DIGITAL IMAGE PROCESSING "HOW NIGHT VISION WORKS"

Abstract:

Night Vision scopes and binoculars are electro-optical devices that intensify (or amplify) existing light instead of relying on a light source of their own. The devices are sensitive to a broad spectrum of light, from visible through infrared. An accessory illuminator can increase the light available at the infrared end of the spectrum by casting a beam of light that is not visible to the human eye.Our paper is an image process application for night vision technology, which can be often used by the military and law enforcement agencies, but are available to civilian users . In our work, night vision googles capture the image even in the dark in the infrared region.

An infrared night vision system senses heat radiated by things and produces a video picture of the heat scene. The gadget that senses the heat is a photocathode, similar to the one in a video camera, except it is sensitive to infrared radiation instead of visible light. ability to improve poor night vision.

There are two methods of operating night vision systems, being either in a 'passive' mode or an 'active' mode. Passive systems amplify the existing environmental ambient lighting, while active systems rely on an infrared light source to provide sufficient illumination. Active systems are often used today on many consumer devices such as home video cameras.

Night vision works on two techniques: image enhancement, thermal imaging.Applications of this technology are Surveillance,Security,Wildlife observation,law enforcement.

Key words: *Infrared radiation.*

Conclusion: Application of DSP may be very well employed to have a night vision by writing suitable night camera.

How Night Vision Works :

Introduction To How Night Vision Works :

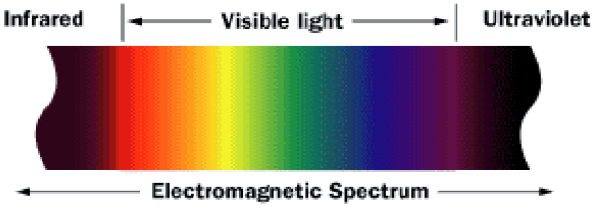
The first thing you probably think of when you see the words night vision is a spy or action movie you've seen, in which someone straps on a pair of night-vision goggles to find someone else in a dark building on a moonless night. And you may have wondered "Do those things really work? Can you actually see in the dark?"

Night Vision Image Gallery:

The answer is most definitely yes. With the proper night-vision equipment, you can see a person standing over 200 yards (183 m) away on a moonless, cloudy night! Night vision can work in two very different ways, depending on the technology used.

Infrared Light:

In order to understand night vision, it is important to understand something about light. The amount of energy in a light wave is related to its wavelength: Shorter wavelengths have higher energy. Of visible light, violet has the most energy, and red has the least. Just next to the visible light spectrum is the infrared spectrum.



Infrared light is a small part of the light spectrum.

Infrared Light Can Be Split Into Three Categories:

- Near-infrared (near-IR) - Closest to visible light, near-IR has wavelengths that range from 0.7 to 1.3 microns, or 700 billionths to 1,300 billionths of a meter.
- Mid-infrared (mid-IR) - Mid-IR has wavelengths ranging from 1.3 to 3 microns. Both near-IR and mid-IR are used by a variety of electronic devices, including remote controls.
- Thermal-infrared (thermal-IR) - Occupying the largest part of the infrared spectrum, thermal-IR has wavelengths ranging from 3 microns to over 30 microns.

The key difference between thermal-IR and the other two is that thermal-IR is emitted by an object instead of reflected off it. Infrared light is emitted by an object because of what is happening at the atomic level.

Basic Technologies:

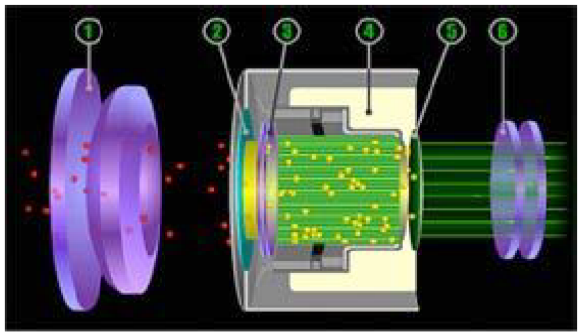
Night vision work in two very different ways, depending on the technology used

Image Enhancement - This works by collecting the tiny amounts of light, including the lower portion of the infrared light spectrum, that are present but may be imperceptible to our eyes, easily observe the image.

Thermal Imaging - This technology operates by capturing the upper portion of the infrared light spectrum, which is emitted as heat by objects instead of simply reflected as light. Hotter objects, such as warm bodies, emit more of this light than cooler objects like trees or buildings.

Infra-Red Illuminators :

All Starlight scopes need some light to amplify. This means that if you were in complete darkness you could not see. Due to this we have a built in infra-red illuminator (IRI) on all of our scopes. Basically what an IRI does is throw out a beam of infra-red light that is near invisible to the naked eye but your NVD can see it. This allows you to use your scope even in total darkness. The IRI works like a flashlight and the distance you can see with it will be limited. We do use the most powerful eye-safe illuminator on the market. This allows our IRI to extend out to 100 yards However, because of the power at a short distance the IRI may cover only 40-60% of the viewing area.



1. Front Lens
2. Photocathode
3.Micro-channel plate
4. High Voltage Power Supply
5. Phosphorus Screen
6. Eyepiece

When you look through a night vision device you may notice black spots on the screen. A NVD is similar to a television screen and attracts dust and dirt. Typically these spots can be cleaned. However, this may also be a spot in the tube itself. This is normal. Most tubes will have some spots in them. These black spots will not affect the performance or reliability of the night vision device. Night vision devices gather existing ambient light (starlight, moonlight or infrared light) through the front lens. This light, which is made up of photons goes into a photocathode tube that changes the photons to electrons. The electrons are then amplified to a much greater number through an electrical and chemical process. The electrons are then hurled against a phosphorus screen that changes the amplified electrons back into visible light that you see through the eyepiece. The image will now be a clear green-hued amplified re-creation of the scene you were observing.

Recent Development In The Field Of Night Vision:

Night Vision's Mission Is To:

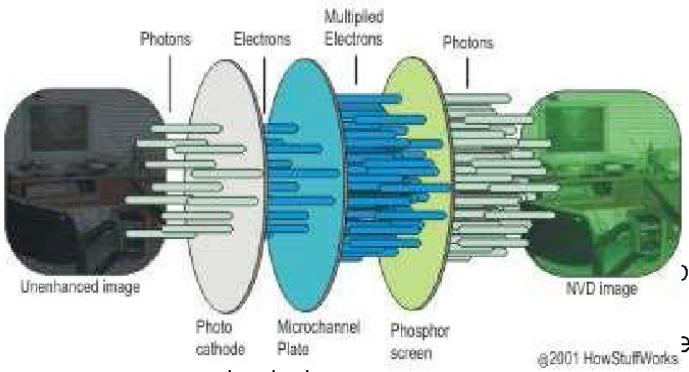
- Conduct Research and Development to Provide US Land Forces with Advanced Sensor Technology to Dominate the 21st Century Digital Battlefield;
- Acquire and Target Enemy Forces in Battlefield Environments;
- Detect and Neutralize Mines, Minefields, and Unexploded Ordnance; Develop Humanitarian Demining Technology;
- Deny Enemy Surveillance & Acquisition through Electro-Optic, Camouflage, Concealment and Deception Techniques;
- Provide for Night Driving and Pilotage; and
- Protect Forward Troops, Fixed Installations and Rear Echelons from Enemy Intrusion.

Working Of Image Enhancement:

Image-enhancement technology is what most people think of when you talk about night vision. In fact, image-enhancement systems are normally called night-vision devices (NVDs). NVDs rely on a special tube, called an image-intensifier tube, to collect and amplify infrared and visible light.

Here's how image enhancement works:

1. A conventional lens, called the objective lens, captures ambient light and some near-infrared light.
2. The gathered light is sent to the image-intensifier tube. In most NVDs, the power supply for the image-intensifier tube receives



oe outputs a high voltage, about 5,000 volts, to

e, which is used to convert the photons of light energy into electrons.

4. As the electrons pass through the tube, similar electrons are released from atoms in the tube, multiplying the original number of electrons by a factor of thousands through the use of a

microchannel plate (MCP) in the tube. An MCP is a tiny glass disc that has millions of microscopic holes (microchannels) in it, made using fiber-optic technology. When the electrons from the photo cathode hit the first electrode of the MCP, they are accelerated into the glass microchannels by the 5,000-V bursts being sent between the electrode pair. As electrons pass through the microchannels, they cause thousands of other electrons to be released in each channel using a process called cascaded secondary emission. Basically, the original electrons collide with the side of the channel, exciting atoms and causing other electrons to be released. These new electrons also collide with other atoms, creating a chain reaction that results in thousands of electrons leaving the channel where only a few entered. An interesting fact is that the microchannels in the MCP are created at a slight angle (about a 5-degree to 8-degree bias) to encourage electron collisions and reduce both ion and direct-light feedback from the phosphors on the output side.

At the end of the image-intensifier tube, the electrons hit a screen coated with phosphors. These electrons maintain their position in relation to the channel they passed through, which provides a perfect image since the electrons stay in the same alignment as the original photons. The energy of the electrons causes the phosphors to reach an excited state and release photons. These phosphors create the green image on the screen that has come to characterize night vision.

The green phosphor image is viewed through another lens, called the ocular lens, which allows you to magnify and focus the image.

Thermal Imaging Process:

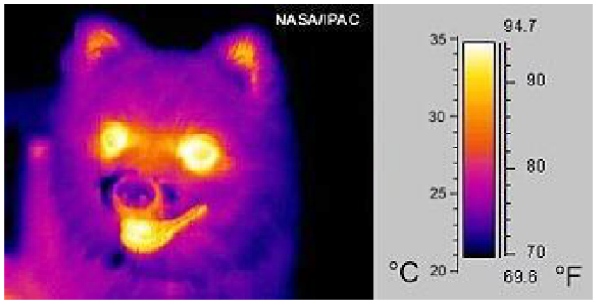


Image of a small dog taken in mid-infrared ("thermal") light (false color)

Thermal imaging, also called as thermo graphic or thermal video, is a type of infrared imaging. Thermo graphic cameras detect radiation in the infrared range of the electromagnetic spectrum (roughly 900–14,000 nanometers or 0.9–14 µm) and produce images of that radiation. Since infrared radiation is emitted by all objects based on their temperatures, according to the black body radiation law, thermograph makes it possible to "see" one's environment with or without visible illumination. The amount of radiation emitted by an object increases with temperature, therefore thermograph allows one to see variations in temperature (hence the name). As a result, thermography's extensive use can historically be ascribed to the military and security services.

Thermal imaging photography finds many other uses. For example, firefighters use it to see through smoke, find persons, and localize the base of a fire. Thermal imaging cameras are also installed in some luxury cars to aid the driver, the first being the 2000 Cadillac DeVille. The appearance and operation of a modern thermo graphic camera is often similar to a camcorder. Enabling the user to see in the infrared spectrum is a function so useful that ability to record their output is often optional. A recording module is therefore not always built-in.

Generations:

NVDs have been around for more than 40 years. They are categorized by generation. Each substantial change in NVD technology establishes a new generation.

Generation 1 - First generation viewers are is currently the most popular type of night vision in the world. Utilizing the basic principles described , a 1st generation will amplify the existing light several thousand times letting you clearly see in the dark. These units provide a bright and sharp image at a low cost, which is perfect, whether you are boating, observing wildlife, or providing security for your home.

Generation 2 - These are primarily used by law enforcement or for professional applications.The main difference between a 1st and a 2nd generation unit is the addition of a micro-channel plate, commonly referred to as a MCP. The MCP works as an electron amplifier and is placed directly behind the photocathode. The MCP consists of millions of short parallel glass tubes. When the electrons pass through these short tubes, thousands more electrons are released. This extra process allows 2nd generation units to amplify the light many more times then 1st generation giving you a brighter and sharper image.

Generation 3 - While there are no substantial changes in the underlying technology from Generation 2, these NVDs have even better resolution and sensitivity. This is because the photo cathode is made using gallium arsenide, which is very efficient at converting photons to electrons. Additionally, the MCP is coated with an ion barrier, which dramatically increases the life of the tube.

Generation 4 - 4th generation / Gated Filmless technology represents the biggest technological breakthrough in image intensification of the past 10 years. By removing the ion barrier film and "Gating" the system Gen 4 demonstrates substantial increases in target detection range and resolution, particularly at extremely low light levels.

Night Vision Equipment :

Night-vision equipment can be split into three broad categories:

Scopes - Normally handheld or mounted on a weapon, scopes are monocular (one eye-piece). Since scopes are handheld, not worn like goggles, they are good for when you want to get a better look at a specific object and then return to normal viewing conditions.

DARK INVADER Multi-purpose Pocketscope

Goggles - While goggles can be handheld, they are most often worn on the head. Goggles are binocular (two eye-pieces) and may have a single lens or stereo lens, depending on the model. Goggles are excellent for constant viewing, such as moving around in a dark building.

Cameras - Cameras with night-vision technology can send the image to a monitor for display or to a VCR for recording. When night-vision capability is desired in a permanent location, such as on a building or as part of the equipment in a helicopter, cameras are used. Many of the newer camcorders have night vision built right in.

Applications:

Common applications for night vision include:

- Military
- Law enforcement
- Hunting
- Wildlife observation
- Surveillance
- Security
- Navigation
- Hidden-object detection
- Entertainment

The original purpose of night vision was to locate enemy targets at night. It is still used extensively by the military for that purpose, as well as for navigation, surveillance and targeting. Police and security often use both thermal-imaging and image-enhancement technology, particularly for surveillance. Hunters and nature enthusiasts use NVDs to maneuver through the woods at night.

Detectives and private investigators use night vision to watch people they are assigned to track. Many businesses have permanently-mounted cameras equipped with night vision to monitor the surroundings.

Law enforcement has used this to discover items that have been hidden by criminals, including money, drugs and bodies

Many people are beginning to discover the unique world that can be found after darkness falls.

Night Vision System for Cars:

Night Vision makes a vehicle's darkened surroundings visible out to a distance of 150 meters.

Depending on the automotive industry's design requirements, Night Vision works with two different systems. With the near-infrared system, two barely noticeable infrared emitters are integrated into the headlights. The infrared light they produce is captured by a small camera positioned close to the rear-view mirror. The second system, a solution in the long-wave spectral range, a high-resolution infrared camera is installed behind the radiator grille. Using a wavelength of six to 12

micrometers, it detects the infrared heat radiation from the vehicle's surroundings, which is displayed as a negative image: Objects that are cold— because they are inanimate — appear darkened and living things are displayed as brightobjects.