Lighting for Digital Video

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Light Defined

- Electromagnetic radiation of a wavelength that is visible to the human eye (about 400–700 nm), or up to 380–750 nm
- Light can exhibit properties of both waves and particles (photons). This property is referred to as wave–particle duality.
- The study of light, known as optics, is an important research area in modern physics.

Speed of Light

- In a vacuum is presently defined to be exactly 299,792,458 m/s (about 186,282.397 miles per second)
- Astronomical distances are sometimes measured in light-years
- The distance that light would travel in one Earth year, roughly 9.46 x 10^12 kilometers or about 5.88 x 10^12 miles
- E=mc²
  - Means that energy (E) is equal to mass (m) times the speed of light (c) squared
  - Going really fast is really hard to do
Additive Color

- Lighting is an additive color mixing process vs. the subtractive process used commonly in printing
  - We mix light by adding beam of colored light on top of one another to produce colors
  - Three additive primary colors used in lighting
    - Red
    - Green
    - Blue
  - All three colors together produce white light

Types of Light

- Directional Light
  - Has a precise beam that causes harsh shadows
  - Has very little spill other than where it is aimed
  - The sun and car headlight are good examples
- Diffused Light
  - Causes a more general illumination
  - The light beam spreads out quickly and illuminates a large area
  - It seems to come from all directions and is thus considered omni-directional light
  - It has no clearly defined shadows – they seem soft and transparent
  - A foggy day and large fluorescent lights are good examples

Lighting Source

- Ambient Light
  - Ambient light means the light that is already present in a scene before any additional lighting is added
  - Usually refers to natural light, either outdoors or coming through windows etc.
  - It can also mean artificial lights such as normal room lights
  - Ambient light is important in photography and video work, as most shots rely largely or wholly on ambient lighting
  - Ambient light may be the wrong color temperature, intensity or direction for the desired effect
  - You may choose to block out the ambient light completely and replace it with artificial light
Lighting Direction

- Incident Light
  - Light seen directly from a light source (lamp, sun, etc)
- Reflected Light
  - Light seen after having bounced off a surface

Light Effects

- Reflection
  - A lot of objects reflect light to some degree, but something that is particularly reflective, has more free electrons that are able to pass from atom to atom with ease.
  - The light energy that is absorbed by these electrons, is not passed onto to any other atoms - instead the electrons vibrate and the light energy is sent out of the material at the same frequency as the original light coming in.

- Absorption
  - When something appears to have no reflection or is opaque, than the incoming light source frequency is the same as, or very close to, the vibration frequency of the electrons in the given material.
  - The electrons of the material absorb the energy of the light source, and because the light is absorbed, the material or object appears opaque - it has very little or no reflection.
**Light Effects**

- **Transmission**
  - This occurs when the energy of the incoming light is either much lower or much higher than the energy or frequency required to make the electrons in the particular material vibrate.
  - Because of this, the electrons in an object that appears to be transparent, instead of capturing the light energy, they let the light wave pass through the object/material unchanged, thus the object/material is transparent to that frequency of light.

- **Refraction**
  - If the energy of the incoming light is the same as the vibration frequency of the electrons in the material, the light is able to go deep into the material, and causes small vibrations in the electrons. These vibrations are passed on to the atoms by the electrons, and in turn, they send out light waves at the same frequency as the incoming light. Although this happens extremely quickly, some of the light that is inside of the material slows down, but the frequency of the light outside the material stays the same. The result of this is the light inside the material is bent. The angle of the distortion (refraction) depends upon how much the material is able to slow down the light.
  - Straw in water example

- **Scattering**
  - When light hits small particles, the light scatters in all directions - so long as the particles are small compared to the wavelength.
    - When light is reflected from a mirror, the angle of reflection equals the angle of incidence.
    - When light is reflected from a piece of plain white paper - the reflected beam is scattered, or diffused - because the surface of the paper is not smooth, the reflected light is broken up into many light beams that are reflected in all directions.
Light Effects

- Electromagnetic radiation – in this case light - undergoing refraction, reflection, absorption, and scattering

![Light Effects Diagram]

Color Temperature

- Color Temperature
  - Standard of measuring the characteristics of light, measured in Kelvin
  - William Thomson (1824 – 1907)
  - Indoor tungsten lighting
    - 3200K – reddish
  - Most fluorescent lighting
    - 4800K – greenish
  - Sunlight (mid-day)
    - 5600K – bluish / white
  - Sunlight (very early or late)
    - 10000K – deep orange / red

![Color Temperature Chart]

Color Temperature problems

- If you have clashing light sources (e.g. artificial interior lights with sunlight coming through the windows) - you may find the colors in your image appear unnatural
- It’s best to control the light sources yourself if possible (e.g. turn off the lights or close the curtains)
- When moving between locations - think about what light source you are using
- If you move from an outside setting to an inside one with artificial lights the amount of light may seem the same but the color temperature will change according to the type of lights
- You may need to white balance your camera for the new light source
Lighting Terms

- **Contrast Ratio**
  - The difference in brightness between the brightest white and the darkest black within an image.
  - High contrast ratio means that brighter and darker areas of the image will be recorded with more accuracy and apparent detail.
  - Avoid having very bright and very dark objects in frame at the same time.
  - Always expose for the subject.

Lighting Terms

- **Contrast Ratio Limits**
  - Most video cameras: 50:1
  - Film approximately: 70:1
  - Human eye: 1000:1
  - Hand in front of a computer screen - squinting.

Three Point Lighting

- **Key Light**
  - The main light on the subject, providing most of the illumination and contrast.
- **Fill Light**
  - Light placed to the side of the subject to fill out shadows and balance the key light.
- **Back Light**
  - A light placed at the rear of a subject to light from behind.
  - Forms the basis of most lighting techniques.
Three Point Lighting

Key Light
- This is the main light
- It is usually the strongest and has the most influence on the look of the scene
- It is placed to one side of the camera/subject so that this side is well lit and the other side has some shadow
  - If you only have one light, it becomes the key
  - If you have 2 lights, one is the key and the other is either the fill or the backlight

Fill Light
- This is the secondary light and is placed on the opposite side of the key light
- It is used to fill the shadows created by the key. The fill will usually be softer and less bright than the key. To achieve this, you could move the light further away or use some diffusion material
- You might also want to set the fill light to more of a flood than the key

Back Light
- The back light is placed behind the subject and lights it from the rear
- Rather than providing direct lighting (like the key and fill), its purpose is to provide definition and subtle highlights around the subject’s outlines
- Sometimes called rim light or hair light
- Helps separate the subject from the background and provide a three-dimensional look
Four Point Lighting

- Background Light
  - A fourth light, you could use it to light the background of the entire scene.
  - Used to illuminate the background area of a set.
  - The background light will also provide separation between the subject and the background.
  - In the standard 4-point lighting setup, the background light is placed last and is usually placed directly behind the subject and pointed at the background.
  - Can be used to eliminate shadows cast by foreground elements onto the background.

Inverse Square Law

- Light decreases with the square of the distance from the source.
- If you get 1/4 the light every time you double the distance from the source.
- Remember across the street is almost the same distance from the sun.
- The sky is also far away—but as the total amount of sky that lights a person is reduced—the amount of light is reduced.

Light Shape

- Spot
  - A controlled, narrowly-focused beam of light.
  - A laser beam for example.
- Flood
  - A broad beam of light, less directional and intense than a spot.
  - A street light for example.
Light Quality

- **Hard Light**
  - Light directly from a source such as the sun, traveling undisturbed onto the subject being lit
  - Light from a small source
  - Creates hard shadows and accentuated detail such as lines in the face

- **Soft Light**
  - Light which appears to "wrap around" the subject to some degree
  - Produces less shadows or softer shadows
  - Make a subject appear more beautiful or youthful through making wrinkles less visible

Light Quality

- Light quality depends on two things
  - Distance
    - The closer the light source, the softer it becomes
  - Size of light source
    - The larger the source, the softer it becomes
  - Quality of light can be altered by using diffusion gel or aiming a lighting instrument at diffusing material such as a silk, tough spun, or a soft box
  - When shooting outdoors, cloud cover provides nature’s version of a softbox

Light Falloff

- Indicates the degree of change from light to shadow
- Refers to the relative abruptness or speed which light turns into shadow areas
- Abrupt change is fast fall off
  - Sharp edge
  - Hard shadow
- Gradual change is slow fall off
  - Shaded edge with continuous change
  - Soft shadow
High / Low Key Light

- **High key lighting**
  - Has an abundance of bright, diffused light, resulting in a slow fall off or flat lighting
  - News studio desk

- **Low key lighting**
  - Much more dramatic lighting
  - Uses relatively few spot lights to create selective lighting with fast fall-off
  - Has prominent shadows – floor areas kept dark
  - Most night scenes in crime shows and sf-fi

Blub Types

- **Tungsten**
  - Light from an ordinary light bulb containing a thin coiled tungsten wire that becomes incandescent - emits light - when an electric current is passed along it
  - Tungsten color temperature is around 2800K to 3400K (Usually 3200K)
  - Also known as incandescent light

- **Halogen**
  - A lamp in which a tungsten filament is sealed in a clear capsule filled with a halogen gas such as iodine or bromine
  - More efficient and a higher color temperature than standard tungsten lights
**Blub Types**

- **HMI or Hydrargyrum Medium-Arc Iodide**
  - A type of light which uses an arc lamp instead of an incandescent bulb to produce light
  - HMI lights are high-quality and correspondingly expensive
  - HMI lights require a ballast, an electronic (or magnetic) device which provides the ignition pulse and regulates the arc
  - 2 to 5 times as efficient as incandescent lights
  - Use less power and run cooler
  - HMI run at around 5600K - daylight temperature - this makes daylight shooting easier, as well as eliminating loss of light from gels

- **Fluorescent lamp or fluorescent tube**
  - A gas-discharge lamp that uses electricity to excite mercury vapor
  - The excited mercury atoms produce short-wave ultraviolet light that then causes a phosphor to fluoresce, producing visible light
  - Usually about 4800K
  - Always require a ballast to regulate the flow of power through the lamp unlike incandescent
  - More efficient than incandescent lights

- **LED – Light Emitting Diode**
  - A type of solid state lighting (SSL) that uses light-emitting diodes (LEDs) as the source of light, rather than electrical filaments plasma (used in arc lamps such as fluorescent lamps), or gas
  - Most efficient light source currently
  - Very little power use
  - Very little heat emitted
Measuring Light

- **Lumen (lm)**
  - Unit of light flow or luminous flux
  - The output of artificial lights can be measured in lumens

- **Lux (lx)**
  - Unit of illumination equal to one lumen per square meter
  - The metric equivalent of foot-candles
  - One lux equals 0.0929 foot-candles
  - Also called meter-candle.

- **Candela (cd)**
  - Unit of luminous intensity of a light source in a specific direction
  - Also called candle
  - Technically, the radiation intensity in a perpendicular direction of a surface of 1/600000 square meter of a black body at the temperature of solidification platinum under a pressure of 101,325 newtons per square meter.

- **Footcandle (fc or ftc)**
  - Unit of light intensity, measured in lumens per square foot
  - The brightness of one candle at a distance of one foot
  - Approximately 10.7639 lux

Light Level

- **Light Meter**
  - A device used to measure the amount of light
  - Used to determine the proper exposure for a scene
  - Typically a light meter will include a computer that allows the photographer to determine which shutter speed and f-number should be selected for an optimum exposure for a lighting situation and film speed
## Fixture Types

- **Blonde**
  - 1000-2000w - used as a key flood light for large areas
- **Redhead**
  - 650-1000w - used as a key flood light for large areas
- **Pepper Light**
  - 100-1000w - small light used as a more focused key or fill light
- **HMI**
  - Usually 1,200W – 18,000W - High-quality type of light which uses an arc lamp instead of filament bulb
- **Halogen Work Lamp**
  - 150-500w, used as a key flood light for lighting large areas - a low-budget lighting solution
- **Chinese Lantern**
  - 20W – 200W low-cost light useful in some situations for soft light

## Other Fixture Types

- **Scoop**
  - Named after scoop like reflector
  - Good for lighting larger studio areas
- **Soft light**
  - Relatively large light
  - Usually with a long tube like lamp that reflects off of a light diffusing curved reflector
- **Fluorescent bank**
  - Consists of a row of fluorescent tubes
  - Creates a smooth soft light
- **Fresnel light**
  - Has thin step-like glass that allow for either a narrow / focused beam of light or wide soft beam of light (flood or spot)
- **Ellipsoidal light**
  - Produces an extremely sharp beam of focused light
  - Has two holes for the reflector and gobo
  - Can project custom or stock gobos also called gobos (go-betweens) to create light patterns

## Camera Mounted Light

- An easy, practice, and versatile solution
- Typically the light will draw power from the camera battery, although a separate power supply can be used
- Be aware that lights which draw power from the camera battery will significantly shorten the battery’s charge time
- This type of lighting does not create pleasing effects
- It is a “blunt instrument” approach which is really only designed to illuminate the scene enough to allow normal camera operations
Light Gels
- Color gel or color filter or a lighting gel or simply gel
  - Is a transparent colored material that is used to color light and for color correction – placed in front of the fixture
  - Modern gels are thin sheets of polycarbonate or polyester - placed in front of a lighting fixture in the path of the beam
  - Gels have a limited life - especially in saturated colors - the color will fade or even melt, depending upon the energy absorption of the color, and the sheet will have to be replaced
- In permanent installations and some theatrical uses, colored glass filters or dichroic filters are being used

Gels have a limited life – especially in saturated colors – the color will fade or even melt, depending upon the energy absorption of the color, and the sheet will have to be replaced.

There are gels for color correction
- CTO and CTO, “Color Temperature Blue”,” and “Color Temperature Orange” respectively
- Color correction gels alter or “correct” the color temperature of a light

Light Reflector
- A specially-designed reflective surface used to act as a secondary light source – no power needed
- The board is lightweight and often flexible
- Normally folded up for transport in a small carry-case
- Usually easily mounted on a grip stand
- Useful as a fill light when working in strong sunlight
- Often found in white, silver or gold surfaces
- Many things can be used as a reflector
  - Windscreen sunshades for automobiles
  - Polystyrene sheets
  - Tin foil on cardboard
  - Whiteboard

Light Stands & Clamps
- Lighting Support refers to the range of systems used to support lights and hold them in the correct position - usually means light stands and clamps
- Clamps and other accessories are sometimes referred to as grip gear
- Like microphone stands - most lighting stands and clamps use a standard system of fittings usually 5/8th inch diameter
- On simple light stands the light slides down onto the fitting and screws tight
- Sand bags will hold a stand in place
Night-Mode Shooting

- Some cameras offer a special "night vision" option which allows you to shoot with virtually no light.
- This mode uses infrared light instead of normal visible light.
- This is useful in extreme circumstances when you have no other option.
- Unfortunately, the results tend to be poor-quality monochrome green.
- CBS's Survivor at night or other reality shows.
- Use this mode for a special effect if it suits the content.

Lighting People

- Harsh light is not flattering - soft light creates a warmer feel.
- Avoid strong nose shadows or any strong contrast on the face - place the key light on the same side as the camera and fill the shadows.
- Avoid reflections from glasses - you may need to adjust the position of the subject and/or lights to do this.
- Beware bald heads - they can reflect a lot of light and appear over-exposed - try weakening or softening the light with a diffusion gel.
- Soft light and diffusion helps reduce the appearance of wrinkles.

Windowed Background

- Lighting indoors with windows in the background can be challenging.
  - Large difference in light levels between the room and the outside view make finding the correct exposure a challenge.
  - Video is particularly susceptible to this problem due to its relatively low contrast ratio.
  - First use the manual iris to set your exposure correctly for the subjects - the window will be over-exposed but that's a necessary compromise.
  - If possible, add more light to the room or reduce the light from the window with neutral density material or a mesh scrim.
Lighting Effects

- Colder or warmer mood lighting
  - Add to the feeling of coldness or warmth by using additional filters or doubling up on gels.
  - Very blue means very cold - very red/orange means very hot.
  - Make daytime seem like night by lowering the exposure slightly and adding a blue filter to the camera.
  - You also need to think about any other lighting which should appear in shot.

- Moonlight or night time effect
  - A convincing illusion may require more effort than this - you don’t want any daytime gimmicks such as birds flying through shots.
  - A sound effect sells this illusion.

- Firelight
  - Point a redheat -left orange gel away from the subject at a large reflector which reflects the light back at the subject. Make the reflector to simulate firelight.
  - A sound effect sells this illusion.

- Watching TV
  - Shine a blue light at the subject and wave a piece of cloth or paper in front of the light to simulate flickering or use a dimmer that is varied during the shot.

Light Safety

- Keep bystanders away from lights - they are notorious for knocking them over.
- Always be extremely careful with the heat created by lights. The barn doors can burn your fingers - wait until lights cool down before touching or moving them.
- Don’t handle bulbs with your fingers use a piece of cloth or something else to avoid getting oil on the bulb.
- Only use material for gels which is specifically designed for lighting - don’t use paper, tracing paper, baking paper, plastic, etc. and never attach anything to a light which isn’t designed for the application.
- Make sure stands are stable and loose cables are taped to the ground.
- Lights are power-hungry - don’t overload sockets - never plug more than 2Kw of lighting into a domestic power point.
- Make sure all lights have adequate ventilation and never cover them.

Video
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