# Basic Knowledge of Cultural Properties Photographs

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## 1. Introduction

Photographs are indispensable for study of cultural properties and must therefore be understood by anyone engaged in the study. If however cultural properties are photographed without understanding the objective and framework for taking photographs, the photographs will not yield an abundance of information. The fundamental principle of photography of cultural properties is to enable storage of materials that record an exhaustive amount of information in place of the cultural properties themselves for an extended period of time.

## 2. Role and types of photographs of cultural properties

Photographs of cultural properties include photos used for work and documentary photographs obtained by research and restoration as shown in Fig. 1. There are many types of photography including the most common type of photography used on a routine basis and so-called "optical survey" such as X-ray photography and infrared (IR) photography as shown in Fig. 2.

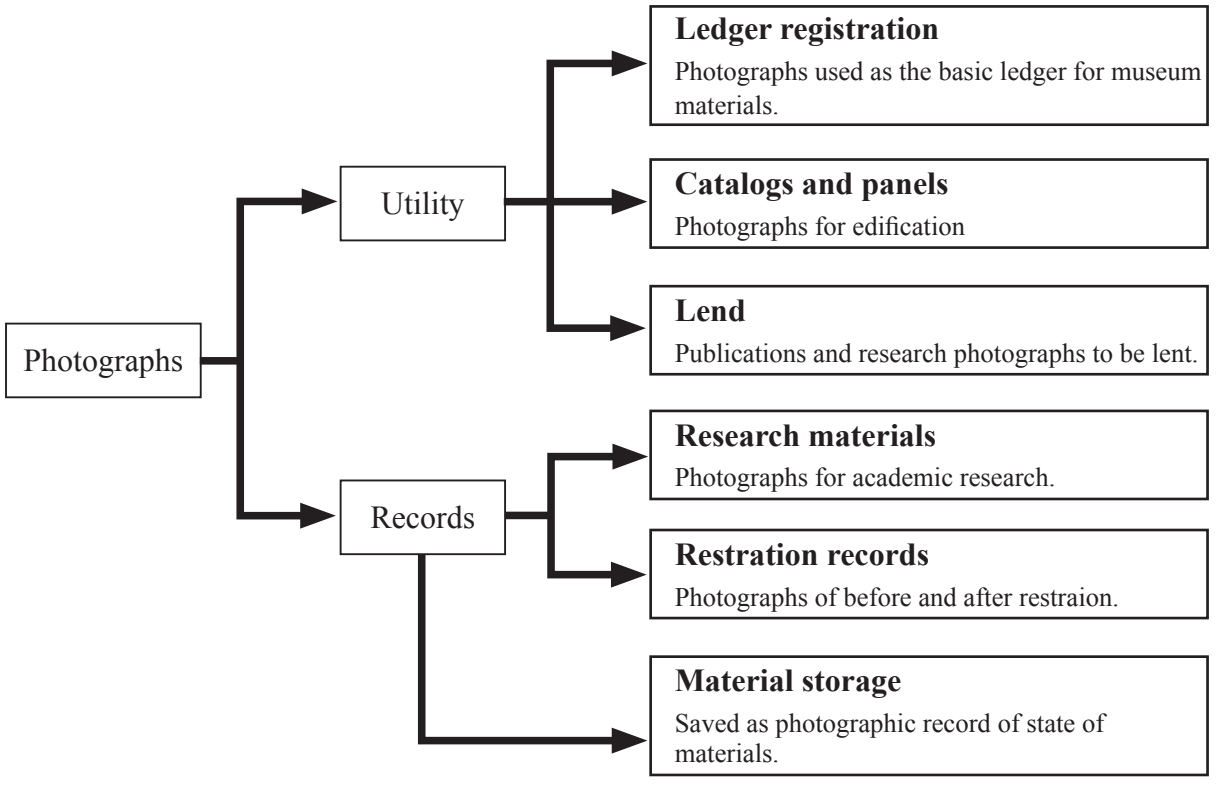



Fig. 1: Role of photographs

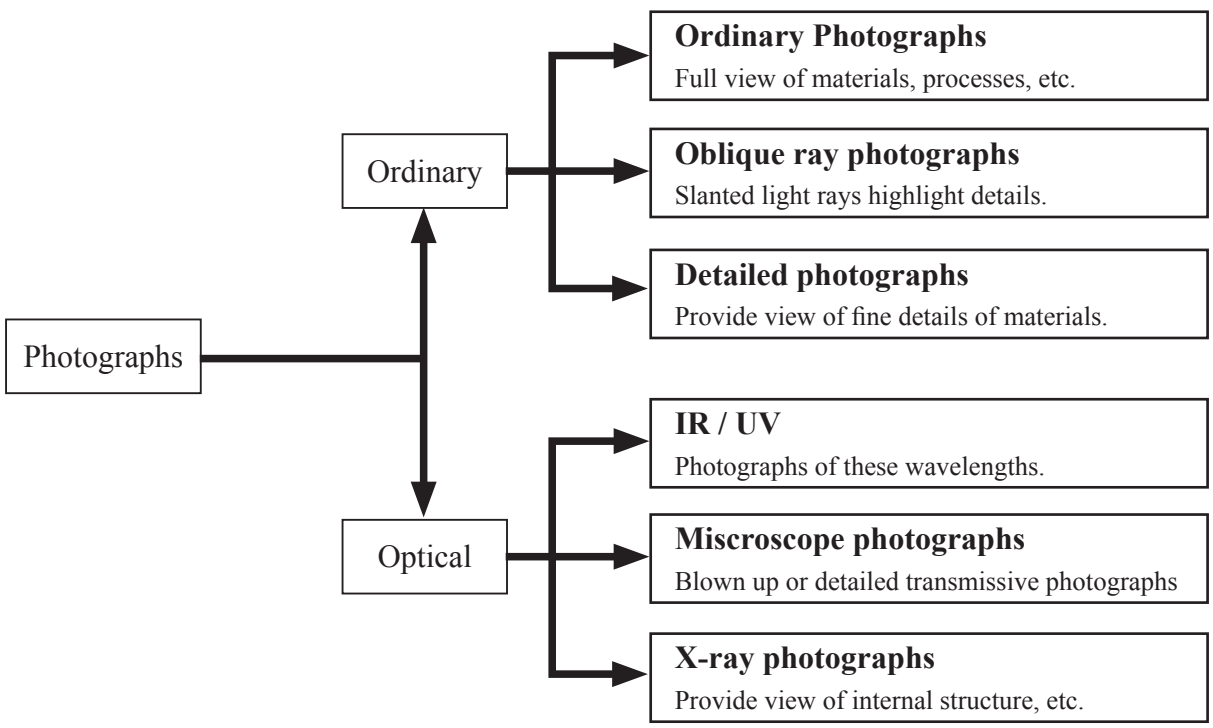



Fig. 2: Types of photographs

3. Types of cameras

There are various types of cameras, which differ according to film size. The larger the film size, the larger the camera tends to be. Larger film size also offers better picture quality. Consequently, larger cameras are used if better picture quality is desired. The size of the camera does not only affect picture quality. Single-lens reflex cameras take photographs in 24 x 36 mm rectangular format; there are also cameras that take 60 x 60 mm square photographs. The difference between rectangular and square significantly affects the photograph itself. Digital cameras also have a surface called CCD or CMOS that records images (photo-sensitive element). Just as with film size, the larger the surface, the better the picture quality generally is.

(1) 35 mm single-lens reflex camera

The most commonly used camera can flexibly adjust to various photographing conditions such as automatic focus, manual focus, macro photography, lens change, etc.

(2) Medium size cameras

Sixty millimeter roll film is referred to as "Brownie film." This type of film is used by medium sized cameras that take 60 x 45 mm or 60 x 90 mm photos. Medium size cameras are often equipped with separate film holders. Some conventional cameras can be converted to digital cameras by exchanging the film holder for a picture element such as a CCD picture element.

(3) Large cameras

Sheet film is changed for each photograph for large cameras. Film sizes include 4 x 5 inch (postcard size) and 8 x 10 inch (A4 size). Such film offers superior quality photographs. The photographer must however make all adjustments manually, including focusing and setting the diaphragm and shutter speed. The lens and film holders are connected by bellows, and therefor offer the advantage of tilt-shift photography to correct distortion that can be caused by the lens. Digital photographs can be taken by replacing the film holder with a picture element such as a CCD picture element.

4. Digital single-lens reflex camera

Digital cameras also come in many types that vary according to size, type and effective sensor resolution (hereinafter referred to as "pixels"). Here we have used a digital single-lens reflex camera equipped with a 35 mm picture element as a model. Let's take a look at its features.

***Pixel count**

If we enlarge the picture you can see a mosaic like image consisting of rows of squares. Each of these squares is called a "pixel." The number of pixels is the pixel count. For example, if the image consists of 4000 pixels vertically and 6000 pixels horizontally; it therefore consists of 4000 x 6000 pixels, or 24 million pixels. This is an index in addition to determining quality of a photographic record. It does not however mean the larger the pixel count, the better the picture quality is, but rather determines the total performance such as the lens precision and CCD recording format.

***Gradation**

Gradation expresses rich coloring for the factors that decide picture quality. Gradation refers to picture representation performance. Rich gradation enables expression with smooth color. There are shades of gray between white and black; some shades of gray are closer to white, while others are closer to black. If gradation is rich, color changes smoothly from white to black. If gradation is poor, smoothness is lost.

***Picture element**

Picture elements come in various sizes. Recently, many single-lens reflex cameras use 24 x 36 mm picture elements called "full size." 1/1.8 picture elements often used by compact cameras are only 1/16 the size of a 35 mm picture element. If the pixel count is the same for these picture elements. that is, 10 million pixels, the per pixel area of the 35 mm size would be larger. The larger per pixel area is able to receive more optical information, so gradation is richer (See Fig. 3).

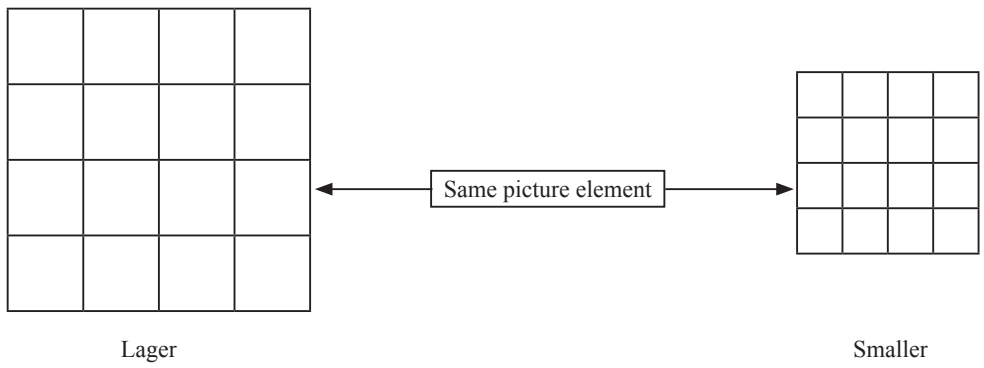



Fig. 3: Correlation of picture elements and gradation; The large area is capable of receiving more light.

***High sensitivity / noise prevention**

The larger the picture element, the larger per pixel area is and the more optical information it can contain. Improving efficiency of converting light to electronic information makes noise less likely to be produced. Also, because conversion is efficient, low intensity light can also be recorded efficiently, and better photographs can be taken because sensitivity is higher.

***Resolution**

Resolution indicates concentration of pixels per unit area for output. The number of pixels required depends on output method and size, but if the pixel count is too low, resolution will be low (see Fig. 4) and the image will not be clear. The number of pixels required for output size must be met (see Fig. 5).

Fig. 4: Unclear output
Low resolution
(Ex. 50 dpi 2 x 3 inch output)

Fig. 5: Clear output
Sufficient resolution
(Ex. 96dpi 2 x 3 inch output)

5. Digital photograph image saving format

Images photographed with a digital camera are first recorded as raw image files. With digital cameras such as single-lens reflex type, you can choose to save as raw image files or JPEG format. Compact digital cameras may only be capable of saving in JPEG format. JPEG format enables you to view the photos is all sorts of digital environments. Raw image files, on the other hand, can only be handled as they are, and must be processed on a computer. Image processing refers to converting digital data to a format that can be viewed such as JPEG or TIFF (See Fig. 6).

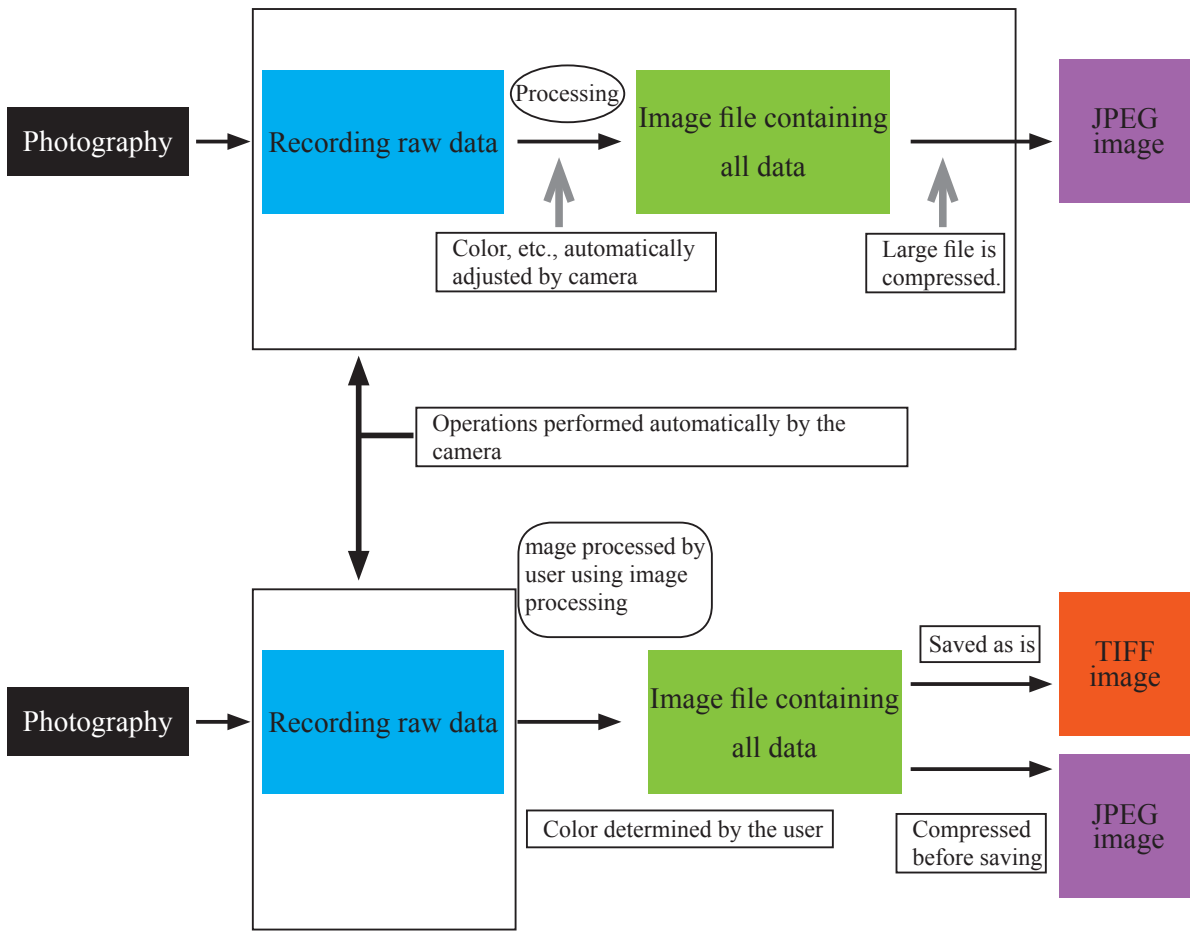



Fig. 6: JPEG format

***Raw image files**

Raw image files are the optical data obtained by photographing itself; raw image files are raw data prior to processing. Raw data (all data pertaining to the image) cannot be viewed as an image until it is processed. Raw data is the origin from which JPEG images are produced. The camera just automatically processes and compresses the raw data. As long as you have the raw data, you can avoid having the camera process it and decide the picture quality for you. Cultural properties must be saved as raw image files.

***JPEG format**

Image data obtained by a digital camera and saved in JPEG format is raw data that is automatically processed by the camera. Automatically processed image files are compressed to a degree where image quality is not affected. The degree of compression can usually be selected. If you want to preserve quality by maintaining a large file, you select a lower compression ratio, and if you prefer a smaller file with lower quality, you select a higher compression ratio. JPEG format maintains comparatively high quality even if the compression ratio is altered.

The drawback of JPEG format is that compression ratio is left up to the camera. The information of compressed files is inferior to the raw image data before being automatically processed by the digital camera; once data is lost it cannot be recovered. Because the data is automatically processed by the camera, aspects such color are determined by the processing; the images can only be processed within the parameters of the camera itself. Consequently, because photographs of cultural properties may have to be used in various sizes and subsequent processing may be required later on, processing by the camera is not really suited to such photography.

***TIFF format**

TIFF format allows photographic image data to be saved without compression, thereby maintaining the size of the file. Bitmap data, which simply consists of a mapped array of bits of optical data, is a basic format, and is therefore suited to a wide range of applications. TIFF format is a stable format with a high potential for being reproduced in the future. Uncompressed files can be quite large, but it the most suitable format for saving photographic image data of cultural properties that may have to be used in various sizes or subsequent processing may be required later on.

In the case of digital photography, no matter what format an image file may be saved or by what procedure it is saved, you must record the proper tone and light status by photographing a gray card or color target, and save the image data processed based on it, and then make use of the saved image data.

In the case of photographing using a gray card, light source by which the image was photographed and neutral tone are reproduced by computer based on gray without being affected by color bias, so it is necessary to save the digital image reproduced based on it when photographing cultural properties requiring precise recording. Details concerning the methods of photography and preproduction processing are provided in the attached document. Theses can be viewed by accessing the website at the following URL (Japanese only). http://maishaken.cool.ne.jp/cgi-bin/diarypro/data/upfile/5-1.pdf

6. Mechanism by which a photograph is taken

Up to this point, we have talked primarily about cameras. Now we will talk about the mechanism by which photographs are taken to produce the desired results.

***Photograph and exposure**

For our purposes, the object of taking a photograph is to record the subject exactly as it is. To do this, the image of the subject is reflected by adjusting the focus and shutter speed. The light that enters the camera through the lens must be properly recorded on the surface of the film or picture element. Adjusting the proper amount of light is called "exposure." As long as the light is adjusted to the proper amount, the subject will be photographed at the correct exposure. The diaphragm adjusts the size of the aperture through which the light enters. If the diaphragm is opened, more light enters, and if it is closed, only a small amount can enter. Shutter speed is the amount of time the shutter the covers the aperture through which light passes is open. If the film or picture element continues to be exposed to light longer than is needed, the photograph will eventually appear white. "Overexposure" occurs when there is too much light. Inversely, if there is not enough light, the photograph will be dark. This is referred to as "underexposure."

***Function of the diaphragm**

We learned that the amount of light can be adjusted by how much the aperture of the diaphragm is opened. Now let’s take a look at how this works. Under ordinary circumstances, the lens are marked with FX. X, FY and FZZ. These units are diaphragm numbers called "f numbers." The larger the diaphragm number, the smaller the aperture is, and the smaller the number, the large the aperture becomes.

***Function of shutter speed**

Shutter speed is the amount of time between when the camera shutter is pressed, the shutter opens, light comes in through the aperture in the diaphragm, and the shutter closes, thereby ending exposure. Cameras are equipped with a shutter speed adjustment function.

***Correlation of the diaphragm and shutter speed**

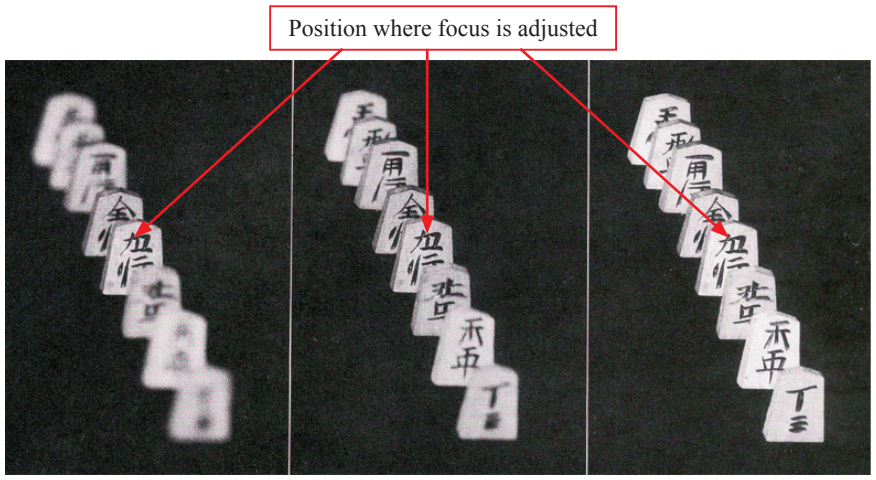
How do the diaphragm and shutter speed affect the photograph? Here is a photograph taken with the f number set to F8 and correct exposure of 1/125 of a second. If we consider the diaphragm and shutter speed, several patterns of correct exposure can be prepared. If for example we think we can get correct exposure by changing the setting of the diaphragm from F8 to F16, the diaphragm aperture becomes smaller and the amount of light that passes through the diaphragm aperture is reduced. In order to secure the amount of light necessary for correct exposure, we must therefore reduce the shutter speed. Oppositely, if we change the setting from F8 to F4, the amount of light that passes through the aperture increases, so shutter speed must be increased.

***Correct exposure and exposure compensation**

If the built-in automatic exposure function of the camera is used, the diaphragm aperture and shutter speed are automatically adjusted according to the amount of light that the camera determines to be correct exposure. Both may however exist simultaneously if the subject is too light or dark, or is photographed against a white backdrop, and the exposure may consequently not be correct for the subject. The light distribution of the entire screen is calculated according to the characteristics of the camera to determine correct exposure, and the camera is incapable of determining what the subject is. If photographing a dark subject against a bright backdrop, the camera determines the amount of light for the entire screen and darkens the exposure; correct exposure can however be obtained if the photographer takes the initiative to brighten the exposure. If photographing a bright subject against a dark backdrop such as black or gray, correct exposure can be obtained if the photographer takes the initiative to darken exposure. This is called "exposure compensation." Positive compensation is provided for a bright subject and negative compensation for a dark subject in order to archive correct exposure. The method by which exposure compensation is achieved differs according to the camera. It is important to read the camera's instruction manual carefully and get empirical knowledge of the procedures.

***Focus range = field depth and focus depth** (Fig. 7)

One function of the diaphragm is to adjust the amount of light, but it has another important role, i.e., to adjust focus range. Increasing the f number widens the focus range, and decreasing it shrinks the range. The focus range is referred to as "field depth." Field depth varies according to the type of lens as well as the diaphragm setting.




Diaphragm setting F2.8 F8 F22

Fig. 7: Field depth and focus depth

The photograph taken with F22 appears sharper than the one taken with F2.8. This tells us that the range(field depth) of F22 is wider. The focus is behind the silver general in the photograph taken with the F2.8 setting. This tells us that focus depth is the rear surface.

***ISO sensitivity**

The mechanism by which photographs are taken contains another important factor. The factor is "sensitivity." "ISO sensitivity" is the sensitivity for the films reaction with light. In other words, the reaction differs according to the sensitivity with which the film receives the same amount of light.

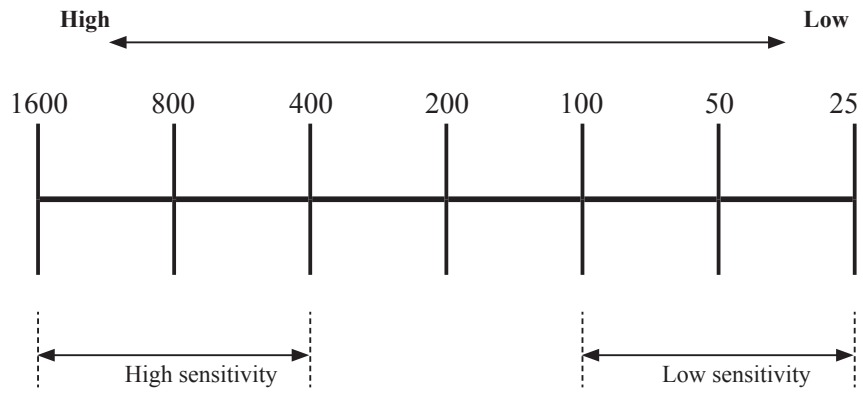



Fig. 8: ISO sensitivity

As shown in Fig. 8, The higher the number, the higher sensitivity is, and the lower the number, the lower the sensitivity is. This means that the higher sensitivity is, the less light is needed to take photographs, and the lower the sensitivity is, the more light it takes to achieve correct exposure.

There are several combinations of diaphragm and shutter speed settings that realize correct exposure. The same goes for ISO sensitivity. Changing from ISO100 to ISO200 is the same as changing the diaphragm and shutter speed settings by one increment. The higher ISO sensitivity is, however, the more gradation and sharpness deteriorate, regardless of whether film or digital medium is used. ISO sensitivity must be carefully set (see Fig. 9). Cultural properties may generally be photographed with sensitivity set between ISO100 - 200.

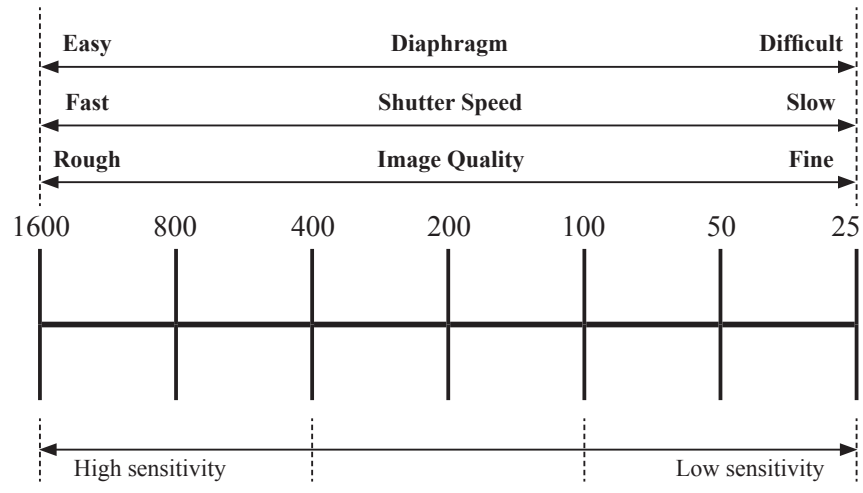



Fig. 9: Correlation of ISO sensitivity and diaphragm setting

7. Light orientation = Lighting

It would not be an exaggeration to say lighting and composition are everything to photographing point when photographing cultural properties. Light orientation -- the angle at which light strikes the subject -- is an element that has a decisive effect on the quality of the photographs. With the exception of special circumstances, the fundamentals of lighting refer to making it reflect off the walls, or flexible "indirect light" such as light dispersed through tracing paper or white cloth. With direct light, strong shading or halation are caused by the angle of the light, resulting in a photograph that does not convey enough information. Lighting includes types with various functions. The light beams that affect expression and atmosphere are called "main light,"and the light beams that adjust brightness of the subject are called "sub light." Key light, which is used to express fine parts of the subject or top light / sky light, which adjust brightness of the background are sometimes used.

Quite a significant amount of heat is produced by lighting equipment. Organic substances, in particular, may be damaged by rapid drying. It is consequently necessary to device a way to minimize irradiation time.

***Main light irradiation direction and effect**

***Forward light (light from front)**

State where the subject receives light from the front; in this state, the photograph provides a planar impression. This type of lighting produces a dark vertical shadow according to the irregularities of the subject. This type is not generally used because shading of the subject cannot be expressed.

***Oblique light (oblique light from the side)**

Forward oblique light from the side. Part where light is angled and shading is pronounced. Produces a more 3-dimensional photograph than forward light. Most basic type of light.

***Side light (light completely from the side)**

Light directly from the side of the subject. Irregularities on the surface of the subject can be clearly recognized.

***Top light (light from directly above)**

State where the subject receives light from directly above. Does not tend to produce a shadow, so there is no need to worry about the direction in which the shadow will be produced.

***Back light**

Light that strikes the subject from directly behind.

***Semi back light**

Light that strikes the subject obliquely from behind.

***Transmission light**

Light that clearly shows the contour, etc., of the subject. Used in combination with forward light and oblique light. Subjects are photographed using combinations of these types of light so the subject can be recognized well.

***Photographing pottery shards and stone tools from above**

In order to avoid the shadow of the subject from falling into the background thereby making the contour unclear, the subject is placed on a sheet of transparent glass that if raised from the background. If the background is not bright enough, brightness is adjusted by shining auxiliary light on the background. The subject and background are both basically illuminated by main light. It is necessary to come up devise measures to avoid producing halation for shiny subjects such as stone tools made of obsidian, such as using reflected light or creating indirect light using tracing paper.

***Photographing planar subjects such as ancient texts from above**

Subjects such as ancient texts are placed on a copier and photographed from above. A level is first however placed on the camera and the subject is set parallel to the camera. The entire subject is uniformly illuminated. The light source is aimed at the copier with lamps set at 45 degree angles to the left and right.

***Photographing using paper backdrop**

Color of the paper backdrop is selected according to the color of the subject. A neutral color such as gray or white is generally used to avoid color transfer to the subject. Illumination varies according to the size and 3-dimensional structure of the subject, but basically consists of a combination of top light and main light.

8. Structural outline

Photography is the act of forcing the subject to fit in a limited frame. The appearance of the photograph varies according to the way it is fit into the frame, in other words, the structural outline.

***1/3 structural outline**

This is the method of arranging the subject by separating the screen into 1/3 horizontally and vertically.

***Structural outline with subject in center:**

Structural outline with the subject positioned in the center of the screen. The information you want to convey about the object to be photographed is directly expressed. Lots of museum materials are photographed using this structural outline. Since it is used for publications and so on as well, a proper margin is left around the subject.

***Camera angle**

When considering the structural outline, it is important to think about what is to be placed where. It is also important to consider from where the subject is to be photographed, in other words, the camera angle. The impression varies according to whether the subject is photographed from a high or low angle, or from a frontal angle. The appearance of the subject also varies if the left and right angles are changed.

9. Lens

Lens are classified by millimeter units. This is referred to as "focal length." If the focal length is small, it is capable of photographing a wide angle (wide angle lens), and if it is large, it can zoom in on a limited range (telephoto lens). In addition to these, there are standard lens that can photograph from close up without restriction.

Telephoto lens

Standard lens

Wide Angle lens

10. Image processing

In the case of film, color tone and contrast are adjusted when developing. In the case of digital photographs, images are processed using image processing software such as Photoshop after photographing. These processes are classified as "adjustment" or "processing." Operation differs according to the type of image processing software used. The user must therefore read the software manual well familiarize himself with operation.

***Adjustment**

Adjustment refers to precise adjustment of color tome reproduction or contrast, trimming, etc. This task is always required when processing digital images. In an ideal situation, digital images should basically not be processed any more than necessary for saving. It is therefore important to sufficiently consider photographing conditions before taking pictures.

***Processing**

Processing basically includes getting rid off unwanted images, converting color tones or altering color of the subject; it also refers to adding effects, etc., to images. There are many problems with processing photographs of cultural properties which play an important role as a record. Photographs are not processed under ordinary circumstances.