SPECTRO AI

Cow Detection

Performance & Operating Guide

PREPARED BY	Spectro-AI	SUBJECT	Cow detection algorithm
RUNS ON	DJI Matrice 4 Series (on-board)	MORE INFO	spectroai.ai
ALGORITHM	CowDetect-SAI-V2	DOCUMENT	v1.0 · Public
DATE	07 June 2026	MORE INFO	spectroai.ai

Contents

1 About this guide 3

2 Supported aircraft 3

3 What the algorithm recognises 3

Apparent size is the lever that matters 4

4 Detection performance 5

What these numbers mean 5

5 Operating recommendations 5

Light and visibility 5

Flight height, gimbal angle and zoom 6

Choosing a flight height 6

Matching zoom to flight height 7

Ground, cover and the animals themselves 7

Lens cleanliness 7

6 Limitations 7

7 Deployment 8

OPERATIONAL SAFETY The algorithm is an operator-assistance tool and does not replace the pilot's responsibility to maintain safe flight or comply with applicable aviation regulations. All detections should be verified before operational decisions are made.

INTENDED USE This algorithm is designed to assist operators in locating cattle during aerial surveys of pasture. It can highlight areas requiring further investigation, but should not be used as a replacement for manual verification, stock reconciliation or any assessment of an individual animal.

1 About this guide

This guide explains how the Spectro-AI cow detection algorithm performs when running on-board DJI Matrice 4 Series aircraft, and how to fly and configure the payload to obtain the most reliable results.

The algorithm runs directly on the aircraft and reports detections in real time during the flight through the DJI Pilot 2 application. It detects a single class, Cow, from the visible-light (RGB) camera. It is intended for livestock work: locating and counting cattle across pasture from the air, in a fraction of the time a ground check would take.

Performance figures presented in this guide were established under validated operating conditions and should be used as operational guidance rather than guaranteed performance. Detection accuracy varies with light, weather, ground cover, flight height, the apparent size of the animals in the image and image stability.

2 Supported aircraft

This is a visible-light algorithm. It uses the RGB camera, not the thermal payload, and therefore runs on every aircraft in the Matrice 4 Series.

Table 2.1 *Aircraft compatibility*

Aircraft	Status	Reason
DJI Matrice 4T	**Supported**	RGB camera fitted
DJI Matrice 4TD	**Supported**	RGB camera fitted (dock variant)
DJI Matrice 4E	**Supported**	RGB camera fitted
DJI Matrice 4D	**Supported**	RGB camera fitted (dock variant)

NO THERMAL PAYLOAD NEEDED Unlike the Spectro-AI thermal algorithms, this one places no constraint on the payload and none on the thermal palette. Any Matrice 4 Series aircraft will run it. On the thermal variants, the algorithm still works from the visible camera and does not read the thermal feed.

3 What the algorithm recognises

The algorithm detects a single class, Cow, and displays each detection as a bounding box with an associated confidence score on the live image in DJI Pilot 2. Every animal in the image is boxed separately, which is what makes counting a herd from the air practical.

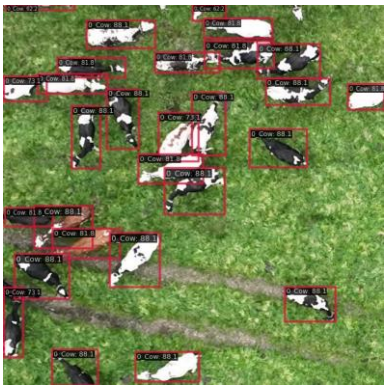
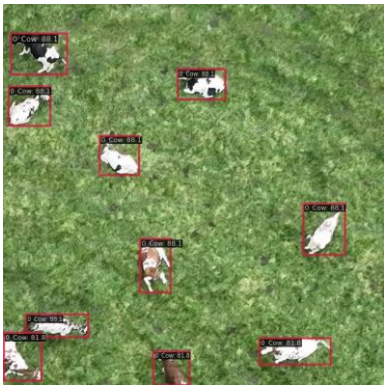
Apparent size is the lever that matters

This algorithm is unusually sensitive to how large the animals appear in the image, and the validation figures show it plainly: performance on large objects is nearly twice as good as on small ones. Apparent size is governed almost entirely by flight height, and secondarily by zoom.

The practical consequence is simple. At the top of the height band a herd is a scatter of small shapes and the algorithm is working at the hard end of its range. Come down, or zoom in, and the same animals become large, well-resolved objects that are boxed reliably and scored highly. If a count looks thin, the first thing to change is not the threshold; it is the apparent size of the cattle in the picture.

> **IMPORTANT: DETECTIONS ARE NOT STOCK COUNTS** The algorithm identifies where cattle appear in the image. It does not produce a count of the herd. Animals under trees, hedgerows or shelters will not appear at all, and animals standing close together may be merged into a single box, so a detection total will generally understate what is present. Treat the output as a strong aid to counting and a map of where the cattle are, not as a stock reconciliation.

Table 3.1 *Example detections*

Detection (with bounding boxes)	What it shows
	**Cattle large in the image** Thirteen animals boxed, the largest filling a substantial part of the image. This is the easy end of the range: animals are well resolved, boxes fit them closely, and scores are high.
	**A mixed herd at working height** Nine animals detected across a range of apparent sizes, some close to the camera and some further off. A typical working image, and the condition most of the height band produces.

Detection (with bounding boxes)	What it shows
	**A scattered herd, small in the image** Ten animals, each occupying only a small part of the image. Detection still works, but this is where scores fall and where animals begin to be missed. Descend or zoom in before trusting a count taken like this.

4 Detection performance

Validation was performed on an independent dataset that was held out from training and evaluated separately. The results presented below describe the algorithm's performance under the validated operating conditions and should be regarded as estimates of expected performance. Actual performance may vary with light, ground cover, environmental conditions and operating practices.

0.932	0.649
mAP@0.50	mAP@0.50–0.95

What these numbers mean

- **mAP@0.50 (0.932).** The algorithm achieves strong overall detection performance when moderate localisation accuracy is required. For most operational users, this is the metric that best reflects the algorithm's operational performance.
- **mAP@0.50–0.95 (0.649).** This applies progressively stricter requirements on how tightly the bounding box must fit the animal. It does not materially affect whether a cow is detected.
- **Apparent size changes everything.** Broken down by object size, average precision runs 0.481 on small animals, 0.764 on medium and 0.908 on large. That spread is the single most useful number in this guide: the same herd, flown lower or seen through zoom, is a substantially easier problem.

Precision and recall at a single fixed confidence threshold were not measured in this validation. Use the threshold guidance below as a starting point and tune it against your own ground.

> **CONFIDENCE-THRESHOLD SLIDER** A confidence threshold around 0.50 is recommended as a starting point. Lower thresholds may improve sensitivity but will increase false alarms; if animals are visibly present but not being boxed, check the flight height first, because a threshold cannot recover an animal that is too small in the image to resolve. Higher thresholds reduce false alarms but risk missing smaller animals, and suit ground where bales, feeders or other livestock are being reported as cattle. The recommended setting may vary depending on terrain, season, weather, and mission objectives.

5 Operating recommendations

Light and visibility

This is a visible-light algorithm, so it needs light. It works in daylight and in good visibility; in poor light and in darkness it may struggle or fail to function altogether. There is no thermal palette to set, and no palette constraint of any kind, but the lighting constraint is the equivalent one.

DAYLIGHT ALGORITHM Fly in daylight and in reasonable visibility. Rain, fog and failing light all reduce what the camera can resolve, and the algorithm can only find what the camera can see. Cattle standing in deep shade, under trees or against strongly shadowed ground are harder to detect than the same animals in open light.

Flight height, gimbal angle and zoom

Table 5.1 *Operating envelope*

Parameter	Setting	Notes
Camera	**Visible (RGB)**	The algorithm reads the visible feed. It does not use the thermal camera, even where one is fitted.
Flight height	**30 – 100 m above ground level (AGL)**	Lower heights make the animals larger in the image and detection markedly more reliable; higher heights cover more pasture per pass.
Gimbal pitch	**−90° (nadir)**	Straight down. Oblique views are not validated.
Zoom	**Optional, optical only**	No recommended level. Use optical zoom where it helps to make the animals large enough in the image; see below.
Confidence threshold	**0.50 to start**	Adjustable in DJI Pilot 2. Tune to the field and conditions.

HOW TO USE THIS Point the gimbal straight down, fly within 30 to 100 m AGL in daylight, and start the threshold at 0.50. Work the upper end of the band to sweep a large field quickly; drop towards the lower end, or bring in optical zoom, whenever the animals are small enough in the image that the count starts to look unreliable.

Choosing a flight height

Lower altitude improves image detail; higher altitude improves coverage. The table below turns that trade-off into practical choices, using only heights within the validated range.

Table 5.2 *Suggested approach by survey scenario*

Survey scenario	Suggested approach
Sweeping a large open field	Work the upper end of the range, approximately 70 to 100 m, to cover more pasture per pass.
Checking a herd in detail	Work the lower end, approximately 30 to 50 m, so that the animals are large and well resolved in the image.
Cattle near trees or hedgerows	Fly lower, and pass the same ground from more than one direction. Animals hidden on one pass may be visible on another.
The count looks thin	Descend, or bring in optical zoom, before adjusting the confidence threshold.

Survey scenario	Suggested approach
When lower altitude is not possible	Use optical zoom to increase the apparent size of the animals in the image.

Matching zoom to flight height

Detection performance depends on how many pixels an animal occupies in the image. Near the lower end of the height range cattle occupy a large part of the image and are detected reliably at the default optical zoom. As flight height increases, the same animals occupy progressively fewer pixels, and the validation figures show exactly what that costs.

Increasing the optical zoom increases the apparent size of the animals in the image, allowing a higher flight height to achieve detection comparable to that obtained lower down. There is no single correct height-to-zoom combination and none is prescribed here: the workable setting depends on flight height, ground cover and the area to be covered. At the start of a flight, trial a few optical zoom settings over cattle you can already see, and keep the one that boxes them reliably.

> **OPTICAL ZOOM, NOT DIGITAL** Use optical zoom whenever possible. Optical zoom increases the target's image resolution by changing the camera optics, increasing the apparent size of the animal in the image and providing additional detail. Digital zoom simply crops and enlarges the existing image, adding no new information. As a result, digital zoom should not be relied upon to improve detection performance or extend detection range. Treat it only as a viewing aid for the operator after a detection has been made.

Ground, cover and the animals themselves

- **Open pasture is the easy case.** Animals standing clear on grass, seen from directly above, are what the algorithm is trained on and where it performs best.
- **Cover causes misses.** Cattle under trees, beneath hedgerows or inside shelters may be partly or entirely hidden from a nadir view, and what the camera cannot see the algorithm cannot find.
- **Grouped animals may merge.** Cattle standing close together or overlapping can be reported as a single detection. This matters when the point of the flight is a count.
- **Look-alikes on the ground.** Bales, feeders, dark ground features and other livestock can occasionally be reported as Cow, particularly at low confidence thresholds.
- **Shadow and low sun.** Long shadows and strong low sun reduce contrast between the animals and the ground, and a dark shadow cast on pasture can itself be flagged.

Lens cleanliness

Dirt, water droplets or condensation on the camera lens soften the image and may degrade detection performance, and animals that are already small in the image are exactly what a soft image loses first. Inspect the lens before each flight and clean it as required, and allow time for condensation to clear when a cold aircraft is brought into warmer, more humid air.

6 Limitations

- **Daylight only.** In poor light or darkness the algorithm may struggle or fail to function. It has no thermal capability to fall back on.

- **Apparent size drives performance.** Detection reliability decreases significantly as animals occupy fewer pixels in the image. Cattle that are small in the image, because the aircraft is high or the zoom is wide, are substantially more likely to be missed.
- **No breed, no age, no health.** Every detection is reported as Cow. The algorithm does not distinguish breed, age, sex or condition, and it does not assess the animal.
- **Detections are not a certified count.** Animals under cover may be missed and closely grouped animals may merge into one box. Treat a detection count as a strong aid to counting, not as a stock reconciliation.
- **Cover causes misses.** Cattle beneath trees, hedgerows or shelters may be invisible from a nadir view and cannot be detected by any algorithm.
- **Look-alikes cause false positives.** Bales, feeders, ground features and other livestock can be reported as Cow, particularly at low confidence thresholds.
- **Nadir only.** Oblique gimbal angles fall outside the validated envelope.
- **Performance figures are intended for operational planning and should not be interpreted as guaranteed performance under all conditions.**

7 Deployment

The algorithm is licensed to the individual aircraft serial number and delivered through DJI Pilot 2. Once activated, it runs entirely on-board and does not require a network connection during operation.

> **VALIDATED VERSION** The validated performance described in this guide applies to the released algorithm version identified on the cover of this document, CowDetect-SAI-V2. Later algorithm updates, aircraft firmware changes and different camera configurations may perform differently, and the figures here should not be assumed to carry over to them. Check the algorithm version shown in DJI Pilot 2 against the cover of this guide, and record it alongside any results you keep.

Questions, or results in conditions not covered here? Visit spectroai.ai.