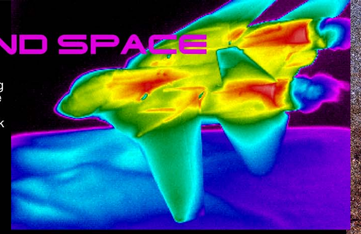
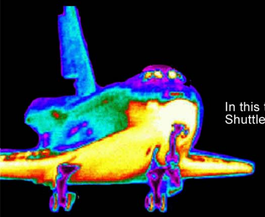
MILITARY AND SPACE

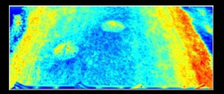
The U. S. military has used infrared imaging since World War II to enable soldiers to see in the dark. During the 1991 Gulf War, soldiers used infrared cameras to track tank and troop movements across the desert.



Aerospace engineers use infrared images to study thermal stresses in an airplane, identifying where special maintenance might be needed.



In this thermal infrared image, the protective heat shield of the Space Shuttle glows brightly after re-entering through the Earth's atmosphere.



In this infrared image, you can see two otherwise invisible anti-tank mines buried in a dirt road. After being heated by the daytime sun, metallic portions of the mine remain warm at night, allowing an infrared camera to detect them from a safe distance.

LAW ENFORCEMENT

Criminals cannot hide in the dark from the peering eyes of an infrared camera. Police and security officers can now monitor areas in total darkness just as easily as if it were broad daylight.

Infrared detection is very useful in traffic surveillance and in high-speed motor vehicle chases. When a vehicle tries to elude police officers in the dark, the hot engine and tires can easily be tracked and monitored.

Infrared cameras are widely used for perimeter surveillance and nighttime monitoring of U.S. borders. Infrared cameras can also detect concealed weapons and are used to read text that has been intentionally blacked out.

ASTRONOMY

Infrared technology is revealing a universe considerably richer and more dynamic than we've ever seen before. Infrared detectors on the Galileo spacecraft observed Jupiter's moon Io, and caught a spectacular volcanic eruption spreading hot sulfur in a plume 800 miles across.

The center of the Milky Way is hidden behind a vast lane of dust, thousands of light-years across. In visible light, this area of the sky is almost completely dark, due to the obscuring material. In the infrared, however, astronomers can see into the dynamic heart of our galaxy. In this near-infrared image (background), the galactic center glows bright yellow, as millions of stars orbit a mysterious, hot center, which may harbor a massive black hole.

Stars are born deep inside (visibly) opaque clouds of dust and gas. Short-wavelength infrared light serves as an invaluable probe, piercing through the intervening dust to reveal stellar nurseries of newborn stars.

The Flame Nebula (below) is part of the vast Orion molecular cloud complex, the largest area of star formation in our local astronomical neighborhood. This near-infrared photo shows a bright and dense cluster of new stars behind the dark lane of dust in the center of the nebula.

Images provided by:
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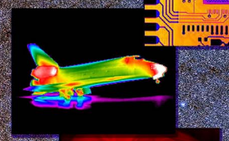
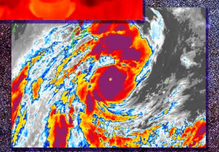
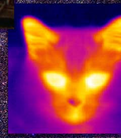
Waikiki Aquarium

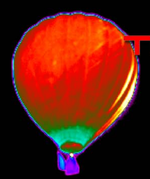
INFRARED

SEEING OUR WORLD IN A DIFFERENT LIGHT









THE INFRARED

Infrared light is primarily thermal radiation (heat), although it is part of the electromagnetic spectrum. Infrared represents a type of 'light' that our eyes cannot see, and is found beyond the red portion of the visible-light spectrum. Any object that has a temperature above absolute zero (about -273° C, or -460° F) radiates in the infrared. Even objects we think of as being very cold, like ice cubes, emit infrared light.

Recent advances in technology have led to a revolution in our ability to image and measure infrared light. The development of these new infrared detectors is a result of cooperation between aerospace industries funded by the military, and civilian companies funded primarily by NASA and the National Science Foundation. These research efforts have led to a huge range of useful applications for infrared technology.

SEARCH AND RESCUE

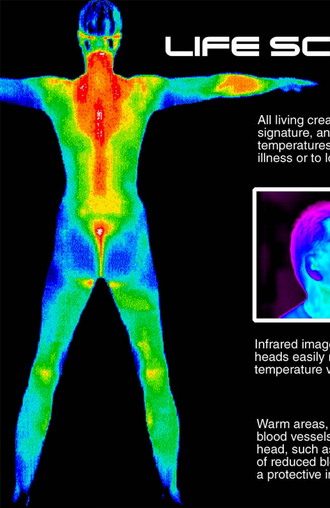
One of the most useful properties of short-wavelength near-infrared light is that it is unaffected by smoke. Firefighters with infrared cameras can see into smoke-filled houses and quickly locate people trapped inside.

In structural fires, infrared cameras are used to detect hot spots in walls and roofs, and to find fires behind solid doors. Using airborne infrared cameras, firefighters can locate 'hot spots' in a raging forest fire, even through clouds of obscuring smoke.

Humans and other warm-blooded animals usually radiate more heat than their surroundings, especially in the cool nighttime air. In search and rescue operations, we now use infrared light to find people lost in thick foliage, in deep canyons, in choppy seas, or in the darkness of night.

Infrared cameras can also be used to find avalanche and earthquake victims buried under snow or debris.

LIFE SCIENCES

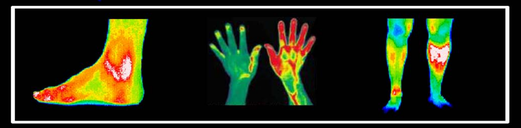


All living creatures have a unique heat signature, and slight changes in temperatures can be used to diagnose illness or to locate injuries.

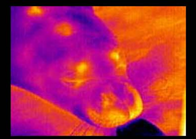
Infrared cameras provide a glimpse of the inside of a body. Examples include producing a full-body temperature map and looking at the face of a cat (the eyes and ears are warm, the nose is cold).

Infrared images of human heads easily reveal temperature variations.

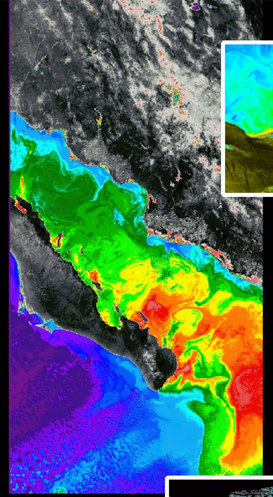
Warm areas, like the neck and near the eyes, indicate that blood vessels are just below the skin. Extremities of the head, such as the nose and ears, are cooler and indicative of reduced blood flows. Hair (and fur in animals) provides a protective insulating blanket, helping to retain body heat.

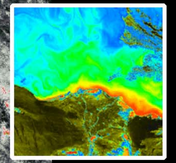


Infrared diagnostics can reveal the location and extent of a sprained ankle, uneven blood flow in hands, or even the calf muscle strain caused by a person shifting his or her weight off an injured ankle.



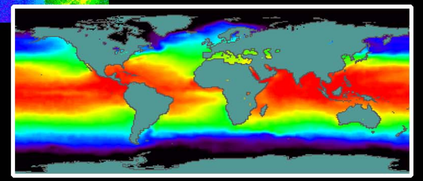
Infrared images also are used to study the behavior and habitats of animals. Marine mammals, like the harbor seal (left), must have natural protection to maintain their warmth in cold water.

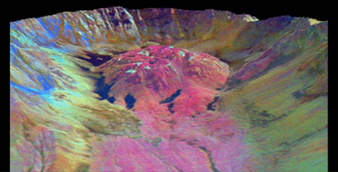




Infrared maps allow us to chart ocean currents and to predict their effect on long-term weather patterns. Sea surface temperatures reveal the degree of ocean heating by sunlight and the amount of carbon dioxide that is absorbed. Both of these measures help scientists track global warming.

Infrared satellite images show us detailed water currents in the Nile Delta (top) and Baja California (left), and the global impact of "El Nino" (below).

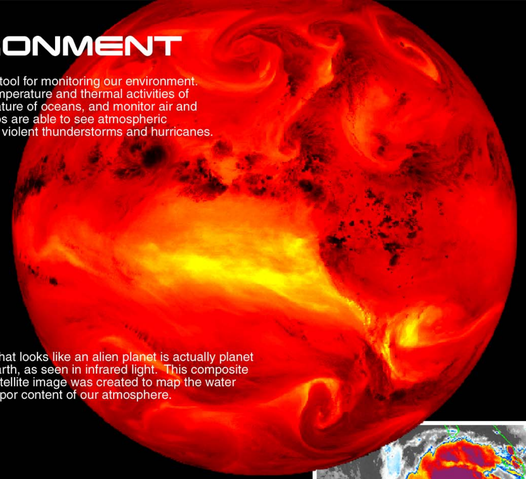




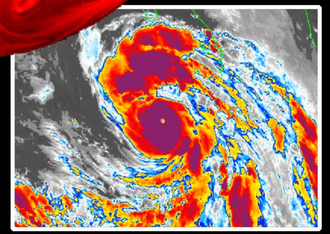
Detailed infrared images taken from airplanes can be used to study volcanoes and to predict eruptions by remotely measuring ground temperature variations. Infrared radiation is also useful for studying the composition of lava flows and levels of sulfur dioxide in volcanic plumes. Infrared images of Mount St. Helen's lava dome (left) reveal hot spots and temperature changes.

THE ENVIRONMENT

Infrared images provide an invaluable tool for monitoring our environment. Orbiting infrared satellites track the temperature and thermal activities of our atmosphere, measure the temperature of oceans, and monitor air and water pollution in cities. Infrared photos are able to see atmospheric convection, a necessary ingredient for violent thunderstorms and hurricanes.

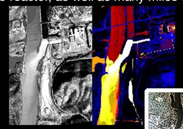


What looks like an alien planet is actually planet Earth, as seen in infrared light. This composite satellite image was created to map the water vapor content of our atmosphere.



Infrared images allow us to remotely map cloud temperatures, even over oceans and at night. These measurements provide invaluable information about cloud heights and the destructive strength of hurricanes.

The aerial image below shows hot water flowing from a nuclear power plant into a river. This 'thermal pollution' can affect plant and animal life near the reactor, as well as many miles downstream.



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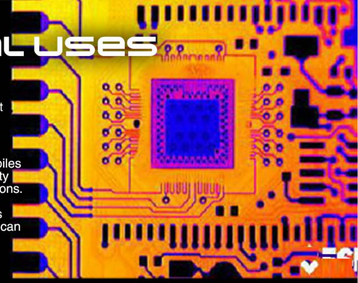
COMMERCIAL USES

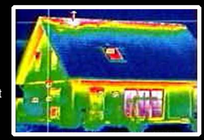
Private industry has found a wealth of uses for infrared technology. In the electronics industry, infrared images are used to inspect circuit boards for faulty connections or overloaded circuits.

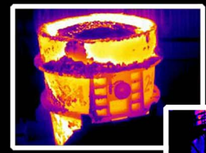
Infrared cameras are now being installed in automobiles to enhance drivers' visibility at night or in foggy conditions. With an infrared camera projecting images onto his lower windshield, a driver can see five times farther at night, and identify stranded motorists or animals on the road.



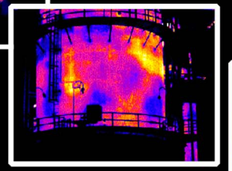
Infrared light is also used in maritime navigation and harbor traffic management. Boats can be located and easily tracked at night or through the thickest marine fog.

Infrared imaging can be used to detect heat loss in buildings, providing information on where additional insulation is needed to reduce energy costs.





Infrared images can detect mechanical stresses that might lead to catastrophic breaks, making industry safer and more cost-effective.



With an infrared camera, foundry workers can detect leaks and weak spots in a metal-casting cauldron. Structural weaknesses in a power plant reactor wall are seen as areas of increased heat.

Power companies use infrared cameras to detect overheating or faulty connections in transformers and substations, allowing them to be fixed before they might cause a power-outage.