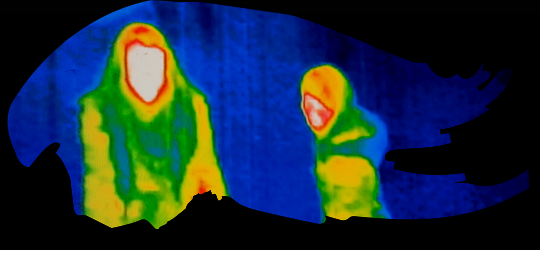
THERMAL™ RADAR
Visionary Thermal Detection

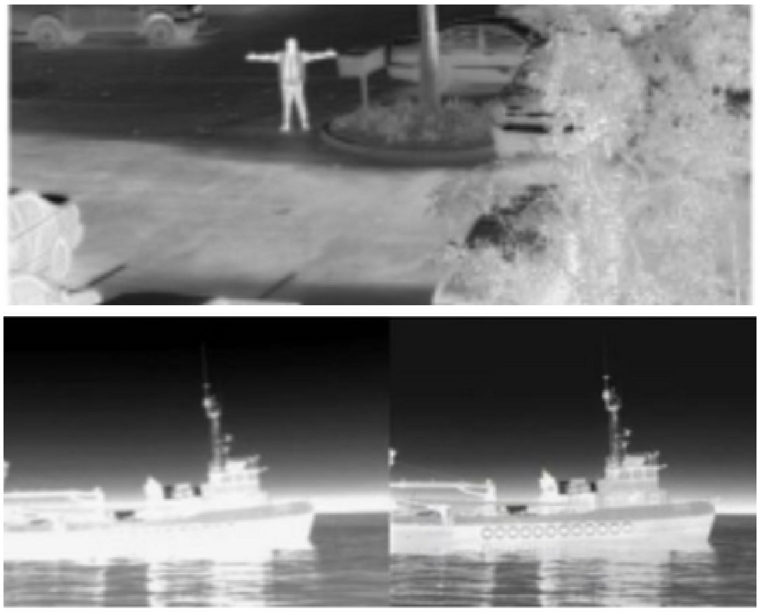


THERMAL DETECTION WHITE PAPER

Thermal imaging cameras have been providing security professionals with the upper hand in the detection of threats for the past decade. Thermal imagers have unique advantages, such as allowing users to detect people, vehicles, or other objects during daytime and nighttime as well as under difficult environments such as light fog, smoke, haze, and dust. In addition, thermal sensors/imagers provide a reliable platform for integrating intelligent security software applications used in perimeter security applications. A conventional visual/optical IP camera is affected by changes in the captured image and can, for example, be disturbed by darkness, shade, and backlighting. A thermal imaging camera detects the thermal radiation emitted from objects, which provides a consistent target compared to illumination variances in visual light systems.

Thermal imaging cameras utilize a thermal sensor/imager which "sees" heat instead of light. Thermal images depict objects using their temperature rather than their visible properties. So how can thermal imaging "see" heat? All objects warmer than absolute zero (-273°C/-459°F) emit infrared radiation in the MWIR and LWIR wavelengths (3µm–14µm) in an amount proportional to the temperature of the object. Thermal imaging focuses and detects this radiation, then translates the temperature variations into a greyscale image, using brighter and darker shades of grey to represent hotter and cooler temperatures, thus giving a visual representation of the heat shapes in the field of view.

To "see" radiated heat, special lenses, and sensors are needed to focus and detect electromagnetic radiation in the MWIR (mid-wave infrared) and LWIR (long-wave infrared) ranges. Thermal Radar uses an LWIR sensor.



MD-24 comes with a 320 x 240 detector (left). MD-625 comes with a high-resolution 640 x 480 detector (right), which provides a sharper image and longer-range performance.

Thermal Imagers/Sensors
The FLIR Boson sensor, used in all Thermal Radar units detects thermal radiation emitted from the surrounding environment. Thermal Radar utilizes the thermal sensor most efficiently by rotating the thermal sensor perfectly to continuously gather a 360° thermal field of view every 1-4 seconds. Thermal Radar is integrated with edge-based, intelligent video applications, such as thermal video motion detection which will automatically trigger an alert to an operator and at the same time direct a pan-tilt-zoom (PTZ) camera on target to supply live surveillance video into a video management system (VMS).

Thermal Imaging Lenses
Glass lenses are used primarily for optical cameras to focus light on a camera sensor. Glass, however, is not translucent to thermal radiation. Thermal lenses are manufactured from a metalloid called Germanium (Ge). Germanium is a rare element and thus is quite costly. With Germanium prices often as high as $2000 per kilogram, thermal imaging cameras have traditionally cost significantly more than optical cameras, depending on the type of sensor, lenses of different specifications are required for various security applications.

No Light Needed
Most cameras require a light source to create an image. But since thermal energy is naturally emitted radiation, a thermal imager can “see” the environment regardless of lighting conditions. This passive technology can be used in complete darkness without the need for an illuminator, making it an extremely covert and versatile solution.

Wide Area Threat Detection
Humans, animals, and vehicles are characteristically warmer than their environment in most cases, providing a high disparity that allows for fast wide-angle detection of threats.

Reliable Day/Night Coverage
An optical camera’s image is dependent on good illumination circumstances. In areas where contrast is poor or the dynamic array is too wide, optics can become virtually useless. Thermal, however, is entirely immune to changes in light, permitting it to see reliably in any lighting environment for daytime and nighttime imaging.

Fog, Dust, and Smoke
Thermal energy passes through many visually evident obscurants including smoke, dust, fog, and light vegetation.

Pixels, Pixels, Pixels
The terms detection, recognition, and identification (DRI) can be ambiguous, especially to customer-level contacts and the public who do not have a security or electromagnetic background. The terms detection, recognition, and identification do not relate to performance but rather are calculated based on their pixel counts. To better understand this, Thermal Radar’s high-res thermal sensors have a resolution of 640×512 which is over 300,000 pixels per field of view. Human “detection” only requires 3 to 4 pixels and “identification” only requires 230 pixels, which is an extremely small number of pixels on the screen. Such small pixels can often go unseen by the human eye. Even when magnified, the amount of detail visible at the detection, recognition, and identification distances are not as high as one might expect, as seen in the following chart.

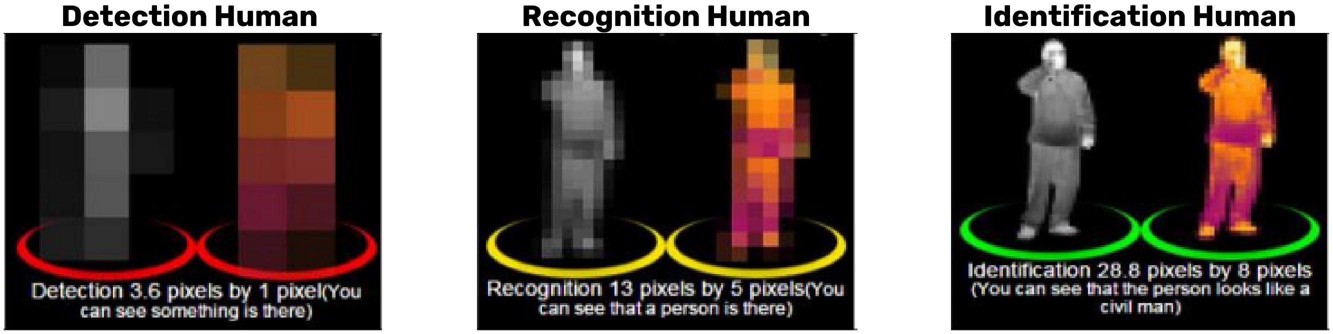
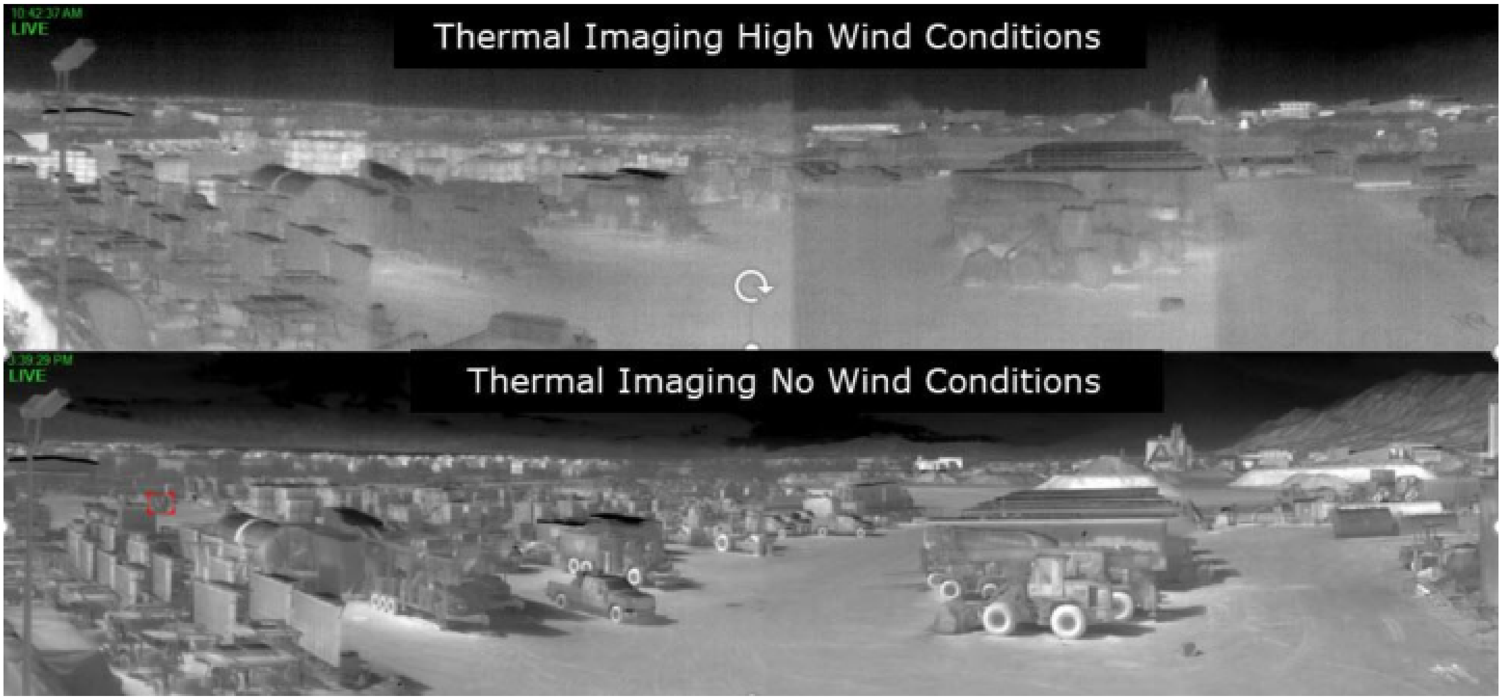


Figure 1. Pixel count required for human detection, recognition and identification



Performance Under "Ideal Conditions"
With thermal imaging, it is essential to remember that DRI (Detect - Recognize - Identify) criteria are valid only in ideal conditions. Ideal conditions are often not mentioned and are based on conditions that rarely happen in the real world. The average environmental application will get 25% less than the maximum distance that the thermal camera is rated for and in extreme conditions detection can be less than 10% of the maximum rated distance. We wrote this white paper to give customer-level contacts and security integrators a better understanding of the actual performance they can expect from thermal imaging.

Figure 2. Thermal Radar 360° RTSP (180° FOV on Top, 180° FOV on Bottom, Geospatial Map, Zoomed Alarm Window)

Environmental Conditions to Consider

Weather and environmental conditions will affect the thermal radiation emitted from an object and decrease the effective detection range due to the lack of contrast between the background and foreground. Environmental factors that affect thermal imagers include weather conditions and the temperature difference between an object and its background. An object with nearly the same thermal emission temperature as the background, such as a body on a moderately hot summer day, is harder to distinguish from its background than an object with a greater temperature difference, such as a car with a running engine on a cold winter day. The two most important environmental factors that affect the image of an object in the thermal imager are absorption and scattering. They reduce the thermal radiation that reaches the imager, thereby reducing the distance at which the imager can detect an object.

Absorption

Water vapor (H_2O) and carbon dioxide (CO_2) in the air are the primary causes of absorption. During absorption, the heat radiated from the object is absorbed by water vapor and carbon dioxide and loses some of its energy before reaching the thermal imager. The water vapor content of the air affects image quality even in sunny and clear weather. In winter, if all other weather conditions are the same, the water vapor content of the air is lower than in summer. Since water vapor content is lower, less thermal radiation is absorbed by the water molecules, allowing more thermal radiation to reach the thermal imager and resulting in better image quality when compared to a summer day.

Scattering

During scattering, the thermal energy radiated from the object is dispersed when it hits particles in the air. The loss of radiation is directly related to the size and concentration of the particles, droplets, or crystals that constitute polluting, condensing, or precipitating conditions such as smog, fog, rain, or snow.

Fog, Smog & Haze

Fog appears when water vapor in the air condenses into water droplets. The droplet sizes vary with different kinds of fog. In dense fog, the water droplets are bigger due to accretion, thus scattering thermal radiation more than in light fog. Also, fog scatters thermal radiation more than smog and haze because of the greater size and concentration of its water droplets.

Rain - Snow

Even though raindrops are larger than fog droplets, their concentration is lower. This means that rain does not scatter thermal radiation as much as fog does. The level of scattering during snow is somewhere in between the range of fog and rain. Sleet or wet snow has a scattering level more like rain, whereas dry snow is more like fog.

Conclusion

Thermal Imaging Radar is the most cost-efficient and effective product for wide-area intrusion detection during daytime and nighttime conditions. Thermal Radar is a mission-critical and operationally relevant solution for wide-area detection. Thermal Radar provides a continuous 360° field of view of any physical incursion that may threaten a perimeter and provides real-time actionable intelligence. Detection is the most critical step in securing a border of any kind; therefore, a perimeter detection solution must be both highly-effective and cost-efficient. Thermal Radar utilizes edge analytics performing millions of computations per second allowing Thermal Radar to be a low-power, standalone detection outpost or the centerpiece of your integrated physical security strategy.

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