By Les Simmonds

CCTV Lens Selection

Lenses are probably the most underrated and mysterious item in the CCTV chain. All general CCTV images pass through a lens and the importance of the lens in the whole system is sometimes over looked.

Lens Selection

There are many lens selection aids available these days; there are complex formula and the most common selection aids are similar to the following:

* Focal length angle of view charts supplied by all manufacturers and their suppliers. These charts contain many figures that can confuse and are sometimes open to misinterpretation.

* Mechanical lens selection calculators, which are available from most lens manufactures and their distributors. They are similar to a slide rule (rectangle or round) and can take time to learn to use efficiently and when required at a site they are usually still in the office.

* Software lens selection calculators, which are available from some lens manufactures and their distributors. Great with a Laptop on site, but would be a slow process in the field for a large project and would be more practical in the office working with plans.

* Adjustable optical viewfinders, which are available from some lens manufactures and their distributors. They are easy to use and by zooming in or out you can determine the closest lens focal length available for the application. They have the advantage that you can show your client the approximate angle of view from the proposed camera position.

* A purpose built protractor with common lenses marked on it that can be placed on a plan to show the angle of view of common lenses or a Newsagent purchased protractor which can be placed on plans to determine the required angle of view and from a lens chart select the closest available lens size.

* CCTV Camera with zoom lens or Camcorder where the lens includes accurate focal length markings. This method can be expensive and can be stolen when put down for a short period on a building site.

All of the above are valid lens selection methods for fixed or zoom lenses and in particular long lenses. When you look at the table you will see there is a pattern emerging for the two most common Camera chip formats with the most common fixed lenses.

Camera Chip Format	Focal Length for approx. 30 degrees Horizontal View	Focal Length for approx. 60 degrees Horizontal View	Focal Length for approx. 90 degrees Horizontal View
1/2" Camera Format	12 mm	6 mm	3.5 mm
1/3" Camera Format	8 mm	4 mm	2.8 mm

The Horizontal Angle of View in degrees in the table above are only approximate but suitable for almost all CCTV applications.

The Horizontal Angle of View of 30, 60 and 90 degrees represent more than 90% of all fixed lens applications and all can easily be considered by using or thinking of the common 30, 60, 90 degree setsquare that we have all used at some time of our life. These three angles are easy to remember and if you need to show approximate angles of view on a plan you can purchase a setsquare at your local Newsagent to mark up the plan.

In many cases the vertical angle of view also has to be considered and the existing Television Aspect Ratio is 4:3 this means that the Horizontal is 4 units wide and the Vertical is 3 units high. Therefore, the vertical angle of view with this aspect ratio is 75% of the Horizontal Angle of View and easily calculated.

The Lens calculation shown above looks and is very simple. Once you use it a few times it is with you all the time. I use it most of the time and it has not let me down to date.

Now that you have the most simple lens calculation methodology for common fixed lenses available, there are other lens issues that need to be considered, such as:

* Lens formats. Will the lens match or fit the camera?

* The lens speed (f-stop maximum and minimum)?

* Required Depth of Field?

* Manual iris, auto iris, or motorised iris?

* Will the selected lens and camera combination handle the lighting dynamic range?

* Glass, Plastic, or Coke Bottle Lenses?

I have demonstrated how easy it is to calculate 90% of fixed lens sizes using the common 30, 60, 90 degree set square. Now I will show another easy lens size calculation method and talk about some other lens aspects.

Another easy method for field lens size calculation is a simple geometry formula, where the lenses are the common 60 or 30 degree horizontal view lenses, see the table for the relative lenses sizes with 1/2 " and 1/3" camera chip formats. A 60 degree lens will show the same scene width as distance from the object and a 30 degree lens will show half the scene width as the distance from the object.

An example would be if the cam-

era/lens combination was 20 metres from a wall, a 60 degree horizontal view lens would show a horizontal view which is 20 metres wide on the wall. This formula applies to all 60 degree horizontal view lenses and as the distance from the object changes so will the width of the horizontal view, eg if the camera/lens combination was 10 metres from a wall, a 60 degree horizontal view lens would show a horizontal view, which is 10 metres wide on the wall.

A 30 degree horizontal view lens such as those shown in the table would show half the horizontal view on the same wall with the same distance as the previous 60 degree calculation. An example would be, if the camera/lens combination was 20 metres from a wall, a 30 degree horizontal view lens would show a horizontal view, which is 10 metres wide on the wall. If the camera/lens combination was 10 metres from a wall, a 30 degree horizontal view lens would show a horizontal view, which is 5 metres wide on the wall.

The simple angle of view formulas given both this month and last month are approximate and I suggest that they are more that adequate for most CCTV applications and should allow you to satisfy the most important thing, your client's requirements.

CCTV cameras chips are generally available in 1/2", 1/3" and 1/4" formats and it is essential that the camera and lens formats are compatible. Camera and lens formats can be an area where embarrassing mistakes are made, especially, when the lens format is smaller than the camera chip format and a porthole effect is experienced. This effect shows as a round circle around the image with black filling out to the edge of the monitor screen. A lens format larger than the camera chip format is generally acceptable but because a smaller than normal area of the lens elements are used there can be a slight light transfer loss.

The size of the aperture is called the f-stop number (eg) f0.8, f1.0, f1.2, f1.4 etc. The aperture is a mechanical ratio of the lens components. The f stop numbers given above are typical of CCTV lenses when wide open, the same lenses can close down to f360 for some auto iris fixed lenses and f1600 for some auto iris zoom lenses. The f-stop determines the depth of field, which is the distance between the nearest and farthest points in a scene that appears acceptably sharp in an image. The smaller the lens aperture (higher f stop number), the greater the depth of field.

Depth of field is a zone of acceptable sharpness that extends in front of and behind the point on which you focus. To make it more shallow you could widen the aperture (lower f stop number), move closer to the subject with the same focal length lens, or use a longer focal length lens. Stopping down (higher f stop number), moving away with the same focal length lens or using a shorter focal length lens will increase the depth of field.

Depth of field is not a quality that can be measured exactly and objectively. It depends ultimately what the client or you are prepared to tolerate as un-sharp. In an attempt to rationalise this lens manufacturers use the term "circle of confusion". Even a sharp point can be resolved by a lens as a very tiny circle. Below a certain diameter it looks like a point and is known as the permissible circle of confusion.

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