

A typical common module infrared image of a ship underway is shown as seen by the aircrew operator.



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Under the Cover of Darkness

By Commander Howard Wheeler



A FLIR-equipped P-3 Orion undergoes testing with the new infrared imagery system.

The scene is pitch black. There is virtually no light, not even the faint glow of starlight. The prey is crouched in a corner that is even darker than the surroundings. It has an uneasy sense of security, knowing that it can't be seen. If it can't be seen, surely it must be safe.

The hunter lurks nearby shrouded by the same blackness that envelops the entire area. It is as quiet as it is dark. Suddenly, there is a rush of movement as the hunter strikes at its target with lightning speed and deadly accuracy.

In this case, the hunter is a Southern Pacific rattlesnake and the prey is a small rodent. But the scenario is not unlike a combat situation. The survivor in one-on-one combat is almost always determined by which has the better ability to strike first, quickly and decisively before being detected.

During WW II, the odds were fairly even between Naval Aviators and enemy pilots. Night operations at sea were scary at best but there was some comfort in knowing that the enemy had to cope with the same limitations brought on by nightfall. Even though radar was introduced during the early 1940s, one of the best sensors a Naval Aviator had



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to locate a target at night while airborne was his eyes — the “mark one eyeball.” (See “Black Chickens and Bat Teams,” page 6.)

The human eye is primarily a daytime sensor, however, which is dependent on light reflected from the sun or other sources to perceive accurate images. It is extremely limited during the hours of darkness and in low-light situations, and virtually useless in total darkness.

If the rattlesnake in the scene described earlier had to rely solely on its eyes, it would have been hard pressed to locate its prey. The snake, however, is gifted with a remarkable ability to see through the darkness with thermal infrared (IR) sensors in the pits located in its head above the mouth. More accurately, it cannot see in the dark, but rather it can sense the location and apparent size of a warm-blooded animal without the aid of ambient light. Even though the snake's pit sensors do not provide it with a high-resolution image of the prey, they are highly effective.

Modern technology has enabled man to imitate and use many such capabilities found in nature. Several of today's

naval aircraft, for instance, use infrared sensors to localize and identify targets — visually — over ranges suitable for targeting and attacks under completely lightless conditions.

Identifying a potential target as friend or foe — and, if foe, whether it is a high-value or low-value target — is a vital element of any combat mission. For a pilot to be able to confirm the identity of the target without giving away his own position before attack may mean the difference between success and failure.

High technology is the edge today's Naval Aviators have to strike quickly and accurately at their prey. The state-of-the-art of infrared sensors technology is impressive and has significantly enhanced mission success. However, it is in a class by itself in terms of the time and expense involved in manufacturing current infrared detectors.

Let's take a look at one system being used in the fleet today.

The current Navy AN/AAS-36 infrared detecting set (IRDS) is in the category of sensors called forward-looking infrared (FLIR) systems, used to examine the earth's surface

by detecting different intensities of infrared energy radiated by specific objects or ground formations. The IRDS is used to detect objects on or just below the surface of the sea, or along the flight path of the P-3 Orion aircraft.

According to Mr. W. Theodore Noel, an electrical engineer involved with infrared technology at the Naval Air Systems Command, Washington, D.C., the thermal infrared sensor used in the AN/AAS-36 IRDS is a complex device consisting of a 180-element, semiconductor chip measuring about an inch long and mounted in a vacuum enclosure with an optical entrance window through which the detector can view an infrared scene. Some 24 weeks of manufacturing time under the most stringent environmentally-controlled conditions are required to produce a chip that meets Navy performance requirements. The thermal infrared sensitive semiconductor chip, for example, is manufactured from an exotic mixture of three metals — mercury, cadmium and telluride. The fabrication process for these substances alone requires approximately three months and involves an array of semiconductor operations that include photolithography, thin and thick film technology, metal etching, diffusion, plasma etch, and high vacuum technology. If during this lengthy and elaborate production process a detector fails to meet standards, it cannot be salvaged or reused.

While the eye of the pilot needs visible light and radar depends on microwave energy to locate targets, the IRDS depends solely on the man-made or natural thermal heat energy emitted by an object in the infrared spectrum.

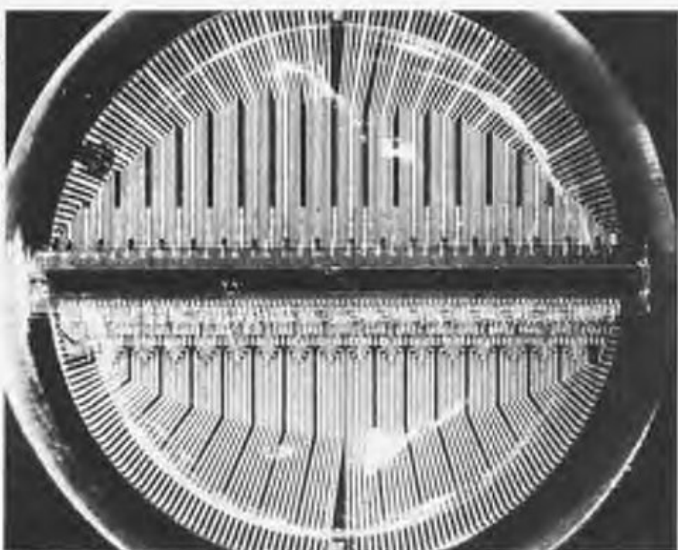
To a physicist, visible and thermal infrared radiation can be measured in terms of their respective wavelengths. For example, the wavelength of ultraviolet light (the invisible part of sunlight that causes sunburn) is approximately .2 to .4 microns. Visible light which the eye perceives as colors has wavelengths of between .4 to .75 microns. Slightly

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A TV image of fuel farm is shown on a typical common module infrared image device.

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The heart of the infrared detection system (IRDS) is this one-inch diameter, 180-element infrared detector. It senses thermal infrared energy given off by a target and its surroundings, and changes it into electrical signals which are used to create a high-resolution TV image. The imagery provided by the video display is used by the operator to locate and classify the target.

higher on the electromagnetic spectrum is thermal infrared energy with wavelengths between 8 and 14 microns.

The IRDS is a passive thermal imaging device that detects infrared radiation in the 8 to 14-micron spectral region. Since the earth's natural emissions occur in this range, the earth as "seen" by the IRDS provides a consistent background against which all objects show in relief by virtue of their normally higher or lower intensities of infrared emissions. Even an object cooler in infrared terms than the earth's surface will be "visible" to the IRDS because the system will detect this against the background.

Since IR emissions are always present, the IRDS can detect objects in spite of the presence of haze, smoke, camouflage or darkness. However, it does have some limitations because moisture in the air (clouds, rain, fog) tends to absorb and scatter IR energy. Its presence in the atmosphere can somewhat degrade the system's range.

Unlike radar and active sonar-detecting devices that can be located by the presence of their emissions, the IRDS is a totally passive scanning receiver/sensor that emits no energy. Therefore, it is difficult for the target to detect that it is the subject of surveillance by the IRDS. Also, since the IRDS is entirely passive, there is no effective way to jam the system with countermeasures.

The IRDS can detect targets such as surface ships and temperature anomalies that are caused by ship bulkheads, heated and cooled ship compartments, and snorkel wakes. The system converts these variations in IR energy intensities to an electrical signal that is displayed on a television-type display. The operator viewing the video display can then detect and identify targets from an ample standoff range.

Compared to yesteryear, today's Naval Aviators and flight crews have the benefit of highly reliable and effective detection systems such as IRDS to enhance mission readiness and enable them to strike first when going in harm's way. ■

The infrared receiver detection system (IRDS) is basically a high-performance infrared (IR) television. It senses IR heat energy emitted by an object, and converts it first to an electrical signal and then to visible light which is received by a TV camera.

The infrared radiation from the target scene is collected by afocal telescopic optics and focused onto one side of an oscillating, double-faced scan mirror. From the mirror, the IR energy is reflected onto an array of IR detectors that operate at -196°C (-107°F). The detector array converts the IR energy to an electrical signal that is processed and amplified. The amplified signal then modulates the light intensity from an array of light-emitting diodes (LEDs) where it is converted to a visual image. The back side of the scan mirror projects the image from the LED array onto the face of the camera/vidicon. The visible image is converted to a video signal which is amplified and then converted into a standard composite TV video signal that provides an 875-line display on the IRDS video indicator.

The IRDS system in the P-3 Orion can provide full lower hemispheric coverage. The system's line of sight rotates a full 200 degrees both left and right of the aircraft's centerline and swivels 15 degrees up and 82 degrees down in elevation. The IRDS has two fields of view (FOV): a wide FOV (search) for initial acquisition, and a narrow FOV (track) for identification and classification of a target. ■

IRDS Receiver Operation

