



Thermal Fawn Detection

Performance & Operating Guide



PREPARED BY	Spectro-AI	SUBJECT	Thermal fawn detection algorithm
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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 fawns during aerial thermal searches ahead of mowing. It can highlight areas requiring further investigation, but should not be used as a replacement for manual verification, species identification or the ground search itself. It does not clear a field.

OBSERVING PEOPLE One of the three classes detects people, so a search flight records where members of the search party are working. Thermal imagery carries no faces or other identifying features, which limits what can be learned about an individual, but recording the position of identifiable colleagues may still fall under workplace monitoring or data protection obligations in your jurisdiction. Confirm your position before routinely retaining footage, and treat a Person detection as a warm shape in the picture rather than an identification.

1 About this guide

This guide explains how the Spectro-AI thermal fawn 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 three classes, Deer, Fawn and Person, from White Hot thermal imagery. It is built for pre-mowing fawn searches: finding fawns lying up in tall grass before machinery reaches them, while telling them apart from adult deer and from the search party on the ground.

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 three classes and displays each detection as a bounding box, a class label and a confidence score on the live thermal image in DJI Pilot 2. Every detection in the image is boxed and labelled separately.

Table 3.1 *Detection classes*

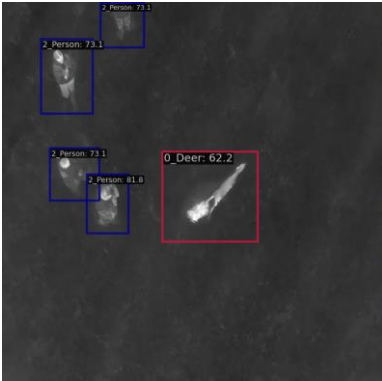
Class	What it is	Why it matters
Fawn	A fawn lying up in cover.	The class the survey exists for. Fawns freeze rather than flee, so they will not move out of the path of machinery and must be located and lifted before mowing.
Deer	An adult deer.	Separating adults from fawns prevents the search party from being sent to an animal that can move itself out of harm's way.
Person	A person in the field.	Searchers walking the field are warm and roughly deer-sized from the air. Giving them their own class stops the search party being reported as wildlife.

Reading the confidence score

Every detection carries its own class and score, and the three classes do not behave alike. A fawn is small, partly hidden and often curled into an ambiguous shape, so fawn detections tend to be scored lower than the people and adult deer in the same image. That is expected, and it is the reason the recommended threshold sits at 0.50 rather than higher: a fawn scored at 0.50 is still worth walking to.

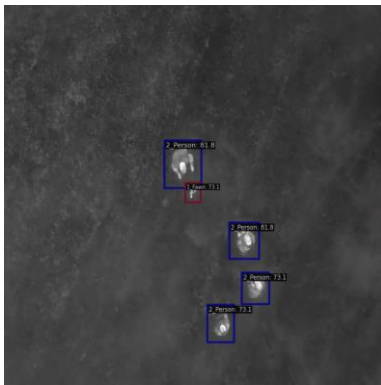
IMPORTANT: DETECTIONS ARE NOT ANIMAL COUNTS The algorithm identifies where warm shapes appear in the image. It does not produce a count of the animals in a field. A fawn lying beside its dam, or two fawns together, may be reported as a single detection, and any animal fully hidden beneath vegetation will not appear at all, so a detection total will generally understate what is present. Above all, an absence of detections is not evidence of an empty field, and must never be treated as clearance to mow.

Table 3.2 *Example detections on White Hot thermal imagery*

Detection (with bounding boxes)	What it shows
	Adult deer among a search party Five detections in one image: one Deer, boxed at 62, and four Person. Each is labelled with its own class, so the operator can tell at a glance which warm shapes are the people doing the searching and which is the animal.

Detection (with bounding boxes)

What it shows

**Fawn located during a search**

A Fawn boxed at 73 alongside four Person detections. This is the working case: the aircraft finds the fawn, the class label separates it from the searchers, and the party is directed to it.

**Two fawns, low confidence**

Two Fawn detections, both scored at 50, alongside Person detections scored well above them. Weak scores like these are exactly what the 0.50 threshold is set to catch; raise it and these two fawns disappear.

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.

0.977

mAP@0.50

0.621

mAP@0.50–0.95

What these numbers mean

- **mAP@0.50 (0.977).** 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 (0.621).** This applies progressively stricter requirements on how tightly the bounding box must fit the animal. The lower value reflects the difficulty of drawing pixel-tight boxes around small, partly occluded thermal signatures. It does not materially affect whether an animal is detected.

These scores do not directly represent guaranteed field success. The figures are also averaged across all three classes. Per-class performance was not measured separately, so a strong overall score should not be read as a guarantee that Fawn, the smallest and most often concealed class, performs as well as Deer or Person. Precision and recall at a single fixed confidence threshold were likewise not measured. 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. In a fawn search the cost of a miss is not symmetrical with the cost of a false alarm: a false positive costs a walk across a field, a missed fawn does not get a second chance. Lower thresholds may improve sensitivity but will increase false alarms, and in this application that is usually the right trade. Raise the threshold only with good reason. The recommended setting may vary depending on terrain, season, weather, and mission objectives, so expect to re-tune between fields and between mornings.

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	20 – 110 m above ground level (AGL)	Lower heights give larger, clearer thermal signatures; higher heights cover more ground per pass. A fawn is small, so favour the lower end when it matters.
Gimbal pitch	–90° (nadir), ±5°	Straight down. Fawns lie flat in cover and are seen from directly above; oblique angles are not validated.
Thermal palette	White Hot	Mandatory. No other palette is supported.
Confidence threshold	0.50 to start	Adjustable in DJI Pilot 2. Fawns score lower than deer or people, so do not raise this without good reason.

HOW TO USE THIS Set White Hot, point the gimbal straight down, and fly within 20 to 110 m AGL with the threshold at 0.50. Fly early, while the ground is still cold. Work the higher end of the band to cover a field quickly, and drop towards the lower end wherever the grass is tall or a fawn is suspected but not being boxed.

Choosing a flight height

Lower altitude improves thermal detail; higher altitude improves coverage. The band here is wide, so the choice matters more than in most of the range. The table below turns the trade-off into practical decisions, using only heights within the validated range.

Table 5.2 *Suggested approach by search scenario*

Search scenario	Suggested approach
Covering a large field quickly	Work the upper end of the range, approximately 80 to 110 m, and accept that the smallest signatures are the first to be lost.
Tall or dense grass	Fly lower, approximately 20 to 50 m, so that whatever heat escapes the canopy occupies more of the image.
A fawn is suspected but not boxed	Descend, or increase optical zoom, before lowering the threshold. Neither the threshold nor the algorithm can recover a signature the sensor never resolved.
Confirming a detection	Hold position and inspect the live image, then direct the ground party. Descending further risks flushing an adult off a fawn.
Late in the morning	Fly lower to compensate for falling thermal contrast, and treat the results as less complete than a first-light search.

Matching zoom to flight height

Detection performance depends on how many pixels an animal occupies in the thermal image. A fawn is far smaller than an adult deer or a person, so it is the class that runs out of pixels first as the aircraft climbs. Near the lower end of the height range a fawn occupies enough of the image to be found reliably at the default optical zoom; by the top of the range it may not.

Increasing the optical zoom increases the apparent size of the animal in the image, allowing higher-altitude flights to achieve detection performance comparable to that obtained at lower altitudes. There is no single correct height-to-zoom combination: the optimal zoom depends on flight height, the size of the animal, thermal contrast and the area to be covered. At the start of each search, evaluate a few optical zoom settings and select the one that reliably boxes a fawn rather than one that merely boxes the people in the field. The adults and searchers will be found at settings under which a fawn is still missed.

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 thermal image and providing additional thermal detail. Digital zoom simply crops and enlarges the existing image, adding no new thermal 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.

Thermal contrast and time of day

The algorithm can operate during both day and night, provided sufficient thermal contrast exists between the animal and the surrounding vegetation. What matters is not light but heat.

- **Best conditions.** Cool ambient temperatures, cool ground and a clear sky. In practice, early morning before the sun has warmed the grass. This is also when fawn searches are flown, immediately ahead of the mowers, so the operational window and the optimal thermal window coincide.
- **Degraded conditions.** As the sun climbs, the grass warms towards the temperature of the animal lying in it and the contrast the algorithm relies on narrows. A field left until mid-morning is materially harder than the same field at first light. Thermal crossover periods have the same effect.
- **Warm nights and humid air.** After a hot day the ground may not have cooled by first light, and humidity absorbs thermal energy on its way to the sensor. Both reduce the contrast available.

- **Obstruction.** Rain, fog and wet vegetation attenuate the thermal signature. A fawn pressed flat beneath tall, dense grass may be largely shielded from the sensor, and one fully covered cannot be detected by any algorithm.
- **Warm ground features.** Sun-heated bare soil, tracks, machinery and recently used vehicles hold heat and can be reported as animals, particularly at low confidence thresholds.

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.
- **Per-class performance is not characterised.** The published figures are averaged over Deer, Fawn and Person. Fawn is the smallest and most often concealed of the three and should not be assumed to perform as well as the other two.
- **Deer and Fawn can be confused.** The classes are separated largely on apparent size and shape. A large fawn, a small adult, or a fawn lying against its dam can be assigned to the wrong class, and the higher the aircraft, the harder that distinction becomes. Treat the class label as a strong hint, not a verdict.
- **Warm objects can be flagged.** Sun-heated ground, machinery, vehicles and other animals can produce false positives, particularly at low confidence thresholds.
- **Occlusion causes misses.** A fawn lying flat beneath tall or dense vegetation may be shielded from the sensor. An absence of detections is not evidence of an empty field.
- **Closely spaced animals may merge.** A fawn lying beside an adult, or two fawns together, can be reported as a single detection. Detection counts are not a reliable census.
- **The algorithm does not clear a field.** It is a search aid. The decision to mow remains with the operator and the landowner, and should not rest on the absence of detections alone.
- **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, Fawn-WhiteHot-SAI-V3. 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.