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Video Recording

Cameras

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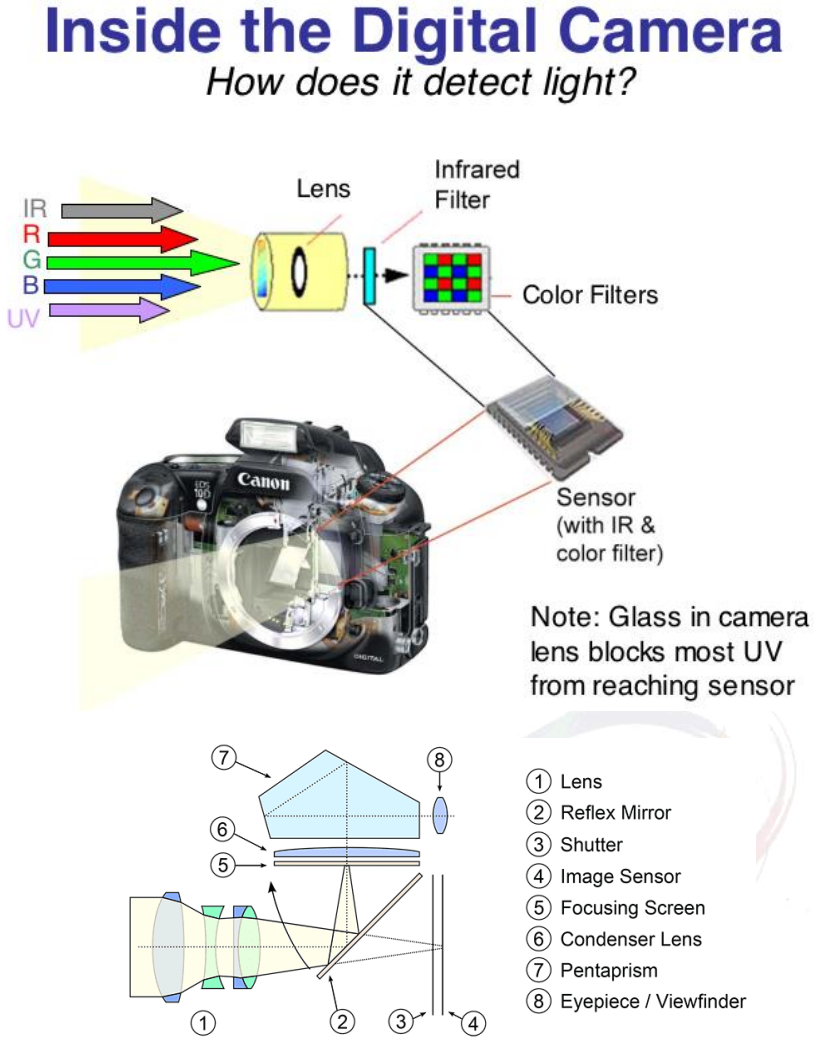
What is a camera and how does it work?

- A camera is a device that **captures light and converts it into** an image or video. The basic task of the camera is to **"capture" the scene** through the lens and record it through a **sensor or film.**
- **Basic principle:**
  - Ambient **light** enters the **lens**.
  - The lens focuses the light rays on the **sensor** (or film tape in analog cameras).
  - **The sensor** (CCD or CMOS) converts light signals into electrical signals.
  - Electrical signals are processed via an **image processor**.
  - The record is stored on a **memory card** (or external device).
  - Result: digital image or video.



Camera types

- **ENG (Electronic News Gathering) cameras**
  - They are used for live streaming and fast shooting in the field.
  - Easy portability, battery powered, built-in recorder.
  - Examples: TV reporters.

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Camera types

- **EFP (Electronic Field Production) cameras**
  - Larger production cameras often use cables to connect to the overhead.
  - They are used for sports events, shows, concert broadcasts.

Camera types

- **Cinematic cameras**
  - They use a large sensor, replacement lenses, and advanced image control.
  - They give a "film look" (shallow depth of field, high resolution).


ARRI ALEXA LF


ARRI ALEXA Mini


ARRI AMIRA

Ranger Body Shown


RED GEMINI (Sensor)


Panasonic EVA-1


ARRI ALEXA SXT


Sony Venice


Canon C700FF with Codex


Sony FS7 II


Blackmagic URSA Mini Pro G2


Ranger Body
RED MONSTRO (Sensor)


Panasonic VariCam *(3 Models)*

DSMC2 Body Shown


RED HELIUM (Sensor)


Canon EOS C300 Mark II

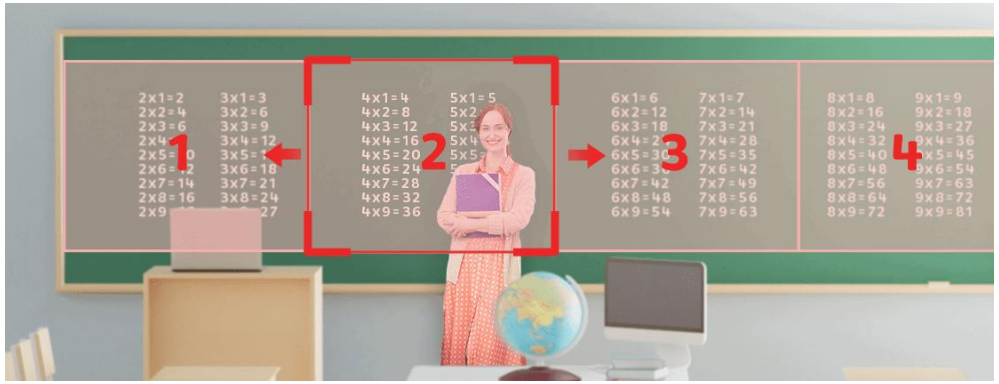
35mm Film

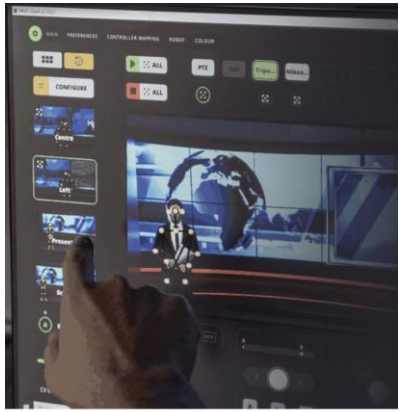
Camera types

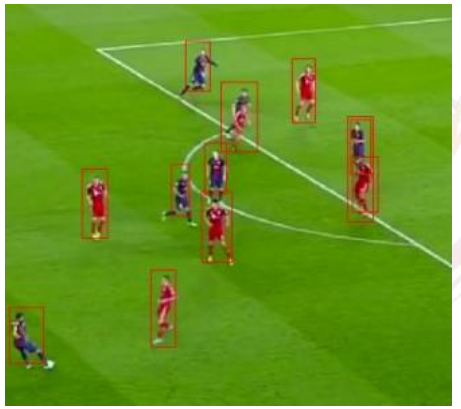
- **PTZ (Pan-Tilt-Zoom) cameras**
  - Remotely controlled cameras with the ability to move in multiple directions.
  - They are used in studios, video conferences and surveillance.

Camera types

- **Automatic cameras and AI Tracking**
  - Artificial intelligence cameras that automatically track the person in the frame.
  - They use face recognition and tracking algorithms.
  - Popular in education, conferences, sports analysis.

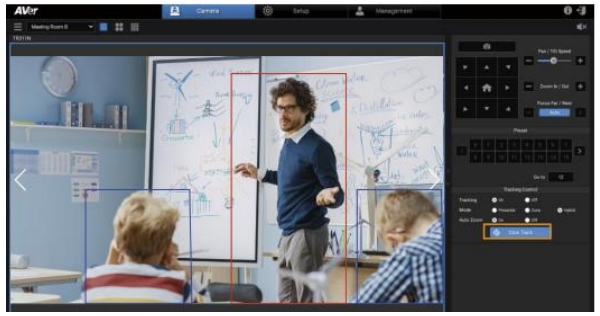






Remote Control

- Software control – PTZ angle and zoom adjustment software.
- Hardware controllers – Joystick and control panels.
- Wireless control – Wi-Fi or NDI camera control from remote locations.



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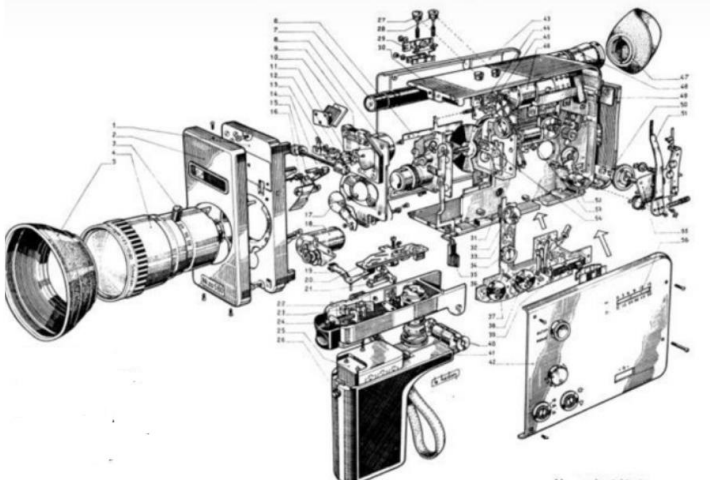
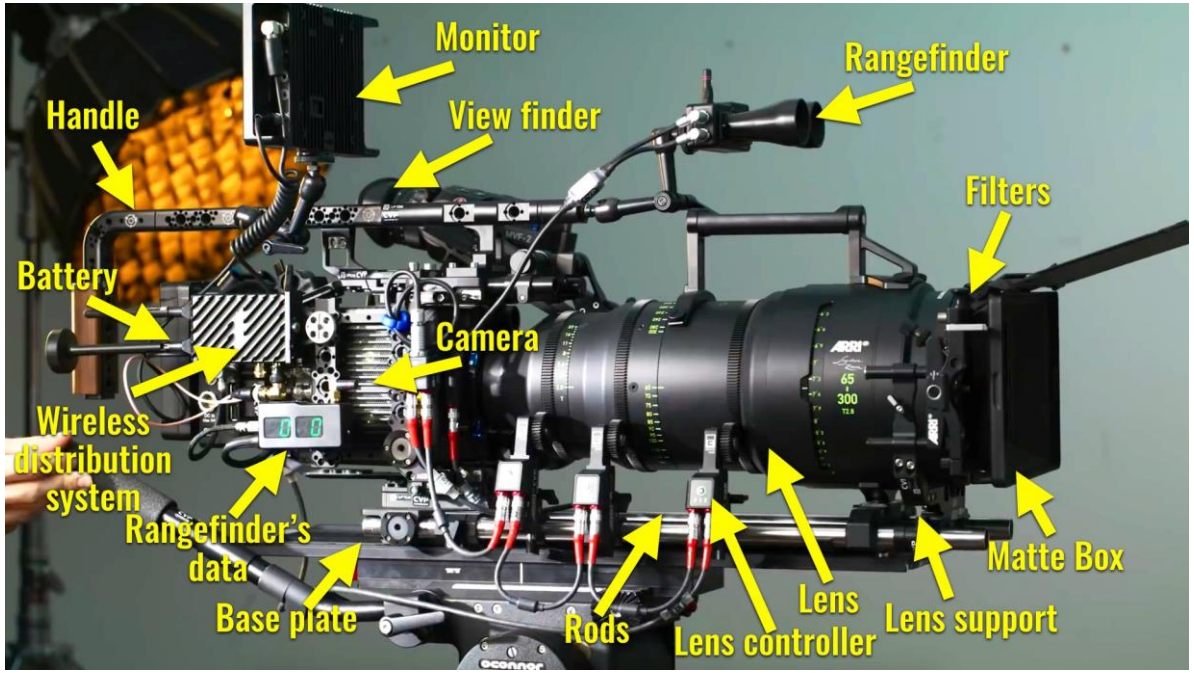
Camera Parts

- Camera Body
  - Lens (lens)
  - Image sensor
  - Image Processor
  - Monitor
  - Controls and buttons
  - Memory cards.
  - Battery
  - Connections



Camera Parts



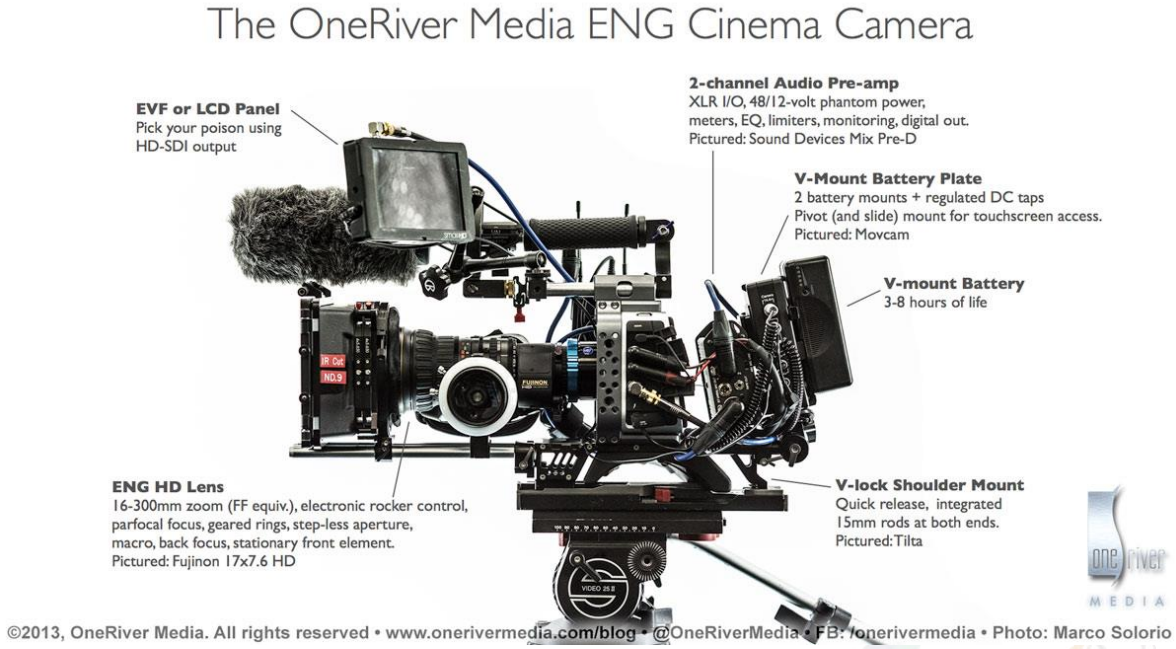
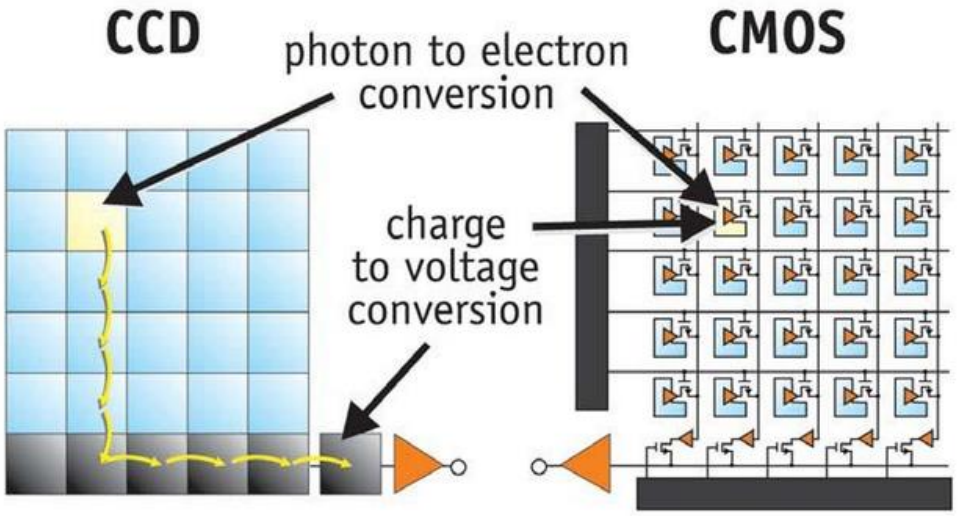
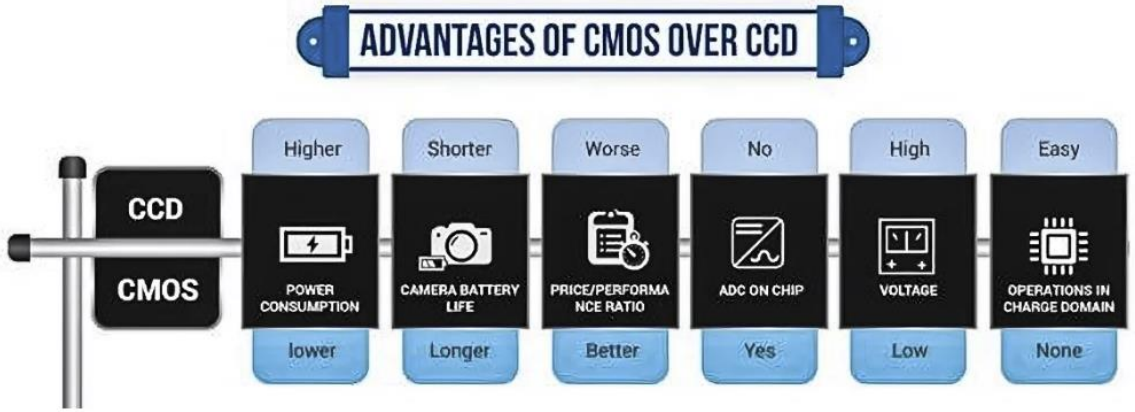


Image Sensor

The sensor converts light into electrical signals.

- **Sensor types:**
  - **CCD (Charge-Coupled Device)** – better image quality, but more expensive.
  - **CMOS (Complementary Metal-Oxide Semiconductor)** – faster image processing and lower power consumption.





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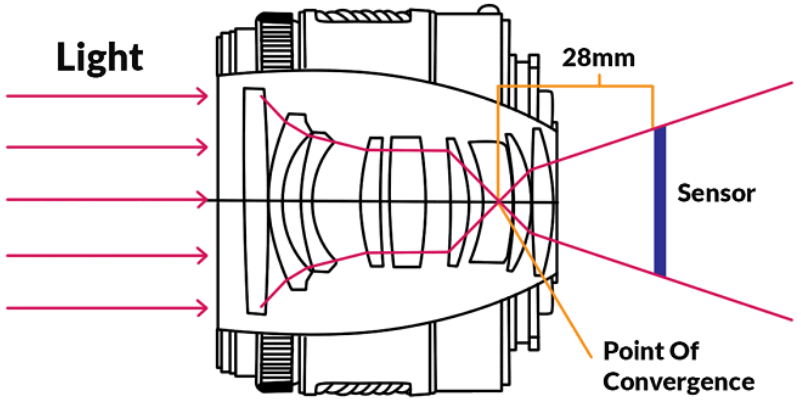
Lens

- It directs light to the sensor and determines the appearance of the image.
- **Lens types:**
  - **Prime lenses** – fixed focal length (better image quality).
  - **Zoom lenses** – variable focal length.
  - **Macro lenses** – for extremely close-ups.
  - **Telephoto lenses** – for distant subjects.



Viewfinder & LCD Screen

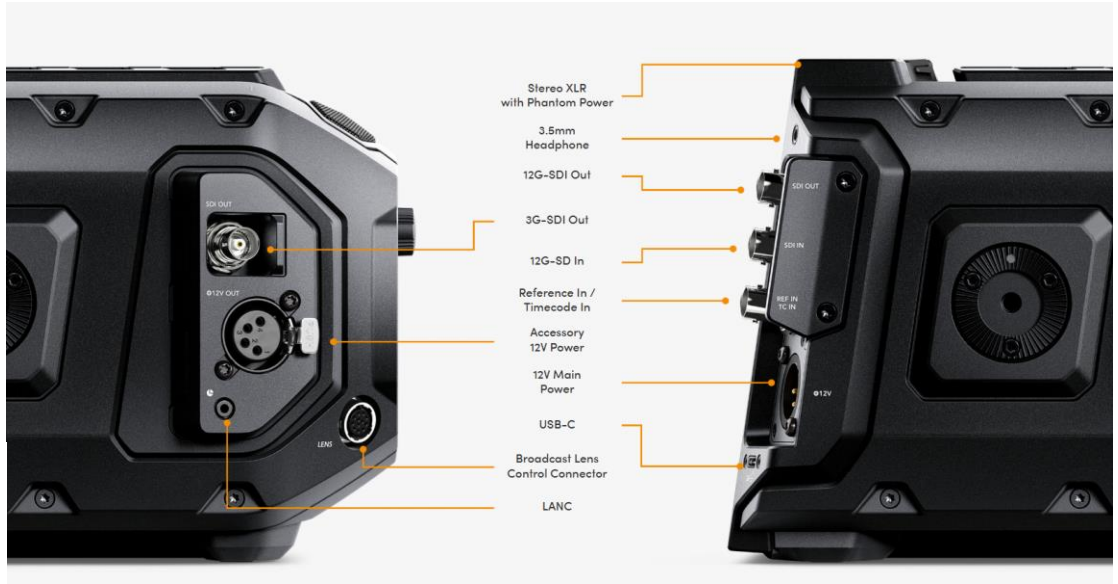
- **Optical** Viewfinder (OVF) – used in DSLR cameras.
- **Electronic** Viewfinder (EVF) – uses the screen to display the image in real time.
- The LCD screen enables live viewing and navigation through the menu.

Battery and power supply

- The cameras use high-capacity **lithium-ion batteries.**
- Professional cameras can use **V-Mount or Gold-Mount batteries.**
- Alternative power supply: **AC adapters and external powered grips.**

Connectors and connectors

- **SDI and HDMI** – video outputs.
- **XLR and 3.5mm** – audio inputs.
- **USB-C or Thunderbolt** – for data transfer.
- **NDI or Ethernet** – network control and image transfer.

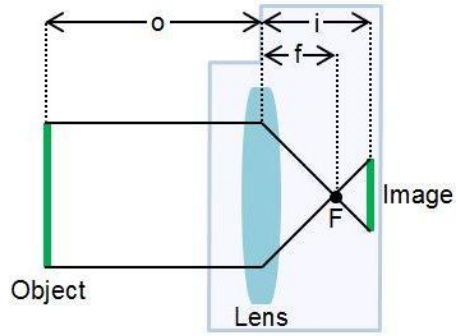


BACKGROUND CHARACTERISTICS

- The lens is a key part of the camera because it determines how light enters and forms an image on the sensor. The quality of the lens, its optical properties and adjustment options have a huge impact on the quality of the shot.
- **Lens main parameters:**
  - **Focal length** – is expressed in millimetres (mm) and determines the angle of view.
  - **Aperture (Aperture/f-stop)** – determines the amount of light entering the lens.
  - **Depth of field** – depends on the aperture and focal length.
  - **Aberrations and distortions** – optical errors that affect image quality.

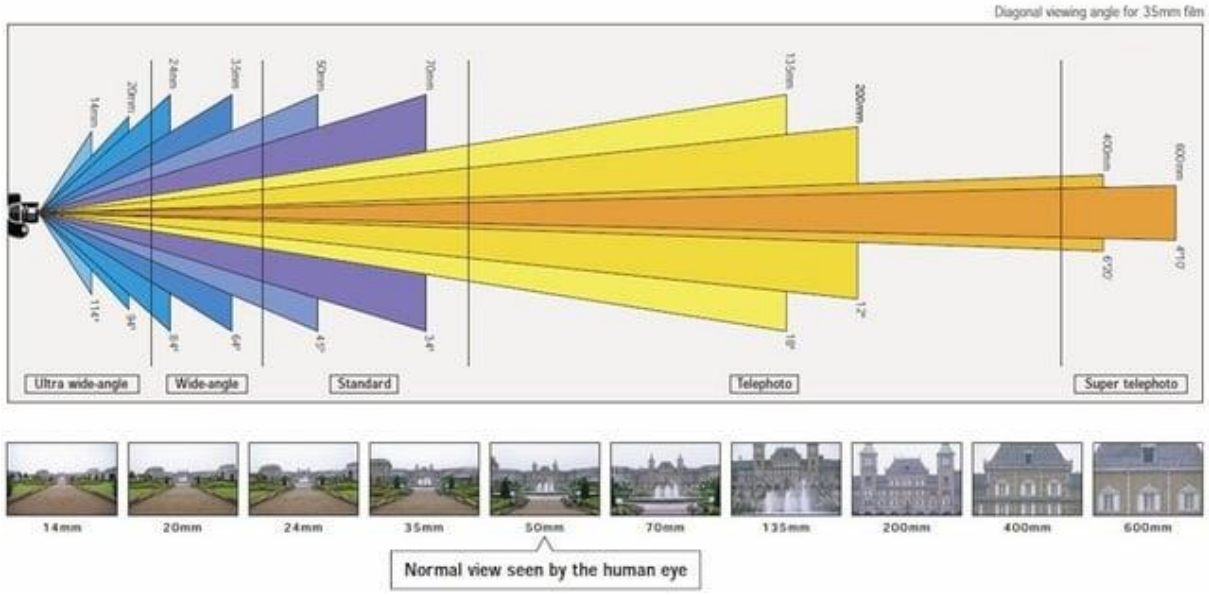
Focal length

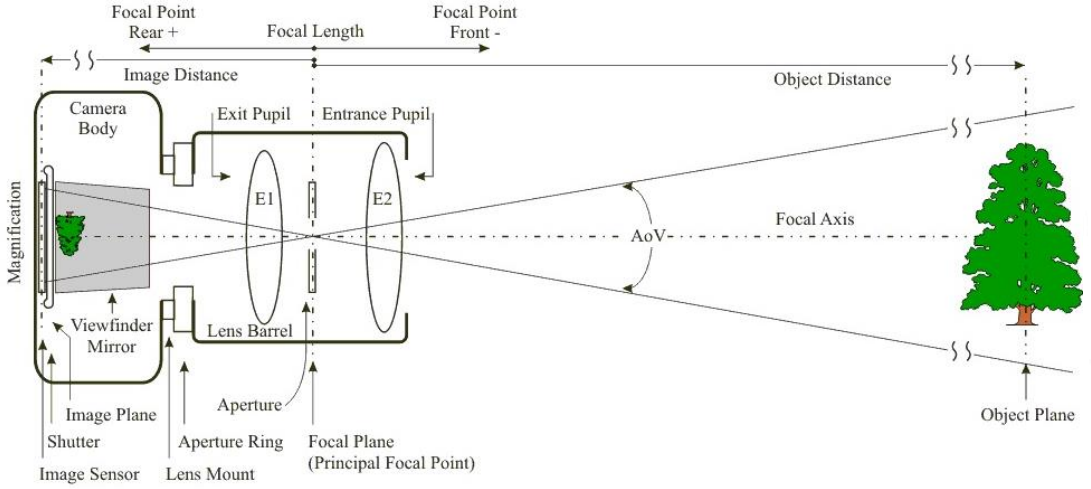
- **Focal length (f)** is the physical distance expressed in millimeters between the **main optical point** of the lens and the **plane of the sensor** (or film), when the focus is set to infinity. In optical terms, the **focal length** is the basic lens parameter that determines the **size of the viewing angle and the** degree of spatial compression.



Focal-Length Equation

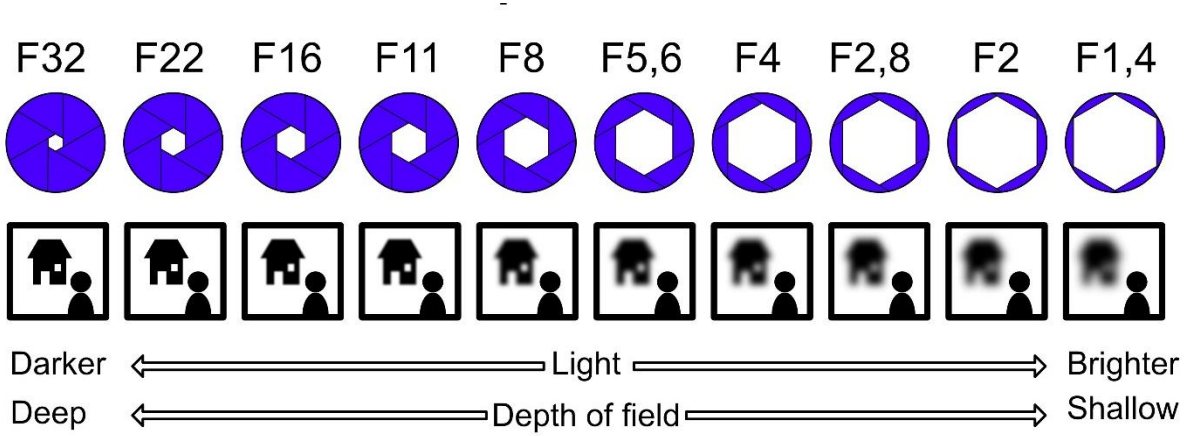
$$\frac{1}{f} = \frac{1}{o} + \frac{1}{i} \text{ or } f = \frac{1}{\frac{1}{o}+\frac{1}{i}}$$

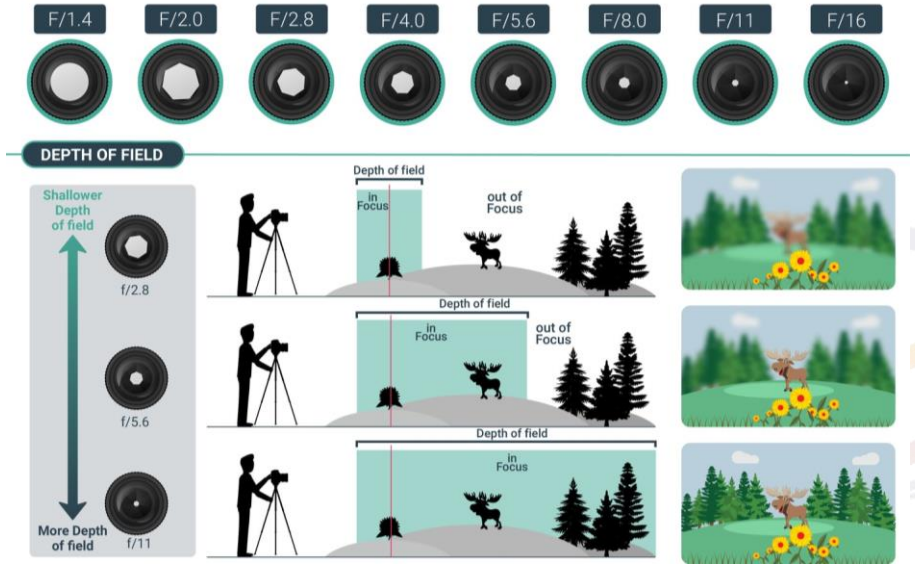




Aperture (Aperture, f-stop)

- An opening in the lens that regulates the amount of light entering the camera.
- Wide aperture (e.g. f/1.4) - more light, less depth of field.
- Narrow aperture (e.g. f/16) - less light, greater depth of field.
- **Depth of field: Determines how many subjects in the frame will be sharply focused.**
  - Shallow depth of field – sharp object, blurred background.
  - Great depth of field – all in focus.
- **Adjustment in practice:**
  - A wide aperture (f/1.4 – f/2.8) is used for portraits and low light conditions.
  - A narrow aperture (f/8 – f/16) is used for landscapes and a sharper image.





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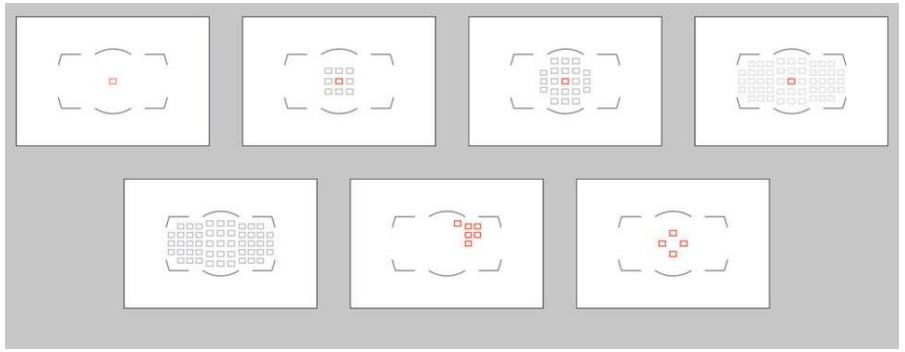
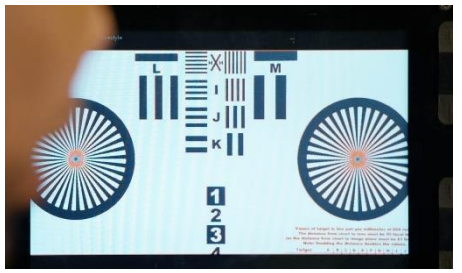
Focus (Manual vs. Auto





- **Manual Focus**
  - More precise control, used in film productions.
  - Does not change focus unexpectedly.
- **Auto Focus**
  - Fast and convenient for dynamic scenes.
  - May err in low light conditions.
- **Autofocus Types**
  - **Single AF (One-Shot AF)** – focus locks once, used for **still subjects**.
  - **Continuous AF (AF-C)** – continuously monitors movement, used for **moving subjects**.
  - **Face/Eye Tracking AF** – Automatically focuses on the **face or eye of a person** in the frame.
  - **Touch AF / Zone AF** – the user selects the zone on the screen that the camera focuses on
- **Adjustment in practice:**
  - **Manual Focus** – used for controlled scenes and precise frames.
  - **Auto Focus (Continuous AF, Face Tracking AF)** – used for vlogging and shooting on the go.

Shutter Speed

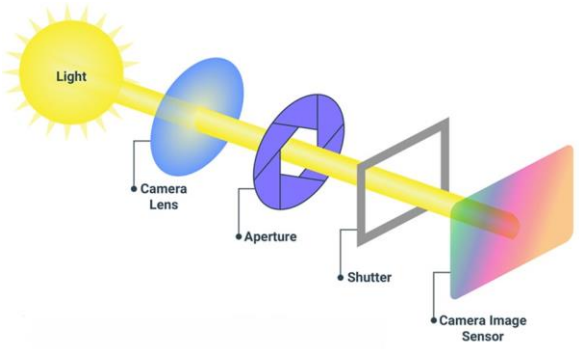
- Determines how long the camera sensor is exposed to light.
- Fast shutter (1/1000s) - freezes movement (sports, action scenes).
- Slow shutter (1/30s) - more light, may cause motion blur.

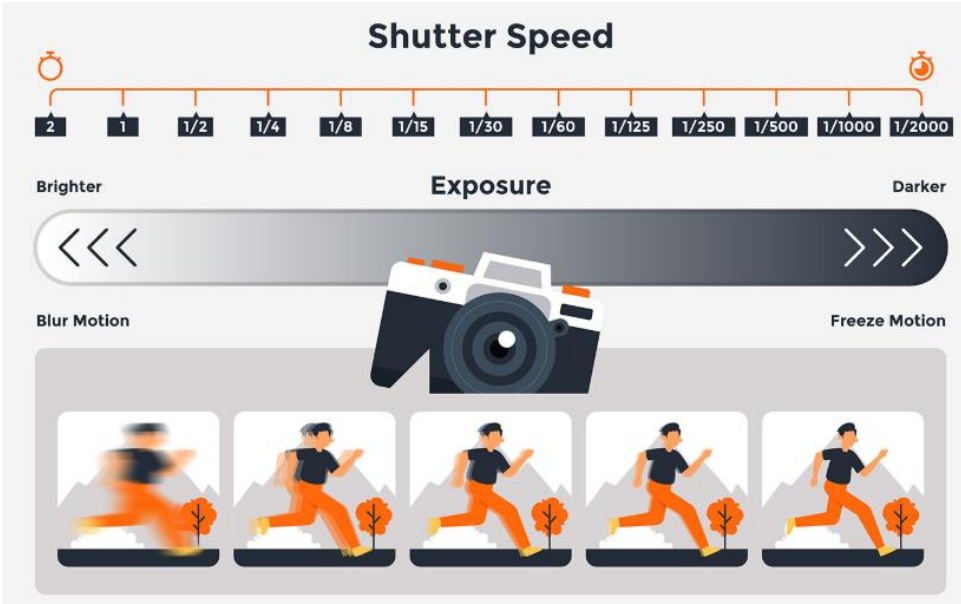
Adjustment in practice:

1/50s to 1/100s for normal scenes and dialogue.

1/500s and faster for sports and action scenes.

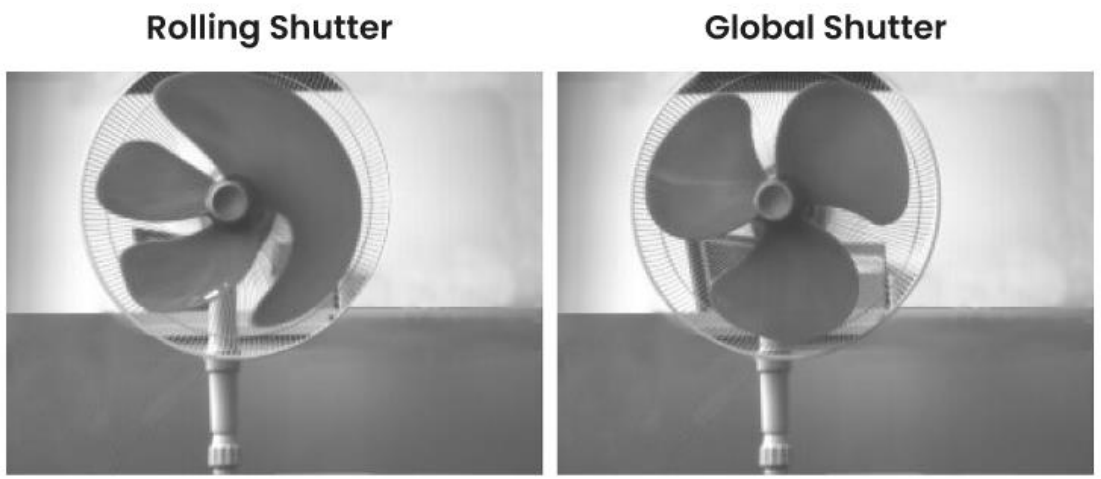
1/30s and slower for low light conditions or artistic effects.





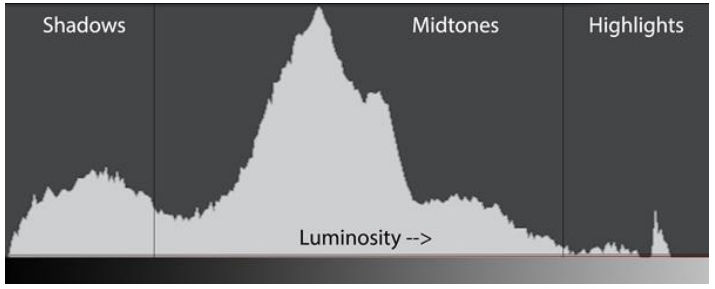
Rolling Shutter vs Global Shutter

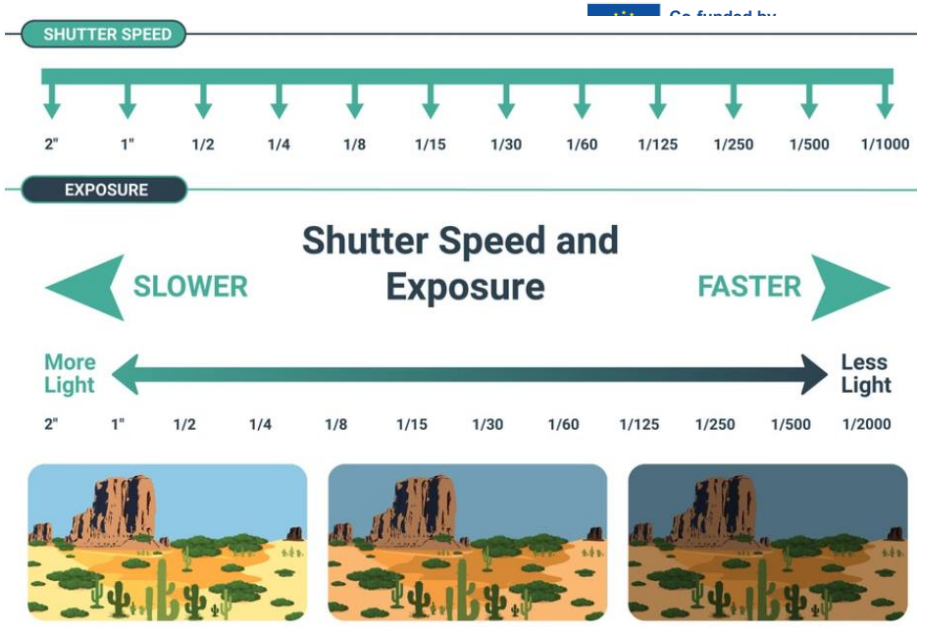
- **Rolling shutter**
  - CMOS sensors scan the image **line by line**, which can cause distortions in fast movements.
- **Global shutter**
  - All pixels illuminate at the same time, there is no distortion in movements.
  - It is used in professional cinema and sports-action cameras.

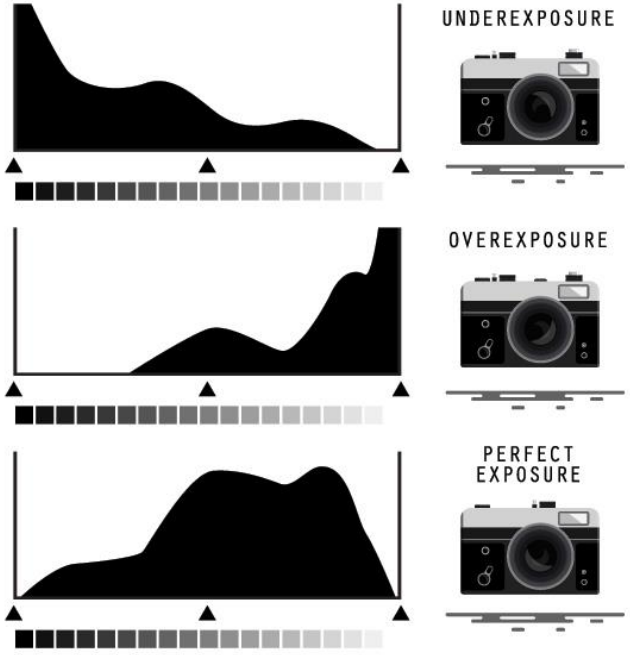


Histogram and Exposure

- **Exposure** in a photo refers to the amount of light that falls on the sensor or film surface of the camera.
- **The histogram shows the distribution of light and dark tones in the image.**
  - Even distribution = correct exposure.
  - It's very dark → overexposed.
  - Too bright → overexposed.
- **Adjustment in practice:**
  - **Using the "Zebra pattern"** – visual guide to overexposed parts of the image.







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Histogram and Exposure

- Exposure can be controlled in three ways: **aperture, shutter speed, and ISO**. These elements are used together to get the right exposure.
- The **blend in the exposure controls the amount of light entering the camera**. It is an opening on the camera lens that can be adjusted to let in more or less light.
- **The shutter speed controls how long the camera sensor is exposed to light**. When the shutter speed decreases, the sensor is exposed to light for a long time, resulting in a higher exposure
- **ISO refers to the sensitivity of the sensor to light**. When the ISO is increased, the sensor becomes more sensitive to light, which means that a larger amount of light will fall on the sensor and result in a higher exposure.

ISO value

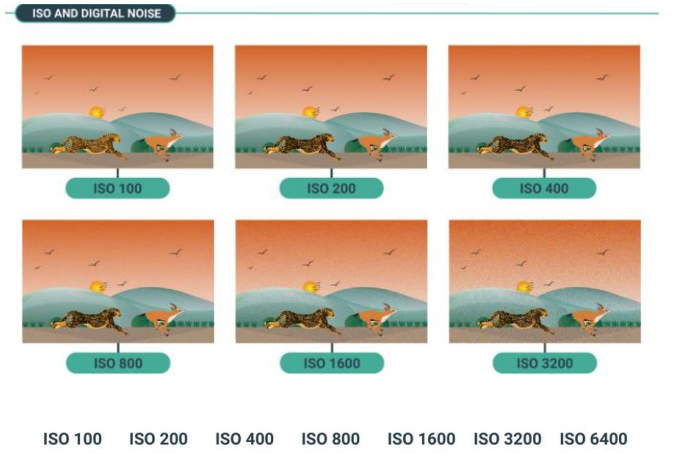
- Light sensitivity.
- Lower ISO (100-400) → better image quality, less noise.
- Higher ISO (1600+) → more light but increases noise.

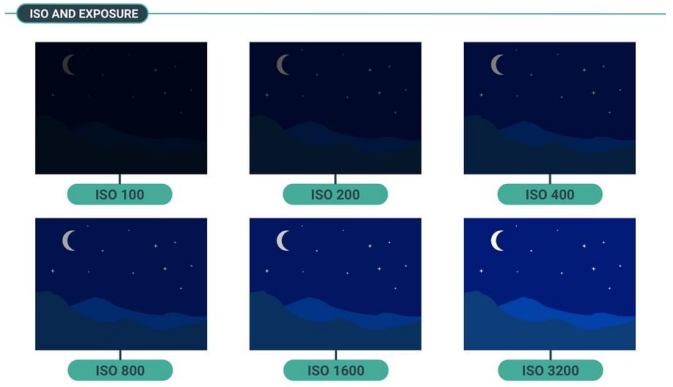
Adjustment in practice:

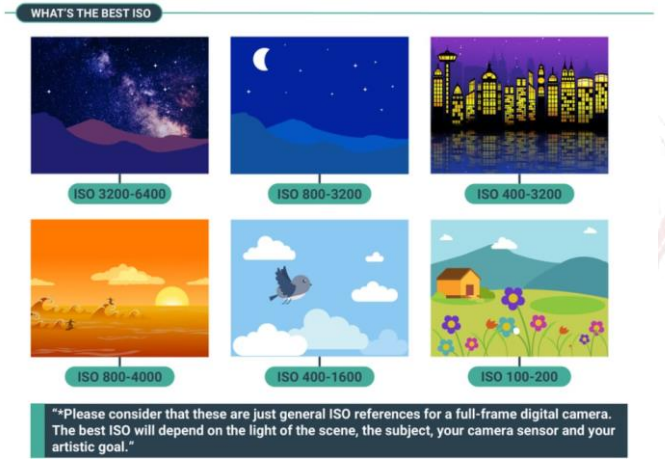
ISO 100-400 → bright conditions (daylight).

ISO 800-1600 → indoor spaces with moderate lighting.

ISO 3200+ → shooting in the dark, but noise may be noticeable.

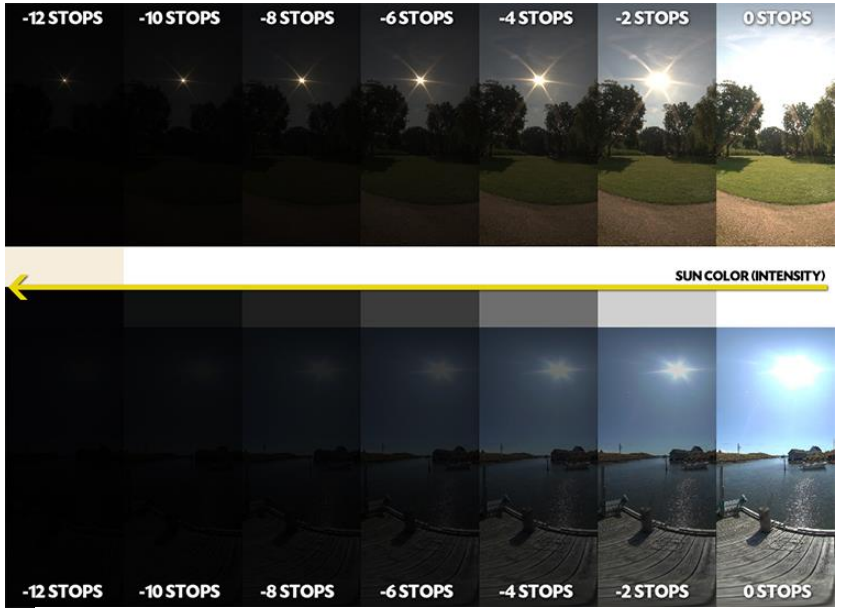






Dynamic range and ISO

- **Dynamic Range:**
  - Determines the difference between the brightest and darkest parts of the image.
  - Cameras with a larger dynamic range better capture detail in shadows and highlights.
  - Measurement in **degrees (stops)** – typical values are from 10 to 16 stops.
- **Stop (step, degree)** is a standard unit in photography and video that indicates **doubling or halving the amount of light** reaching the sensor.
  - **+1 stop** = **2x more light**
  - **-1 stop** = **2x less light**



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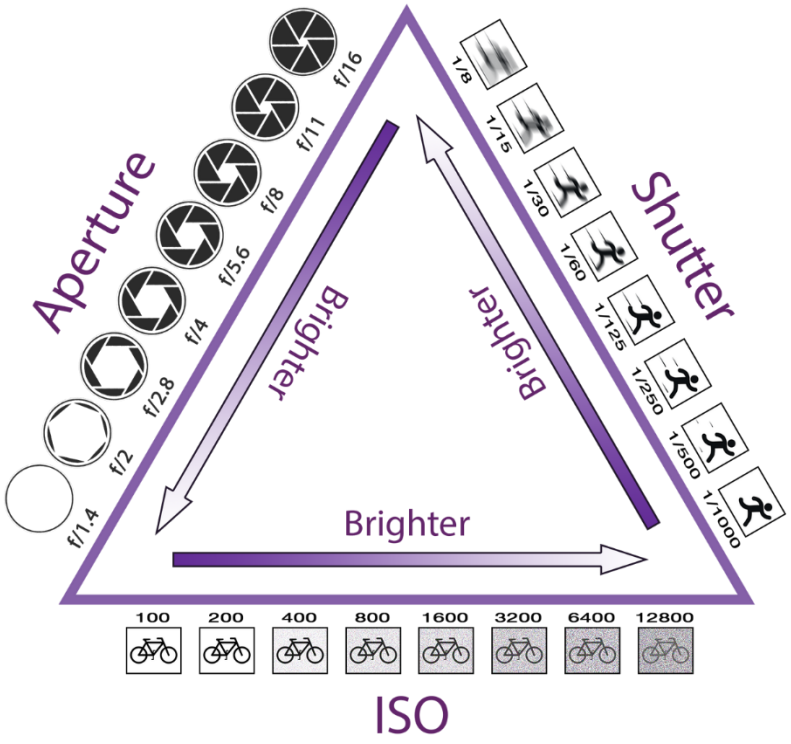
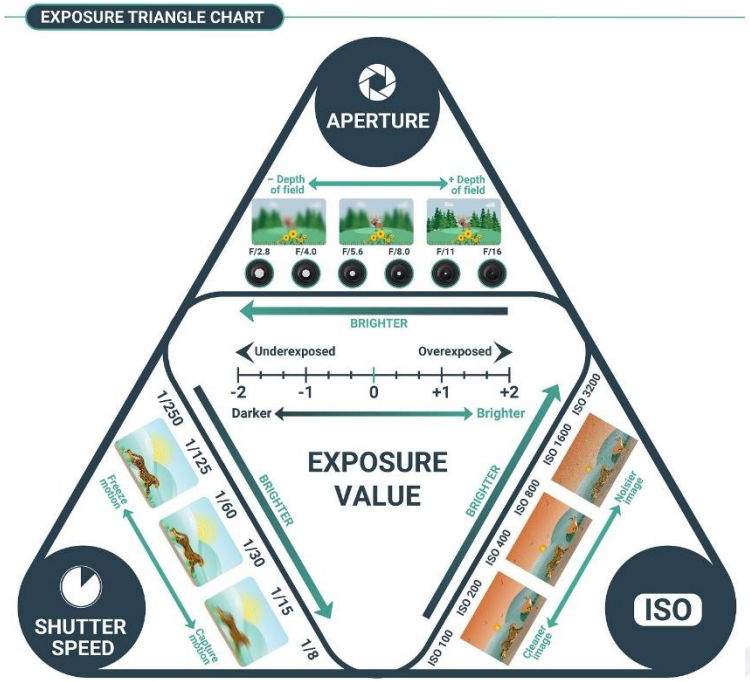
Exposure triangle





White balance

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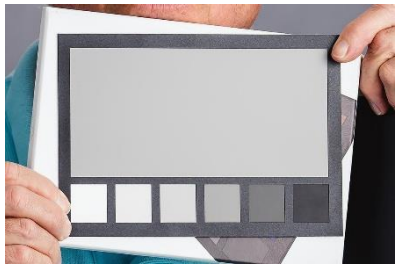
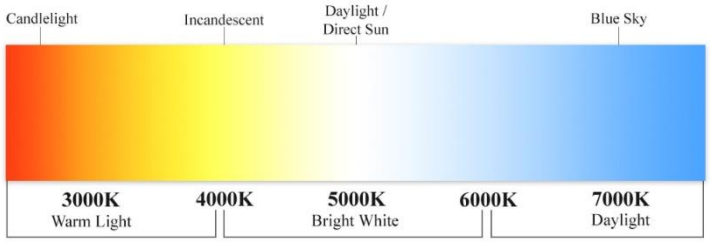
- **The white balance determines the exact color tones depending on the light source.**
  - **Daylight (5600K)** – blue tones.
  - **Tungsten (3200K)** – warm, yellow tones.

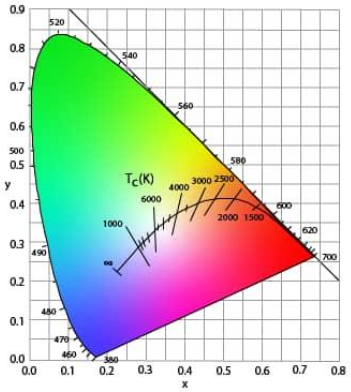
•Color temperature is a measure of the color of light emitted by a light source, expressed in Kelvin (K). It is based on the idea of what the light emitted by the so-called ideal black body would look like when heated to a certain temperature.

•Adjustment in practice:

- **Auto White Balance (AWB)** – automatic adjustment, but not always accurate.
- **Manual adjustment (Kelvin scale)** – precise color control.
- **Custom White Balance** – Measurement using a white or gray card.







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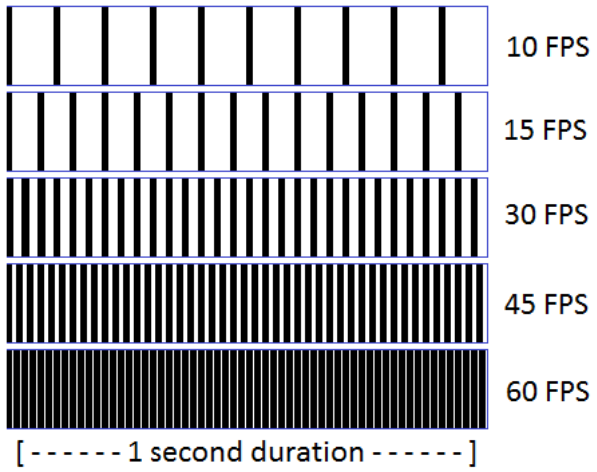
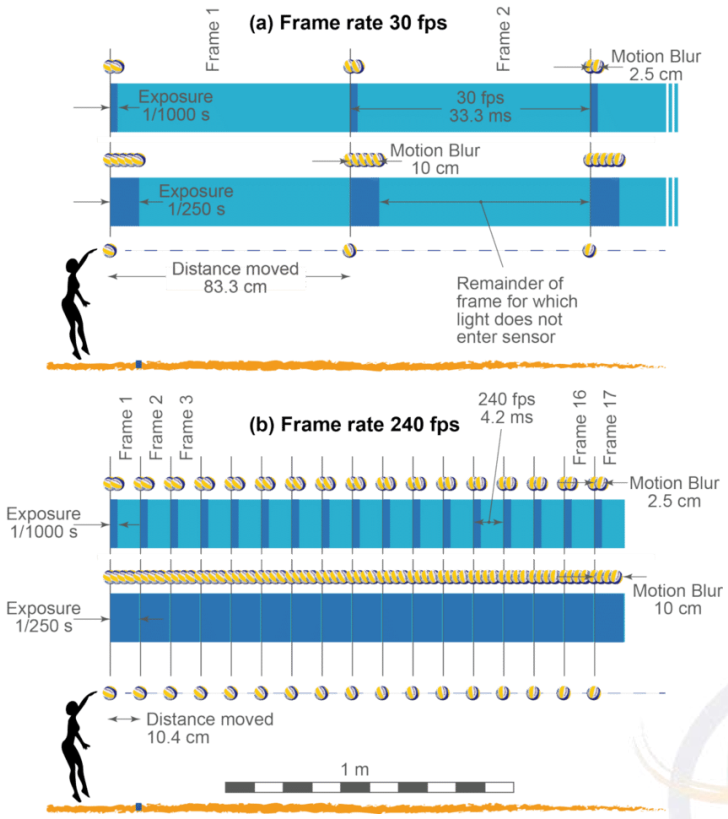
Technical Aspects

- **Resolution and record formats**
- **The most common resolutions in video production:**
  - **HD (1280x720)** – used in television shows and online video content.
  - **Full HD (1920x1080)** – standard in professional productions.
  - **4K (3840x2160)** – used in movies, commercials and high production.
  - **8K (7680x4320)** – superior image quality, used in advanced productions.
- **Codecs:**
  - **H.264 / H.265** – efficient compression, used for online streaming.
  - **ProRes / DNxHD** – professional formats with fewer quality losses.
  - **Raw video** – uncompressed data from the sensor, allows maximum control over image processing.

Frame Rate

- The frame rate determines how the movement will look on the screen.
- **The most common frame rate values:**
  - **24fps** – used in movies for a “cinematic look”.
  - **30fps** – standard for television and news.
  - **60fps** – used for sports and action scenes.
  - **120+ fps** – slow motion effects.





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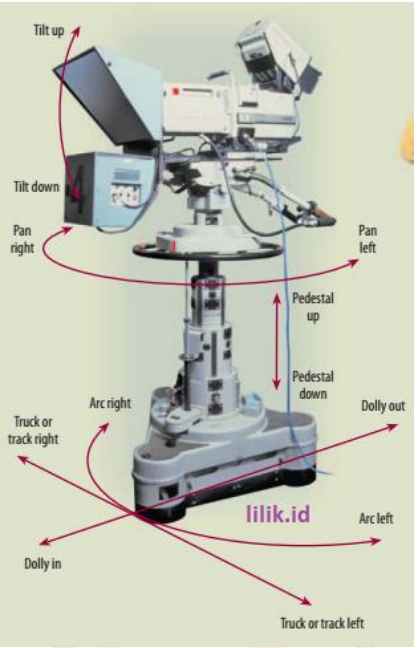
Static Cameras & Stabilizers

- **Static cameras – When and why are they used?**
- **Features of static cameras:**
  - They are **mounted on a tripod, pedestal or fixed support**.
  - **They do not move** during recording.
  - They are used when we want stable, controlled shots.
  - They provide a professional look without unwanted vibrations.

Types of static cameras and mounts

- **Tripod – The most common static camera mount**
  - **Basic tool** for stable shooting.
  - It has **three height-adjustable legs**.
  - **Fluid heads** allow smooth panoramic movements.
- **Pedestal Camera – Studio Stabilization**
  - Used in television studios and live productions.
  - Mounted on **a hydraulic bracket** with wheels for easy movemen
  - Allows height adjustment and movements without shaking.



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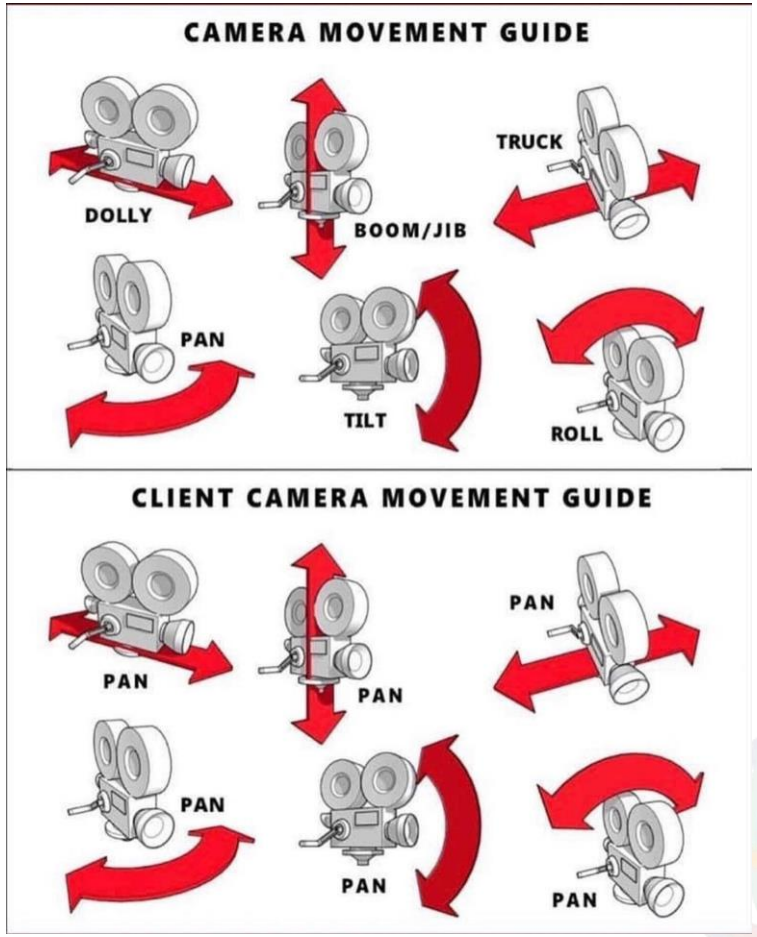
Dynamic Camera & Motion

- A dynamic camera is used to capture scenes with movement, where the camera is physically moved to achieve a specific visual effect. This technique allows for better tracking of subjects, expressing emotions and adding dramatic intensity to scenes.
- **Why use a dynamic camera?**
  - **It adds energy and dynamics to scenes** – ideal for action movies and sports.
  - **Provides better immersion** – viewers feel part of the scene.
  - **Tracks a moving subject** – used in vlogs, interviews, and documentaries.
  - **It changes the perspective and sense of space** – it is used in horror films and dramatic scenes.

Camera Motion Types

- **Pan and Tilt – Horizontal and vertical camera movement**
  - **Pan** – The camera rotates **left and right from** a static position.
  - **Tilt** – The camera moves up **and down** without changing the position of the tripod.



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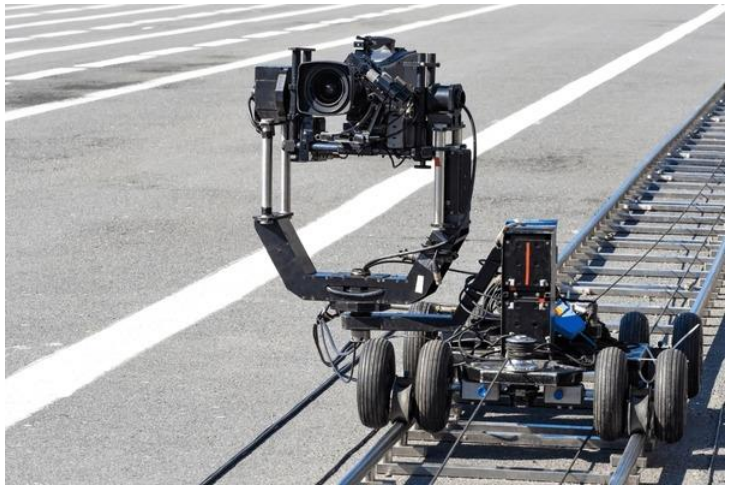
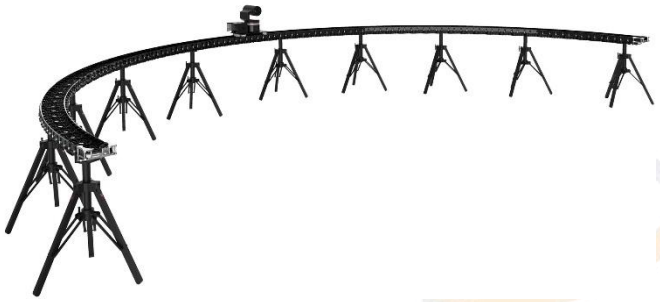
Camera Motion Types

- **Dolly and Tracking Shot – Moving to or with the Subject**
  - **Dolly In/Out** – The camera moves toward or away from the subject (In).
  - **Tracking Shot** – The camera tracks the subject as it moves.
  - The wheels and rails allow the camera to move forward, backward or sideways smoothly.
  - Used for motion picture and subject tracking.





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Camera Motion Types

- **Crane and jib – Vertical camera movement**
  - **Crane Shot** – The camera is raised and lowered using a crane.
  - **Jib arm** – Smaller crane that allows fluid vertical movements
  - It enables shooting from a height and large movements in 3D space.
  - It is used in movies, sporting events and concerts.

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Camera Motion Types

- **Handheld Camera – Realistic Handheld Movement**
  - The camera is held manually, giving a **naturalistic, documentary look**.
  - It can have a **shaky effect**, which adds **authenticity** to the scene.

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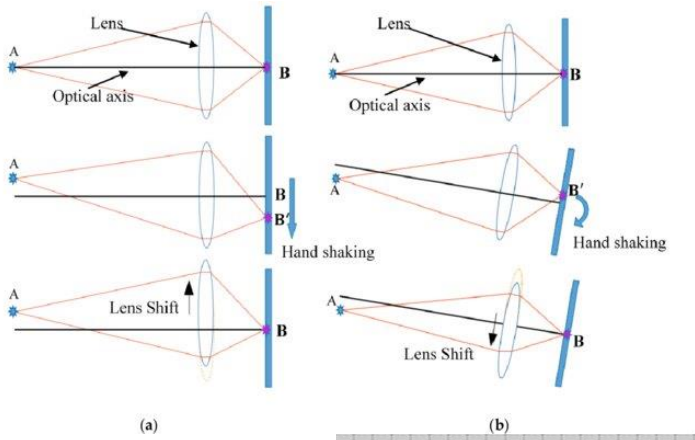
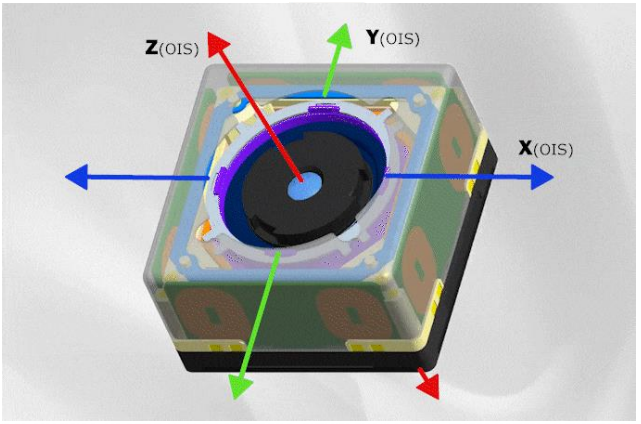
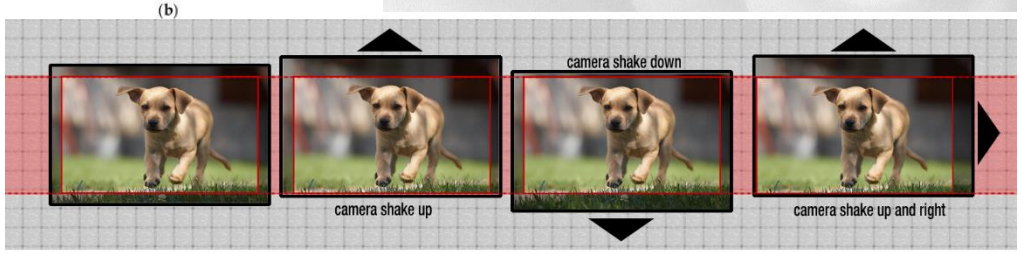
Camera Motion Types

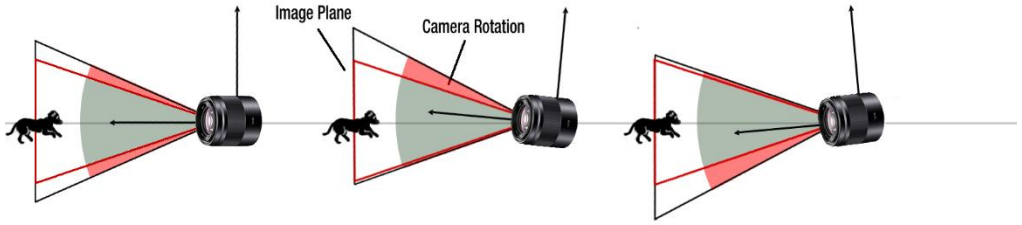
- Steadicam and Gimbal – Stabilized camera movements
  - Steadicam – System with counterweights for smooth camera movement.
  - Gimbal Stabilizer – An electronic device that stabilizes the camera on the move.

Stabilizers!









- **-Why is it important?**
  - Reduces image shake.
  - Enables smooth camera movements.
  - It gives the shot a professional look.
- **Types of stabilization:**
- **Optical Image Stabilization (OIS)**
  - Built-in lens or sensor.
  - Automatically corrects small vibrations and hand movements.
  - Used in handheld cameras and DSLRs.
- **Electronic Image Stabilization (EIS)**
  - Vibration-reducing image processing software.
  - Less accurate than optical stabilization, but useful for mobile phones and action cameras.
- **Mechanical stabilization (Gimbal and Steadicam)**
  - **Gimbal stabilizers** use **electronic motors** to compensate for movement.
  - **Steadicam systems** use **weight and counterweights** to balance the camera.
  - These systems allow **fluid camera movements without shaking**.

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Stabilization accessories

Crane 2

Easyrig Steadicam Camera

Flycam in fibra di carbonio

MediaPro Camera Stabilization System

MediaPro Flycam

MediaPro Long Handgrip Set

MediaPro Ventosa Car Suction Campod Mount

MediaPro Ventosa Car Suction Mount

MediaPro Ventosa Magnetica Car Mount

Ready Rig GS Steadicam

Ronin

Ronin 2

Other parts

- **Microphones & Audio Equipment**
- **Sound is just as important as image, and the built-in microphones in cameras are often not of sufficient quality.**
- **Microphone types**
  - **Shotgun microphone** – directional sound, used for interviews and film scenes.
  - **Lavalier microphone (bug)** – a small microphone attached to clothes, used in shows and vlogs.
  - **USB or XLR external microphones** – used for professional audio recordings.
- **On-camera audio jacks**
  - **3.5mm Jack** – standard external microphone input.
  - **XLR inputs** – professional audio connectors for high-quality microphones.
  - **Wireless microphones** – Connect via Bluetooth or Wi-Fi.

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Other parts

- **Connections and connection**
- **The camera has various connections to connect to external devices.**
- **Video outputs**
- **USB, WiFi and Ethernet ports**
  - **USB-C or Thunderbolt** – used for data transfer and charging.
  - **Ethernet port (RJ45)** – allows **live streaming over the network**

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Other parts

- **Camera equipment.**
- **External monitors and recorders**
  - **Field Monitor** – allows you to view the image in real time.
  - **External recorders (e.g. Atomos Ninja V)** – record better video than built-in camera recorders.

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Why is the proper movement of the cinematographer important?

- **Stable frame** – Improper movement may cause unnecessary vibration and blurred images.
- **Professional appearance** – Proper technique makes shots fluid and visually pleasing.
- **Composition control** – Movements must be **planned** so that the frame remains well framed.
- **Reducing cinematographer fatigue** – Proper camera posture allows for longer, effortless shooting.

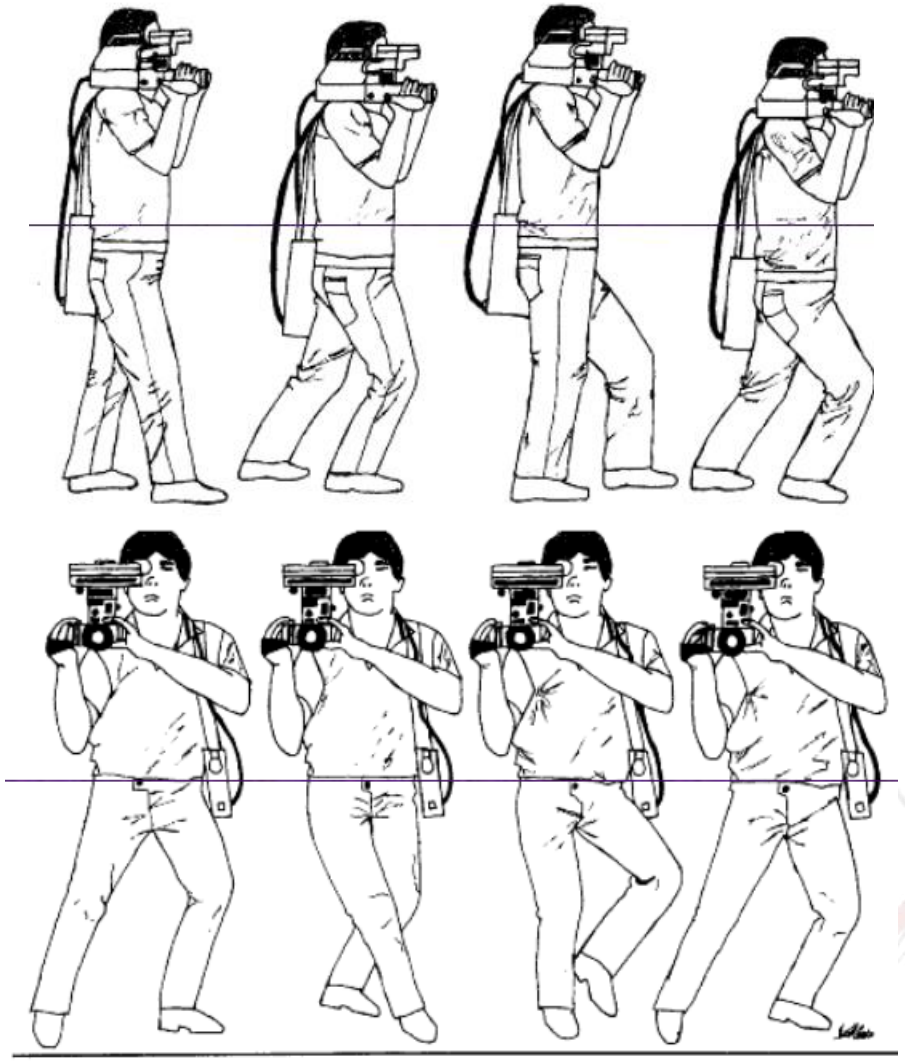
Basic mistakes when holding the camera and moving the cameraman

- **The most common errors that cause poor image quality:**
  - **Sharp camera movement** – Excessive movement can make a frame unreadable.
  - **Improper camera posture** – If the cameraman does not use both hands or support, the camera will tremble.
  - **Incorrect body movement** – If the cameraman quickly changes position without control, the frame will lose stability.
  - **Zooming while the camera is moving** – Moving the camera and zooming at the same time can seem unrealistic and confusing to the viewer.
  - **Poor AF Usage** – Changing the focus too often can interfere with the story the shot is meant to convey.
  - - Slightly included.

Basic rules of camera holding (static and handheld camera)

- **How to hold your handheld camera correctly?**
  - **Use both hands** – Right hand holds the handle or grip of the camera, left hand stabilizes the lens.
  - **Keep elbows close to body** – This reduces hand tremor and adds stability.

  - **Bend your knees when moving** – Instead of just moving your arms, use your body for controlled movements.
  - **Use the camera belt** – Prevents accidental camera drop and adds extra stability.
  - **Use camera grips** – Each camera has handles to help hold the camera. Also, as well as the possibility of installing new ones.



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Basic rules of camera holding (static and handheld camera)

- **How to properly use a static camera on a tripod?**
  - **Place the tripod on a stable surface** – A tilted tripod can lead to distorted shots.
  - **Use a levelling head** – Adjust the camera angle to make it completely flat.
  - **Lock tripod legs** – If the tripod moves, the frame will not remain stable.
  - **Use body weight for pan/tilt** – Gently pushing the camera with the body gives fluid movements.

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Body balance and motion control when shooting

- **How to move correctly while holding the camera?**
  - **Use the "walk like a ninja" technique** – Walk gently, first lowering your toes, then the heel to reduce vibration.
  - **Do not use your hands to balance** – Hands should only be focused on holding the camera.
  - **Move with bent knees** – This reduces vertical oscillations.
  - **If you are shooting for a long time, use a support** – Wall, pole, shoulders of other filmmakers can be used for additional stability.

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General rules:

- **Walk like a "ninja"** -
  - Walk slowly and in control, lowering the toes first, then the heel.
  - This reduces vertical oscillations and allows stable shots.
- **Use body weight, not just arms** -
  - Instead of moving the camera with just your hands, use your entire torso and legs to keep the movement steady.
  - This is especially true for **handheld cameras and steadicam systems**.
- **Breathing in sync with movements** -
  - Breathing gently while recording helps control movement.
  - Avoid sudden camera movement while changing your breathing or body position.
- **Avoid sudden changes of direction** -
  - Camera movements should be **planned and fluid**.
  - If you are changing direction, do it **gradually** to avoid jerks.

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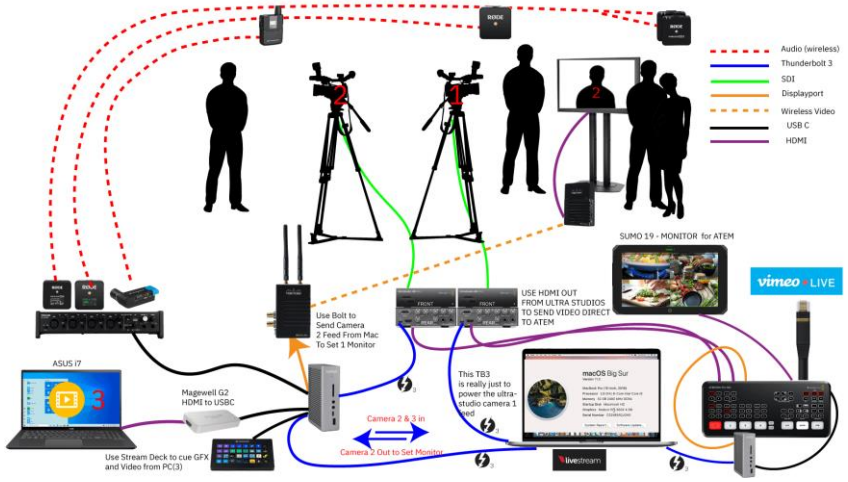
Advantages of multi-camera shooting

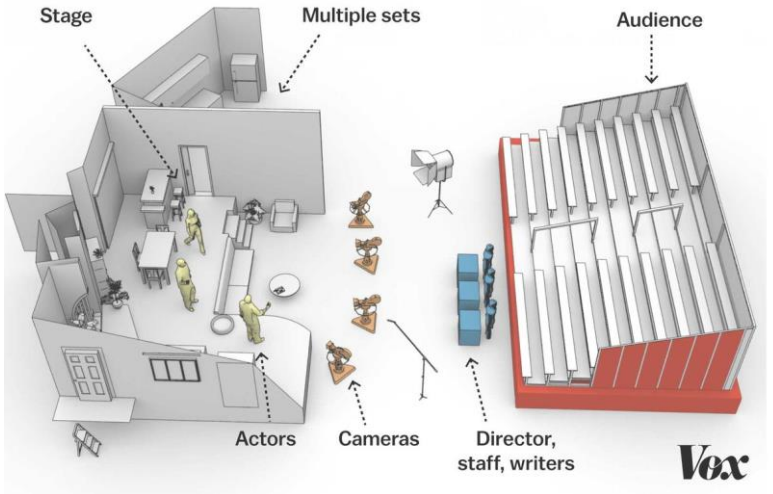
- Enables **the continuity of the scene without repeated shooting**.
- Increases **production efficiency**, especially in interviews, shows and live events.
- It allows multiple visual perspectives at the same time (near, medium and wide plan).
- Facilitates **dynamic assembly and switching between frames**.

How to organize multiple cameras on set?

- Camera and parameter synchronization
- **Installation of cameras according to visual needs:**
  - **Main camera (A camera)** – Fixed wide plan for the base frame.
  - **Secondary camera (B camera)** – Medium plan or zoom on the subject.
  - **Third camera (C camera)** – Alternate angle or scene details.
- **Coordination between operators** - All cameramen must know **when and how to change the frame.**
- **Using the Utility Monitor** - To ensure that all frames are visually aligned.



Typical multi-camera sitcom setup



Multi-camera synchronization techniques

•**Using a clapper** – Allows you to easily synchronize sound and image in post-production.

•**Automatic synchronization in software** – Programs such as Adobe Premiere Pro and DaVinci Resolve can automatically synchronize recordings using audio.

•**Timecode synchronization** – All cameras use the same timecode to facilitate assembly.

•**Live switching (for live events)** – The cameras are connected to the overhead system where the director selects the frames in real time.

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How to recognize a good and bad shot?

- A good shot has clear focus, proper lighting, and stable composition.
- A bad shot is often the result of tremors, improper lighting, and poor framing.
- Proper use of the camera requires knowledge of the basic principles of framing, exposure and camera movement.

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The most common recording errors to avoid

- **Too much or too little light** – A strong light source can illuminate the subject too much, while insufficient light causes dark and blurry shots.
- **Sudden and uncontrolled camera movement** – Leads to tremors and loss of focus.
- **Poor focusing – AF** can change the sharpness of an image unpredictably.
- **Incorrect composition** – Using too much overhead space or placing the subject in the center of the frame without balance.
- **Using the digital zoom** – Decreases the image quality compared to the optical zoom.

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Technical tips to improve image quality

- **Use stabilizers** – A tripod, gimbal or hand steadice prevents image shake.
- **Correct exposure adjustment** – Set the balance between ISO, aperture, and shutter speed.
- **Match White Balance** – Choose the right WB mode to make colors look natural.
- **Check audio before recording** – Use external microphone if necessary.
- **Use histogram** – This on-camera tool helps avoid overexposed and underexposed images.

WBnet

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Questions & Answers

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Call: ERASMUS-EDU-2023-CBHE

Project number: 101128813

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