The Basics of CCTV

The scene and light

The scene refers to the objects or area to be observed and the total environment in which the exist. A scene often contains different colors, surfaces and materials that reflect varying levels of light. To select proper equipment, it is necessary to determine the minimum lighting level (day or night) that will arrive from the scene to the camera lens. A scene or target area can be illuminated by natural or artificial light sources. Natural sources include the sun, the moon, and the stars. Artificial sources include incandescent, sodium, florescent, infrared, and other man-made lights. An axiom in CCTV security applications is: The better the light, the better the picture.

Colour vs. Black and White

Colour cameras generally require higher levels of lighting than their monochromatic (B/W) counterparts. Colour produces a more natural, richer image than black and white and may keep the operator's interest for longer periods of time. It also makes it easier to detect subjects. For example, with a color system a viewer can easily distinguish a red car from a green one, while on a black and white system both cars would appear a similar shade of grey. In retail applications, a colour system can help security personnel identify shoplifters and their clothing more easily and convincingly. Colour accuracy is extremely important in gambling casinos, where hundreds of pounds can ride on the ability to recognize the difference between maroon chips and red ones. While the use of colour cameras is growing, black and white cameras continue to offer some distinct advantages. Black and white cameras are better suited for extremely low light situations. The ability to capture good quality images in low light situations increase the cost of both black and white and colour cameras. Before purchasing cameras, you should consider the crossover points between lighting costs and camera costs. It's possible that low-light cameras will cost less than paying to increase the lighting level of a parking lot.

The Camera

Cameras convert the visible scene captured by a lens into an electric signal and transmit that signal to a monitor for viewing. Several considerations should be taken into account when choosing the proper camera/lens for any video system: The purpose of the video system (detection, assessment, identification etc...)The overall sensitivity of the camera needed based upon the actual applicationThe amount of varying levels of light available at the sceneThe environment in which the camera will operate (indoors/outdoors)The field of view (FOV) required by the applicationThe lensCostCamera performance depends largely upon the reflected light at the scene and the quality of the cameras imager Where the level of available light can change dramatically, a camera equipped with automatic iris control can help assure consistent image quality. Automatic iris control enables cameras to open or close an auto iris lens to adjust the amount of light passing through the lens. On a bright, sunny day an auto iris lens camera will close the lens' iris to prevent strong light from reaching into the camera's imager. At night, the camera will open the iris to allow greater amounts of light into the camera. Cameras are available in various "formats" expressed as 1/2, 1/3, or 1/4 inches. These measurements represent the overall usable size of the cameras imager. In general, you should match the cameras format to the lens format. For example, a half inch camera should be paired with a half inch lens. This only applies to camera that need a separate lens (i.e. C-Mount types) as opposed to cameras with a built in lens.

Fixed and PTZ Cameras

CCTV cameras can be fixed or have pan, tilt, and zoom (PTZ) capabilities. Fixed cameras are mounted on a fixed bracket and cannot move in response to operator commands. PTZ cameras are motor driven and can pan left or right, tilt up or down, and zoom in and out. A camera housing protects the camera and lens from vandalism and the environment. It also can enhance the appearance of the camera installation and conceal the equipment from the casual observer. All outdoor cameras require a housing of some type. The National Electrical Manufacturers Association (NEMA) rates housings on their ability to withstand environmental conditions. Protection from cold, heat, dust, dirt, or other elements is needed to ensure optimal performance and extend the life of the camera.

Dome Cameras

Many PTZ cameras today are disguised in dark coloured Plexiglas housings called domes. Dome cameras are found in practically every major department store and in many industrial/commercial locations such as hospitals, colleges and government facilities. They are particularly popular wherever aesthetics are valued. Dome cameras offer three primary benefits: Deterrence - Domes make it virtually impossible for suspects to determine where the camera is pointed.Economy - Domes equipped with a camera, lens, and PTZ capabilities can be augmented with dummy camerasAesthetics - Domes conceals all the internal equipment in a nice clean shell.Smoked Plexiglas bubbles have the same effect as wearing sunglasses. It reduces the amount of light reaching the lens affecting the colour accuracy picked up by the camera.

The Lens - optics

Lenses (Optics) play an important role in the design of a CCTV system. Their primary function is to collect reflected light from a scene and focus a clear, sharp image on the camera's imager. Typically the more light that passes through the lens, the better the quality of the picture. Selection of a lens is especially critical because it directly affects the size, shape, and sharpness of the image to be displayed on the imager. Factors such as distance from the scene, focal length, desired field of view, lighting and format affects the size and clarity of the image on cameras imager.

Field of view

The field of view (FOV) is the actually picture size (height and width) produced by the specific lens. If the field of view is not suitable, you may consider using a different lens (wide angle, telephoto, etc...) to increase or decrease the field of view. Camera lenses can be divided into two basic types.: fixed focal and varifocal (sometimes known as zoom). A fixed focal lens has a constant focal length, while the varifocal lens can change its focal length. Focal length is simply the distance from the optical center of the lens to a focal point near the back of the lens. This distance is written on the lens and expressed in millimeters (mm). Fixed focal length lenses are available in various wide, medium, and narrow fields of view. A lens with a "normal" focal length produces a picture that approximates the field of view of the human eye. A wide-angle lens has a short focal length, while a telephoto lens has a long focal length. When you select a fixed lens for a particular view, bear in mind that if you want to change the field of view, you must change the lens. When both wide scenes and close-up scenes are needed, a varifocal lens is best. A zoom lens is an assembly of lens elements that move the change the focal length from a wide angle to a telephoto while maintaining focus on the camera's imager. This permits you to change the field of view between narrow, medium, and wide angles.

F-stop

The ability of a lens to gather light depends on the relationship between the lens opening (aperture) and the focal length. This relationship is symbolized by the letter f, which is commonly referred to as the "F-stop," and can be found printed on the

side or front of the lens. The lower the F-Stop number, the larger the maximum lens aperture and the greater the lens' ability to pass light to the camera imager and the better it can view a low light scene. For example, a lens with an F-stop of f/1.2 can gather a great deal more light than a lens with an F-stop of f/4.0. A lens with a low F-stop number is sometimes also called a "fast lens".

Depth of Feild

Another consideration when determining the proper lens is depth of field. Depth of field is the area in focus before and behind a subject. This means that when you focus precisely on a subject a certain distance in front of and behind the subject also will be in focus, although not as sharp. Depth of field increase or decreases based on the Iris.

Lens Length

short lens (wide angle lens) longer depth of field long lens (telephoto) shorter depth of field

Aperture

wide aperture (low F-Stop) shorter depth of field narrow aperture (high F-stop) longer depth of field

Distance to object

Short distance, shorter depth of field, long distance, longer depth of field
Purchasing and planning decisions should take these factors into account since depth of field can affect image quality (and may jeopardize the ability to identify and prosecute subjects). If depth of field is important, you may want to explore options such as increasing artificial lighting or installing cameras with normal lenses rather than telephoto lenses, etc...

Lens Mounts

Camera lenses generally come with either a C-mount or CS-mount and must be matched appropriately to the camera's mounting requirements. The difference between the two mounts is the distance of the lens options from the camera's imager. The C-Mount lens is 17.5mm from the imager; the CS-Mount lens is 12.5 mm from the imager. Follow these guidelines when purchasing equipment: A C-Mount lens can be used on a CS-mount camera only if a 5mm spacer is added. A CS-Mount lens cannot be used on a C-Mount camera.

Video Transmission Methods

The purpose of the transmission medium is to carry the video signal from the camera to the monitor. Today, many video transmission methods exist: coaxial cable, fiber optic, phone lines, microwave, and radio frequency. Due to varying application technologies in use within the same CCTV system. The choice of transmission mediums depends on factors such as distance, environments, cost and facility layout. In addition nearly all methods of transmission suffer from various forms of interference or loss. The essence of good design is to minimize this impact.

Examples of current video transmission include:

Coaxial cable

A coaxial cable is one that provides a continuous physical connection - or closed circuit - between the camera and the monitor. The cable is shielded to minimize interference from any nearby electronic devices or electrical wires. Copper braided coaxial cable is recommended to maximize conductivity and minimize potential interference. For traditional CCTV systems, as well as many applications today, this is the most common economical method of signal transmission over relatively short distances (few hundred feet).

Fibre Optics

Fiber optic technology changes an electronic video signal into pulsed or laser light and injects (transmits) it into one end of a glass rod (the fiber optic cable). At the

other end, a receiver translates the pulsed light back into an electronic signal capable of being displayed on a monitor. The transmission is unaffected by any kind of interference, water in conduit or high voltage being run in the same conduit. Fiber optic capable have a large signal capacity (bandwidth) and no possibility of a spark from a broken fiber. Hence, there is no fire hazard to a facility even in the most flammable environment. Fiber optics offers a cost-effective method of sending large transmissions over long distances.

Telephone Line

A telephone line is a standard twisted pair of wires that can transmit the image for distances up to one kilometer without signal boosting. The dedicated line connects the transmitter (camera end) with a receiver (monitor end). Through the use of specialized transmission and receiver equipment, it is possible to use standard telephone lines for video signal transmission (RSM).

Microwave

If already in place, microwave can be a very efficient and cost-effective method of delivering black and white or colour video. Microwave turns the video and data signals into high radio frequency signals and transmits them from one point to another via free air and space. A receiver then converts the transmission back into the video and data signals and displays the scene on a monitor. Good quality transmission can be achieved over a line of sight path. Microwave technology offers a large bandwidth to carry video, however it can be affected by environmental conditions. It is a practical option when a wire path between the camera and the monitor locations cannot be established or is prohibitively expensive. Microwave transmissions are regulated by the FCC and a license is required.

Radio Frequency

Radio frequency (RF) is a reliable, but short distance, line of sight video transmission technology. It is becoming increasingly popular where hardwiring methods are easier impossible or impractical, and has been used successfully to reduce cabling costs even within large buildings. Environment conditions or other RF in the area can affect it.

The Monitor

The monitor receives the transmitted electronic video signal from the camera from the paints it across a cathode ray tube (CRT) to display an image to a viewer. Although similar in function to a TV, a CCTV monitor provides higher lines of resolution (better picture quality) and accepts only video signals rather than RF/antenna signals. Lines of resolution refers to the total number of horizontal lines the camera or monitor is able to reproduce. The more lines on a screen, the better or sharper the video picture will appear. CCTV monitors can provide up to 1000 lines of resolution compared to an average of 300 lines provided by some TV sets. Several factors can affect the monitoring function: Size of the monitor, its positioning and angle relative to the viewer, and the quality (resolution) of the monitor itself. In all cases, sufficient growth must be factored into any console design. It's also important to note that all monitors generate heat. Whether on a table or enclosed in a console, be sure to provide adequate ventilation and air-conditioning. Most CCTV systems use both dedicated monitors and call-up (switchable) monitors. A dedicated monitor displays the video from only one camera. A call-up or switchable monitor enables the operator to call or switch different or multiple cameras into view. Generally call-up/switchable monitors are larger than dedicated monitors and give operators the ability to view multiple images simultaneously (multiplexed) as well as scrutinize the camera image more closely. There are many different monitor sizes available. When choosing the proper size of monitor, you must first determine the distance of the monitor in relationship to the user. Also determine the quantity of cameras to be displayed on a given monitor simultaneously (multiplexed). The peripherals As the

number of cameras and monitors increase, simple system design eventually gives way to more complex designs that require peripheral components. The peripheral components may include switchers, VCRs, Multiplexors, quads, video printers and time date generators.

Switchers

A video switcher enables different cameras to be switched to call-up monitors. In a smaller, cost-conscious applications, a manual switcher allows users to select the camera they want to see by pressing the appropriate button. The most popular type of switcher, a sequential switcher, contains circuitry that will switch one camera to another automatically. The operator can set the length of time (dwell time) that a scene remains on the monitor before sequencing automatically to the next camera. This allows operators to keep tabs on numerous cameras with only one monitor, but also creates a drawback know as "switcher dilemma". To illustrate switcher dilemma, imagine a system with eight cameras, each programmed to switch after dwelling on the monitor for 5 seconds. In this scenario, a considerable gap will occur between the time the first image is displayed and the time the eighth image is displayed. The situation worsens when recoding the video for review at a later time. On playback, you may see a door opening on camera 1, then suddenly the video switches to camera 2, followed by camera 3 and so on. By the time camera 1 appears again, the door is closed and you are left wondering who came through the door while camera 2 through 8 were flashing sequentially on the monitor.

Matrix Switcher

A matrix switcher is a more complex design enabling the user to switch any video signal to any call-up monitor in a large-scale system. They normally incorporate PTZ control and other features such as preset and alarm inputs and outputs.

Multiplexers

Unlike conventional recording systems, a video Multiplexors collects full-screen pictures from up to 16 cameras and displays them simultaneously on a monitor. Operators have the option of displaying any camera full screen or multiple cameras in reduced sizes. Multiplexors also can record all cameras in the system onto a single videotape. The cameras are recorded sequentially at a high rate of speed. As mentioned earlier, a standard video signal is comprised of 30 separate frames each second. In a video system containing 15 cameras, the Multiplexors selects two frames from each camera and records them to a single videotape. The result is an effective frame rate of 2 frames per second, instead of the standard 30. Most Multiplexors today contain motion detection features that enables the system to record more frames of video from cameras showing motion than from those not showing any motion. The Multiplexor does this by reallocating frames from one camera to another as needed. The net result is higher quality recordings of scenes that are more likely to be important to security personnel. When a time lapse VCR is used with a multiplexor, the recording mode should be as short as possible to reduce the number of seconds required to record all the cameras. This is why it is a great advantage to use hi-density or virtual real-time recorders when using Multiplexors. Virtual real-time VCRs record 4 times the frames per second of conventional time-lapse VCRs. One of the strongest advantages of using Multiplexors is that during playback the multiplexor decodes the tape allowing investigators to display only selected frames with the same address. This pullout feature saves investigators hours of time reviewing recorded actions. Another advantage is that during playback, any desired camera can be displayed full screen. (duplexing)

Quads

The main feature of a quad is the ability to compress images from four separate cameras and simultaneously display them on a single monitor screen. When four cameras are displayed, each occupies a quarter of the screen. A single camera can

be selected and displayed full screen as well. Unlike Multiplexors recording, quad recordings yield only what appears on the monitor at the time of recording. If the VCR is recording in quad mode, then the playback is in quad mode.

Recording CCTV

Most systems now use Digital Video recording direct to hard drive. Long recording periods can be achieved by using the right video compression the following types are used:

1. MPEG4
2. JPEG2000
3. Wavelet
4. MPEG
5. H.265
6. MJPEG

Recording times can be increased with the combination of Video motion detection , selectable frames rates, and the right video compression.

Archived images are normally saved to CDR or DVD complete with watermark to prevent unauthorised tampering of the evidence.