THE PLACE OF USEFUL LEARNING

University of Strathclyde Glasgow

Cattle video analytics: Data tsunami and the pathway to ambient sensing

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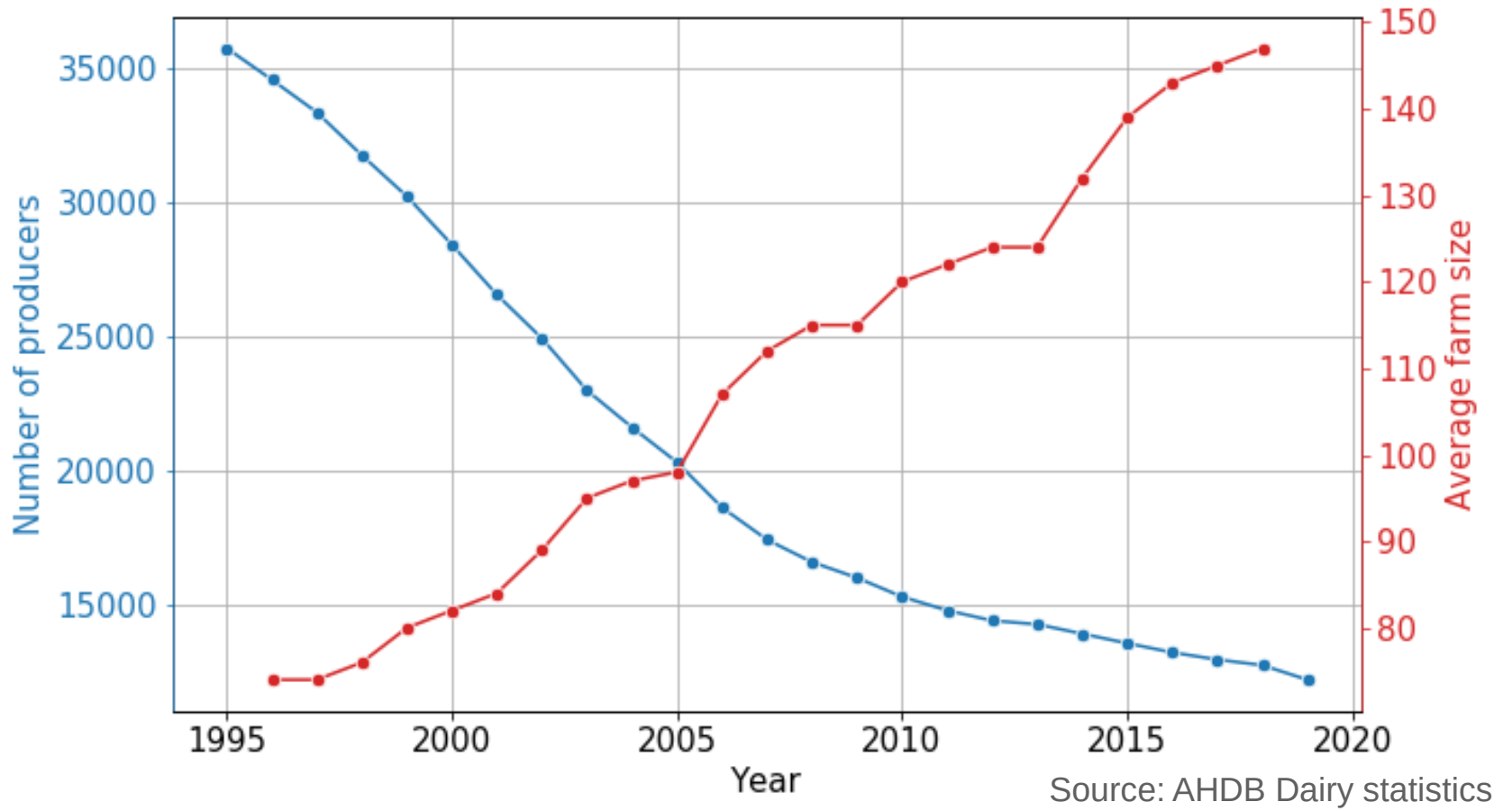
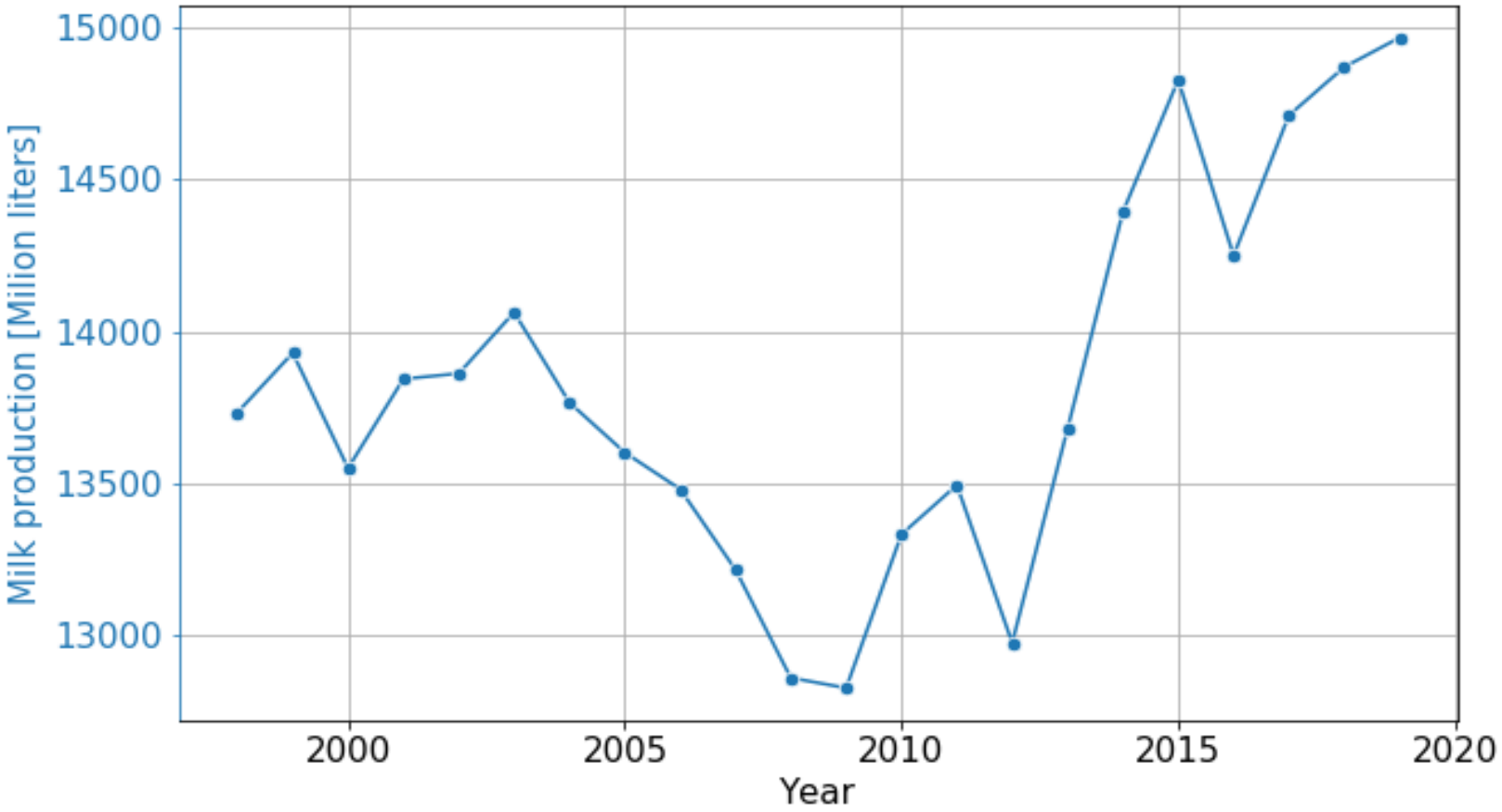
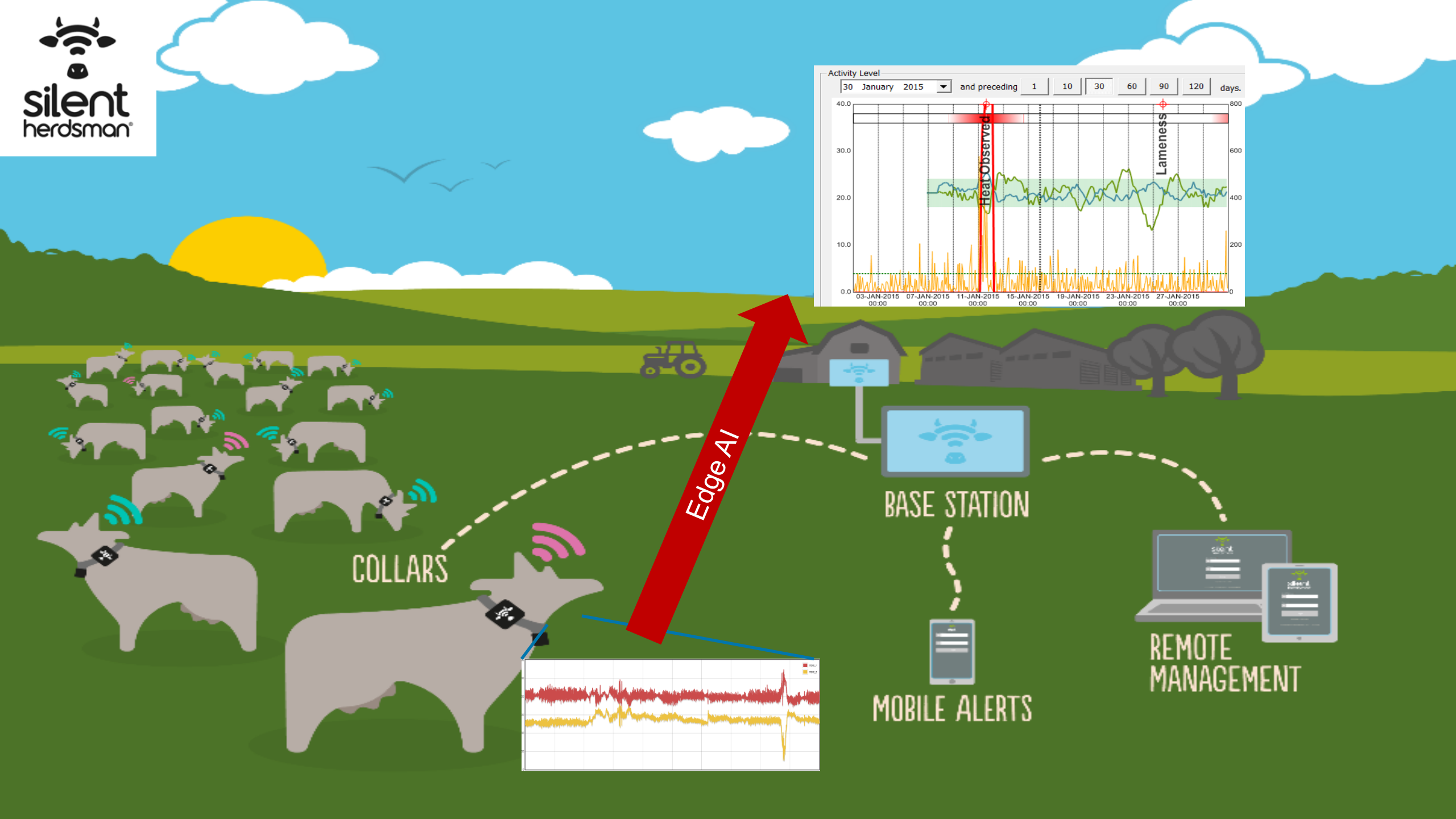
Number of Producer ↘
Average Herd Size ↗



Source: AHDB Dairy statistics

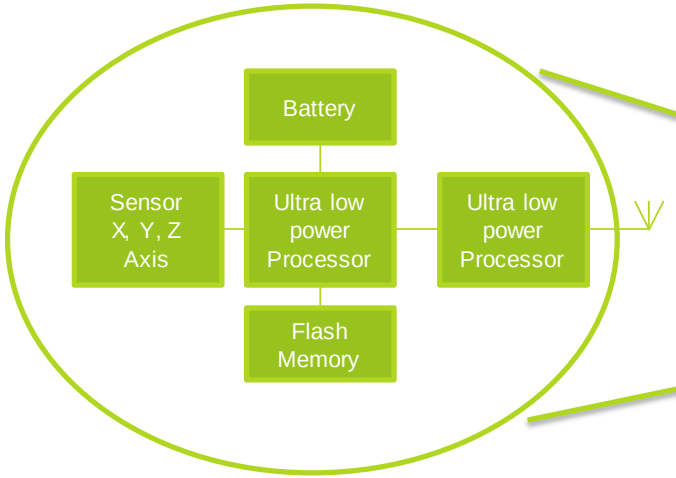
Milk Production ↗

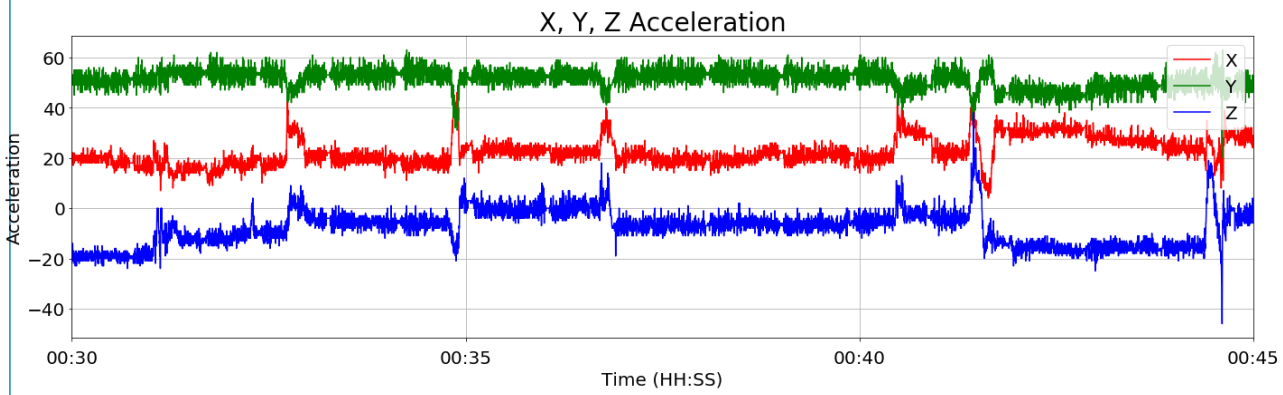



silent herdsman
Activity Level
30 January 2015
and preceding
1
10
30
60
90
120
days.
Heat Observed
Lameness
03-JAN-2015 00:00
07-JAN-2015 00:00
11-JAN-2015 00:00
15-JAN-2015 00:00
19-JAN-2015 00:00
23-JAN-2015 00:00
27-JAN-2015 00:00
Edge AI
COLLARS
BASE STATION
MOBILE ALERTS
REMOTE MANAGEMENT

Collar

- Heat Detection
- Activity Detection
  - Rumination
  - Eating
  - Other





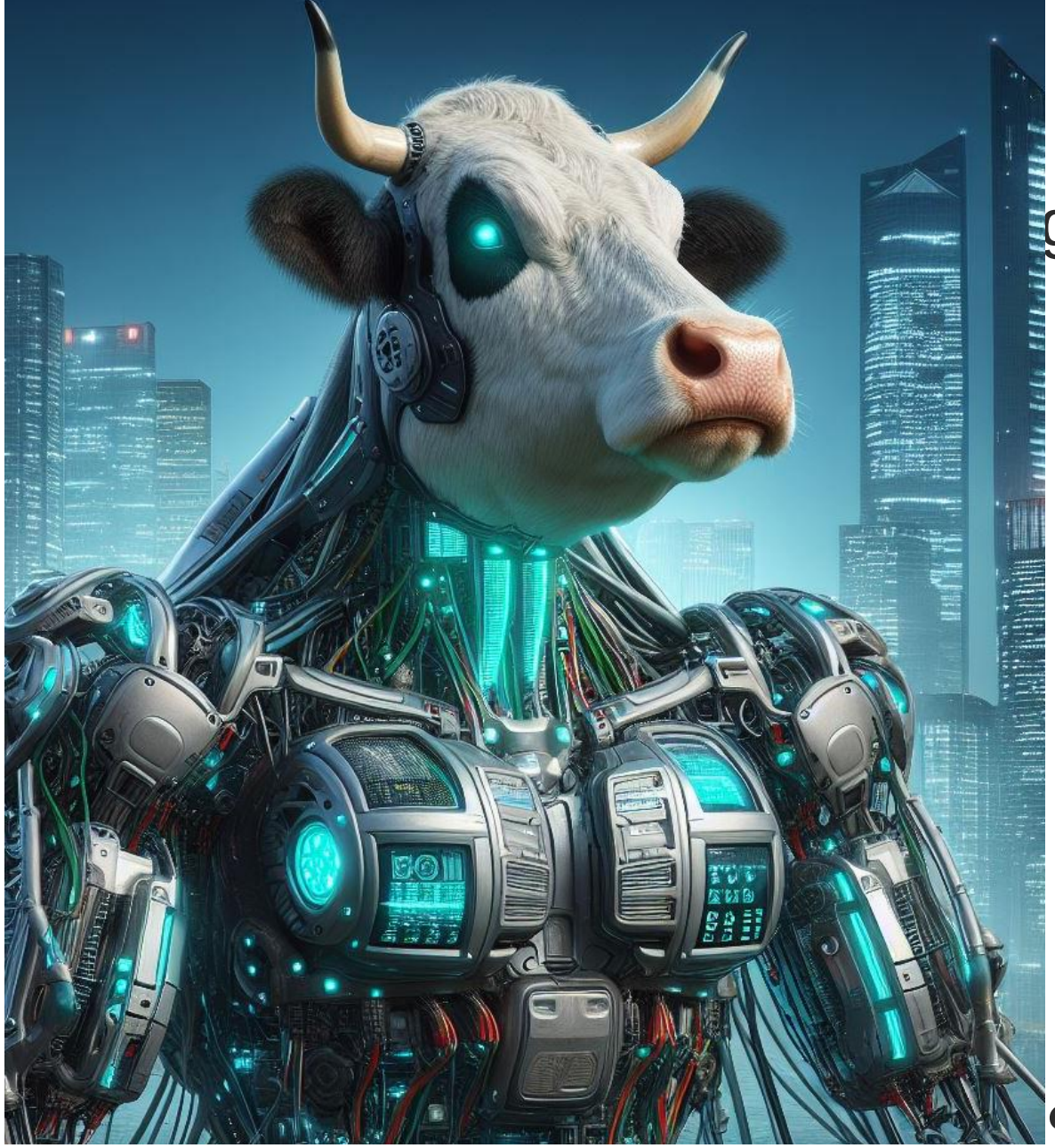
12.5 Hz Sampling

12-bit

Data Rate: 12.5x12x3 axis = 450 bps

Constraints

- Battery lifetime is critical for adoption (7+ years for the lifetime of the animal)
- Radio has the most significant energy consumption
- Compute needs to fit memory and processing constrained hardware
- Edge processing to extract signal features every 90s



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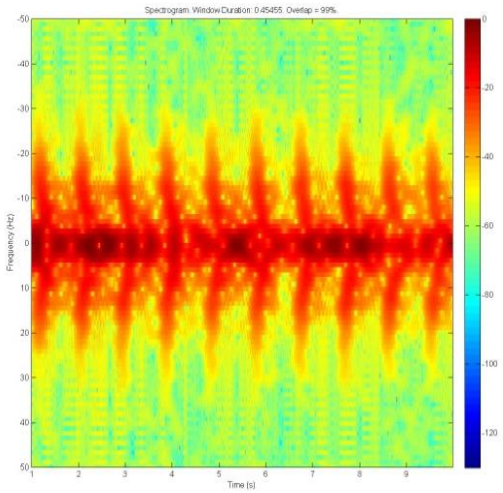
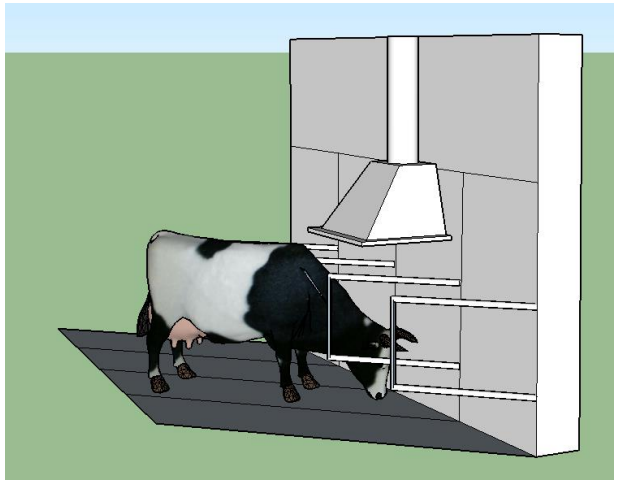
ROBOCOW

Remote Ambient Sensing

Eliminate wearable sensor

- Cameras
- Microphones
- Radar
- Gas Sensors





DIGITALDAIRYCHAIN

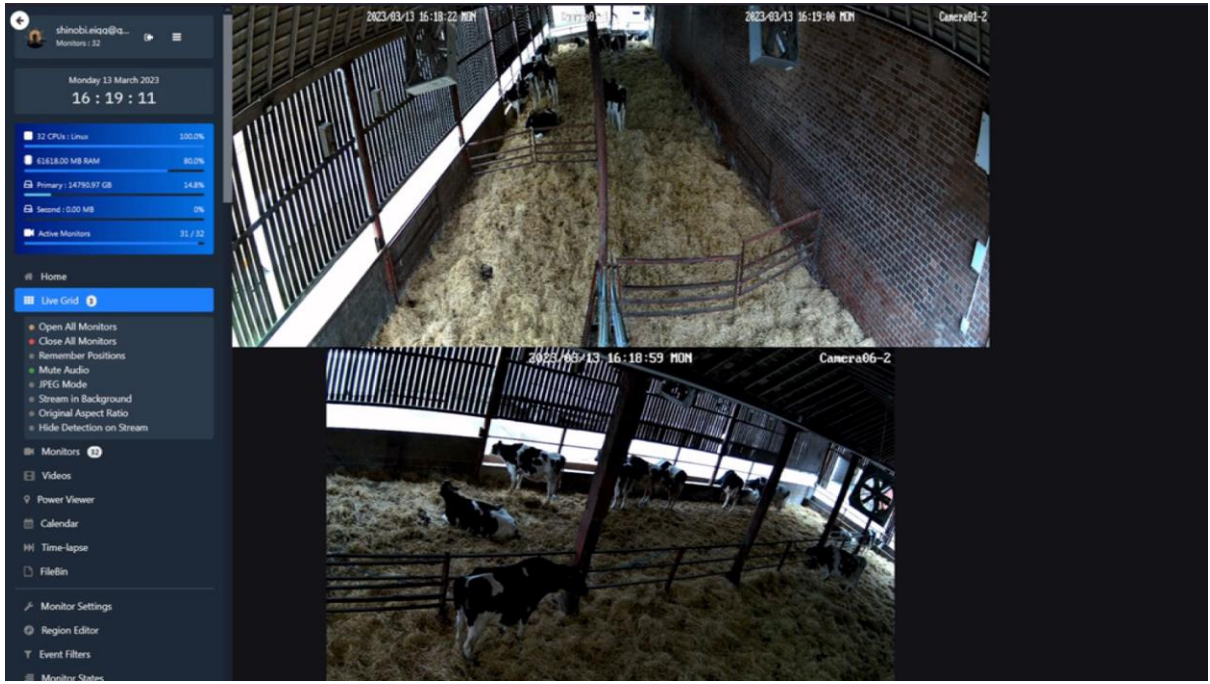
Cameras and Machine Vision

Replicate, and extend, existing sensors to democratise digitalisation:

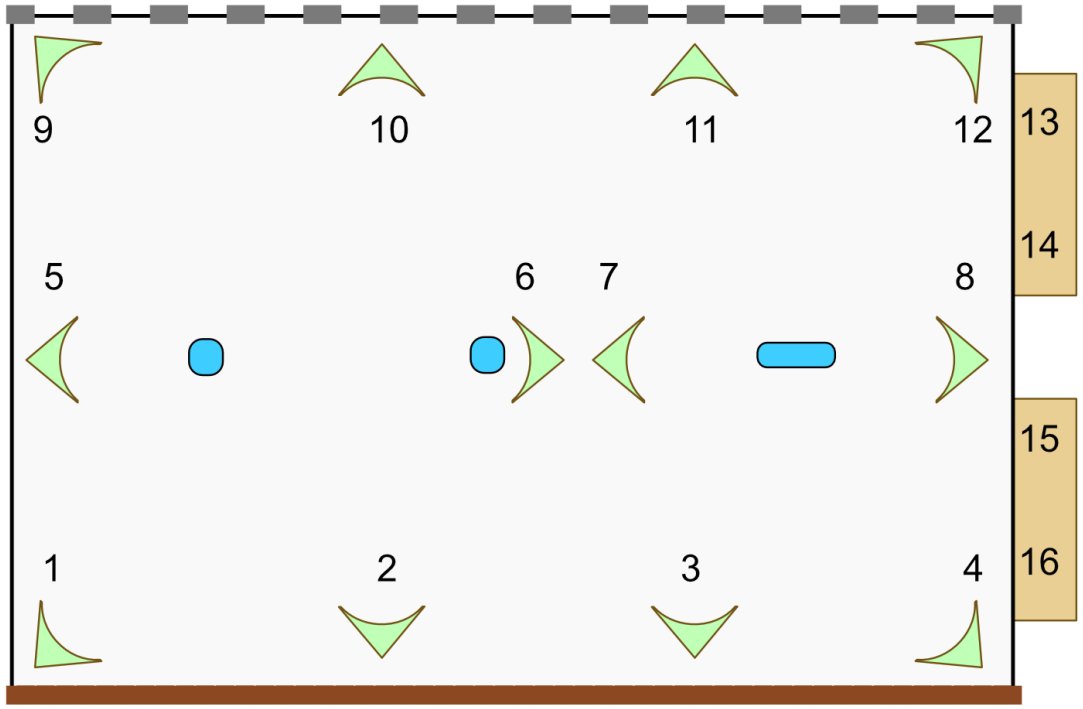
- Detect Heat
- Behaviour Detection (eating, rumination, walking, lying, etc.)
- Animal Welfare (lameness, Body Condition Scoring)
- Feed/Water Intake
- Calving monitoring
- Heat Stress
- Social Interaction

Cow Tracking & Behaviour Recognition

- 24/7 recording
- 16 Dual-cameras (H: 180°)



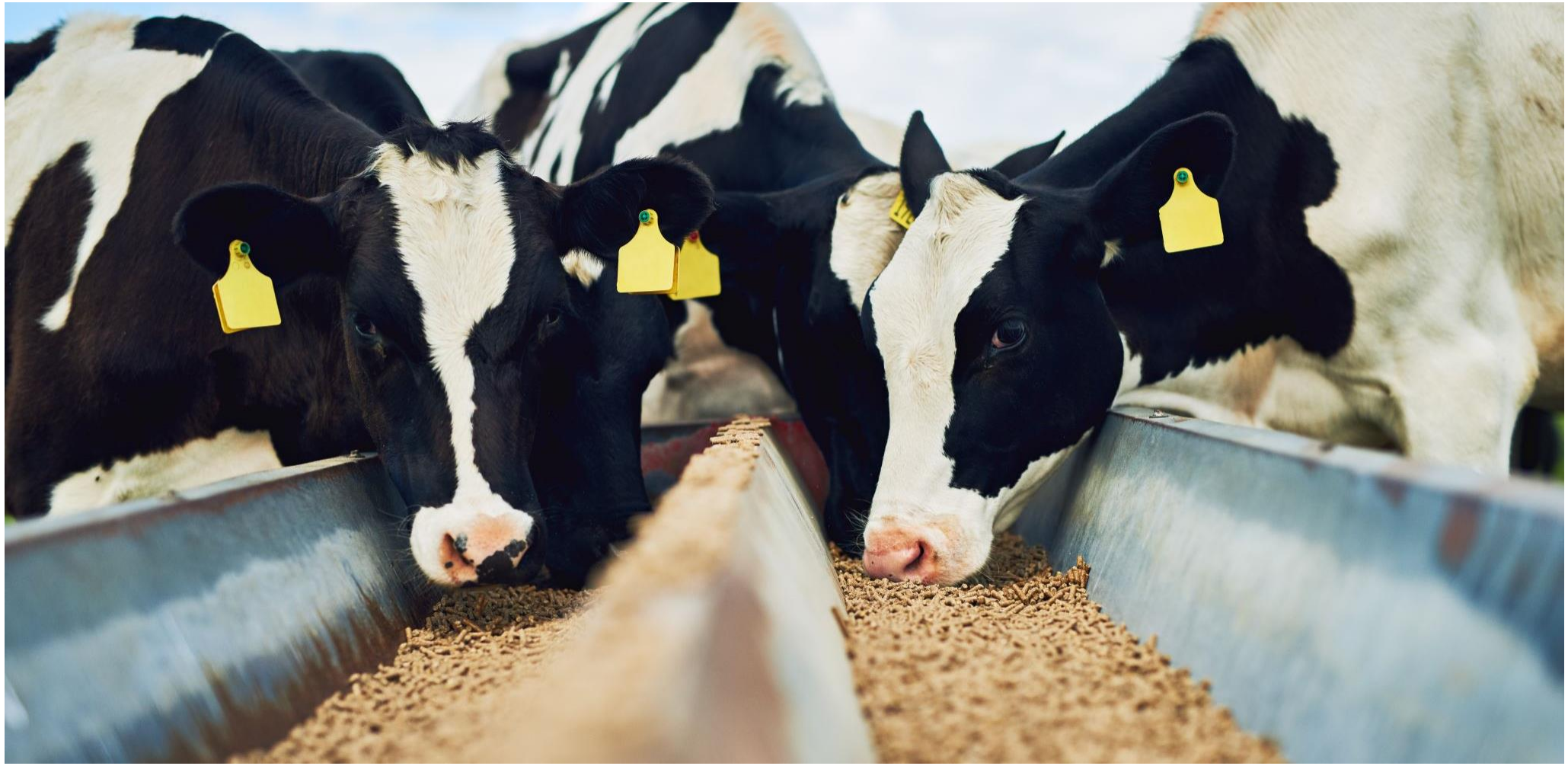
Calving Shed Crichton Royal Farm



Comparing Data Volumes

	3 axis - 12 Hz accelerometers	Aggregation @ 90s	2 video streams of 4K Video (2560x1440)
Hourly	202KB	80B	4.8GB
Daily	4.8MB	1.9KB	115.2GB
Monthly	145MB	57KB	3,456GB
			For 16 cameras: 55,296GB

Herd Level Information



Automatic Standing/Lying Classification

Standing – Detecting cows using feed trough

Lying – Cows like to spread out and rest

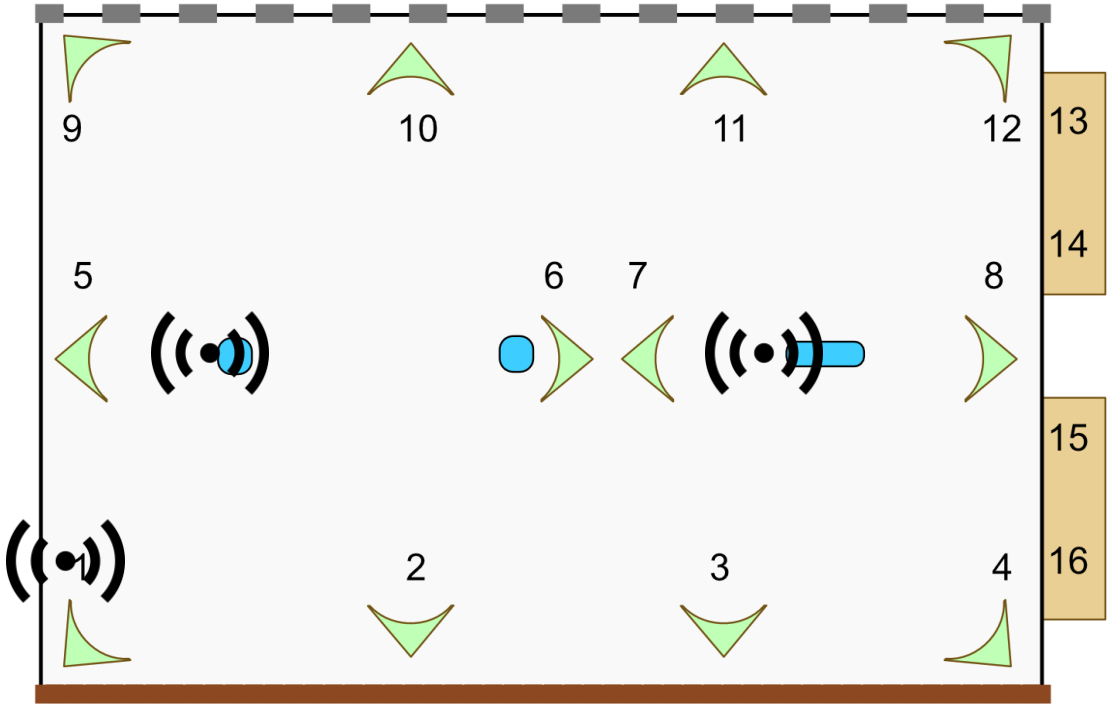
Lying - 1 hours

Identifying Individual Animals

- Phenotyping approaches (typically Holstein)
- Monitor in constraint environments (sorting gate or race) and for short period of time

Proposed Approach

- Scan RFID at the gate/water trough/robotic milker
- Long-term tracking (harder than it sounds)



Challenging Tracking in High Occlusion Environments

YOLOv8 Obj. Detection + BoT-SORT Tracking

- Animals and environment causes **occlusion**
- **Unpredictable** animal movement
- **Re-identification**
- 2D makes segmentation and motion tracking challenging

Retrieve Depth Information

- Object-background segmentation
- Tracking during occlusion

Monocular Depth Estimation

“Estimate depth from single image from one camera”

Depth Retrieval

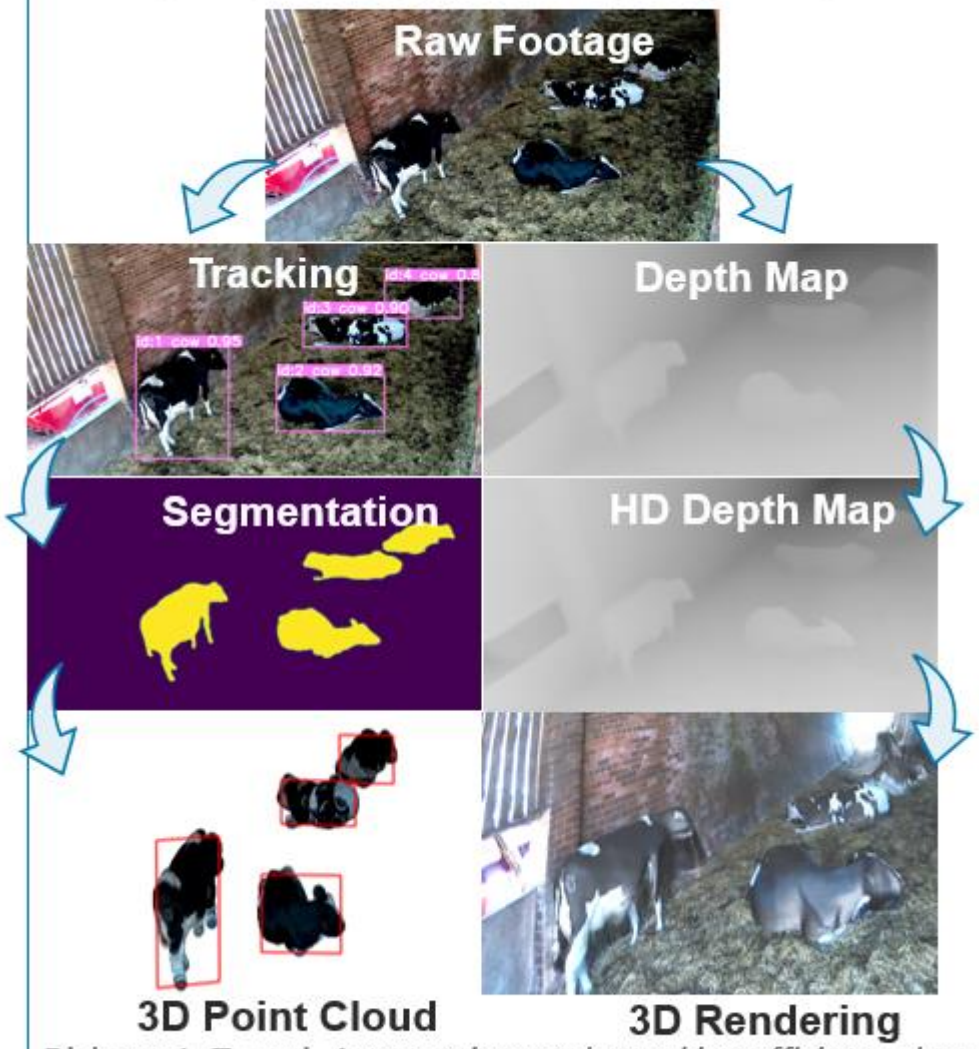
- Works well when applied frame-wise to video sample
- Inter-frame depth smoothing not required

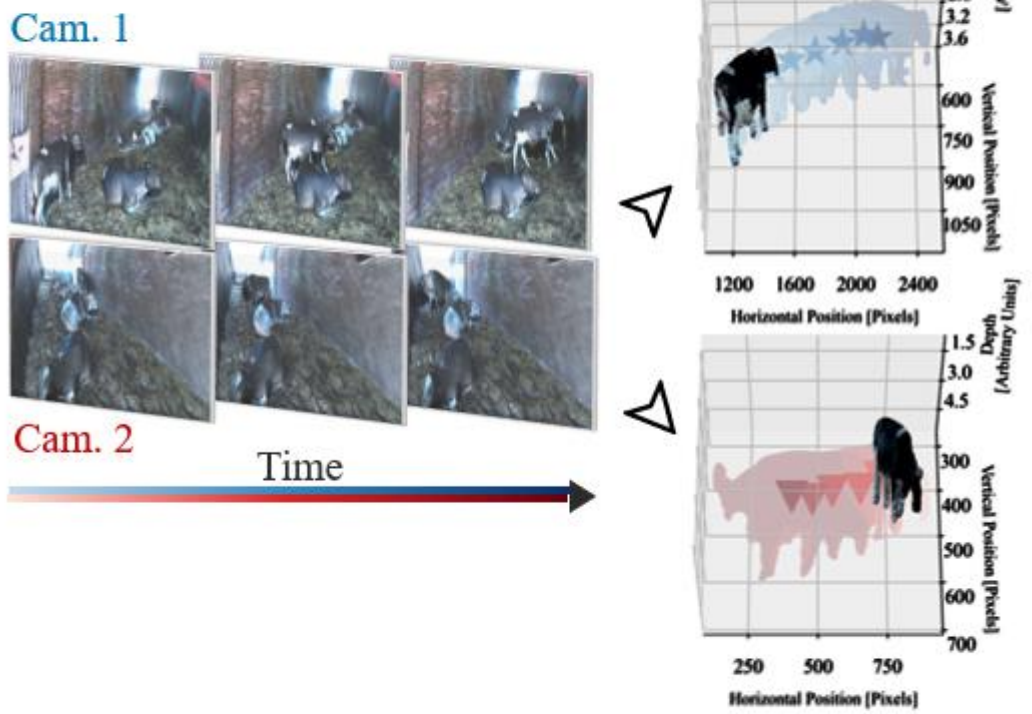
Extract depth cues from:

- Texture gradients
- Object sizes
- Shading
- Perspective

Depth Anything

Multi-Camera 3D Video





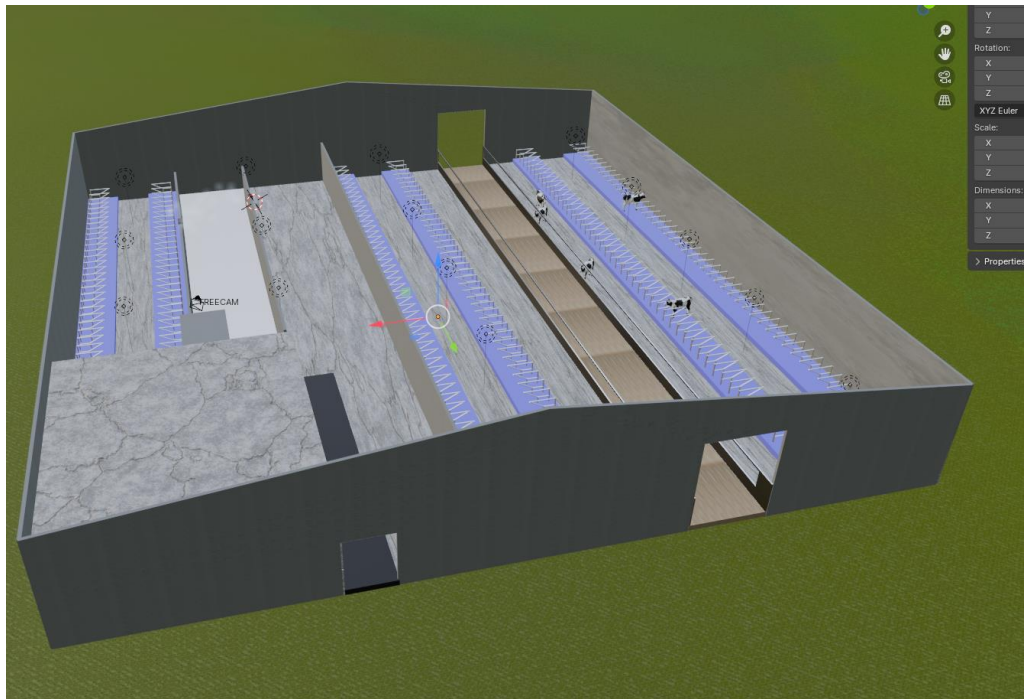
Dickson, L. T. et al, *Augmenting cattle tracking efficiency through monocular depth estimation*, IEEE Conference on AgriFood Electronics , Xanthi, Greece, Sept. 2024.

Multi-Camera 3D Video

Novel-angle view rendered using RGB + depth map in Blender for 2 cams

Next Steps

- Deploy in environment with stalls
- Data rate reduction with edge processing



Next Steps

- Deploy in environment with stalls
- Data rate reduction with edge processing

Summary

- Device fragmentation (often measuring the same/similar thing)
- Remote ambient sensing could consolidate devices and provide more insight to stakeholders

SRUC Dumfries, Primary School Child's collage