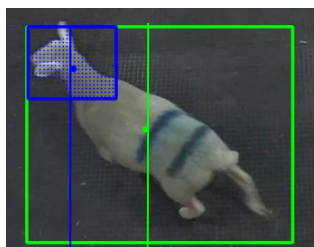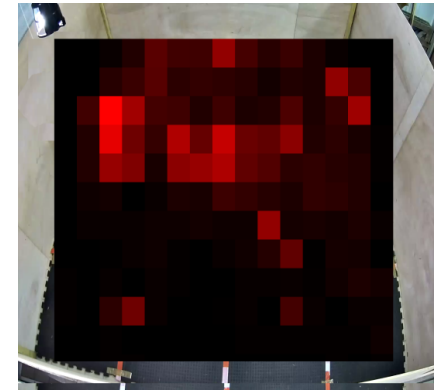
D > threshold → Left orientation
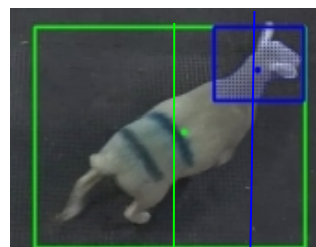
D > threshold → Right orientation

Otherwise Neutral orientation

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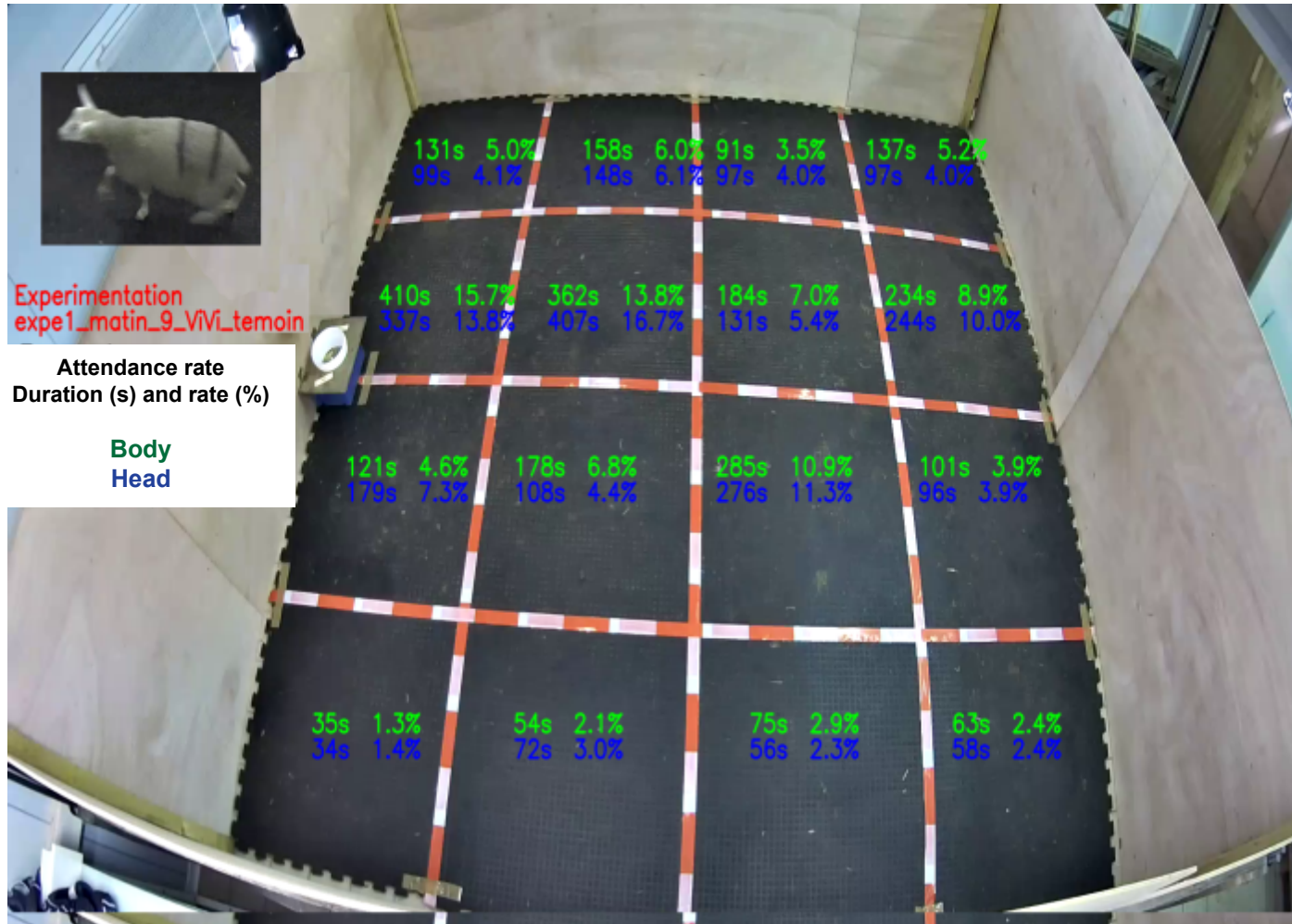# Step 3: Identification of the gravity centre of the lamb's body and head
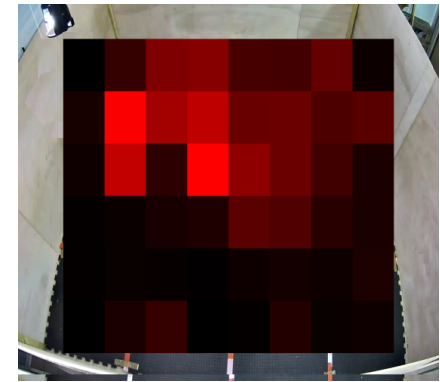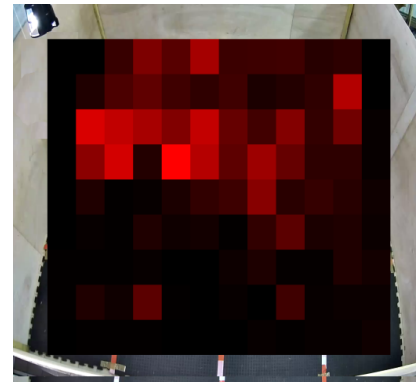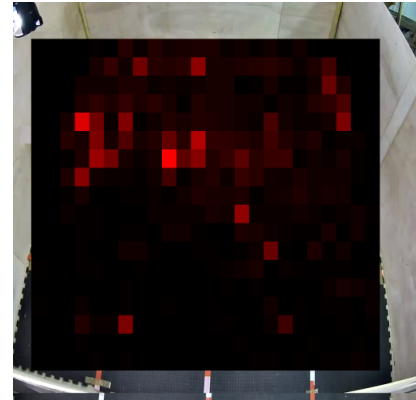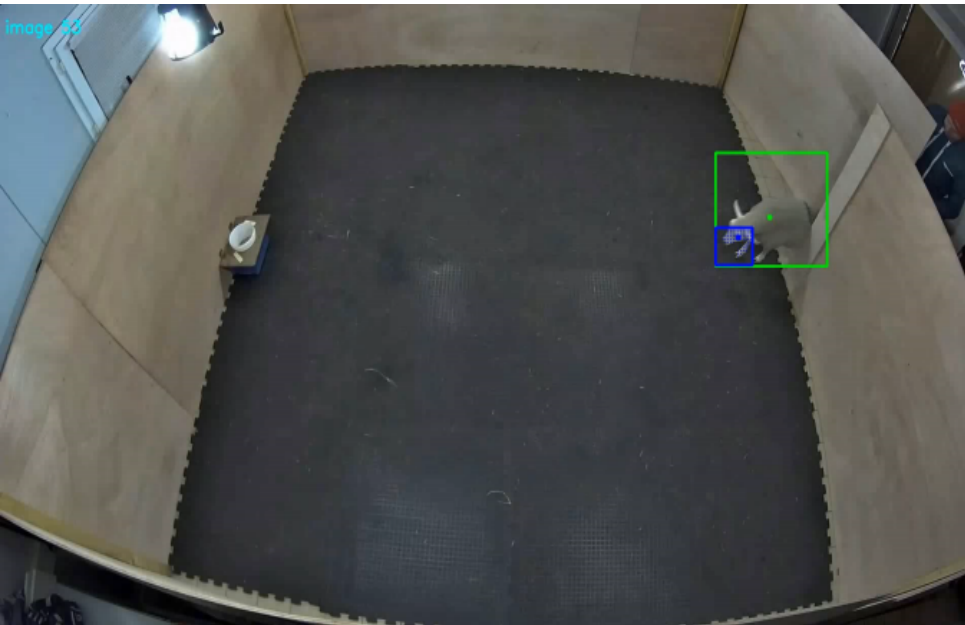
Presence mapping
Meshes (in pixels) more or less fine
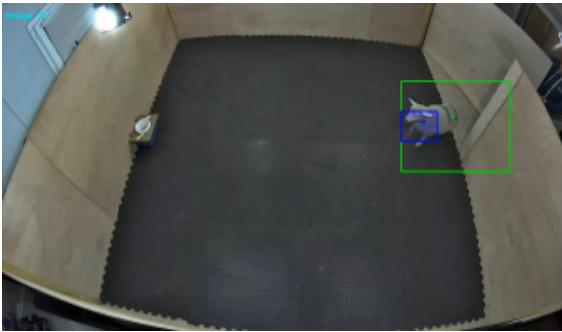50, 80, 100 and 150 pixels

Results: Time spent by the lamb (body and head) in each area

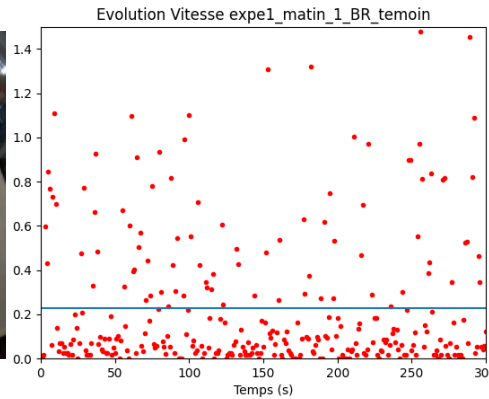Positioning in the 16 area during the 5-minute test

Results: Analysis of lamb movement speed

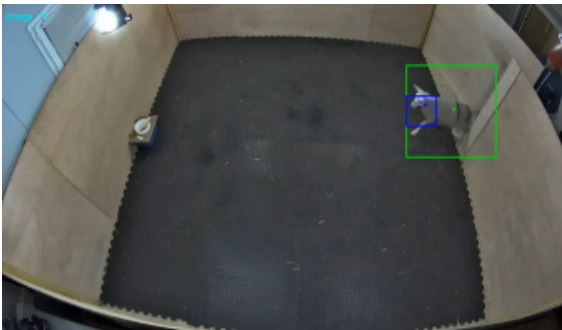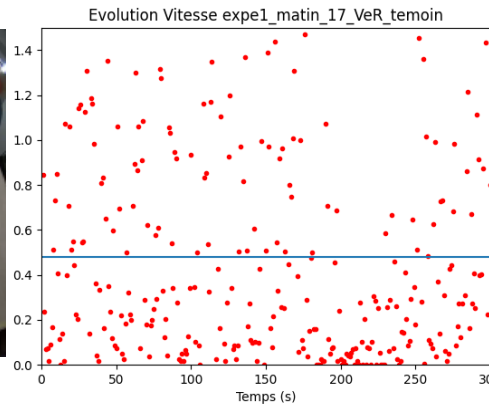## Comparison of the movement speeds of two lambs

Evolution Vitesse expe1_matin_1_BR_temoin

Average speed = 0.24 m/s
Average speed (without stops) = 0.26 m/s
Stopping time = 61 s

← 0,24 m/s

Lamb with little mobility

Evolution Vitesse expe1_matin_17_VeR_temoin

Average speed = 0.48 m/s
Average speed (without stops) = 0.51 m/s
Stopping time = 37 s

← 0,48 m/s

Very mobile lamb

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Results: Analysis of lamb orientation

Analysis of areas of interest

left side orientation   right side orientation
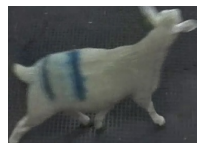
Over the whole surface: 21.9% of the time 14.9% of the time 63.2% of the time (neutral orientation)
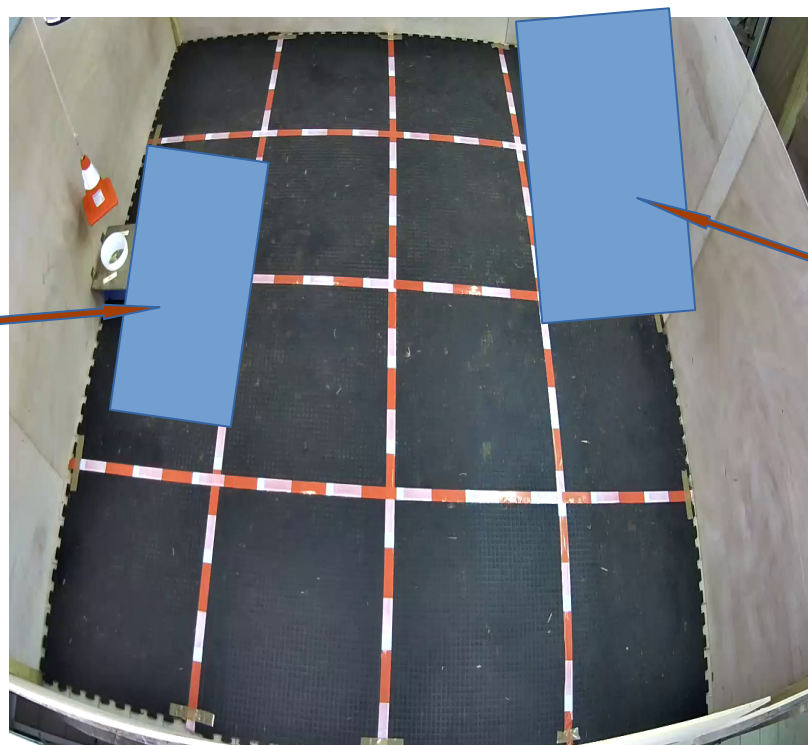

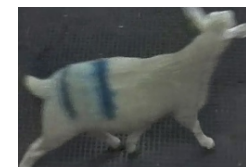Oriented towards the food zone

12.7% of the time

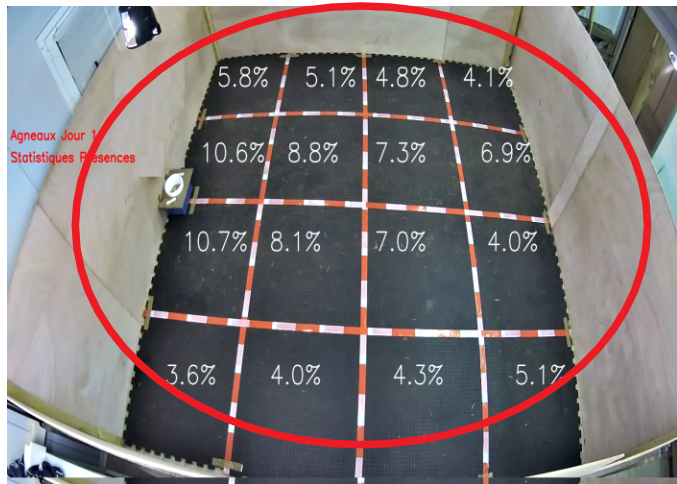1.4% of the time

4.2% of the time
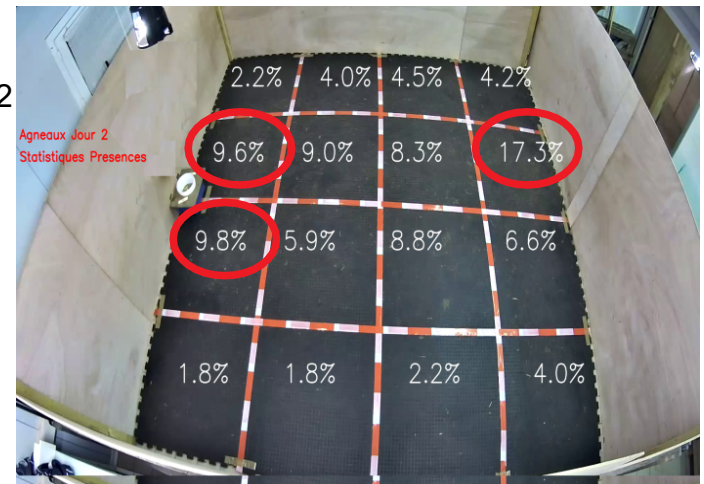
Towards the door

5.7% of the time

Results: Comparison over the 4 days of testing
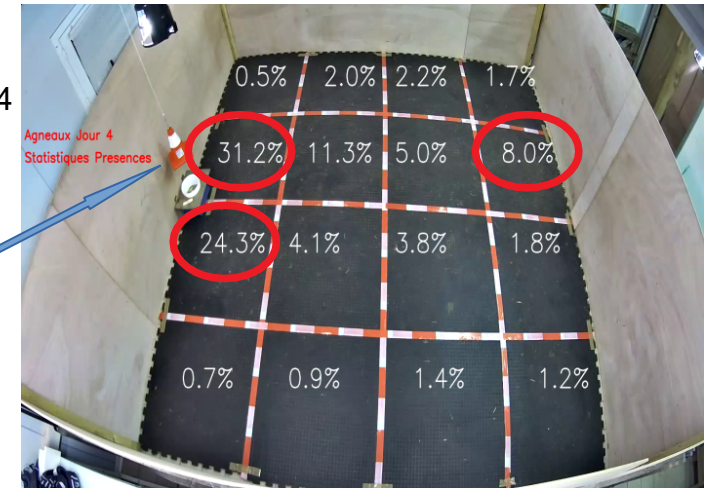
Positioning the lambs over the 4 days

Day 1

Day 2

Day 3

Day 4

New object (day 4)

Results: Comparison over the 4 days of testing

Orientations in areas of interest and speeds

Over the entire surface

|			
Day 1:	18.9% of the time	16.3% of the time	Average speed= 0.39 m/s
Day 2:	13.0% of the time	22.3% of the time	Average speed= 0.45 m/s
Day 3:	13.4% of the time	22.7% of the time	Average speed= 0.36 m/s
Day 4:	**24.8% of the time**	15.7% of the time	Average speed= 0.37 m/s

New object (day 4)

Day 1: 9.5% of the time
Day 2: 6.3% of the time
Day 3: 11.6% of the time
Day 4: 40.5% of the time

Day 1: 3.8% of the time
Day 2: 6.7% of the time
Day 3: 8.0% of the time
Day 4: 7.5% of the time
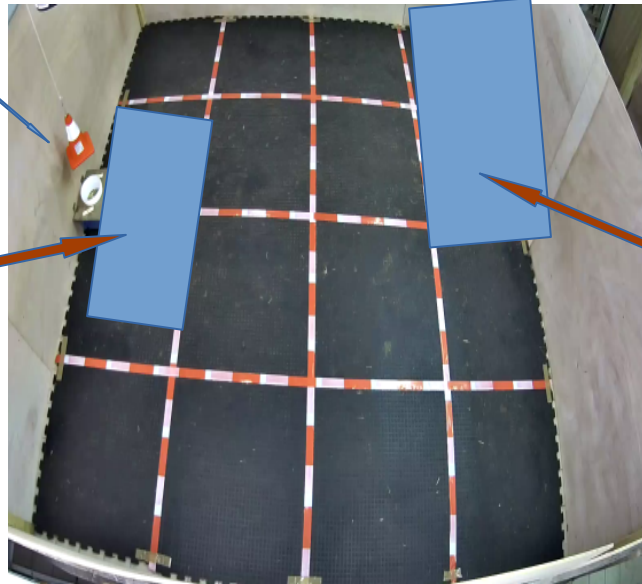
Day 1: 3.4% of the time
Day 2: 4.6% of the time
Day 3: 3.6% of the time
Day 4: 2.5% of the time

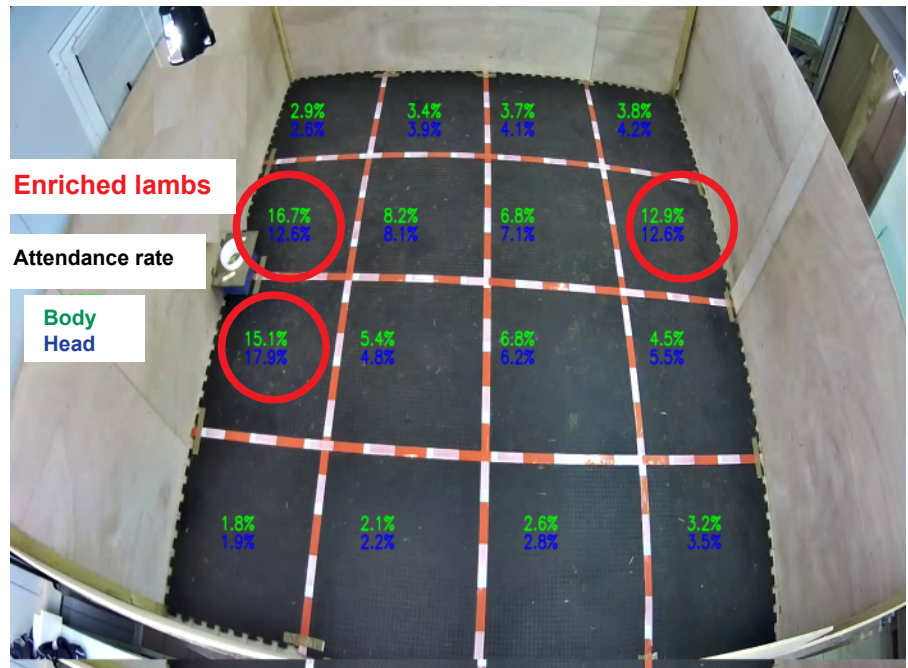Day 1: 4.8% of the time
Day 2: 13.9% of the time
Day 3: 14.3% of the time
Day 4: 10.6% of the time

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Results: Comparison of control and enriched lambs

Statistics on lamb positioning in the 16 areas
(averages for control and enriched lambs)
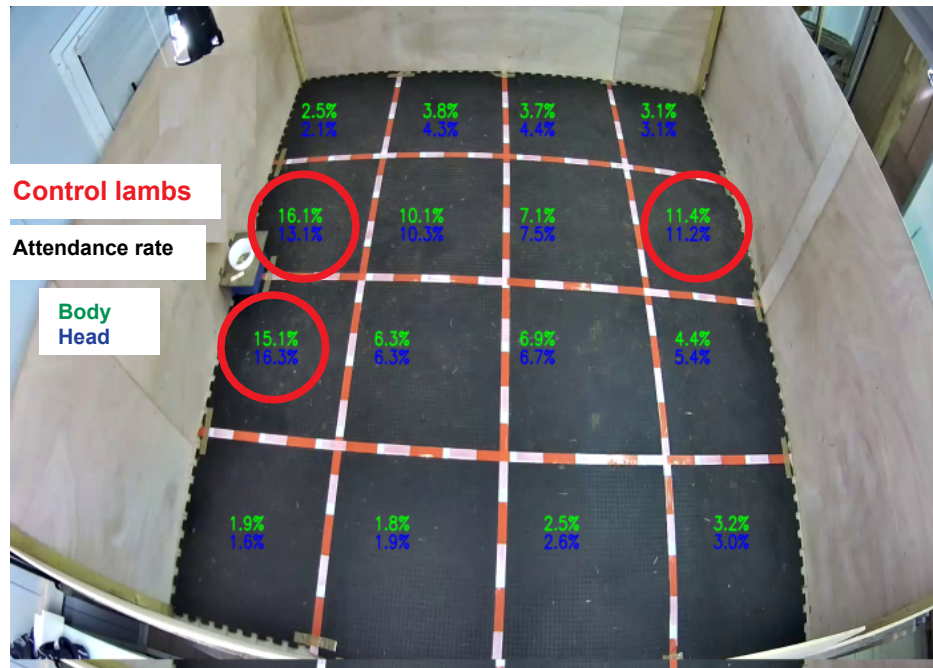
Control lambs

Enriched lambs

Conclusions & outlook

Image processing and artificial intelligence software has been developed to measure the behaviour of lambs (positioning, orientation, speed).

Advantages:
→ Work over long periods, on numerous videos.
→ Automation of measurements
→ Saves time compared with manual video analysis
→ Possibility of taking measurements on many animals
→ Possibility of detailed measurements: shorter time step, finer geolocation, detailed analysis of animal movement, etc.

Prospects :

- Application of the measurement software to other videos (ewes, lambs, goats, etc.) for different animal behaviour study applications, to study animal movements in different situations, in different environments (individual animals or groups), in indoor or outdoor farms.

- Automated identification of individuals (colour marking) to identify all the animals in a group and take measurements on each animal.

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THANK YOU FOR YOUR ATTENTION

Enrichments