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1. Learning Outcomes

After studying this module, you shall be able to know about -

- The basics of forensic photography
- Selection of Photographic Lenses

2. Introduction

The word photography is derived from the Greek word, photos meaning “light” and graphos meaning ‘pertaining to drawing or writing’. Therefore, photography can be defined as the art, science and practice of creating the durable images by recording light or other electromagnetic radiations, either chemically by means of a light sensitive material such as photographic film, or electronically by means of an image sensor.

In crime cases, the documentation of evidence is one of the most important stages of any crime scene investigation. Besides others, photography is considered as one of the important documentation technique in the field of forensic science which can record the whole crime scene area, exact conditions of crime scene and the evidences present over there. Photography is also sometimes used to further enhance the details that are not being visible to the human eye. The forensic photography section supports the forensic science in general, but to various divisions like questioned document; chemistry; toxicology; ballistics; physical section; biological section; DNA and medical examiner's departments by documenting evidence, crime scenes, and autopsies etc. specifically. The photography section of any laboratory is also responsible for the design of displays and graphics for reports to be presented in the court of law, training and the web. So this division is considered to be an essential part of general crime scene investigation and thereafter in the laboratory.

In addition, it is often used in the laboratory to visualize and store the patterns and phenomena that some time might not be detectable with naked eye. This application of photography in Forensic Science is based upon the fact that it can be done in different spectral regions like ultraviolet and infrared.

Knowledge of some of the following basics is essential to understand the basics of photography.

3. Light sources

There is need to understand the concept of light and their types to understand the photography. Light or visible light is a narrow region of electromagnetic spectrum (Table-1&2). Electromagnetic energy with wavelengths within the range of 400 to 700 nm is capable of stimulating receptors (rods and cones) in the retina of the eye and for this reason is known as visible light (Fig-1 and Table-1). When light falls on the object the visual and photographic images are produced by gathering a portion of the light emitted or reflected by an object and reassembling it to form an image. When light interacts with object sometimes it gets transmitted in case of transparent objects and other times it get reflected when there is an opaque object. The way in which the light has interacted with the object helps in getting information about the resembling of the light to form an image.

4. Illumination or Lighting Conditions

Illumination or lighting conditions makes a significant difference between a photograph which is of good quality and the photograph which is of poor quality. When the natural light is not sufficient or it is not available then we have to opt for artificial light. Artificial illumination sources include arc light, flashbulb, and electronic flash etc. They can be moved and positioned accordingly so that various angles of illumination can be obtained. Control of the illumination angle is difficult when available light such as sunlight or normal room light is being relied upon for the exposure. Thus, artificial illumination is preferred when control of the angle of illumination is important. For this, one should try different angles if it is not sure which of the illumination angle is to be used.

Table-1 Frequency and Wavelength of Electromagnetic Spectrum

S. No	Name of Radiation	Frequency (Hz)	Wavelength (meters)
1	Gamma rays	10^{21} - 10^{19}	More than 10^{-12}
2	X-Rays	10^{19} - 10^{17}	10^{-8} - 10^{-12}
3	UV Rays	10^{17} - 7×10^{14}	3×10^{-7} - 10^{-8}
4	Visible rays	7×10^{14} - 4×10^{14}	8×10^{-7} - 4×10^{-7}
5	IR Rays	4×10^{14} - 10^{12}	10^{-3} - 8×10^{-7}
6	Microwaves	10^{12} - 10^9	1 - 10^{-3}
7	Radio waves	10^9 - 10^7	Less than 1

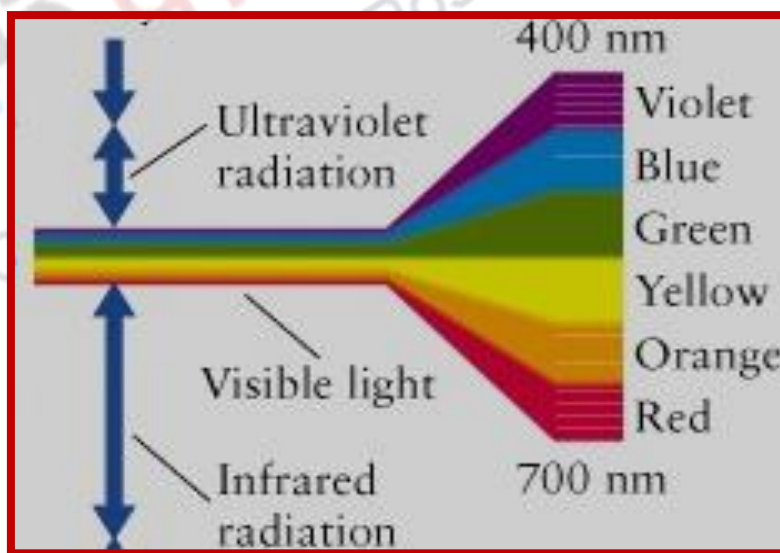


Fig-1: Showing Range of colours present in the Visible Part of Spectrum

The electromagnetic radiation other than visible light which are called *infrared radiation* was first discovered by William Harchel in 1800, when he was checking the temperature of various colours of the spectrum by splitting through the prism. He observed the highest temperature away from red colour. Then he suggested a theory that change of temperature was due to a type of "calorific rays" or light ray that could not be seen.

Immediately in the next year, Johann Ritter, while working on the other end of the visible spectrum, noticed 'chemical rays' later named as *ultraviolet radiation*, which are also invisible light rays but induced certain chemical reactions. These were beyond visible spectrum and behaved similar to visible violet light rays.

Ultraviolet Light (UV) has shorter wavelength than the shortest visible wavelength. But Infrared Light (IR) has longer wavelength than longest visible wavelength. These two lights (UV and IR) do not fall in the sensitivity level of the human eye (which varies from 400-750nm), but still have important applications in forensic examination of clue materials at crime scene and in the laboratory as well.

Photographs has to be taken on a special film with these two lights (UV and IR) and reveals different properties of different types of physical evidences like semen stained garments or bed sheets, questioned documents (including obliterated writing), and GSR discharge, etc. etc.

Table-2: Showing Major Colors and their complements along with Wavelengths

S. No.	Wavelength Range (approx.) In nm	Colour	Major Complements
1	400-450	Violet	Yellow-Green
2	450-480	Blue	Yellow
3	480-490	Green-blue	Orange
4	490-500	Blue-green	Red

5	500-560	Green	Purple
6	560-575	Yellow-green	Violet
7	575-590	Yellow	Blue
8	590-625	Orange	Green-blue
9	625-750	Red	Blue-green

5. Contrast

Contrast is the degree of difference between black and white or dark shadows and bright highlights of the photographs/images. Without contrast, there wouldn't be any difference between light and dark. There are two types of contrasts in photography; high contrast and low contrast.

An image is said to be in *high contrast* when it exhibits a full range of tones ranging from black to white and strong, bold colours and textures of the images are emphasized. On the contrary, in a *low contrast* photograph appears dull as it doesn't exhibit a great deal of difference between its darks and lights. Best examples of low contrast are the photos taken in the fog or mist.

Contrast in forensic photography is very important. Light sources play significant role in providing contrast. Angle of incident light is one parameter that can be different. In a unidirectional light source, the light is subjected from one direction only which gives too much contrast or shadowing. In such situations, source of diffuse illumination can be selected which can be obtained by placing a translucent material such as thin white paper or ground glass in between the source and the subject to scatter the light and act as a diffuser and further help in the reduction of shadow contrast.

6. Filters

Filters are camera accessory, which modify the images recorded may be on any recording medium. Sometimes they are used to make only minor changes to images; other times they need a major change in the images. Coloured filter plays an important role to get the selected colour and further enhancing the contrast of an image, when placed over the light source or the camera lens. An object will appear darker in the photograph if the filter of complementary colour is used. For example if a filter of the same colour is used then the object appears comparatively lighter. If filters of black and white film are used then they are called *colour contrast filter* (fig-2). The filter which is to be placed over the camera lens must be of higher quality but there is no such requirement in case of white light source.



Fig-2: Showing Different types of Filters

Filters also changes the colour balance of images, so photographs taken under incandescent light source show colours as they are perceived, rather than a reddish tinge. There are filters which distort the image as desired, diffusing an otherwise sharp image, adding a starry effect, etc. Supplementary close-up lenses can also be used as filters.

7. Temperature and Colour balance

It is well known that white light is made up of all the seven colours of visible spectrum (Fig-1). The colour of the white light used in colour photography is critical. *Colour contrast filters* are required for black and white photography. However, all sources of white light are not the same. For example, the light given off by a candle contains a higher proportion of the longer wavelengths corresponding to yellow, orange, and red colour. Hence light appears yellowish or yellow-white. The light produced by a tungsten filament in a normal incandescent lamp bulb also contains a preponderance of longer wavelengths, although to a lesser degree. This light appears whiter than that from the candle flame but is noticeably yellow as compared to sunlight. The tungsten filament is hotter than the candle flame. There is a direct correlation between the temperature and colour balance. For example the hotter the incandescent light source, the whiter the light it will produce. This relationship between the colour of the source and its temperature specifies *the degree of whiteness* of the source by comparing it to the colour of the light emitted from a standard source.

To prove, when an experiment was conducted by matching the colours of the two sources by adjusting the temperature of the known standard source in Kelvin scale (K), which is a measure of the colour temperature of light or in other words the degree of whiteness of the unknown source. The numerical values are called the colour temperature of the source and are given below:

Electronic flash has approximately 6000 K colour temperature; whereas the photo floods bulbs/ professional tungsten have 3200 or 3400 K colour temperatures and 5500 K for daylight. Sources with colour temperatures other than 6000 K can be utilized with daylight films if special filters are used to change the colour temperature to 6000 K. The filters are known as colour correction filters.

The Kelvin scale (K) has little value,

- As colour correction filters are identified by non-standardized numbers which vary from manufacturer to manufacturer.
- Because it runs counter to the way in which we use some photographic terms.

For example, in photographic terms, when a photographers talk about adding “warmth” to a scene, which usually mean to add some reddish tones. On the other hand, when photographers talk about “cool” tones, they’re referring to the bluish side of the spectrum. This logic is just the opposite of the Kelvin scale of colour temperature.

The need for these filters has been greatly reduced by the widespread adoption of digital photography, since colour balance may be corrected with camera settings as the image is captured, or by software manipulation afterwards.

8. Lenses

Some of the lenses are fixed permanently on the camera or some time interchangeable with lenses of different physical properties like focal length and apertures. Lenses used in still and video camera are more or less same as used in a microscope or a telescope, their detailed construction is different.

A camera lens or photographic lenses either individually or assembly of lenses are capable of making image on either photographic film chemically or presently on any other media (hard disc or card) electronically.

The image formed onto film in a camera is a real image. As the latent image formed on the film is affected by the spatial variation of intensity, the treatment with developer and fixer chemicals make the latent image permanent. The following factors contribute significantly in the selection and use of photographic lenses:

Focusing

Focusing of a camera is accomplished by altering the distance that separates the lens and the film.

- For a distant subject this separation should be little more than the focal length of the lens.
- If the subject is at infinite distance with respect to the focal length of the camera lens in that case parallel light is brought to focus at the principal focus of the lens.
- For objects closer to the camera, the lens must be moved farther from the film to produce an image.

9. Selection of Photographic Lenses

Lens Types

The quality of camera depends upon the type of lenses used. The better quality cameras often have complex lens. These lenses are made up of a combination of individual lenses as various elements mounted together. These assemblies are called multi element lenses. The additional elements are some time necessary to make this lens perform more closely to a hypothetical ideal lens.

Focal Length

Focal length of a lens is one of the major parameter to select the lens for a particular type of camera and photography. Focal length can be defined as the distance from the lens and a point where the parallel rays of light comes to meet. Particular types of lens can be selected for a particular type of camera used for a particular type of photography.

There are three general classes of lenses which can be distinguished on the basis of their focal length. These are

- Normal
- The wide-angle
- Telephoto

➤ Normal lens

Focal length these lenses are approximately equal to the length of a diagonal line drawn between opposite corners of the picture area on the film (Fig-3). A normal lens cannot focus much if tried from a distance. For example if we need to focus the interior part of a room it has to be focused from a closer distance.

➤ The wide-angle lenses

Lenses with focal length substantially less than 45 mm, particularly when they are used on 35-mm cameras (Fig-3) are known as wide angle lenses. These lenses provide a wider angle of view than a normal lens. Wide-angle lenses are particularly useful for making overall photographs in the cramped quarters that are typical of many indoor scenes.

➤ **Telephoto lenses**

Focal lengths these lenses are longer than the normal have narrower angles of view but yield larger images of distant objects (Fig-3). A telephoto lens may be used to produce an enlarged image of a remote or inaccessible object from a reasonable or more convenient distance.

The normal and wide-angle lenses are sufficed for most crime-scene situations. Telephoto lenses (a "tele lens" or "long lens") are less commonly used for taking photographs of subjects at moderate to far distances. True zoom lens is par focal lens; is one that maintains focus when its focal length changes and is available for most 35-mm cameras. These are complex lenses with provision for moving certain groups of internal elements so that the focal length can be varied continuously. The image quality produced with zoom lenses is generally not as good as it is with high-quality fixed-focus lenses. This lens should have macro capabilities so that close-ups of evidence at crime scenes can also be taken.

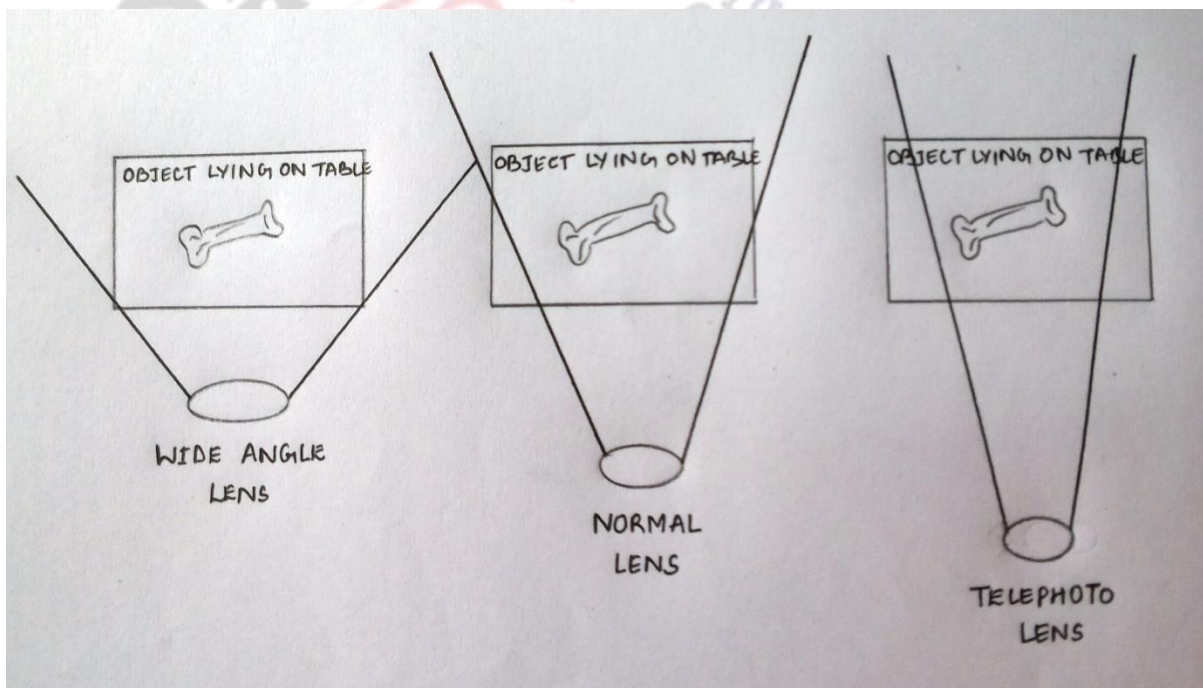


Fig-3: Showing Different Types of Lenses

➤ **Lens Speed:**

To select a photographic lens the second main descriptive variable is its speed. Lens speed refers to the maximum aperture diameter (or a smaller minimum f-number) of photographic lens. The *aperture* of a lens can be defined as the diameter of the open circle or diaphragm inside the lens. This diameter can also be expressed in the form of *f-number*, such as $f/2.8$ or $f/16$ (Fig-4). Lens speed is to measure a power of a lens to gather light.

Two lenses with same focal length can have different speeds. When both are used under identical conditions, the speed of a lens is related to the maximum size of its opening or aperture. Larger the aperture, faster will be the speed of lens.



Fig-4: Showing Lens Speed

A lens with a larger maximum aperture or a smaller minimum f-number is called a *fast lens*, as it delivers more light intensity to illuminate the focal plane, achieving the same exposure with a faster shutter speed. It also requires reducing interference from extraneous (light) noise i.e. lower the noise floor.

A smaller maximum aperture or a larger minimum f-number is *slow lens* as it delivers less light intensity i.e. has a higher noise floor and requires a slower shutter speed.

Lens speed has importance:

- While taking pictures in dim light,
- taking pictures with Telephoto lenses
- In controlling depth of field especially in portrait photography
- With respect to key variable in combination with other variables such as focal length and camera format size.

10. Summary

1. The word photography is derived from the Greek word, photos meaning “light” and graphos meaning ‘pertaining to drawing or writing’. Therefore, photography can be defined as the art, science and practice of creating the durable images by recording light or other electromagnetic radiations, either chemically by means of a light sensitive material such as photographic film, or electronically by means of an image sensor.
2. Contrast is the degree of difference between black and white or dark shadows and bright highlights of the photographs/images. Without contrast, there wouldn't be any difference between light and dark. There are two types of contrasts in photography; high contrast and low contrast.
3. A camera lens or photographic lenses either individually or assembly of lenses are capable of making image on either photographic film chemically or presently on any other media (hard disc or card) electronically.
4. Some of the lenses are fixed permanently on the camera or some time interchangeable with lenses of different physical properties like focal length and apertures. Lenses used in still and video camera are more or less same as used in a microscope or a telescope, their detailed construction is different.
5. Two lenses with same focal length can have different speeds. When both are used under identical conditions, the speed of a lens is related to the maximum size of its opening or aperture. Larger the aperture, faster will be the speed of lens.