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Introduction to video camera

Parts of video camera and their functions

Camera movement equipment

Lenses – functions and types

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CAMERA

Introduction to video camera

A video camera is a camera used for electronic motion picture acquisition (as opposed to a movie camera, which records images on film), initially developed for the television industry but now common in other applications as well.

The earliest video cameras were those of John Logie Baird, based on the mechanical Nipkow disk and used in experimental broadcasts through the 1920s-1930s. All-electronic designs based on the video camera tube, such as Vladimir Zworykin's Iconoscope and Philo Farnsworth's image dissector, supplanted the Baird system by the 1930. These remained in wide use until the 1980s, when cameras based on solid-state image sensors such as CCDs (and later CMOS active pixel sensors) eliminated common problems with tube technologies such as image burn-in and made digital video workflow practical. The transition to digital TV gave a boost to digital video cameras and by the 2010s, most video cameras were digital.

With the advent of digital video capture, the distinction between professional video cameras and movie cameras has disappeared as the intermittent mechanism has become the same. Nowadays, mid-range cameras exclusively used for television and other work (except movies) are termed professional video cameras.

Video cameras are used primarily in two modes. The first, characteristic of much early broadcasting, is live television, where the camera feeds real time images directly to a screen for immediate observation. A few cameras still serve live television production, but most live connections are for security, military/tactical, and industrial operations where surreptitious or remote viewing is required. In the second mode the images are recorded to a storage device for archiving or further processing; for many years, videotape was the primary format used for this purpose, but was gradually supplanted by optical disc, hard disk, and then flash

memory. Recorded video is used in television production, and more often surveillance and monitoring tasks in which unattended recording of a situation is required for later analysis.

Modern video cameras have numerous designs and uses.

- Professional video cameras, such as those used in television production, may be television studio-based or mobile in the case of an electronic field production (EFP). Such cameras generally offer extremely fine-grained manual control for the camera operator, often to the exclusion of automated operation. They usually use three sensors to separately record red, green and blue.
- Camcorders combine a camera and a VCR or other recording device in one unit; these are mobile, and were widely used for television production, home movies, electronic news gathering (ENG) (including citizen journalism), and similar applications. Since the transition to digital video cameras, most cameras have in-built recording media and as such are also camcorders. Action camera's often have 360° recording capabilities.
- Closed-circuit television (CCTV) generally uses pan tilt zoom cameras (PTZ), for security, surveillance, and/or monitoring purposes. Such cameras are designed to be small, easily hidden, and able to operate unattended; those used in industrial or scientific settings are often meant for use in environments that are normally inaccessible or uncomfortable for humans, and are therefore hardened for such hostile environments (e.g. radiation, high heat, or toxic chemical exposure).
- Webcams are video cameras which stream a live video feed to a computer.
- Camera phones have video cameras that are incorporated into mobile phones.
- Special camera systems are used for scientific research, e.g. on board a satellite or a space probe, in artificial intelligence and robotics research, and in medical use. Such cameras are often tuned

for non-visible radiation for infrared (for night vision and heat sensing) or X-ray (for medical and video astronomy use).

(b) Parts of video camera and their functions

Camera Imaging Devices

The very heart of a video camera is its imaging device. The first TV cameras used rather large tubes, as shown on the left.

Some early color cameras had four of these tubes (for red, blue, green, and luminance), which explains why early color TV cameras weighed more than 200 kilograms (500 pounds) and had to be hauled around in trucks.

An example of one of the first color cameras used in broadcasting in the 1950s, is shown next to the woman on the right. Note how it compares to one the latest pocket sized cameras (complete with a video recorder) shown in the insert at the bottom of the photo.

The latter camera, and in fact most of today's video cameras, use an imaging chip, such as the CCD shown on the left. Many cameras have now moved to a CMOS chip, but at this point the distinction is not that important.

The most common chip sizes are 1/2 inch and 2/3 inch (the size of the little box shown near the center of the CCD chip above).

The 1/2 inch chip has a diagonal surface distance of 8 mm (less than a third of an inch), while the 2/3 inch has a diagonal of 11 mm (less than a half of an inch).

High resolution professional cameras often use a larger chip, up to the size of a 35mm motion picture film frame.

Camera Functions

Most domestic camcorders can do just about everything automatically. All you have to do is turn them on, point, and press record. In most situations this is fine, but automatic functions have some serious limitations. If you want to improve your camera work, you must learn to take control of your camera. This means using manual functions. In fact, professional cameras have very few automatic functions, and professional camera operators would never normally use auto-focus or auto-iris.

This is where most beginners ask "Why not? My auto-focus works fine, and my pictures seem to look okay." There are two answers:

1. Although auto-functions usually perform well enough, there will be some situations they can't cope with (e.g. bad lighting conditions). In these circumstances you may be faced with unusable footage unless you can take manual control. More commonly, your shots will be useable but poor quality (e.g. going in and out of focus).
2. Your camera can't know what you want. To get the best results or obtain a particular effect it is often necessary to over-ride auto-functions and go manual.

As you learn more about camera work you will begin to appreciate the better results gained through manual functions.

The most common camera operations are briefly explained below. Starting at the beginning, learn and practice one at a time, leaving the others on auto-function.

Zoom

This is the function which moves your point of view closer to, or further away from, the subject. The effect is similar to moving the camera closer or further away.

Note that the further you zoom in, the more difficult it is to keep the picture steady. In some cases you can move the camera closer to the subject and then zoom out so you have basically the same framing. For long zooms you should use a tripod.

Zooming is the function everyone loves. It's easy and you can do lots with it, which is why it's so over-used. The most common advice we give on using the zoom is *use it less*. It works well in moderation but too much zooming is tiring for the audience.

Focus

Auto-focus is strictly for amateurs. Unlike still photography, there is no way auto-focus can meet the needs of a serious video camera operator. Many people find manual focus difficult, but if you want to be any good at all, good focus control is essential.

Professional cameras usually have a manual focus ring at the front of the lens housing. Turn the ring *clo*ckwise for *clo*ser focus, anti-clockwise for more distant focus. Consumer cameras have different types of focus mechanisms — usually a small dial.

To obtain the best focus, zoom in as close as you can on the subject you wish to focus on, adjust the ring until the focus is sharp, then zoom out to the required framing.

Iris

This is an adjustable opening (aperture), which controls the amount of light coming through the lens (i.e. the "exposure"). As you open the iris, more light comes in and the picture appears brighter.

Professional cameras have an iris ring on the lens housing, which you turn *clo*ckwise to *clo*se and anticlockwise to open. Consumer-level cameras usually use either a dial or a set of buttons.

The rule of thumb for iris control is: Set your exposure for the subject. Other parts of the picture can be too bright or darks, as long as the subject is easy to see.

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White Balance

White balance means colour balance. It's a function which tells the camera what each colour should look like, by giving it a "true white" reference. If the camera knows what white looks like, then it will know what all other colours look like.

This function is normally done automatically by consumer-level cameras without the operator even being aware of it's existence. It actually works very well in most situations, but there will be some conditions that the auto-white won't like. In these situations the colours will seem wrong or unnatural.

To perform a white balance, point the camera at something matt (non-reflective) white in the same light as the subject, and frame it so that most or all of the picture is white. Set your focus and exposure, then press the "white balance" button (or throw the switch). There should be some indicator in the viewfinder which tells you when the white balance has completed. If it doesn't work, try adjusting the iris, changing filters, or finding something else white to balance on.

You should do white balances regularly, especially when lighting conditions change (e.g. moving between indoors and outdoors).

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Audio

Virtually all consumer-level cameras come with built-in microphones, usually hi-fi stereo. These work fine, and are all you need for most general work.

Getting better results with audio is actually quite difficult and is a whole subject in itself. We won't go into it much here — you just need to be aware that audio is very important and shouldn't be overlooked.

If you're keen, try plugging an external microphone into the "mic input" socket of your camera (if it has one). There are two reasons why you might want to do this:

1. You may have a mic which is more suited to the type of work you are doing than the camera's built-in mic. Often, the better mic will simply be mounted on top of the camera.
2. You might need to have the mic in a different position to the camera. For example, when covering a speech, the camera could be at the back of the room with a long audio lead running to the stage, where you have a mic mounted on the pedestal.

The level at which your audio is recorded is important. Most cameras have an "auto-gain control", which adjusts the audio level automatically. Consumer-level cameras are usually set up like this, and it works well in most situations. If you have a manual audio level control, it's a good idea to learn how to use it (more on this later).

If possible, try to keep the background (ambient) noise level more or less consistent. This adds smoothness to the flow of the production. Of

course, some shots will require sudden changes in ambient audio for effect.

Listen to what people are saying and build it into the video. Try not to start and finish shots while someone is talking — there's nothing worse than a video full of half-sentences.

Be very wary of background music while shooting — this can result is music that jumps every time the shot changes, like listening to a badly scratched record. If you can, turn the music right down or off.

One more thing... be careful of wind noise. Even the slightest breeze can ruin your audio. Many cameras have a "low-cut filter", sometimes referred to as a "wind-noise filter" or something similar. These do help, but a better solution is to block the wind. You can use a purpose-designed wind sock, or try making one yourself.

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Shutter

At the beginner level you don't really need to use the shutter, but it deserves a quick mention. It has various applications, most notably for sports or fast-action footage. The main advantage is that individual frames appear sharper (critical for slow-motion replays). The main disadvantage is that motion appears more jerky.

The shutter can also be used to help control exposure.

Effects

Many consumer cameras come with a selection of built-in digital effects, such as digital still, mix, strobe, etc. These can be very cool, or they can be very clumsy and tacky. They require dedicated experimentation to get right. Like so many things in video, moderation is the key: use them if you have a good reason to, but don't overdo it.

You should also be aware that almost every effect you can create with a camera can be done better with editing software. If at all possible, shoot your footage "dry" (without effects) and add effects later.

(c) Camera movement equipment

Basic Camera Moves

we refer to moving (rolling) the entire camera toward or away from the subject as a dolly ("dolly in" for a close shot or "dolly back" for a wide-shot).

A lateral move (rolling the camera to the left or right on the pedestal) is trucking, as in "truck left" or "truck right."

And, finally, you'll recall that a zoom optically achieves somewhat the same effect as a dolly, but without moving the entire camera.

Studio Camera Mounts

In the studio the entire camera assembly is mounted on a pedestal or dolly so that the operator can smoothly roll it around on the floor. The three wheels in the base of the pedestal can be turned using the steering ring.

The camera is directly attached to a pan head, which enables the pan and tilt (horizontal and vertical) camera movements to be adjusted.

Controls on the pan head allow the camera either to move freely, to be locked into position, or to offer controlled resistance to facilitate smooth pans and tilts.

Although the camera may weigh more than 100 pounds (45kg), internal counterweights allow an operator to easily raise and lower the camera when the telescoping column in the center is unlocked.

Unlike the elaborate studio pedestal that can be smoothly rolled across a studio floor (even while the camera is on the air), the wheels on small dollies are intended to move the camera from place to place between shots.

Robotic Camera Mounts

Camera operators have disappeared at many, if not most, production facilities -- replaced by remotely controlled, robotic camera systems.

From the TV control room, technicians can adjust the pan, tilt, zoom and focus, and even remotely dolly and truck these cameras around the studio.

Although robotic cameras are not desirable for unpredictable or fast-moving subject matter, for programs such as newscasts and interviews (where operating cameras can get pretty boring anyway) they significantly reduce production expenses.

Camera Jibs

A device that's come into wide use in the last decade is the camera jib, essentially a long, highly maneuverable boom or crane-like device with a mounted camera at the end. You frequently see them in action swinging overhead at concerts and major events.

Note the two video monitors (one for camera output and one for program video) and the heavy weights that help balance the weight of the camera and crane.

A jib allows sweeping camera movements from ground level to nine meters (thirty feet) or more in the air.

For more mobile camera work outside the studio, handheld camera supports allow significant mobility while still offering fairly steady camera shots.

The camera is mounted on a flexible arm that uses a series of spring balances to hold its position. A camera operator can walk and even run and still get a reasonably steady shot.

In addition to being costly, these units are heavy and require an experienced operator.

The separate viewfinder (at the bottom of the picture) allows the unit to be held away from the body, where it won't be inadvertently bumped.

With a bit of practice an operator can walk in front of or behind a moving subject without undue camera movement.

Walking around with a full cup of coffee in your hand is good practice for using one of these. When you can go up and down stairs without spilling the coffee, you'll probably do a good job with one of the smaller Steadicam type units.

Camera Tracks

For elaborate productions, installing camera tracks allows the camera to more smoothly follow talent and move through a scene. Although a camera operator can ride with the camera as shown below, some cameras are remotely controlled.

Once the track is laid down and leveled the result can be smooth dollies and tracking shots. However, because of the set-up time involved, many directors of photography (DPs) prefer to simply go with hand-held camera shots.

Drones

In 2015 a new aerial "camera mount" came into general use which had major advantages for surveillance videography and news.

Drones, which appeared in different levels of sophistication from different manufacturers, can provide areal views of scenes which are impossible from the ground level.

The initial wave of drones were unregulated and sometimes ran afoul of commercial, firefighting, and safety aircraft. This prompted laws backed by stiff penalties that limited when and where they could fly.

Some models have image stabilization and some have "follow me" capabilities, which can automatically follow moving, ground-level objects.

Camera Mounts and

Handheld Camera Shots

Although a tripod may be a hassle to carry and set up, the results can be worth the effort -- especially when displayed on HDTV screens where camera movement on static scenes can make an audience a bit "seasick."

Hand-holding cameras for a period of time can also get tiring. After trying to hold a camera steady for some time, the inevitable fatigue translates into progressively less steady shots.

The traditional exceptions to using a tripod are in news and sports where you must be mobile enough to follow moving subjects, documentary style production where shots are brief and rapid, and subjective camera shots that simulate what a moving subject is seeing.

That having been said, in recent years the interior shots of many dramatic productions are being routinely shot with handheld cameras. For one thing, it saves production setup time, which means money.

Camera Pan Heads

On most tripods the pan and tilt head (which attaches the camera to the tripod) is not meant to be used for smooth panning and tilting while shooting -- only to reposition and lock the camera into position between takes.

And, this may be just as well, given the fact that a cut from one scene to another is faster and generally better than panning, tilting or zooming to new subject matter.

Even so, pans and tilts are commonly seen -- especially for following action, for revealing the relationship between objects in a scene, etc. Therefore, many tripods have heads designed to smooth out pan and tilt movements.

There are many types, but the most-used type is the fluid head shown here. It provides an adjustable resistance to pans and tilts -- just enough to smooth out the process.

Wireless Camera Modules

Although camera operators doing "live" broadcasts from the field used to have to be "hard wired" to a production truck, today's cameras can relay the camera's signal via a RF (radio frequency) transmitter.

These units are commonly used in award programs, allowing cameras operators to freely roam throughout the isles to get shots of audience members without the problem of trailing and hazardous camera cables.

(d) Lenses-functions and types

Lenses: The Basics

Apart from protecting it from the elements and occasionally cleaning it, the average person doesn't think too much about a camera's lens.

However, variables associated with camera lenses have a major effect on how a viewer will see subject matter. The cameraperson who understands this commands a significant amount of creative power.

To start our investigation of this "power," let's look at some basic information about lenses -- starting with the most basic of all lens attributes: focal length.

The focal length of a lens affects the appearance of subject matter in several ways.

Lens Focal Length

We define focal length as the distance from the optical center of the lens to the focal plane (target or "chip") of the video camera when the lens is focused at infinity.

We consider any object in the far distance to be at infinity. On a camera lens the symbol ∞ (similar to an "8" on its side) indicates infinity.

Since the lens-to-target distance for most lenses increases when we focus the lens on anything closer than infinity (see second illustration above), we specify infinity as the standard for focal length measurement.

Focal length is generally measured in millimeters. In the case of lenses with fixed focal lengths, we can talk about a 10mm lens, a 20mm lens, a 100mm lens, etc. As we will see, this designation tells a lot about how the lens will reproduce subject matter.

Zoom and Prime Lenses

Zoom lenses came into common use in the early 1960s. Before then, TV cameras used lenses of different focal lengths mounted on a turret on the front of the camera, as shown on the right. The cameraperson rotated each lens into position and focused it when the camera was not on the air.

Today, most video cameras use zoom lenses. Unlike the four lenses shown here, each of which operate at only one focal length, the effective focal length of a zoom lens can be continuously varied. This typically means that the lens can go from a wide-angle to a telephoto perspective.

With prime lenses, the focal length of the lens cannot be varied. It might seem that we would be taking a step backwards to use a prime lens or a lens that operates at only one focal length.

Not necessarily. Some professional videographers and directors of photography -- especially those who have their roots in film -- feel prime lenses are more predictable in their results. (Of course, it also depends on what you're used to using!)

Prime lenses also come in more specialized forms, for example, super wide angle, super telephoto, and super-fast (i.e., transmit more light).

However, for normal work, zoom lenses are much easier and faster to use.

Angle of View

Angle of view is directly associated with lens focal length. The longer the focal length (in millimeters), the narrower the angle of view (in degrees).

You can see this relationship by studying the drawing on the left, which shows angles of view for different prime lenses.

A telephoto lens (or a zoom lens operating at maximum focal length) has a narrow angle of view. Although there is no exact definition for a "telephoto" designation, we would consider the angles at the top of the drawing from about 3 to 10 degrees in the telephoto range.

The bottom of the drawing (from about 45 to 90 degrees) represents the wide-angle range.

The normal angle of view range lies between telephoto and wide angle.

With the camera in the same position, a short focal lens creates a wide view and a long focal length creates an enlarged image in the camera.

Put another way, when you double the focal length of a lens, you double the size of an image on the target; and, as you would assume, the reverse is also true.

A Zoom vs. a Dolly

Another way to alter the area that the camera sees is to move (dolly) the camera toward or away from a subject. Although it might seem this would produce the same effect as zooming the lens in and out, that's not quite true.

When you zoom, you optically enlarge smaller and smaller parts of the picture to fill the screen. When you dolly a camera you physically move the entire camera toward or away from subject matter. The latter is how you would see the central and surrounding subject matter if you were to walk toward or away from it.

Some directors, especially in motion pictures, prefer the more natural effect of a dolly, even though it's much harder to smoothly achieve.

Zoom Ratio

Zoom ratio is used to define the focal length range for a zoom lens. If the maximum range through which a particular lens can be zoomed is 10mm to 100mm, it's said to have a 10:1 (ten-to-one) zoom ratio (10 times the minimum focal length of 10mm equals 100mm).

That may tell you something significant, but it doesn't tell you the minimum and maximum focal lengths of the lens. A 10:1 zoom lens could have a 10 to 100mm, or a 100 to 1,000mm lens, and the difference would be quite dramatic.

To solve this problem, we refer to the first zoom lens as a 10 X 10 (ten-by-ten) and the second as a 100 X 10. The first number represents the minimum focal length and the second number the multiplier. So a 12 X 20 zoom lens has a minimum focal length of 12mm and a maximum focal length of 240mm.

The zoom lenses on most handheld field cameras have ratios in the range of 10:1 to 30:1. The photos below show the effect of zooming from a wide-angle position to a telephoto view with a 30:1 zoom lens.

Motorized Zoom Lenses

Originally, the cameraperson manually zoomed a lens in and out by push rods and hand cranks. Today, built-in, variable-speed electric motors do a much smoother and more controlled job. We refer to these electric zooms as servo-controlled zooms.

Although servo-controlled lenses can provide a smooth zoom at varying speeds, directors often prefer manually controlled zoom lenses for sports coverage, because the camera operator can adjust them much faster between shots. This can make the difference between getting to a new shot in time to see the critical action -- or missing it.

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