SHEEP DETECTION · OPERATOR GUIDE

Sheep Detection

Performance & Operating Guide

PREPARED BY	Spectro-AI	SUBJECT	Sheep detection algorithm
RUNS ON	DJI Matrice 4 Series (on-board)	MORE INFO	spectroai.ai
ALGORITHM	SheepDetect-RGB-SAI-V1	DOCUMENT	v1.0 · Public
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Contents

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 sheep during aerial surveys of pasture and open hill ground. 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 sheep 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, Sheep, from the visible-light (RGB) camera. It is intended for livestock work: locating and counting sheep across pasture and open hill ground 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: it does not read the thermal feed.

3 What the algorithm recognises

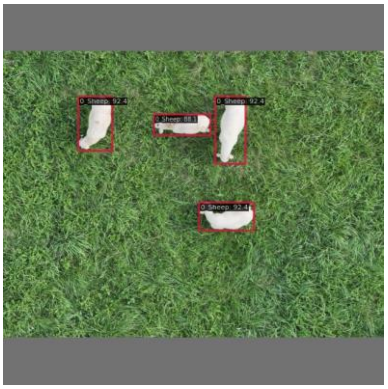
The algorithm detects a single class, Sheep, and displays each detection as a bounding box with an associated confidence score on the live image in DJI Pilot 2. Every animal in the image is boxed separately, which is what makes counting a flock from the air practical.

Apparent size is the lever that matters

A sheep is a small animal seen from the air, and the algorithm is correspondingly sensitive to how large the animals appear in the image. The validation figures show it: performance on large objects is markedly better than on small ones. Apparent size is governed almost entirely by flight height, and secondarily by zoom: which is why the height band for sheep starts lower than for cattle.

The practical consequence is simple. At the top of the height band a flock 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 larger, better-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 sheep in the picture.

Table 3.1 *Example detections*

Detection (with bounding boxes)	What it shows
	**Sheep large in the image** Four animals boxed, each occupying a good share of the image and scored highly. This is the easy end of the range: the animals are well resolved and the boxes fit them closely.
	**A flock at working height** Nine animals detected at a moderate apparent size. A typical working frame, and the condition most of the height band produces.
	**A large flock, small in the image** Nineteen animals detected, many of them only a handful of pixels across. Detection still works, but this is where scores fall and where animals begin to be missed and to merge with one another. 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 thermal contrast, environmental conditions and operating practices.

0.961	0.672
mAP@0.50	mAP@0.50–0.95

What these numbers mean

- **mAP@0.50 (0.961).** The validation results indicate strong detection performance under the tested conditions 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 (0.672).** This applies progressively stricter requirements on how tightly the bounding box must fit the animal. It does not materially affect whether a sheep is detected.
- **Apparent size changes everything.** Broken down by object size, average precision runs 0.611 on small animals, 0.850 on medium and 0.890 on large. That spread is the single most useful number in this guide: the same flock, 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 Start at approximately 0.60 and adjust from there. Lower it if animals are visibly present but not being boxed: though if that is happening, check the flight height first, because a threshold cannot recover an animal that is too small in the image to resolve. Raise it if pale ground features, rocks, bales or other livestock are being reported as sheep.

IMPORTANT: DETECTIONS ARE NOT STOCK COUNTS The algorithm identifies where sheep appear in the image. It does not produce a count of the flock. Animals under trees, hedgerows, walls or shelters will not appear at all, and tightly flocked animals 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 sheep are, not as a stock reconciliation.

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. Sheep 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	**10 – 100 m above ground level (AGL)**	The band starts low because sheep are small from the air. Lower heights make the animals larger in the image and detection markedly more reliable; higher heights cover more ground per pass.
Gimbal pitch	**−90° (nadir), ±10°**	Essentially straight down, with a small tolerance either side. Genuinely 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	**0.60 to start**	Adjustable in DJI Pilot 2. Tune to the field and conditions.

HOW TO USE THIS Point the gimbal straight down, fly within 10–100 m AGL in daylight, and start the threshold at 0.60. Work the upper end of the band to sweep a large field or hillside 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.

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 sheep occupy a good share 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 sheep 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 ground is the easy case.** Animals standing clear on grass or open hill, seen from directly above, are what the algorithm is trained on and where it performs best.

- **Cover causes misses.** Sheep under trees, beneath hedgerows, against walls or inside shelters may be partly or entirely hidden from a nadir view, and what the camera cannot see the algorithm cannot find.
- **Flocking makes merging more likely.** Sheep bunch far more tightly than cattle, and animals standing shoulder to shoulder can be reported as a single detection. This is the main reason a count taken from height should be treated with caution.
- **Look-alikes on the ground.** Pale rocks, bales, feeders and other livestock can occasionally be reported as Sheep, particularly at low confidence thresholds.

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.** Average precision falls from 0.890 on large animals to 0.611 on small ones. Sheep 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 Sheep. The algorithm does not distinguish breed, age, sex or condition, it does not separate ewes from lambs, and it does not assess the animal.
- **Detections are not a certified count.** Animals under cover may be missed and tightly flocked animals may merge into one box. Treat a detection count as a strong aid to counting, not as a stock reconciliation.
- **Cover causes misses.** Sheep beneath trees, hedgerows, walls or shelters may be invisible from a nadir view and cannot be detected by any algorithm.
- **Look-alikes cause false positives.** Pale rocks, bales, feeders and other livestock can be reported as Sheep, particularly at low confidence thresholds.
- **Near-nadir only.** Gimbal angles more than about 10° off nadir 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, SheepDetect-RGB-SAI-V1. 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.