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Fighting Fire With Thermal:

DJI's Complete Guide to Thermal Drones

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Fighting Fire With Thermal

DJI's Complete Guide to Thermal Drones

CONTENTS

INTRODUCTION

In 2019, severe heat waves and sustained drought caused wildfires to ravage more than 330,000 hectares of land across Europe. Record-breaking blazes swept across Spain, Greece, Sweden, Germany, Portugal, and the UK, representing a rise of 15 percent on the decade's annual average[1]. Lives were lost, habitats were destroyed, and billions of Euros of damage was caused.

In Australia, the 2019-20 wildfire season has been labelled 'Black Summer' and is on record as the most devastating in the nation's history. The area burned by wildfires in America has almost quadrupled in the past 40 years[2].

The severity of these fires is expected to increase in the coming years as global temperatures rise and droughts are prolonged.

Fortunately, the next generation of firefighting solutions is beginning to make its mark. These include drones (UAVs) and the latest in thermal imaging technology. Both are being deployed by firefighting crews around the world to support emergency response to wildfires and residential incidents.

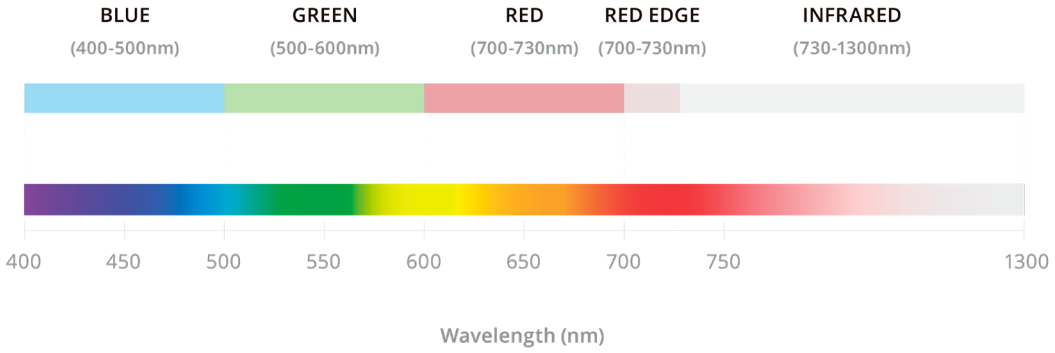
1. https://effis.jrc.ec.europa.eu/applications/data-and-services/
2. https://www.nber.org/papers/w27423.pdf

As you'll discover in this guide, the combination of drones and thermal imaging is enhancing situational awareness for teams on the frontline, providing real-time insights from above, and saving lives.

Read on to discover the basics of thermal imaging, the benefits of using infrared during firefighting operations, and the specifics of DJI's thermal drone technology.

AN INTRODUCTION TO THERMAL IMAGING

We humans have always been bound by the limits of our perception. For thousands of years, we based our understanding of the world on what our eyes are able to see: visible light, otherwise known as wavelengths of electromagnetic radiation between ~400nm to ~700nm.



It was only in 1800 that astronomer Frederick William Herschel confirmed the existence of something beyond.

While studying visible light and temperature changes between the different colors, Herschel discovered a warmer band just beyond red light. We now know that invisible band as infrared, which sits on the electromagnetic spectrum between visible light and microwaves.

Herschel's discovery was the foundation that led to all manner of technologies we now take for granted, including radio communications, microwaves, medical X-rays and, as we'll focus on in this guide, infrared sensors.

To understand the importance of Herschel's discovery to today's thermal imaging applications, we have to go back to two basic principles of physics.

The first is that the primary source of infrared radiation is heat. And heat doesn't always have to be hot. In fact, even things we think of as cold emit infrared.

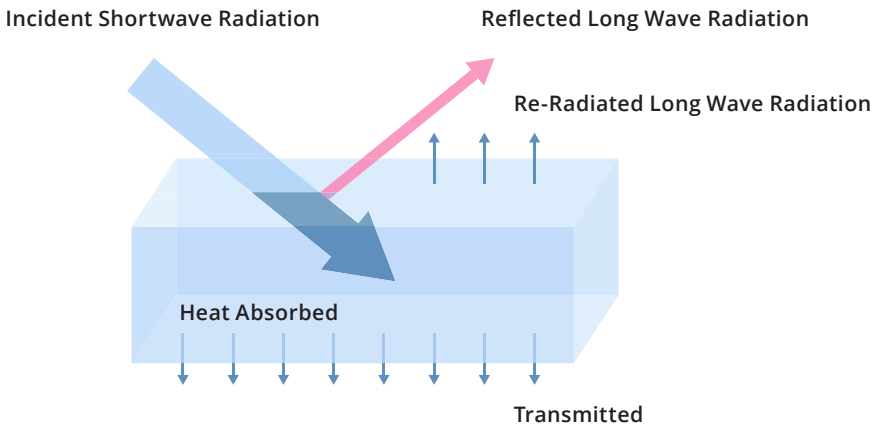
The second is that all matter emits electromagnetic radiation, so long as its temperature is above Absolute Zero. The warmer an object, the more infrared radiation it will emit. This emitted thermal energy is better known as an object's 'heat signature'.

Absolute Zero isn't 0°C on the Celsius scale or 0°F on the Farenheit scale. It's measured in Kelvin, and actually equates to −273.15 °C or −459.67 °F.

All of which means that thermal imaging can make the invisible, visible. The technology can be harnessed to see what's going on under cover of darkness, pinpoint patches of land that are about to go up in flames, and highlight temperature differences between objects.

HEAT 101

Infrared cameras allow us to see thermal energy in action. Some objects produce heat. Some objects absorb heat. Some objects reflect heat. For the sake of this guide we will focus primarily on radiation, a form of heat transfer that relies on infrared waves.



PRINCIPLES OF THERMAL IMAGING

Thermal imaging from above isn't as simple as turning on a thermal camera and sending your drone into the air.

There are a few principles of Radiometry - the science of measuring electromagnetic radiation in any portion of the electromagnetic spectrum - to contend with first. Without a solid understanding of them, it's easy to misuse equipment in a way that actually hinders your firefighting operations.

Thermal cameras measure the temperature of a surface by assessing the intensity of the infrared signal that reaches the camera. When used properly, this method is highly precise (and clearly preferable to sending a firefighter into a situation with a thermometer).

But remotely sensing temperature in this way requires that you account for environmental factors, technology limitations, as well as specific properties of the object you are measuring.

As we'll see, these range from surface characteristics of the object in question, to atmospheric interference, and the technical specifications of the thermal imaging system at your disposal.

To get precise, actionable data from your thermal camera drone, you'll need to take all of these factors into account during operations.

HOW SURFACE CHARACTERISTICS IMPACT THERMAL MEASUREMENTS

When you measure an object's temperature remotely using an infrared sensor, the heat signature you see coming back is indicative of that object's surface temperature. However, certain materials have characteristics that make their true surface temperature harder to gauge.

Thermal Imaging System **Atmospheric Interference** **High Emissivity**

Often that's because different surfaces radiate heat with different levels of efficiency. This efficiency is known as an object's Emissivity. It's measured on a scale from 0 to 1, with 0 being a perfect mirror that reflects all energy and 1 being a theoretical "blackbody" that instead absorbs and radiates all energy.

Shiny or highly polished metallic surfaces are highly reflective. Just as a mirror reflects visible light, they reflect thermal radiation. They have very low emissivity ratings of around 0.1 and are effectively infrared mirrors.

Highly reflective surfaces can lead to misinterpreted readings from your thermal camera, which will

detect infrared energy these surfaces are reflecting from nearby sources, rather than what they are actually radiating. In practice, this might mean a polished surface that's cool to the touch actually registers as being far hotter - perhaps because it's reflecting thermal radiation from the sun, or even you, the operator, standing directly in front of it.

Surfaces with high emissivity, like people (0.98), concrete (0.92) and flat finish/matte paint (0.9), therefore provide more accurate temperature readings when viewed using a thermal camera.

Emissivity and reflectivity can add complication to seemingly simple temperature assessments and lead to inaccurate measurements. But there are ways to compensate for these effects

UNDERSTANDING THE ATMOSPHERE

It's not just the properties of the object you are measuring that influence the accuracy of infrared imaging. There are atmospheric factors, too. These include the density of the air and its humidity.

The air between your drone and the object you are looking at interferes with the accuracy of your thermal readings.

Our atmosphere also absorbs and emits infrared radiation. You can think of this as thermal energy loss as radiation travels between the object in question and the camera.

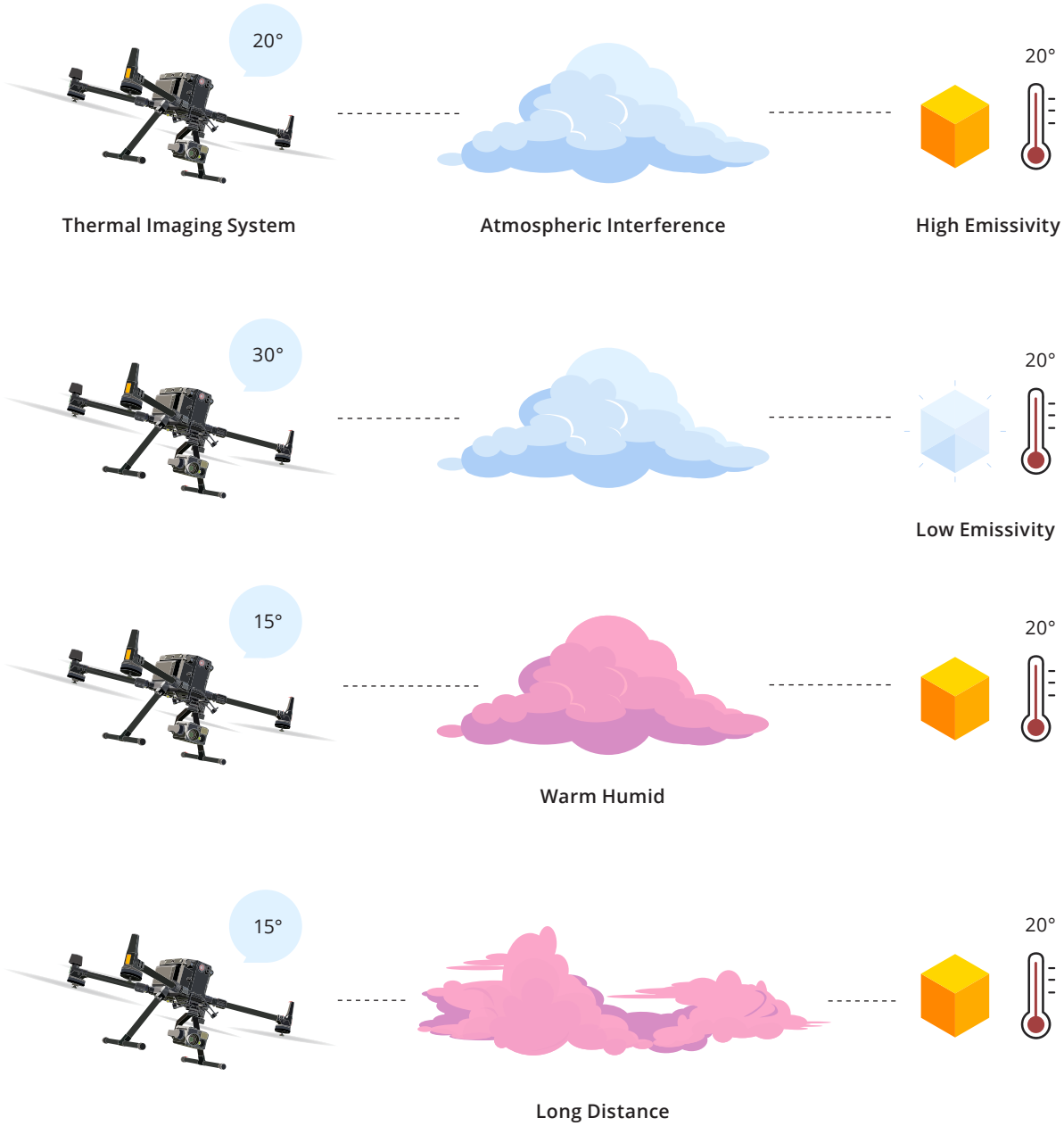
Warm air with high humidity will reduce the transmission of infrared energy between object and camera. As a result, your thermal measurements will appear colder than the actual surface temperature.

The effect of the atmosphere on measurement accuracy increases with the distance between the

drone and the object. So the closer you fly, the more accurate your thermal measurements will be.

It's also worth bearing in mind that dust, strong winds, rain, smoke, and snow will also reduce the transmission of infrared radiation and impact your measurements.

Using thermal cameras during firefighting operations can provide rapid intelligence when you need it most. But getting accurate readings isn't always easy. An object's characteristics, the atmosphere you're flying in, and even the distance from the drone to your area of focus all make an impact.



THE BASICS OF A THERMAL CAMERA

So how do thermal cameras actually work? What kind of software additions have been developed to support the operations of firefighters? And what kind of specifications should you consider when choosing thermal equipment?

As we've seen, thermal cameras work by detecting infrared radiation rather than visible light. A typical thermal camera captures infrared energy and processes the data to create an image that depicts a scene and the temperature of the objects within it.

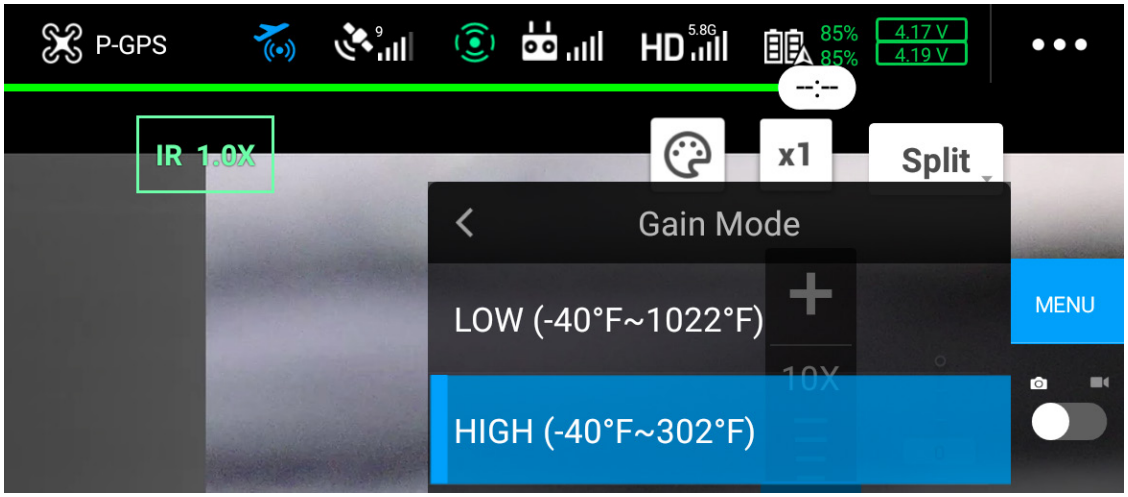
Thermal cameras usually consist of a lens, a thermal sensor, and internal electronics that process the image. The lens focuses infrared energy onto the sensor, and the higher the number of pixels in the sensor, the more detailed that picture will be. Temperature values are measured per pixel; internal algorithms are used to map these accurately and at speed.

There are a few important elements that impact a thermal camera's performance...

RANGE

When we use range in the context of thermal imaging, the term relates to the spectrum of temperatures the camera is able to recognise and measure. Many thermal cameras have more than one range setting, making them adaptable in different scenarios.

For example, our latest Zenmuse H20T camera has two temperature ranges, one for measuring lower temperatures from -40 °C to 150 °C, and a second for accurately measuring temperatures from -40 °C to 550 °C. This can be adjusted in the DJI Pilot app's IR camera menu by selecting "Gain Mode".



THERMAL SENSITIVITY (NETD)

Thermal sensitivity is also referred to as Noise Equivalent Temperature Difference (NETD). This metric refers to the smallest possible temperature difference the camera allows you to see.

Clearly, a low NETD is preferable, indicating a highly sensitive thermal imaging system. The usefulness of this depends on the application at hand, but a low NETD will lead to less noise in your thermal images and greater clarity.

Zenmuse H20T: ≤50 mK @ f/1.0

FIELD OF VIEW (FOV)

Field of View is relatively straightforward. It relates to how much of a scene a lens can see. A wide angle lens will offer more useful thermal images when you're close to the subject.

If you're observing your subject from a distance, a more narrow or telephoto lens will allow you to focus on a particular part of the scene.

H20T: 40.6°

IMAGE RESOLUTION

Just as with a regular camera, the image resolution of a thermal sensor is determined by the number of pixels its sensor has. Thermal cameras provide temperature readings per pixel, so the higher the resolution, the more detail you will be capturing and the more accurate your measurements will be.

Resolution is particularly important if you're flying far away from your subject.

H20T: 640×512

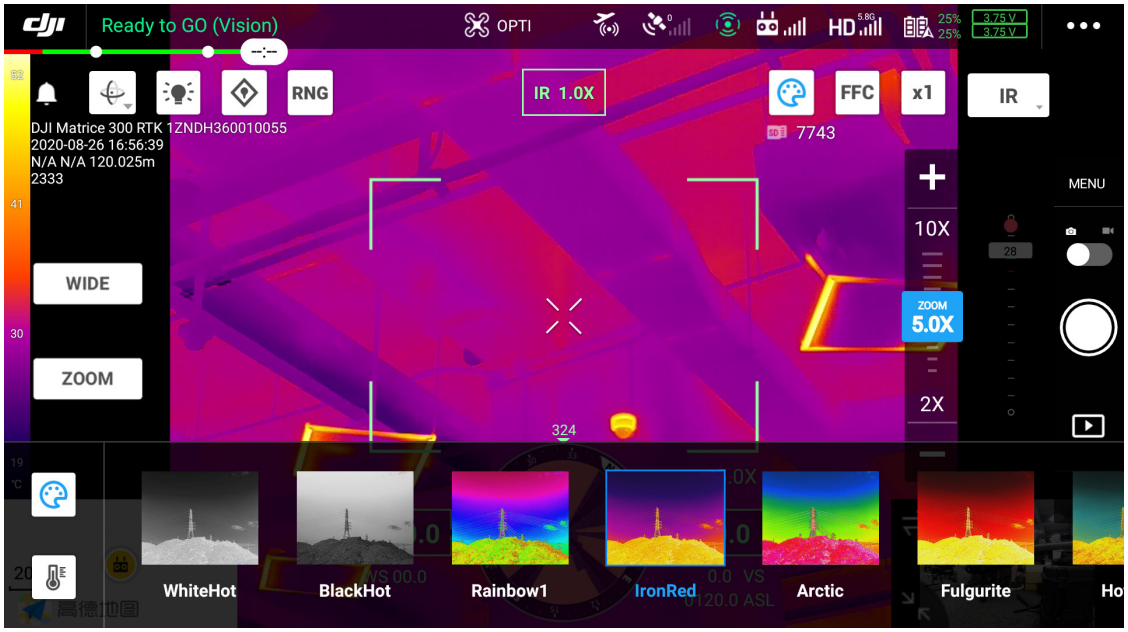
SPECTRAL BAND

Every thermal camera works across a specific band that's measured in micrometers (μm). This determines the range of wavelengths on the electromagnetic spectrum that the camera's sensor can detect. Ideally, thermal cameras for firefighting applications will have a longwave spectral range of between 8μm to 14μm.

H20T: 8-14 μm

THERMAL IMAGING TOOLS

There are several software tools firefighters can use to gather sophisticated and actionable insights using a thermal camera. These on-screen display features, which include blending, color palettes, and isotherms, simplify the process of getting data in the field and can be tailored to suit the situation at hand.



COLOR PALETTES

As we've seen, every pixel captured by a thermal camera is given an individual temperature reading in order to build an accurate image. Part of this process is assigning each temperature point with a specific color.

The result is an image that displays the heat gradient using a spectrum of color to determine the heat sources within the scene. There are several preset color schemes, known as color palettes, which can be used depending on the situation or the operator's preference.

Some palettes have been designed to remove the complexity of color and instead draw attention to body heat - such as Black Hot. Others, such as Rainbow, use the full spectrum of color to highlight small temperature differences.

The best color palette for firefighters depends on the situation at hand. The majority of scenarios require relative temperature information rather than detailed measurements, so palettes focused on displaying thermal contrast clearly are usually preferred.

But ultimately it comes down to the speed at which a scene can be interpreted. This improves with time, familiarity, and practice.

ISOTHERMS

Isotherm settings allow the operator to highlight certain temperature ranges and make them stand out in real time.

Isotherms are best deployed when you want to focus on a specific temperature band. Firefighters can use this tool to highlight patches of land that are at risk of going up in flames or lingering hotspots after a fire has been extinguished in the area.

Isotherms can make sure you don't fail to spot something significant in your image, but they can also be misused. For example, it's not recommended to use isotherms for SAR missions, as there are usually too many variables - including emissivity, reflexivity and atmospherics - in play.

BLENDING/FUSION

Many of the latest thermal sensors operate side by side with RGB visible light cameras. The two can work together to produce a single image that combines elements of infrared images with standard pictures.

This technique fuses details that can only be seen with a regular visible light camera with thermal imagery to enhance the operator's understanding of the scene in front of them. It can bring to light critical information that wouldn't otherwise be visible.

Rather than simply mixing thermal with visible, blending software aims to combine and superimpose the useful visible details that thermal can't see, such as an object's lines and edge.

THE BENEFITS OF THERMAL CAMERA DRONES

Handheld thermal imaging tools have been used to support structure fire operations since the mid-1990s. But a view from the ground has limitations. Today, drones with RGB cameras provide firefighters with a versatile and easy-to-deploy tool that improves situational awareness and helps crews work smarter.

The introduction of flying thermal cameras promises greater visibility and a more rounded view of the situation at hand. With this technology, invisible hotspots can be identified, the safety of operations can be enhanced, additional data can be gathered, and resources can be more effectively allocated to where they are needed most.

It's not unusual for the scope of firefighting missions to change in an instant. Thermal imaging can be harnessed to support operations before, during and after a fire, as well as when dealing with hazardous materials incidents and search and rescue missions.

REMOVING THE GUESSWORK FROM OPERATIONS

Burning forests, grasslands, and buildings are inherently dangerous. But firefighters must contend with uncertainty both as a situation unfolds and after the bulk of the fire is extinguished.

Where and how quickly the fire is spreading, the presence of accelerators, the integrity of any structures involved, risks in the vicinity, the potential for secondary fires, and the safety of those fighting the blaze are just a few of the dynamic elements in play.

With so many variables to consider, situational awareness is priceless. Drone-enabled thermal imaging can provide objectivity and clarity when it's needed most.

HOTSPOT DETECTION

Thermal cameras allow firefighters to see infrared radiation from above. From structural fires to wildfires, the ability to locate hotspots can be the bedrock of smarter operations. By determining hotspots that are otherwise invisible to the naked eye, crews can work in safer conditions, reduce the time it takes to get a blaze under control, and prevent secondary fires from occurring.

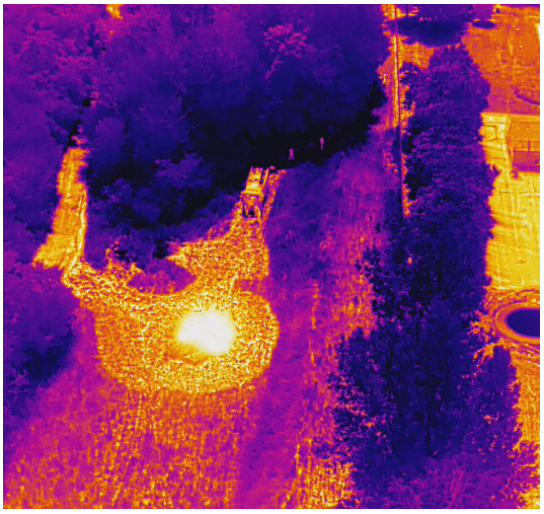
During structure fires, thermal drones can help crews track the progress of a fire as it travels through a building. Traditionally, the cutting of ventilation holes in an effort to make the conditions inside safer for firefighters and those trapped inside is guided by educated guesswork.

Now, crews can see right away where the fire is at its fiercest and get an indication of a structure's integrity during a fire. All of which reduces the time spent in precarious locations while ensuring efforts are safer and better coordinated.

Whether tackling a burning building or a forest fire, no firefighter wants to leave until it's safe to do so. A small smouldering hotspot can easily lead to another blaze in the hours following a crew's departure from the scene.

Signs of heat aren't always easy to spot. With thermal, crews can leave the scene confident they won't have to return in a hurry.

As we'll see, this capability ranges from picking out hotspots and preventing reignition, to guiding operations and ensuring fire chiefs deploy resources effectively.



SUPPORTING OPERATIONS ALONGSIDE CREWED AIRCRAFT

As we'll explore shortly, one of the main challenges facing firefighting teams that want to use thermal drones during operations is the presence of crewed aircraft. This is particularly the case when combating wildfires.

Developments are underway that will see uncrewed aircraft safely integrated with the planes and helicopters that already support these operations. Until those efforts come to fruition, the technology continues to prove its worth after the sun goes down and in the absence of crewed air traffic.

At night, thermal drones can be used to monitor and track the spread of wildfires, ensuring that, when day breaks, those attending the scene have a current and accurate picture to work from.

During the day when conventional aircraft are unavailable, the technology can offer cost effective persistence: monitoring crews in the fire area and determining safe routes of escape and any terrain hazards that might exist.

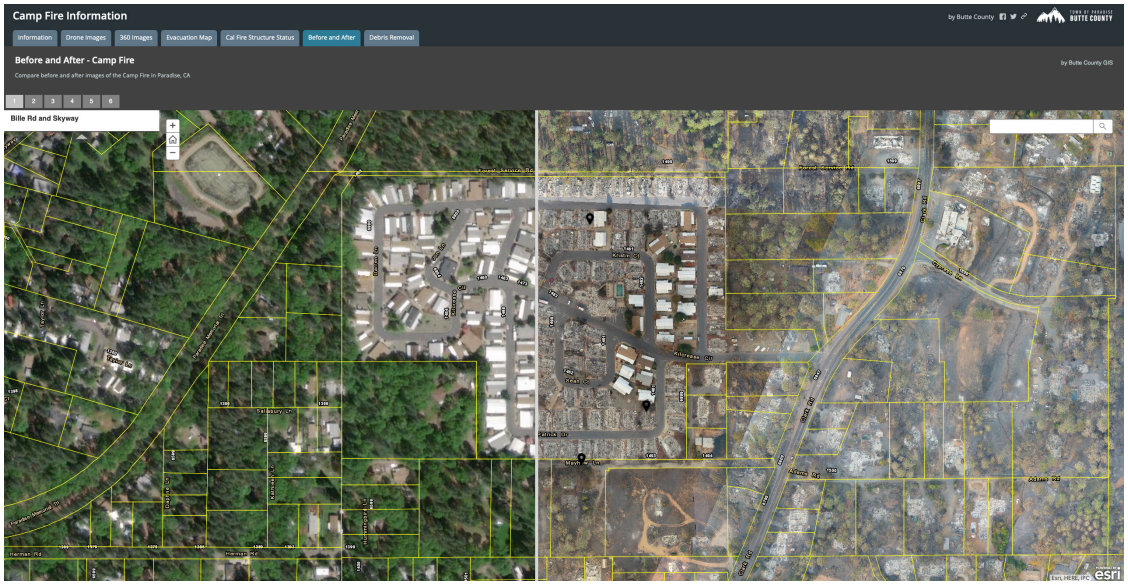
Making timely tactical decisions is central to any effective wildfire response. Thermal drones can provide the data needed to deploy resources where they will be most effective and keep firefighters safe.

FIRE PREVENTION

Firefighters' roles are increasingly focused on preventing fires rather than simply responding to them.

The integration of thermal drones into these efforts is one way to reduce the risk of predictable incidents.

The Los Angeles Fire Department is one of the leading entities in this regard, using thermal drones to carry out damage assessments and brush management. All of this data is used to create accurate maps of at-risk areas and detailed records of past hotspots.

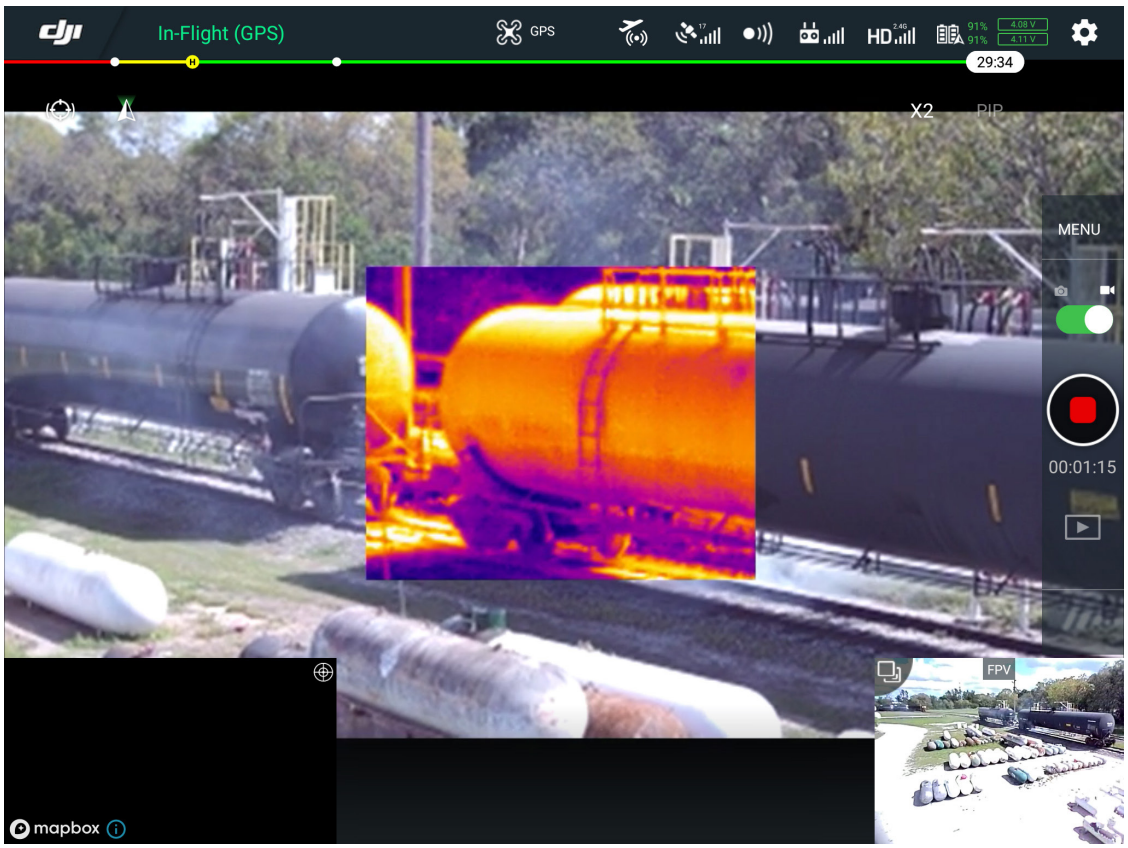


HAZMAT & SEARCH AND RESCUE

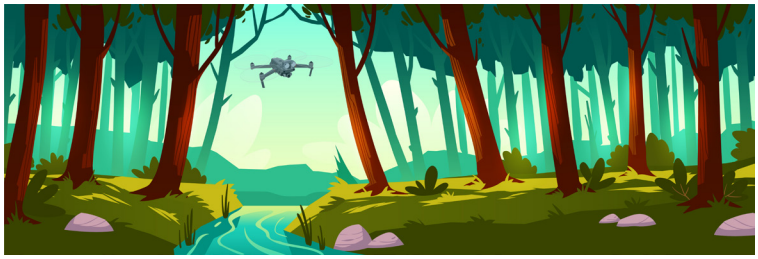
Many fire crews assist with the emergency response during search and rescue and hazardous material operations.

Drones with standard cameras are now established tools for supporting these types of operation. The addition of thermal cameras, just as in conventional firefighting, promises to enhance those methods and further improve safety and efficiency.

Thermal imaging can be used to assess the temperature of sensitive chemical storage, to estimate the contents of chemical containers, and to track down people under cover of darkness. Used in conjunction with software tools such as color palettes and isotherms, this can be done in a fraction of the time when compared with conventional methods.



THERMAL DRONES CONTRIBUTE AT EVERY STAGE OF THE FIREFIGHTING PROCESS



Before: Preventative planning, inspection and brush management

During: Real-time insights and resource management

After: Forensic analysis and damage assessments

THERMAL DRONES: COMMON MISCONCEPTIONS

THE TECHNOLOGY IS NOT SOPHISTICATED ENOUGH

Size isn't everything. DJI's thermal enterprise drones are highly capable and versatile imaging tools with more than 30 minutes of flight time, dual visible and thermal cameras, advanced sensing systems, and a sophisticated suite of software tools.

These are not toys. In fact, drones have already rescued hundreds of people from peril around the world.
https://enterprise.dji.com/drone-rescue-map/

ANYONE CAN USE THERMAL DRONE TECHNOLOGY

Getting the most out of thermal drones requires extensive training and experience.

There are many variables in play when remote sensing during emergency situations, from environmental factors to the properties of the objects you're looking at. The operator's experience and familiarity with the tools at their disposal is vital for collecting useful data.

CASE STUDIES

HOTSPOT DETECTION IN ACTION

At the scene of a 2018 wildfire in Redding, California, DJI drones were being used to carry out damage assessment. It was only after sending up a thermal drone that fire crews were able to spot trees that were still burning - despite appearing to have survived the fire - along with several hotspots on the ground that could have led to reignition.

A year before in Santa Rosa, California, thermal drones were used on a smaller scale to detect hotspots in the remnants of a burned-out home following a wildfire. The data gathered safely guided a canine unit into the property to search for the body of the homeowner.

In both of these examples, the integration of thermal drones enhanced fire crews' awareness of the scene, improved safety, and led to resources being allocated more efficiently.

CHERNOBYL, 2020

In April 2020, devastating fires tore through more than 40,000 hectares of forest surrounding the Chernobyl Exclusion Zone in Ukraine. For ten days, over 1,000 response personnel, 120 fire trucks, several crewed aircraft, and a fleet of DJI Mavic 2 Enterprise Duals battled the blaze, contained the fire, and crucially prevented it from spreading to the remnants of the nuclear plant.

The thermal imaging capabilities of the Mavic 2 Enterprise Dual allowed emergency teams on the ground and in the air to coordinate their efforts despite the thick smoke, guiding the deployment of resources and reducing the time personnel needed to spend in radioactive areas.

FLORIDA, NOVEMBER 2019

In November 2019, the Southern Manatee Fire & Rescue (SMFR) HazMat Team arrived on the scene of an anhydrous ammonia leak at a food distribution warehouse in Florida.

Ordinarily, it was the kind of scenario that would require multiple trips to and from the scene to discover the exact cause and location of the leak. This would lead to high equipment costs, extensive downtime for the business involved, and a greater chance of dangerous exposure for first responders on the ground.

However, having pioneered the use of drones in HazMat response, the SMFR crew quickly launched a Mavic 2 Enterprise Dual to relay thermal and RBG video back to the incident commander with a precise location of the ammonia cloud.

The team was able to determine which valve to shut down, stop the leak, and get started on decontamination - all in a fraction of the time compared to conventional methods.

NOTRE DAME, APRIL 2019

In April 2019, a devastating fire broke out inside the Notre Dame Cathedral in Paris.

Crowds gathered as the city's firefighters fought to rescue one of the world's iconic medieval structures. Using DJI drones, including a Mavic 2 Pro and a thermal-equipped Matrice 210, Parisian firefighters were able to better coordinate their efforts, carefully aim hoses, and track the spread of the fire from above.

After, French firefighter spokesman Gabriel Plus said, "It is thanks to these drones, to this new technique (that's already) absolutely essential today, that we could make tactical choices to stop the fire at a time when it was about to occupy the two belfries."

DJI'S THERMAL DRONE SOLUTIONS

MAVIC 2 ENTERPRISE ADVANCED

MAVIC 2 ENTERPRISE ADVANCED

The Mavic 2 Enterprise Advanced is a lightweight, portable and foldable drone with a thermal sensor and a zoom camera.

- Portable and quick-to-deploy
- Spotlight, loudspeaker, beacon, and RTK accessories available
- 31 minutes of flight time
- 899 g

- 10 m/s wind resistance
- 10 km maximum range (FCC)
- 1/2" CMOS (42 MP) RGB sensor
- 640x512p thermal sensor

MATRICE 300 RTK

MATRICE 300 RTK + ZENMUSE H20T

The new Matrice 300 RTK is DJI's latest enterprise platform, with up to 55 minutes of flight time, omni-directional sense and avoid technology, and unrivalled reliability. Its H20T triple payload combines an RGB camera with a 640x512p thermal sensor and a laser rangefinder.

- Triple payload
- ~ 43 minutes flight time
- Hot-swappable batteries & battery station
- 7.1kg
- 15 m/s wind resistance (FCC)

- IP45 (drone) + IP44 (payload)
- 15 km maximum range
- 1/1.7" CMOS (20 MP) RGB sensor
- 640x512p thermal sensor
- Laser range finder

MATRICE 210 V2

MATRICE 210 V2 + ZENMUSE XT2

The Matrice 210 V2 is a rugged, adaptable solution that's ideal for public safety applications. emergency services. It's compatible with a number of DJI Payloads, including the Zenmuse XT2, our powerful 4K and thermal imaging dual-sensor payload.

- Dual payload
- ~ 30 minutes flight time
- 5.3kg
- 12 m/s wind resistance

- IP43 (drone) + IP44 (payload)
- 8 km range (FCC)
- 1/1.7" CMOS (12 MP) RGB sensor
- 640x512p thermal sensor

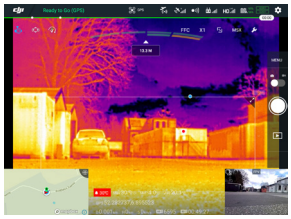
THERMAL SOFTWARE TOOLS

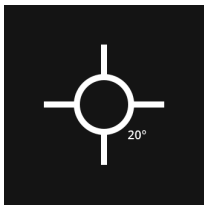
MSX – Multispectral Dynamic Imaging: Quickly interpret data with details from the visual image overlaid on the thermal data stream.

QuickTrack: Select an object to lock the payload onto it and simplify missions in complex environments.

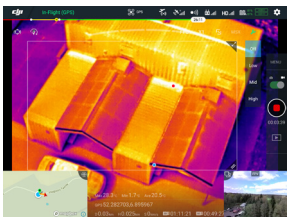
HeatTrack: Capture the most critical information by automatically locking the payload onto the hottest object in view.

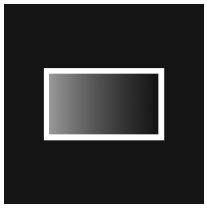
TempAlarm: Don't miss a thing with instant notifications when object temperatures exceed pre-set parameters.



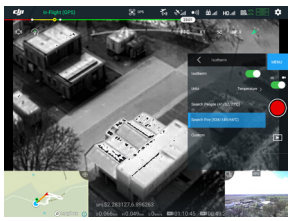


TempCheck: Tap a point or select an area for real-time temperature measurements.

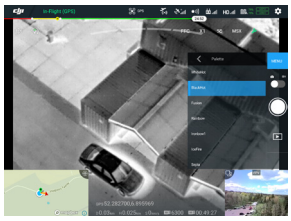




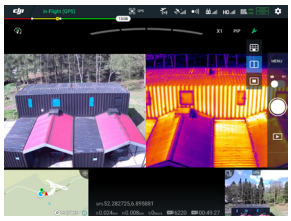
Isotherms: Focus on a specific temperature range to identify what's important.



Color Palette: Adjust the colors applied to the thermal data to easily interpret what's happening.



PiP – Picture in Picture: Optimise how you view the thermal and visual feeds – side by side, overlapping and more.



SETTING UP A DRONE PROGRAM

INTEGRATING THERMAL DRONES WITH THE FUTURE OF FIREFIGHTING

The case for integrating thermal drones into firefighting operations is compelling. But it's a complicated process.

The technology is proven and effective, but its proliferation isn't so straightforward. As we have touched upon, drones represent another aircraft in the sky during major incidents. When fighting wildfires in particular, their use needs to be carefully coordinated alongside the use of planes and helicopters.

Thermal drones have come to the fore during nighttime operations and in the absence of crewed aircraft, but technological advances in the fields of air traffic management are needed if they are to be integrated alongside these conventional fire fighting methods.

There are day-to-day challenges for fire chiefs to consider, too. Quite rightly, firefighters are standards and process-driven. Every tool has a purpose and every action during an emergency response needs to be justified.

Crews will need to think carefully about how thermal drones can fit into their workflows and complement traditional firefighting tactics, as well as how the information gathered can get to where it needs to be, fast.

Training is vital to get the best out of drones and thermal imaging technology. But the prospect of having a firefighter behind the controls rather than tackling a blaze directly, at a time when firefighting budgets have been scaled down, is a significant challenge to overcome.

Many of the solutions to these challenges lie in collaborative software tools and advances in AI and autonomous solutions, but this conundrum also opens the door to greater cooperation between public safety organisations - particularly during large-scale emergencies.

Effectively integrating these novel solutions into existing workflows is perhaps the single greatest challenge to overcome when launching a drone program.

For any public safety body determined to gather data, improve situational awareness, and make life-saving interventions with drones, navigating the early steps will feel like flying into uncharted territory.

There's plenty to think about, from personnel training and developing solutions to the regulatory hurdles that come with operating flying robots.

For a step-by-step guide to planning, managing, and scaling out your drone ambitions, download our Building a Drone Program Playbook.

https://enterprise-insights.dji.com/learning-center/building-a-drone-program-playbook

QEP PROGRAM - CONDUCT PUBLIC SAFETY MISSIONS WITHOUT GEOFENCING RESTRICTIONS

We're committed to supporting national, regional and local public safety agencies in the use of our products.

DJI's Qualified Entities Program (QEP) aims to minimise operational restrictions for our public safety partners. Most commercial and enthusiast users fly with our geofencing technology, which places limits on altitude and flights in No-Fly Zones (NFZ).

We recognise that public safety organisations need greater flexibility to deploy their aircraft anytime, at any height, and anywhere. The QEP process unlocks NFZs in the country of your jurisdiction and gives greater control over altitude restrictions.

https://enterprise-insights.dji.com/qualified-entities-program

CONCLUSION

THE VALUE OF THERMAL DRONES

The scenarios faced by firefighting services around the world vary. But one constant is the need to reduce costs while finding efficiency gains. With tight budgets and the threat - in the case of wildfires - increasing in scope, tools and solutions that promote safety, speed, and efficiency can make a huge impact.

As an affordable force multiplier, thermal drones have enormous potential to improve ROI. The technology enables smarter and safer operational decisions, provides objectivity where previously there has been guesswork, reduces time on scene, and in turn frees crews to attend to other emergencies.

During any operation, firefighters are expending resources in one place that can't be deployed to another. By streamlining efforts on scene and tackling fires more effectively, those savings translate to shorter response times.

But most importantly, the use of thermal drones mitigates risk. Less time spent battling fires means less chance of injury in the line of duty. It means safer working conditions in a perilous profession. Embracing aerial intelligence has profound benefits in the long term: lives saved, injuries prevented, damage avoided, and tragedies averted.

From detecting invisible hotspots and preventing secondary fires to gathering wildfire data at night, these sophisticated tools represent the most revolutionary firefighting aid since the introduction of the firehose. For decades, no emerging technology has improved firefighter and civilian safety to this degree.

Thermal drones offer efficiency gains and cost savings wherever they are used, from preventative data gathering to resource deployment, to ensuring scenes are safe before emergency teams depart.

Adopting thermal drones isn't without its challenges. Getting the most out of this innovative technology requires training, adapted operating procedures, and a willingness to evolve. But the evidence in favour is compelling.

The question facing fire chiefs is no longer whether to invest in these verifiable tools. It's why haven't you done so already?