**ABSTRACT**

A night vision device (NVD) is an optical installment that allows images to be produced in levels of light approaching total darkness. They are most often used by the military and law enforcement agencies, but are available to civilian users. The term usually refers to a complete unit, including an image intensifier tube, a protective and generally water-resistant housing, and some type of mounting system. Many NVDs also include sacrificial lenses, IR illuminators, and telescopic lenses. NVDs are mounted appropriately for their specific purpose, with more general- purpose devices having more mounting options. For instance, the AN/PVS-14 is a monocular night vision device in use with the US military as well as by civilians. It may be mounted on the user's head for hands free use with a harness or helmet attachment, either as a monocular device, or in aligned pairs for binocular "night vision goggles" which provide a degree of depth perception as do optical binoculars. The AN/PVS-14 may also be attached to a rifle using a Pica tinny rail, in front of an existing telescopic or red dot sight, or attached to a single-lens reflex camera. Other systems, such as the AN/PVS-22 or Universal Night Sight, are designed for a specific purpose, integrating an image intensifier into, for example, a telescopic sight, resulting in a smaller and lighter but less versatile system.

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**NIGHT VISION TECHNOLOGY**

1. **INTRODUCTION**

1.1 ABOUT NIGHT VISION

Night vision is the ability to see in a dark environment. Whether by biological or technological means, night vision is made possible by a combination of two approaches: sufficient spectral range, and sufficient intensity range. Humans have poor night vision compared to many animals, in part because the human eye does not have a tapetum lucidum. The tapetum lucidum (Latin: "bright tapestry", plural tapeta lucida) is a layer of tissue in the eye of many vertebrate animals, that lies immediately behind or sometimes within the retina. It reflects visible light back through the retina, increasing the light available to the photoreceptors. This improves vision in low-light conditions, but can cause the perceived image to be blurry from the interference of the reflected light. The tapetum lucidum contributes to the superior night vision of some animals. Many of these animals are nocturnal especially carnivores that hunt at night, and their prey. Others are deep sea animals. Although some primates have a tapetum lucidum, humans do not. Division of Computer Engineering.

**2. NIGHT VISION APPROACHES**

2.1 SPECTRAL RANGE

Night-useful spectral range techniques make the viewer sensitive to types of light that would be invisible to a human observer. Human vision is confined to a small portion of the electromagnetic spectrum called visible light. Enhanced spectral range allows the viewer to take advantage of non-visible sources of electromagnetic radiation (such as near-infrared or ultraviolet radiation). Some animals can see well into the infrared and/or ultraviolet compared to humans, enough to help them see in conditions humans cannot.

2.2 INTENSITY RANGE

Sufficient intensity range is simply the ability to see with very small quantities of light. Although the human visual system can, in theory, detect single photons under ideal conditions, the neurological noise filters limit sensitivity to a few tens of photons, even in ideal conditions. Many animals have better night vision than humans do, the result of one or more differences in the morphology and anatomy of their eyes. These include having a larger eyeball, a larger lens, a larger optical aperture (the pupils may expand to the physical limit of the eyelids), more rods than cones (or rods exclusively) in the retina, a tapetum lucidum, and improved neurological filtering. Enhanced intensity range is achieved via technological means through the use of an image intensifier gain multiplication CCD, or other very low-noise and high-sensitivity array of photo detectors.

**WORKING**

Night Vision technology consists of two major types: image intensification (light amplification) and thermal imaging (infrared). Most consumer night vision products are light amplifying devices. Light amplification technology takes the small amount of light, such as moonlight or starlight, that is in the surrounding area, and converts the light energy (scientists call it photons), into electrical energy (electrons). These electrons pass through a thin disk that's about the size of a quarter and contains over 10 million channels. As the electrons travel through and strike the walls of the channels, thousands more electrons are released. These multiplied electrons then bounce off of a phosphor screen which converts the electrons back into photons and lets you see an impressive night time view even when it's really dark.  
  
All image intensified night vision products on the market today have one thing in common: they produce a green output image .There are three important attributes for judging performance. They are: sensitivity, signal-to-noise, and resolution. As the customer, you need to know about these three characteristics to determine the performance level of a night vision system.  
  
Sensitivity, or photo response, is the image tube's ability to detect available light. It is usually measured in "?A/lm," or microamperes per lumen. That's why many of our products do not come with standard IR illuminators. With many applications illuminators aren't necessary. Some manufacturers put IR illuminators on their products in order to get acceptable performance under low light conditions. Signal-to-noise plays a key role in night vision performance. A micro channel plate used to transfer a signal from input to output. Just as high-end stereo equipment gives you quality sound.  
  
Resolution is the third major consideration when purchasing night vision. This is the ability to resolve detail in your image. Some manufacturers put magnified optics in their systems to give the illusion that they have high resolving systems. In the trade-off, field of view is sacrificed. Some models give the option of higher magnification so you can have it if you want it, not because your system needs it to function effectively. Most of Moro vision's products offer a uniquely formulated phosphor to create the highest contrasting images, therefore generating the highest resolution products available to the consumer.

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?"  
  
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.

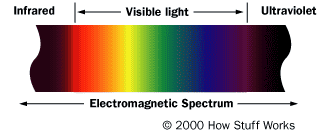
**\* Image enhancement** - This works by collecting the tiny amounts of light, including the lower portion of the infrared light spectrum, that are present but may be imperceptible to our eyes, and amplifying it to the point that we can easily observe the image.

**\* 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. 

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.

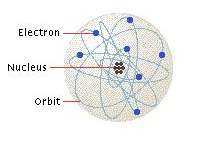
**Infrared light can be split into three categories:**

*\* 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 in many 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.*

An atom consists of a nucleus (containing the protons and neutrons) and an electron cloud. Think of the electrons in this cloud as circling the nucleus in many different orbits. Although more modern views of the atom do not depict discrete orbits for the electrons, it can be useful to think of these orbits as the different energy levels of the atom. In other words, if we apply some heat to an atom, we might expect that some of the electrons in the lower energy orbitals would transition to higher energy orbital , moving farther from the nucleus.



Once an electron moves to a higher-energy orbit, it eventually wants to return to the ground state. When it does, it releases its energy as a photon -- a particle of light. You see atoms releasing energy as photons all the time.

For example, when the heating element in a toaster turns bright red, the red color is caused by atoms excited by heat, releasing red photons. An excited electron has more energy than a relaxed electron, and just as the electron absorbed some amount of energy to reach this excited level, it can release this energy to return to the ground state.

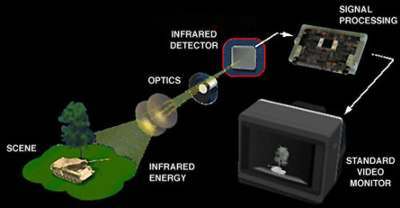
This emitted energy is in the form of photons (light energy). The photon emitted has a very specific wavelength (color) that depends on the state of the electron's energy when the photon is released.

Anything that is alive uses energy, and so do many inanimate items such as engines and rockets. Energy consumption generates heat. In turn, heat causes the atoms in an object to fire off photons in the thermal-infrared spectrum. The hotter the object, the shorter the wavelength of the infrared photon it releases. An object that is very hot will even begin to emit photons in the visible spectrum, glowing red and then moving up through orange, yellow, blue and eventually white. Be sure to read How Light Bulbs Work, How Lasers Work and How Light Works for more detailed information on light and photon emission. In night vision, thermal imaging takes advantage of this infrared emission. In the next section, we'll see how it does this.

**Thermal Imaging**

Here's how thermal imaging works:

1. A special lens focuses the infrared light emitted by all of the objects in view.
2. The focused light is scanned by a phased array of infrared-detector elements. The detector elements create a very detailed temperature pattern called a thermogram. It only takes about one-thirtieth of a second for the detector array to obtain the temperature information to make the thermogram. This information is obtained from several thousand points in the field of view of the detector array.
3. The thermogram created by the detector elements is translated into electric impulses.
4. The impulses are sent to a signal-processing unit, a circuit board with a dedicated chip that translates the information from the elements into data for the display.
5. The signal-processing unit sends the information to the display, where it appears as various colors depending on the intensity of the infrared emission. The combination of all the impulses from all of the elements creates the image.



**Types of Thermal Imaging Devices:-**

Most thermal-imaging devices scan at a rate of 30 times per second. They can sense temperatures ranging from -4 degrees Fahrenheit (-20 degrees Celsius) to 3,600 F (2,000 C), and can normally detect changes in temperature of about 0.4 F (0.2 C).

There are two common types of thermal-imaging devices:  
  
**\* Un-cooled** - This is the most common type of thermal-imaging device. The infrared-detector elements are contained in a unit operating at room temperature. This type of system is completely quiet, activates immediately and has battery built right in.

**\* Cryogenically cooled** - More expensive and more susceptible to damage from rugged use, these systems have the elements sealed inside a container that cools them to below 32 F (zero C). The advantage of such a system is the incredible resolution and sensitivity that result from cooling the elements. Cryogenically-cooled systems can "see" a difference as small as 0.2 F (0.1 C) from more than 1,000 ft (300 m) away, which is enough to tell if a person is holding a gun at that distance!   
  
While thermal imaging is great for detecting people or working in near-absolute darkness, most night-vision equipment uses image-enhancement technology.

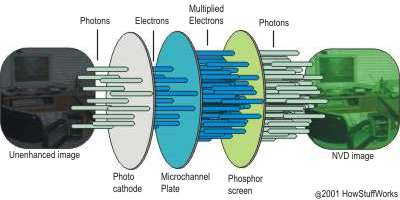
**Image Enhancement**

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.

The image-intensifier tube changes photons to electrons and back again.

**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 power from two N-Cell or two "AA" batteries. The tube outputs a high voltage, about 5,000 volts, to the image-tube components.  
  
3. The image-intensifier tube has a photocathode, 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. The MCP is contained in a vacuum and has metal electrodes on either side of the disc. Each channel is about 45 times longer than it is wide, and it works as an electron multiplier.  
  
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.



5. 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.

6. The green phosphor image is viewed through another lens, called the ocular lens, which allows you to magnify and focus the image. The NVD may be connected to an electronic display, such as a monitor, or the image may be viewed directly through the ocular lens.

**4. Generations of NVD’S:-**

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

**4.1 Generation 0** - The original night-vision system, and M3 infrared night sighting devices, also known as the "sniperscope" or "snooperscope",were created by the United States Army and used in World War II and the Korean War, these NVDs use active infrared. This means that a projection unit, called an IR Illuminator, is attached to the NVD. The unit projects a beam of near-infrared light, similar to the beam of a normal flashlight. Invisible to the [censored] eye, this beam reflects off objects and bounces back to the lens of the NVD. These systems use an anode in conjunction with the cathode to accelerate the electrons. The problem with that approach is that the acceleration of the electrons distorts the image and greatly decreases the life of the tube. Another major problem with this technology in its original military use was that it was quickly duplicated by hostile nations, which allowed enemy soldiers to use their own NVDs to see the infrared beam projected by the device.

**4.2 Generation 1** - First generation passive devices, introduced during the Vietnam War were an adaptation of earlier active Gen 0 technology, and rely on ambient light instead of an infrared light source. Using an S-20 photocathode, their image intensifiers produce a light amplification of around lOOOx, but are quite bulky and require moonlight to function properly. they moved away from active infrared, using passive infrared instead. Once dubbed Starlight by the U.S. Army, these NVDs use ambient light provided by the moon and stars to augment the normal amounts of reflected infrared in the environment. This means that they did not require a source of projected infrared light. This also means that they do not work very well on cloudy or moonless nights. Generation-1 NVDs use the same image-intensifier tube technology as Generation 0, with both cathode and anode, so image distortion and short tube life are still a problem.

**4.3 Generation 2** - Major improvements in image-intensifier tubes resulted in Generation -2 NVDs. They offer improved resolution and performance over Generation-1 devices, and are considerably more reliable. The biggest gain in Generation 2 is the ability to see in extremely low light conditions, such as a moonless night. This increased sensitivity is due to the addition of the microchannel plate to the image-intensifier tube. Since the MCP actually increases the number of electrons instead of just accelerating the original ones, the images are significantly less distorted and brighter than earlier-generation NVDs.

**4.4 Generation 3** - Generation 3 is currently used by the U.S. military. 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.

**4.5 Generation 4** - What is generally known as Generation 4 or "filmless and gated" technology shows significant overall improvement in both low- and high-level light environments.  
  
The removal of the ion barrier from the MCP that was added in Generation 3 technology reduces the background noise and thereby enhances the signal to noise ratio. Removing the ion film actually allows more electrons to reach the amplification stage so that the images are significantly less distorted and brighter.  
  
The addition of an automatic gated power supply system allows the photocathode voltage to switch on and off rapidly, thereby enabling the NVD to respond to a fluctuation in lighting conditions in an instant. This capability is a critical advance in NVD systems, in that it allows the NVD user to quickly move from high-light to low-light (or from low-light to high-light) environments without any halting effects. For example, consider the ubiquitous movie scene where an agent using night vision goggles is sightless when someone turns on a light nearby. With the new, gated power feature, the change in lighting would not have the same impact; the improved NVD would respond immediately to the lighting change.

**4.6 Other technologies**

Panoramic Night Vision Goggles in testing

The US Air Force is experimenting with Panoramic Night Vision Goggles (PNVGs) which double the user's field of view to around 95 degrees by using four 16 mm image intensifiers tubes, rather than the more standard two 18 mm tubes. They are in service with A-10,MC-130 Combat Talon and AC-130U Spooky aircrews. In 2007 Xenonics Holdings, using newly patented technology, offered the first digital night seeing system, a hand held monocule device with 2-8X zoom capability branded Supervision. The PSQ-20, manufactured by ITT seeks to combine thermal imaging with image intensification, as does the Northrop Grumman Fused Multispectral Weapon Sight. 4.6 Gen 4 over Gen 3 Gen 4 technology improves night operational effectiveness & vision goggles and other night vision devices. The signal to noise ratio than Gen 3, resulting in better quality under low-light conditions. The gated power supply fixier improves image resolution under high light conditions,.These improvements also substantially increase the detection range of the systems.

1. **Range of different generations :**

There are many different variables that can affect the distance that you can see with a Night Vision device. First, what are you trying to see? Are you looking for another boat on the water or are you looking for a rabbit in the woods? The larger the object the easier it is too see. Plus, are you trying to see details (what we call recognition range) or are you just trying to see if something is there or maybe you will just see movement but won't be able to 100% determine who or what it is. This is called detection range. Second. Another variable is lighting conditions. The more ambient light you have (starlight, moonlight, infrared light) the better and further you will be able to see You can always see further on a night where the moon and stars are out then if it is cloudy and overcast. We typically state that you can tell the difference between a male and a female or a dog and a deer at about 75 to 100 yards. However, if you were looking across an open field and there was a half moon out you could see a barn or a house 500 yards away. Remember, that the purpose of an NVD is to see in the dark not necessarily a long Way slike a binocular

1. **NIGHT VISION DEVICES**

DEFINITION

A night vision device (NVD) is an optical instalment that allows images to be produced in levels of light approaching total darkness. They are most often used by the military and law enforcement agencies, but are available to civilian users. The term usually refers to a complete unit, including an image intensifier tube, a protective and generally water-resistant housing, and some type of mounting system. Many NVDs also include sacrificial lenses, IR illuminators, and telescopic lenses. NVDs are mounted appropriately for their specific purpose, with more general-purpose devices having more mounting options. For instance, the AN/PVS-14 is a monocular night vision device in use with the US military as well as by civilians. It may be mounted on the user's head for hands free use with a harness or helmet attachment, either as a monocular device, or in aligned pairs for binocular "night vision goggles" which provide a degree of depth perception as do optical binoculars. The AN/PVS-14 may also be attached to a rifle using a Picatinny rail, in front of an existing telescopic or red dot sight, or attached to a single-lens reflex camera. Other systems, such as the AN/PVS-22 or Universal Night Sight, are designed for a specific purpose, integrating an image intensifier into, for example, a telescopic sight, resulting in a smaller and lighter but less versatile system. Night vision devices were first used in World War II, and came into wide use during the Vietnam War The technology has evolved greatly since their introduction, leading to several "generations" of night vision equipment with performance increasing and price decreasing. Division of Computer Engineering.

*Night-vision devices 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.



\* 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.



**7.Common applications for night vision include:**

**\* military \* Law enforcement**

**\* Hunting \* Wildlife observation**

**\* Surveillance \* Security**

**\* Navigation \* Hidden-object detection**

**\* Entertainment**

**8.USAGE**

* The original purpose of night vision was to locate enemy targets at night. It is still used extensively by the military for that purpose.
* 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.
* For wild life preservation in national parks.
* A really amazing ability of thermal imaging is that it reveals whether an area has been disturbed.
* It can show that the ground has been dug up to bury something, even if there is no obvious sign to the [censored] eye.
* Law enforcement has used this to discover items that have been hidden by criminals, including money, drugs and bodies.
* Recent changes to areas such as walls can be seen using thermal imaging, which has provided important clues in several cases.

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**NIGHT VISION TECHNOLOGY**

*A SEMINAR REPORT*

*Submitted by:- Submitted to:-*

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***(0813321043)***

***In partial fulfillment of the requirements of the degree***

***Of***

***Bachelor of Technology(B.Tech)***

***In***

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***DEPARTMENT OF***

***ELECTRICAL AND ELECTRONICS ENGINEERING***

***NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY***

***GREATER NOIDA***

Certificate

Certified that this is a bonafide record of seminar work titled

***Night Vision Technology***

Done by the following student

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of 6th semester electrical and electronics engineering in the year 2011 in the partial fulfillment of the requirement of the award of the Degree of Bachelor of Technology from Noida Institute of Engineering and Technology.

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SEMINAR GUIDE

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