Designer's Guide – Video Motion Detection

This guide describes some of the aspects which should be considered when designing a system incorporating one or more Digital Video Motion Detection systems (VMD).

2.1 Site Design for Video Motion Detection (VMD)

By employing sophisticated detection algorithms, advanced VMDs have significantly reduced the number of nuisance alarms found with older technology VMD systems in outdoor environments. By following some simple site design techniques, the VMD will provide optimum performance, with high probability of target detection and low nuisance alarm rates. Section 2.1.1 to Section 2.1.3 describe some these techniques. These guidelines also apply to the design of any high quality Closed Circuit Television (CCTV) system and are not unique to VMD systems.

2.1.1 Lens Selection and Camera Distance

When deciding on the lens required for a particular camera position, it is first necessary to decide;

1) The type of movement to be detected (e.g. walking people, crawling targets or cars)
2) The area to be covered (i.e. the field of view)
3) The level of security required

A general rule for a high probability of detection under varying environmental conditions is that the target of interest should be at least 3 detection zones high or wide for VMDs that process relationships between detection zones. For VMDs that analyze on the pixel level then only 1 detection zone is required. Do not be confused by the number of programmable detection zones on the screen for units that have 1000 then 3 or more are required, units that have 280 require only on zone.

When describing a camera lens system, the horizontal field of view is normally restricted to a maximum value. The maximum horizontal field of view determines the minimum likely size of a target and the maximum distance between the camera and the target for a particular lens.

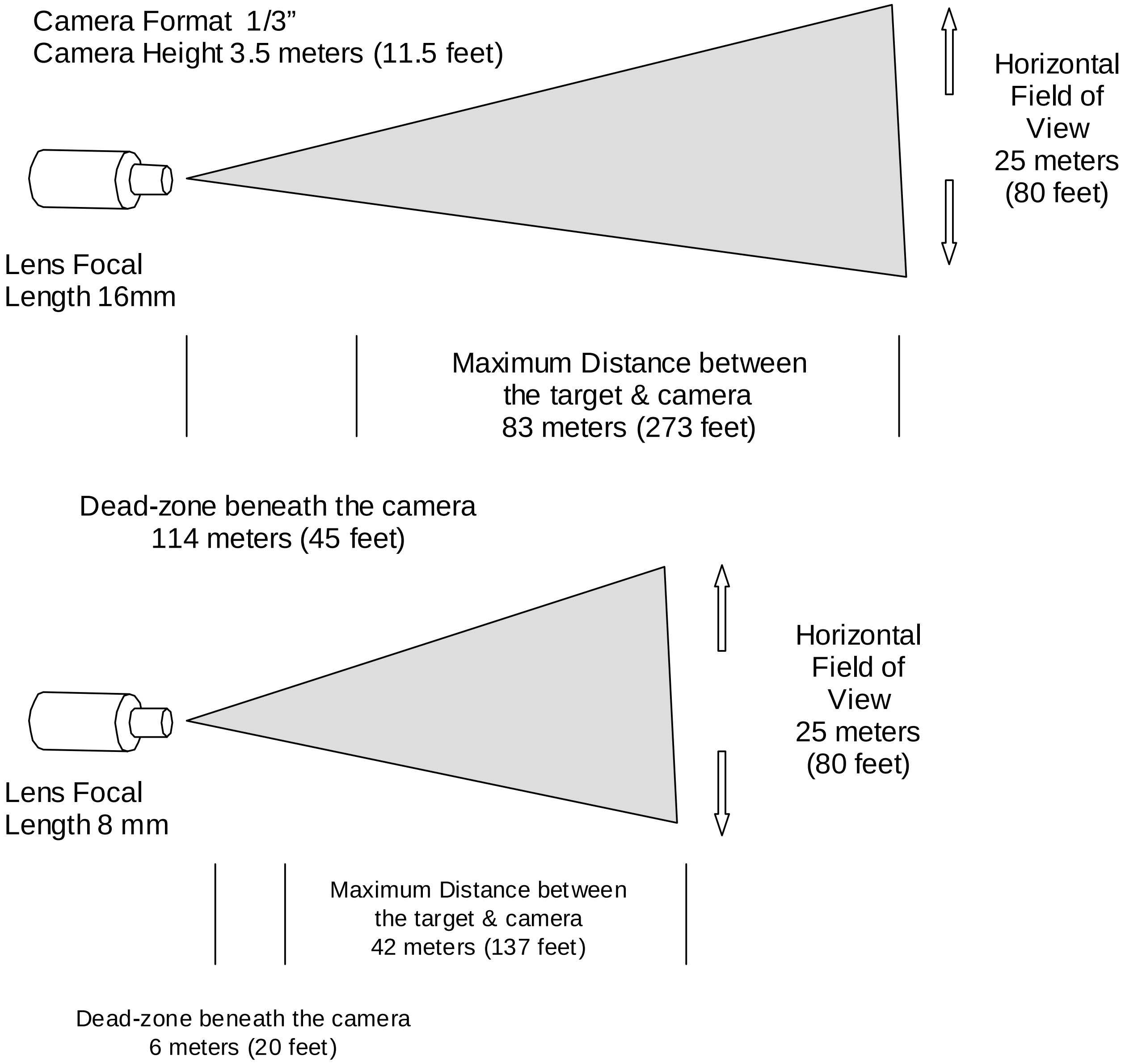

Figure 2-1 The effect of increasing the lens focal length with a constant horizontal field of view.

Figure 2-1 shows the effect of limiting the horizontal field of view to 25 meters (80 feet) on the maximum target distance for two different lenses. For a constant horizontal field of view, increasing the lens focal length increases both the maximum distance between the target and the camera, and the dead zone beneath the camera.

A typical VMD camera lens design is normally based on a maximum horizontal field of view of 25 meters (80 feet) in good lighting conditions. At this distance, a standing person is approximately 3 to 4 detection zones in height (1000 zones VMD) or 1 detection zone height (280 zone VMD).

If a larger field of view is used, the average light change within a detection zone is smaller and the video movement detection will be poorer. Consequently the sensitivity of the VMD would need to be increased, which could adversely affect the number of nuisance alarms, particularly during poor environmental conditions. The horizontal field of view should therefore be restricted to a maximum of 30 meters (100 feet).

For medium to high security applications which require the detection of rolling or crawling target, the maximum horizontal field of view should be reduced to 20 meters, dependent on the environmental conditions of the application. After deciding on the maximum horizontal field of view for reliable detection, the maximum distance between the camera and the target is then calculated for different focal lengths. The formula is the following;

$$\text{Distance Between Camera And Target} = \frac{\text{(Lens focal length)} \times \text{(Maximum horizontal field of view)}}{\text{(Camera format width)}}$$

Where:

Distance between the camera and target is in meters (or feet)
Maximum horizontal field of view (using meters or feet as above)
Lens focal length is in millimeters

Camera format	=	12.8 mm for a 1" camera
Width (mm)	=	8.8 mm for a 2/3" camera
	=	6.4 mm for a ½" camera
	=	4.4 mm for a 1/3" camera

Table 2-1, Table 2-2 and Table 2-3 use this formula to show the maximum distance between the camera and the target for reliable detection, assuming a maximum horizontal field of view of 20, 25 and 30 meters. (66, 80, 100 feet) respectively, for some of the more commonly used lenses and 1/3" camera formats. The dead zone beneath the camera is also shown, for a camera mounted 3.5 meters (11 feet) above ground level. Most security applications would use the values given in **Table 2-2**, while high security applications may use **Table 2-1**.

An example of a lens design is shown in **Figure 2-2.** The maximum horizontal field of view is selected to be 25 meters (80 feet) and the camera format is ½". Note that the dead zone of one camera is covered by an adjacent camera.

Lens Focal Length (mm)	1/3" Camera Format	
	Maximum Distance Between Camera and Target (meters / feet)	Dead Zone Beneath Camera (meters / feet)
4.8	20/66	3/11
6.0	25/82	5/15
8.0	33/108	6/21
12.0	50/164	10/33
16.0	67/220	14/44
25.0	104/341 (Note 1)	21/70
35.0	146/479 (Note 1)	30/98
50.0	208/682 (Note 1)	43/140

Table 2-1 – Lens Selection Chart
High Security Applications
20 meter (66 feet) maximum horizontal field of view
Camera height = 3.5 meters (11.5 feet)

Lens Focal Length (mm)	1/3" Camera Format	
	Maximum Distance Between Camera and Target (meters / feet)	Dead Zone Beneath Camera (meters / feet)
4.8	25/82	3/11
6.0	31/103	5/15
8.0	42/137	6/20
12.0	63/205	10/34
16.0	83/273	14/45
25.0	130/427 (Note 1)	22/72
35.0	182/598 (Note 1)	31/100
50.0	260/854 (Note 1)	44/144

Table 2-2 – Lens Selection Chart
Typical Security Applications
25 meter (80 feet) maximum horizontal field of view
Camera height = 3.5 meters (11.5 feet)

Lens Focal Length (mm)	1/3" Camera Format	
	Maximum Distance Between Camera and Target (meters / feet)	**Dead Zone Beneath Camera (meters / feet)**
4.8	30/98	4/13
6.0	38/125	5/16
8.0	50/164	7/22
12.0	75/246	11/36
16.0	100/328	14/46
25.0	156/512 (Note 1)	23/75
35.0	219/189 (Note 1)	32/104
50.0	313/1027 (Note 1)	45/146

Table 2-3 – Lens Selection Chart
Absolute maximum values
30 meter (maximum) horizontal field of view
Camera height = 3.5 meters (11.5 feet)

Notes

Ranges greater than 100 meters (325 feet) are not normally recommended due to the possibility of reduced visibility in poor weather conditions. Some sites may be restricted to lower ranges. Also, a longer focal length lens tends to 'amplify' the effects of camera movement in the image.

A camera cannot be panned, tilted or zoomed without the risk of causing an alarm, unless video movement detection is inhibited while the view is being changed. This may be achieved with the external Detection Inhibit input available on most quality VMDs.

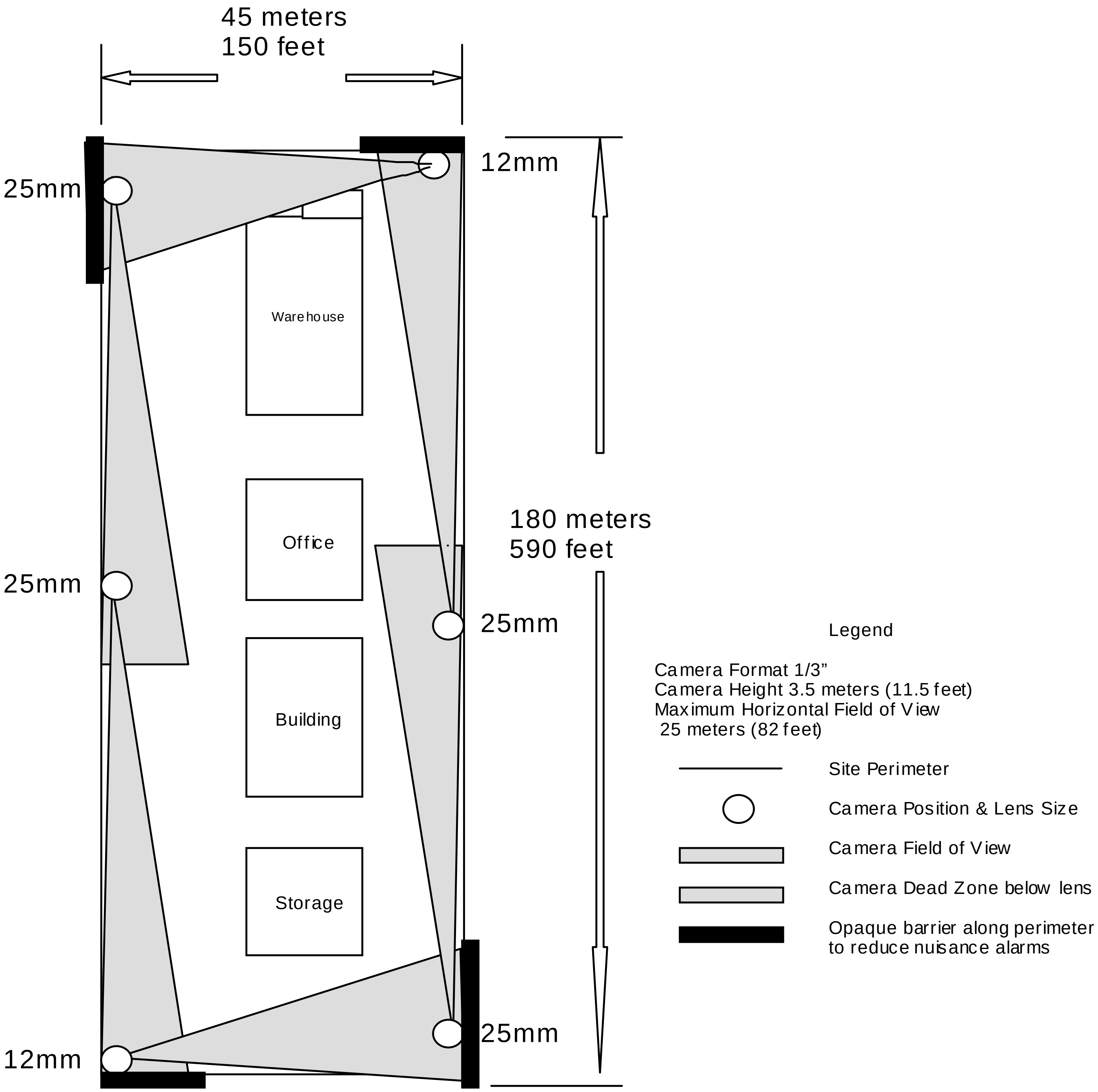

Figure 2-2 – Lens Selection Example

2.1.2 Camera Position and Mounting

To minimize nuisance alarms, avoid mounting cameras;

1) Near lights (particularly infra-red illuminators), which could attract insects;

2) So that they point into lights, windows, the sun or in areas which have a large number of reflections or shadows;

3) So that they point at trees or plants which may move in the wind or drop leaves (note that tree shadows may also move in the wind);

4) So that they point into areas of vehicle headlight activity at night;

5) So that they point over water (consult the factory)

6) On poles or mounts which may flex or move in windy conditions

The ‘dead zone’ under the camera also needs to be considered. Make sure that cameras are positioned (refer to **Figure 2-2**) so that this area is adequately covered by another cameras field of view. The area just in front of the dead zone can be vulnerable to very fast moving targets. It is a good policy to make sure that the field of view of the covering camera takes care of the dead zone plus another 10-15%. Also this may be corrected by VMDs that have perspective settings so different areas can be defined at different lengths from the camera.

Important Note

Vehicle head-lights sweeping the field of view at night should be avoided at all times. The VMD can detect and filter some of the resultant scene activity however, this activity can cause numerous shadows, shapes and sizes of various speeds and travel distances. Some of these meet the detection criteria for an intruder and cause nuisance alarms.

2.1.3 Lighting Conditions for Cameras

Generally, lighting should be evenly distributed throughout the field of view of the camera, and arranged to provide good contrast around the area to be protected. If the scene contrast is poor, and no additional lighting can be installed, then contrast can be increased either by adding stripes to walls and pathways, or by painting background surfaces a light color.

To minimize nuisance alarms, avoid;

1) Reflections from windows, mirrors, wet surfaces, etc.

2) Areas where rapid light changes occur, such as near display signs which turn on and off;

3) Areas where headlights of passing cars may rapidly change portions of the area's light levels.

2.2 Power Requirements

The VMD should not share electrical outlets or circuits with devices which may cause significant electrical interference, such as air conditioners or a photocopier. Some installations may have particularly bad mains power disturbances, such as large voltage spikes, surges and power sags, which may cause system failure. In this case, power line filters/conditioners and /or uninter-ruptable (UPS) power supplies should be fitted between the VMD and the mains.

As with any electronic equipment, to ensure long term reliability, it is advisable to ;

1) Mount the VMD clear of other equipment which may dissipate large amounts of heat, and

2) Ensure adequate convective air flow between the VMD and its surroundings.

2.3 Camera Connection Cable Length

The maximum camera input cable length that can be used before cable compensators are required is dictated by the desired quality of the video picture. Generally, the shorter the cable between each VMD channel and the camera, the better the video picture quality.

A significant degradation in the picture quality will occur due to cable losses before detection performance is affected. The cable length is not restricted by any timing constraints within the VMD.

In order for the VMD channel to synchronize to the incoming video signal from the camera and to provide good performance of the video movement detection, the following conditions must be met;

1) The sync amplitude at the Video Input of the VMD channel must be within the rage of 0.2V – 0.4V, and

2) The video amplitude (not including sync) at the Video Input of the VMD channel must be within the range of 0.5V to 1.0V

If the video level at the Video Input of the VMD channel is low, cable compensators, or video line drivers, should be installed at the camera end. They should be adjusted to boost the video signal to within the voltage limits given above.

As a guide for RG59U type coaxial cable;

1) In a monochrome system, depending on the resolution required, the cable length should be restricted to 500 meters (1600 feet) before cable compensators are installed.

2) Signal degradation due to the coaxial cables characteristics has a far greater effect on color video. In a color system, the coaxial cable length should be limited to 250 meters (800 feet) before cable compensators are installed. Again the length is dependent on the required picture quality.

2.4 Electromagnetic Interference (EMI)

The VMD and its associated cables and peripherals, should be shielded from EMI if it is to operate at its optimum performance. Some sources of EMI include communications transmitters, computers and peripherals, electric monitors, heaters, arc welders, automobile engine ignitions and lightning.

If the VMD is to be installed in such an environment, the effect of EMI must be reduced or eliminated. This can be achieved by either removing or shielding the source of EMI, or fitting a suitable suppressor to the cables entering the VMD. Consideration should also be given to installing fiber optic links, which are not affected by EMI.

2.5 Interference cause by Ground Loops

In some installations, where cameras or monitors are located at a distance from the VMD, considerable ground loop currents can be generated and may cause interference both on the video display and in the detection processes. (these may show as false or nuisance alarms)

Ground loop current may also be caused by supplying power to different components of the VMD system (i.e., cameras, monitors, VMD, etc.) from different phases of a multi-phase supply. Wherever possible, source power to all components of the system from a common phase of the supply.

Where ground loop currents cause a problem in a VMD installation, the installer may reduce the effect by installing video isolation transformers (not supplied with the VMD system) on each video channel affected.

2.6 Installations in Lightning Prone Areas

In lightning prone areas, in-line coaxial lightning arresters should be used on the video cables. The arresters should be installed at the cable entry of the building housing the VMD. Cameras should also have suitable lightning protection rods installed as close to them as possible. The use of fiber optics is recommended in high risk areas.