A SYNECTICS GUIDE TO:

Thermal Cameras for Oil & Gas Surveillance

SYNECTICS

WELCOME

This guide outlines the main differences between thermal and infrared cameras, the performance characteristics of cooled and uncooled thermal cameras, and explains why this information matters when deciding when and where to use this technology for oil and gas applications.

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INTRODUCTION

The first thermal cameras were developed for military use around 60 years ago. Times have changed a lot since then.

Today, the oil and gas industry is one of the technology's biggest users, with thermal cameras deployed across a wide range of applications – from process safety to threat detection.

But where and when do thermal cameras deliver most operational value, particularly in comparison to infrared cameras? And are there situations where thermal technology is used in error?

This guide provides some key facts to help clear things up.

THERMAL Vs INFRARED

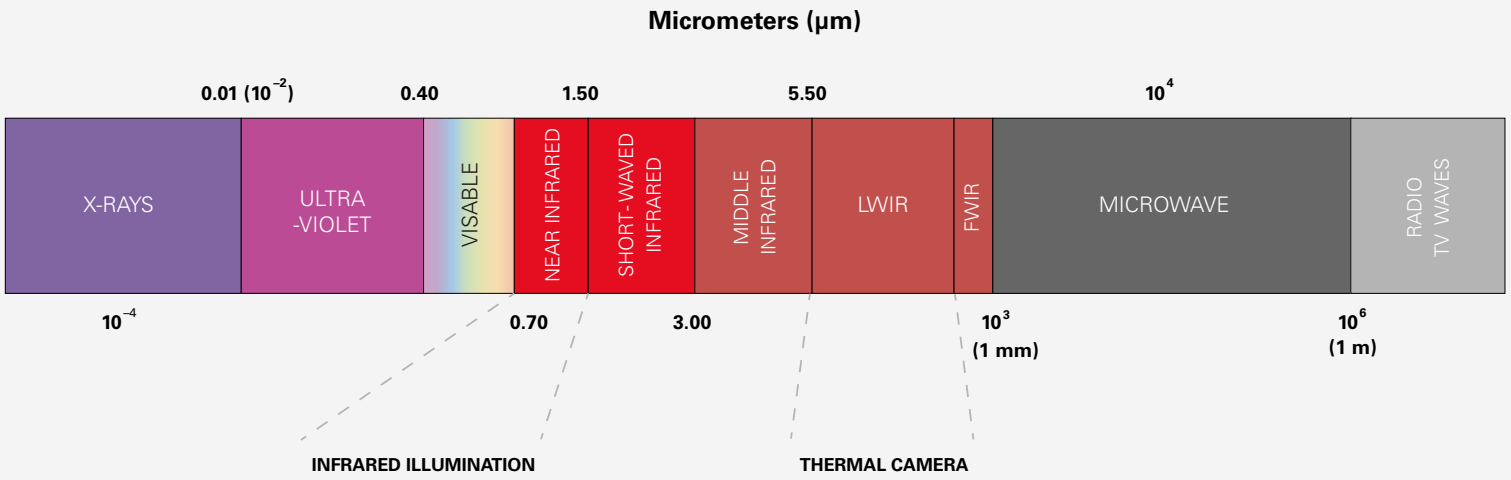
The terms are often used interchangeably which is a mistake and can lead to confusion about where best to use thermal technology.

We're talking different wavelengths

Thermal cameras use radiation from the infrared spectrum. In that sense they are 'technically' infrared (IR) cameras. But the range we are talking about is the very far end of that spectrum – well beyond the frequency range of 'near infrared' i.e. the area of the spectrum where most IR cameras operate.

The IR range is much closer to visible light on the spectrum. As a rough guide, visible light (what the human eye can easily see) spans from about 450nm to 750nm, with near infrared kicking in at approximately 700nm and going up to around 1000nm.

By comparison, thermal cameras operate at wavelengths up to 14,000nm.



SOMETHING TO REFLECT ON

IR cameras detect light (near-infrared light) reflected from an object, meaning that a light source is necessary in complete darkness – typically an integral infrared LED.

Thermal cameras operate by detecting differences in the radiation emitted by an object.

This means that thermal cameras require an entirely different design – most notably using a material such as germanium instead of glass for the optics to accommodate the operational wavelength.

The sensors used also need to be different in order to respond to radiation at this wavelength

CONSIDERING COSTS

Cost is another key difference.

Because thermal cameras have such distinct design differences – germanium vs glass, different sensors etc. – they are also more expensive to buy than standard electro-optical cameras.

However, when considering lifespan, it can be argued that thermal cameras become more cost-effective.

This is because IR cameras require LED illumination, which can be susceptible to degradation.

LED light sources will degrade by approximately 30% in as little as five years, potentially impacting camera capability and image quality.

Thermal cameras will require a more significant initial outlay, but their lifespan is much longer.

DISTANCE MAKES A BIG DIFFERENCE

Thermal vs IR

Both thermal and IR cameras are great for low or no light applications. But because they operate by measuring emissivity rather than capturing reflected light, thermal cameras can detect objects at much greater distances than is possible with IR.

Active illumination with cameras fitted with IR LED illumination only have a limited operational range – typically out to about 200m – and very much depend on the reflectance of the target.

As the distance increases and the camera field of view is reduced or zoomed in, the light attenuation increases and a more powerful illuminator is required, so it becomes a law of diminishing returns.

On the other hand, thermal cameras passively operate in the Medium-Wave Infrared (MWIR) and Long-Wave Infrared (LWIR) bands with their operational range only limited by the lens and sensitivity of the camera.

COOLED THERMAL VS UNCOOLED THERMAL

There are two true types of thermal camera. Cooled and uncooled.

Cooled thermal cameras offer a better signal-to-noise ratio which translates into a higher sensitivity. To achieve this, the imager is cooled to about 70K using a Stirling engine (cryogenic-cooler) which reduces the camera's operating temperature to ensure the sensor isn't affected by the camera's own radiation.

Most cooled cameras offer around 3-4 times the sensitivity of uncooled thermal cameras.

This increase in sensitivity enables longer focal length lens to be used over much greater target distances, making them ideal for distance-based threat detection applications at night or where visibility is poor due to adverse conditions (fog/heat haze/sand etc.)

These may include:

- Onshore perimeter protection
- Offshore approaching vessel detection
- Drone mounted asset integrity monitoring

Detection
'Something is there'

Recognition
'A person is there'

Identification
'Person looks like a maintenance worker'

DO YOU NEED TO DETECT, RECOGNISE OR IDENTIFY?

When it comes to thermal cameras, these things are important.

DRI is different with thermal

Organisations using electro-optical cameras will be very familiar with DRI ranges (Detection, Recognition and Identification).

'Detect' means with high probability a person is present, 'Recognize' enables the observer to confirm the person is someone they have seen before, and 'Identify' enables the observer to confirm the identity of a person beyond reasonable doubt.

With thermal cameras, DRI is based on different criteria – the Johnson Criteria to be exact.

Here 'Detect' confirms that an object is present, 'Recognition' enables the type of object or class to be confirmed e.g. man or car and 'Identification' enables a specific object or class to be discerned e.g. type of car.

So, while cooled thermal cameras can discern much smaller differences in radiation/ temperature at greater distance, this facilitates improved threat detection but not necessarily identification.

WHAT IF I DO NEED TO IDENTIFY THREATS?

In reality, fulfilment of the DRI process from a systems perspective is typically achieved using a combination of camera types.

For instance, as part of a perimeter protection solution for an LNG plant, cooled thermal cameras may be used to detect long-range threats and trigger initial security alerts, with the 'Recognition' and 'Identification' function automatically switched to electro-optical cameras if the object detected continues to approach the site.

For an offshore facility, cooled thermal cameras are often paired with radar and absolute positioning solutions to 'detect, identify and track' potential threats at sea.

PERFECT FOR PROCESS, MADE FOR MAINTENANCE

There are many vital process and maintenance applications for oil and gas projects where distance and superior sensitivity are not key factors, but where the overall benefits of thermal camera technology are still required. Here, uncooled thermal cameras probably have the advantage.

Applications that may fall into this category include:

- Flare stack monitoring
- Gas leak detection
- Pipeline/storage tank hot spot monitoring
- Tank fill level monitoring

Focus on flares

Monitoring a flare stack flame, or pilot flame, to discern burning profiles (heat levels/ gas emissivity etc.) is important from a regulatory, safety, and environmental perspective.

The objective is non-visible detection (not precision imaging) and the detection distance does not necessarily require the use of cooled cameras.

Uncooled thermal cameras provide an ideal, cost-effective solution.

WHEN THERMAL ISN'T SO HOT

While thermal cameras do offer many advantages, many of those are lost when looking at surveillance for retrospective use only i.e. for recording and review.

Thermal cameras won't, for example, offer the same detailed evidentiary review capabilities as electro-optical cameras.

Their strength lies in proactive surveillance as an early warning mechanism for approaching objects, mechanical failure and process issues.

In summary, thermal cameras are an ideal first line of defence in terms of critical detection capabilities in low/no light conditions.

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