SPECTRO AI

Thermal Animal Detection

Performance & Operating Guide

PREPARED BY	Spectro-AI	SUBJECT	Thermal animal detection algorithm
RUNS ON	DJI Matrice 4T / 4TD (on-board)	MORE INFO	spectroai.ai
ALGORITHM	AnimalWhiteHot-SAI-V2	DOCUMENT	v1.0 · Public
DATE	07 June 2026	MORE INFO	spectroai.ai

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 animals during aerial thermal inspections. It can highlight areas requiring further investigation, but should not be used as a replacement for manual verification or species identification.

1 About this guide

This guide explains how the Spectro-AI thermal animal detection algorithm performs when running on-board DJI Matrice 4 Series thermal 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, Animal, from White Hot thermal imagery.

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 thermal contrast, vegetation, weather, flight height, gimbal angle and image stability.

2 Supported aircraft

The algorithm is trained on thermal imagery. It requires a thermal camera and therefore runs only on the thermal variants of the Matrice 4 Series.

Table 2.1 *Aircraft compatibility*

Aircraft	Status	Reason
DJI Matrice 4T	**Supported**	Thermal camera fitted
DJI Matrice 4TD	**Supported**	Thermal camera fitted (dock variant)
DJI Matrice 4E	**Not supported**	No thermal camera. Visual payload only.
DJI Matrice 4D	**Not supported**	No thermal camera. Visual payload only.

THERMAL PAYLOAD REQUIRED The Matrice 4E and Matrice 4D carry visual cameras only (RGB) and cannot run this algorithm. Use a Matrice 4T or Matrice 4TD.

3 What the algorithm recognises

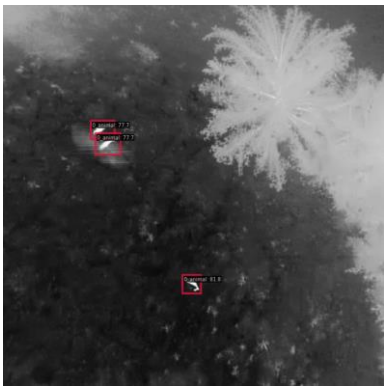
The algorithm detects a single class, Animal, and displays each detection as a bounding box with an associated confidence score on the live thermal image in DJI Pilot 2. It is designed to assist operators in locating animals and does not identify species.

The algorithm was trained using White Hot thermal imagery containing deer, wild boar and livestock. Animals of similar size and thermal appearance may also be detected, but performance has been validated only for these groups.

The algorithm can detect some partially visible thermal signatures, where parts of the animal are exposed. It cannot detect animals fully hidden by vegetation or obstacles. A thermal camera does not see through leaves, branches or solid cover; it can only register heat that reaches the sensor directly.

IMPORTANT: DETECTIONS ARE NOT ANIMAL COUNTS The algorithm identifies animal locations, not animal population counts. Multiple animals close together or overlapping may appear as a single detection. Do not use the number of detections as a census figure or a population estimate.

Table 3.1 *Example detections on White Hot thermal imagery*

Detection (with bounding box)	What it shows
	**Open ground, near-nadir view** Warm bodies stand out clearly as bright signatures against cooler ground. This is the easiest condition for the algorithm and the one that produces the highest confidence scores.
	**Woodland, oblique view** Animals among trees are detected where part of the body is exposed between branches. Expect lower confidence scores here, and expect animals under dense canopy to be missed entirely.
	**Grouped animals near a treeline** Each animal in a group is boxed individually. Animals standing close together or overlapping may be merged into a single detection, which is why detection counts should not be read as animal counts.

4 Detection performance

Validation was performed on an independent dataset that was held out from training and evaluated separately. The results below describe how the algorithm performed under the tested conditions. They are estimates of expected performance, not a guarantee of field results.

0.964	0.629
mAP@0.50	mAP@0.50–0.95

What these numbers mean

The validation scores indicate how consistently the algorithm identified and located animals in the tested images. Higher scores indicate stronger performance under those conditions.

- **mAP@0.50 (0.964).** The measure of whether animals were found and placed in roughly the right position. The validation results indicate strong detection performance under the tested conditions. For most operators, this is the figure that reflects the question that matters: was the animal located?
- **mAP@0.50–0.95 (0.629).** A stricter measure that also rewards how tightly the box is drawn around the animal. Thermal signatures are small and often partly hidden, so a tight box is hard to draw. Thermal signatures may occupy only a small part of the image and are often partly hidden by vegetation, making it harder to draw a tight box around the animal. A lower figure here says little about whether the animal was found.

In plain terms: the algorithm was effective at locating thermal animal signatures in the validated test conditions. These scores do not directly represent guaranteed field success. Actual performance depends on thermal contrast, environment, distance, vegetation and operating conditions, and will vary from one flight to the next.

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 site.

CONFIDENCE-THRESHOLD SLIDER A confidence threshold around 0.60 is recommended as a starting point. Lower thresholds may improve sensitivity but will increase false alarms. Higher thresholds reduce false alarms but risk missing weaker signatures. The recommended setting may vary depending on terrain, season, weather, and mission objectives, so expect to re-tune between sites and between sorties.

5 Operating recommendations

Thermal palette

WHITE HOT ONLY The algorithm is trained exclusively on the White Hot palette and must only be used with White Hot selected in DJI Pilot 2. Black Hot, Ironbow and all other palettes invert or recolour the thermal signature and are not supported. Detection performance on them is not validated and should not be relied upon.

Flight height, gimbal angle and zoom

Table 5.1 *Validated operating envelope*

Parameter	Validated setting	Notes
Flight height	**30 – 110 m above ground level (AGL)**	Lower heights give larger, clearer thermal signatures. Higher heights cover more ground per pass.
Gimbal pitch	**−60° to −90°**	Nadir (−90°) is preferred. Oblique views down to −60° are validated and are useful for seeing under a partial canopy.
Zoom	**×2**	The validated baseline, optical zoom only. See below for when to depart from it.
Thermal palette	**White Hot**	Mandatory. No other palette is supported.

Parameter	Validated setting	Notes
Confidence threshold	**0.60 to start**	Adjustable in DJI Pilot 2. Tune to the site and conditions.

Choosing a flight height

Lower altitude improves image detail; higher altitude improves coverage. The table below turns that trade-off into practical choices.

Table 5.2 *Suggested approach by mission scenario*

Mission scenario	Suggested approach
Searching dense vegetation	Fly lower, approximately 30 to 50 m, to improve thermal detail.
Searching open fields	Fly higher, approximately 70 to 110 m, to cover more area.
Confirming a detection	Reduce altitude and/or increase optical zoom.
When lower altitude is not possible	Use optical zoom to improve target visibility.

> **HOW TO USE THIS** Set White Hot, point the gimbal down, and fly within 30 to 110 m AGL. Fly near the lower end of the height range when animals are in cover and detail matters. Work the upper end when covering open ground quickly. Keep the gimbal between −60° and −90°; shallower, more horizontal angles fall outside the validated envelope.

Using zoom

Zoom controls how large an animal appears in the thermal image. Larger animal signatures generally improve detection reliability. Validation was carried out using ×2 optical zoom as the baseline. Higher optical zoom may improve detection when flying higher or when animals appear small in the image. Use the lowest practical optical zoom when covering large areas, and increase optical zoom when:

- **Animals appear small in the image.** Typically when flying towards the upper end of the height band.
- **Vegetation makes identification difficult.** More detail helps separate an animal from the background clutter around it.
- **Confirming a detection.** Zoom in on the box before deciding what it is.
- **Operating at higher altitude.** The higher you fly, the more zoom is needed to keep the animal at a usable size.

There is no single correct height-to-zoom combination. The workable setting depends on flight height, animal size, thermal contrast and the area to be covered. At the start of a mission, verify that animals occupy a clear, usable size in the thermal image. If they appear too small, increase optical zoom or reduce flight height where operationally possible.

> **OPTICAL ZOOM, NOT DIGITAL** Use optical zoom whenever possible. Optical zoom changes the camera optics, so the animal genuinely occupies more pixels and the algorithm has more thermal detail to work with. Digital zoom simply crops and enlarges the existing image, adding no new thermal information. 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.

Thermal contrast and time of day

The algorithm can operate during both day and night, provided sufficient thermal contrast exists between animals and the surrounding environment. What matters is not light but heat: the algorithm depends on a temperature difference between the animal and its surroundings.

- **Best conditions.** Cool ambient temperatures, cool ground and a clear sky. Typically at night, in the early morning before the sun has warmed the ground, or in the colder months. Animals then generally show stronger thermal contrast.
- **Hot summer nights.** The ground may stay close to body temperature well after dark, so the usual advantage of night flying is reduced or lost.
- **Thermal crossover periods.** Around dawn and dusk, ground and animal temperatures pass through each other and contrast can briefly disappear altogether.
- **Humidity, rain and fog.** Moisture in the air and on vegetation absorbs thermal energy and weakens the signature reaching the sensor.
- **Environmental temperature.** The warmer the surroundings, the smaller the difference between an animal and its background, and the harder detection becomes.

Thermal lens cleanliness

Dirt, water droplets or condensation on the thermal lens reduce image contrast and may degrade detection performance. 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

- **Thermal aircraft only.** The algorithm cannot run on the Matrice 4E or Matrice 4D.
- **White Hot only.** Any other palette places the algorithm outside its validated envelope.
- **No species identification.** Every detection is reported as Animal. Operators must confirm the species visually if it matters. Validation covers deer, wild boar and livestock; other species are not characterised.
- **Warm non-animal objects may be detected as Animal.** Sun-heated rocks, machinery, vehicles and people can produce false positives, particularly at low confidence thresholds. Operators should always verify detections before acting.
- **Occlusion causes misses.** Animals fully hidden by vegetation, terrain or structures cannot be detected. Detection is less reliable in woodland than over open ground.
- **Performance figures are intended for operational planning and should not be interpreted as guaranteed performance under all conditions.**

Conditions where performance may decrease

The following are common situations in which detections become less reliable. Recognising them in the air is more useful than any single number.

- **Hot, sun-heated rocks after midday.** Stone holds heat for hours and can read as warm as an animal, producing false positives.
- **Warm roads, buildings or machinery.** Asphalt, roofs and recently used plant all retain heat and generate bright signatures that are not animals.
- **Wet vegetation after rain.** Moisture reduces thermal contrast and weakens the thermal signature reaching the sensor.
- **Animals lying still against warm ground.** A resting animal on ground at a similar temperature may have almost no contrast to detect.

- **Dense forest canopy.** Animals beneath a closed canopy are hidden from the sensor entirely and cannot be detected.

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, AnimalWhiteHot-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.