Camera Principles
Part I

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**PHOTOGRAPHY**

**Goal:** record an image onto a recording medium

**First attempt:**

**Problem:** light from everywhere arrives at every point

**Solution:** put film in an enclosed box with only one entrance

*(camera obscura: dark chamber, or camera for short)*
THE PINHOLE CAMERA

Problems:

➜ Long exposure necessary  
   (not much light passes through pinhole)

➜ Poor quality due to diffraction effects

Solution: the lens, which collects light from a larger area
THE MODERN CAMERA
How can the photographer tell what the camera sees?

- **Twin-lens cameras** (includes most compact cameras)
  Photographer looks through a second lens, which approximates the camera’s field of view

- **Single-lens reflex (SLR) cameras**
  Magic with mirrors!

- **Electronic viewfinder (EVF)/Live preview**
  Digital sensor constantly takes preview pictures
Basic Camera Settings

- Focal length
- Focus distance
- ISO speed (sensitivity)
- Shutter speed
- Aperture
**Focal length**

Focal length: Controls field of view ("zoom" to a layperson)

In terms of 35mm film:
- Around 50mm focal length is called **normal** (similar to field of view of eye)
- Shorter focal lengths are called **wide angle**
- Longer focal lengths are called **telephoto**

Actual numbers may be different for other cameras, but it is common to refer to 35mm equivalent focal length.

**Prime lenses** have a fixed focal length (e.g. 50mm) **Zoom lenses** can be set to a range of focal lengths (e.g. 16-35mm, 80-200mm). Some consumer cameras specify a multiplication factor instead (e.g. 4x zoom).
Focal length

Also affects perspective!

telephoto (300mm)  wide angle (28mm)
FOCUS DISTANCE

focus distance
Out of Focus

focus distance
DEPTH OF FIELD

focus distance

region of acceptable sharpness
(deepth of field)
ISO Speed (Sensitivity)

ISO Speed: Sensitivity of recording medium

- **Film**: Property of the film used
- **Digital**: Camera setting (gain of digital sensor)

Dark environments and fast motion may require higher ISO speeds, at the expense of more noise/grain.
**SHUTTER SPEED**

**Shutter speed:** Amount of time shutter is open

**Beware of camera shake when handholding!**

**Rule of thumb (1/f rule):**

When handholding the camera, at a focal length of $N \text{ mm}$, use shutter speed of at least $1/N \text{ s}$.

e.g. for 50mm lens, use at least 1/50s.
SHUTTER SPEED

Can be used for creative control

1/50s

1.3s
**Aperture**

**Aperture:** Diameter of light-admitting hole in lens

Usually described as a ratio of focal length (e.g. f/4)

**Smaller number means larger aperture!!!**

**Stops:** 1, 1.4 (\(\sqrt{2}\)), 2 (\(\sqrt{4}\)), 2.8 (\(\sqrt{8}\)), 4 (\(\sqrt{16}\)), 5.6 (\(\sqrt{32}\)), 8 (\(\sqrt{64}\)), 11 (\(\sqrt{128}\)), 16 (\(\sqrt{256}\)), 22 (\(\sqrt{512}\)), 32 (\(\sqrt{1024}\))

Maximum aperture determined by lens.

Each stop halves the amount of light.

Most cameras allow setting in half-stop or one-third-stop increments.
Aperture

Affects depth of field

f/2.8 (large aperture)  f/8 (smaller aperture)
OTHER FACTORS AFFECTING DEPTH OF FIELD

- **Focal length** (at given subject distance)
  Longer focal length reduces DoF

- **Subject distance** (at given focal length)
  Closer subject distance reduces DoF

- **Size of output image**
  Larger print reduces DoF
The Exposure Triangle

- Shutter speed and aperture both affect the amount of light reaching the recording medium.
- ISO speed affects the sensitivity of the recording medium.

These settings need to be balanced to create the right exposure!

ISO speed
(Sensitivity)

Shutter speed
Aperture
Overexposure
EXPOSURE EXAMPLES

ISO100 f/2.8 1/160s

ISO100 f/8 1/20s
EXPOSURE EXAMPLES

ISO100 f/22 1.3s

ISO400 f/5.6 1/50s
Metering

Luckily, modern cameras have built-in metering to help you

- Measures the amount of light reaching the camera
- Camera can guess some or all exposure settings
- More detailed information in Part II!
**FULLY AUTOMATIC () MODE**

All three parameters (and more) are chosen automatically.

- ISO speed (Sensitivity)
- Shutter speed
- Aperture

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**AUTOMATIC**

**MANUAL**
**PROGRAM (P) MODE**

The camera chooses the shutter speed and aperture.

- ISO speed (Sensitivity)
  - AUTOMATIC
  - MANUAL

- Shutter speed
- Aperture
**Aperture-Priority (Av) Mode**

You choose aperture, the camera chooses shutter speed.

ISO speed (Sensitivity)

- **Automatic**
- **Manual**

Shutter speed  Aperture
SHUTTER-PRIORITY (Tv) MODE

You choose the shutter speed, the camera chooses aperture.

ISO speed
(Sensitivity)

— AUTOMATIC
— MANUAL

Shutter speed Aperture
**Manual (M) Mode**

Parameters manually set. Camera just gives you an opinion.

- **ISO speed** (Sensitivity)
- **Shutter speed**
- **Aperture**

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Exposure parameters

- ISO speed
- Shutter speed
- Aperture

Choose shooting mode depending on which of these parameters you want manual control over.

Other parameters discussed

- Focal length
- Focus distance