Planning Instruction
IPS Camera-based Video Analytics

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Disclaimer

The performance of IPS Video Analytics depends on the conditions that are described in this document.

The **General Guidelines** as well as the **Application Specific Guidelines** must be strictly adhered to for each analytics module. All the mentioned requirements must be fulfilled. The restrictions referred to in section **Restrictions and Improvements** apply; partial improvement or relief can be achieved but is not guaranteed.

1 General Guidelines

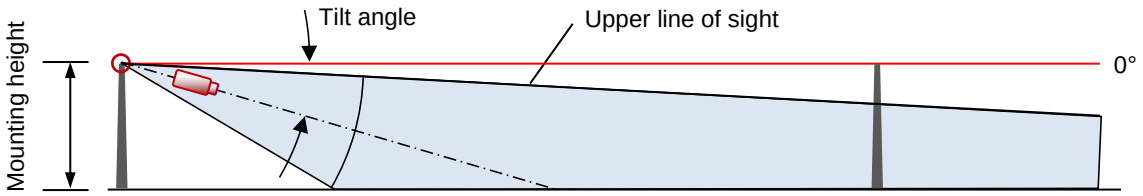
In each specific guideline, the individual sections of the General Guidelines are referenced via a link.

1.1 Camera Planning

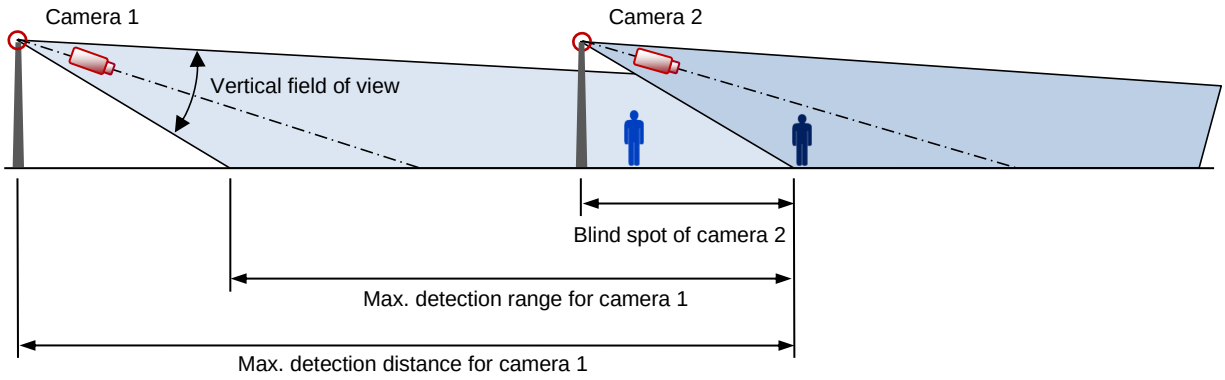
1.1.1 Definition of Terms

Location, mounting height, tilt angle

The upper line of sight shall be parallel to the ground or tilted down as required. Especially avoid the situation that the sun shines directly into the lens.



Blind spot, vertical field of view, maximum detection range, maximum detection distance



1.1.2 Rules

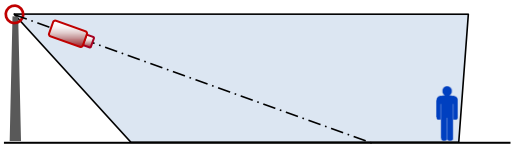
- The mounting height of the cameras is specified per application in the **specific guidelines**.
- The upper line of sight either must be parallel to the ground or tilted down.
- The cameras must mounted straight, i.e. not tilted laterally.
- A different camera (normally the preceding) must detect a person who is residing within the blind spot.
- The position of the subsequent camera results from the maximum detection distance of the current camera minus the blind spot of the subsequent camera. The real distance should be 1 – 2 metres smaller so that monitoring gaps can reliably be excluded.
- In some cases (especially at corners of buildings, fences, etc.) continuous monitoring can only be achieved if a camera is positioned in the opposite direction.

1.1.3 Procedures

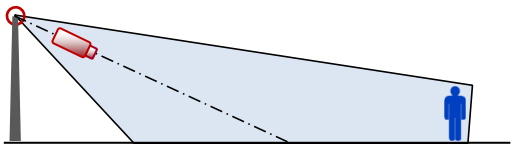
The **maximum detection range** for the detection of a person (- this value is in line with the distance of the cameras -) can be calculated from the following **input data**:

- Horizontal field of view
- Aspect ratio of the image
- Mounting height of the camera
- Type of camera tilt: **type 1**: upper line of sight runs horizontally; **type 2**: upper line of sight runs so that a person appears on top of the screen.

Type 1



Type 2



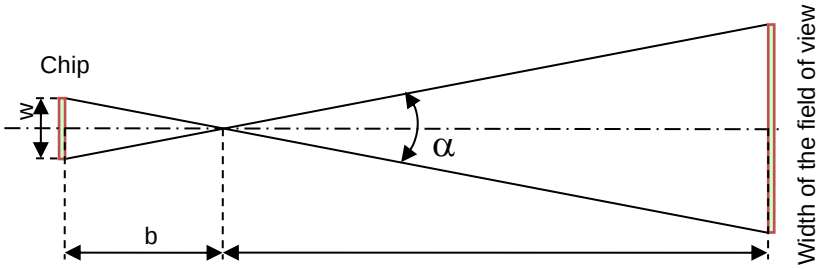
Furthermore, the following is true:

A so-called norm object specifies the size of a person.
The absolute size of the norm object is 1,7 m x 0,6 m (height x width) and
the minimum relative size of the norm object is 7% of the image height and 2% of the image width.

From the input data the following values can be calculated:

- Vertical field of view
- Maximum detection distance
- Blind spot
- Maximum detection range

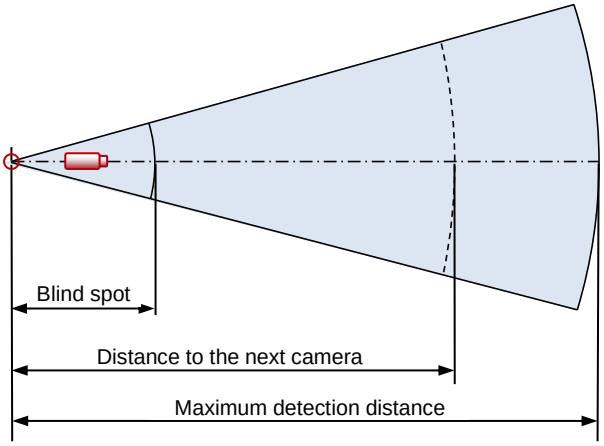
Calculation of the horizontal field of view from the focal length



$$\propto = 2 \times \tan^{-1}\left(\frac{w}{2} \times \frac{1}{b}\right)$$

w	width of the camera chip
b	focal length of the lens
α	horizontal field of view

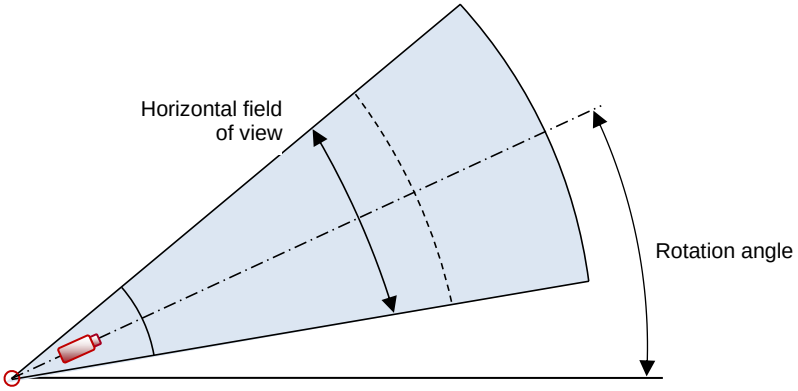
Horizontal view, planning templates



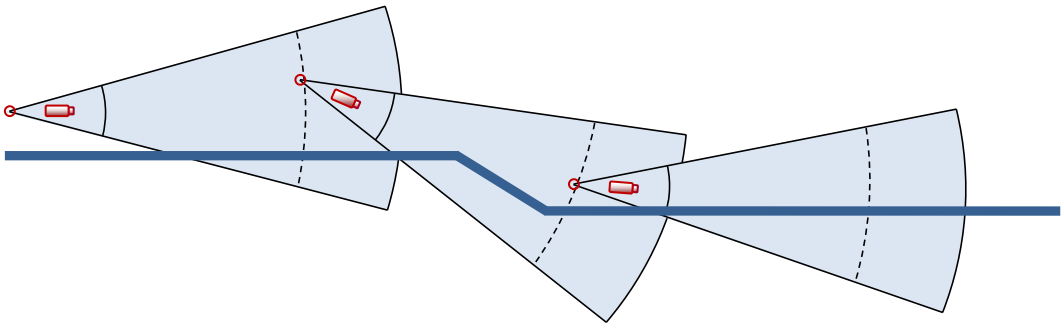
Distance to the next camera = Max. detection distance - blind spot = Max. detection range

Rotation angle

The rotation angle results from the horizontal field of view and from the adaptation to the local conditions (buildings).



Example:



1.2 Lighting Planning

1. Avoid a mixture of differing light types (visible light and IR).
2. Avoid back light blinding.
3. Avoid headlights or lamps being visible in the camera image.
4. Avoid reflections (by sunlight or artificial light) being visible in the camera image.

In outdoor areas, the following points must be observed:

5. Minimum illumination reflected from the ground must be 150 x the sensitivity of the camera (light sensitivity of the camera is defined at a level of 50 IRE) or a minimum of 20 lux (apply when camera light sensitivity is unknown).
6. For outdoor applications observe the distance between camera and lamp must be 1,5 m.

1.3 Analytics Planning

1.3.1 General requirements

1. Object height: minimum 7% of image height; object width: minimum 2% of image width (for a “norm object” which is a person with 1.7 m height and 0.7 m width).

   Object height and object width flow into the calculation of the maximum detection range. The specific guidelines specify example values per application.

   This is true for all modules that detect persons.

   Important note: These values do not depend on the image resolution, because the size of an object on the screen (relative width and height) is equal for different resolutions.

2. IPS Video Analytics require that the contrast between moving objects and the background is at least 4% of the whole grey scale range of the camera.
3. When using thermal cameras the contrast between moving objects and the background must be at least 4% of the whole value range delivered by the camera. Accordingly, the derived video signal (and not the thermal sensitivity) is the key aspect.
4. For each camera, an authorized distributor or solution partner must check camera position, field of view, mounting height, etc. on site relating to the application and according to this specification.
5. At the same time, only a few persons are allowed to stay in the scene (this is true for all modules that detect persons except for Public Transport Protection).
6. There must be no occlusions between camera and monitored area. For optimal detection results, the terrain should be flat. Each rising or sloping can lead to blind spots or weakness in detection accuracy. Furthermore, additional cameras may be required.
7. Cameras in outdoor areas must be tilted down so far that the sunlight does not shine directly into the lens: the sky must not be visible in the image (refer also to the section **Urgent recommendations**).
8. The camera position and the horizontal field of view must be chosen in a way that the object can be seen in an area, which is at least three times the width of the object.

1.3.2 Restrictions and improvements

If one of the **restrictions** listed in the table below applies to the system try to improve the situation as recommended under **improvements**.

	Restriction	Improvement
1	Reduced detection on or under water surfaces	Reposition camera so that scene doesn't contain open water surfaces or at least so that the detection zones are outside of the water surface.
2	Reduced detection when sun shines directly into lens	Tilt down camera and / or install a sun shield and pull it forward.
3	Reduced detection due to infinite length of scene	Tilt down camera.
4	Limited detection in case of mixed light scenes	Only leave illuminators of one type of light.
5	Limited detection in case of mirroring effects	Reposition camera so that it looks parallel to the reflecting surface.
6	Limited detection in case of dense vegetation (restricted view)	Reduce the amount of vegetation.
7	Limited detection due to backlight (depending on camera technology)	Reposition the camera. Sometimes an improvement can be achieved by changing the camera settings (e.g. when using cameras with a WDR feature).
8	Reduced video alarms in case of blinding due to insufficient analogue video level setup	When analogue cameras are used in connection with video encoders ensure the video output signal has a minimum of 1.1 Vpp (peak white) in the case of blinding with a light source.
9	Reduced detection due to smoke or steam or their shadow	Position the camera so that neither smoke nor steam nor their shadow are visible in the detection area. An improvement can be achieved by using thermal cameras.
10	Viewing direction from the side to a rising or sloping terrain	Choose the camera position so that the camera looks parallel or tilted to the rising or sloping terrain.
11	Reduced detection due to hilly terrain	An improvement can be achieved by a special adaptation of the object size setting.
12	High false alarm rate when detecting in forests	For the cameras, use positions with sufficient unobstructed line of sight. A significant improvement can be achieved by using thermal cameras.
13	Limited detection at the border between light and shadow	If possible, choose the image details so that areas with borders between light and shadow are not used for detection.
14	Limited detection due to unfavourable weather conditions like rain, snow, or fog	An improvement can be achieved by using thermal cameras.
15	Increased number of false alarms caused by movements that generate patterns similar to humans	As far as possible exclude areas in which such movements happen.
16	Increased number of false alarms when detecting scenes where changes constantly occur (like road traffic, vegetation, etc.)	Optimize camera position, mounting height, viewing direction, and field of view (focal length of the lens).
17	Increased number of false alarms caused by moving shadows in the detection area	If possible, remove the cause of the shadows or exclude the respective areas.

1.3.3 Urgent recommendations

1. IPS strongly recommends installing a free of charge demo version in order to evaluate the usage of IPS Video Analytics for each specific application.
2. In outdoor areas use sun shields on the camera housings that are pulled to the front as far as possible (so that they are just no longer visible in the image).

1.4 Further planning steps

In this planning guideline the following topics are not covered, that **nevertheless must be observed**:

- Choice of a suitable camera
- Required image resolution
- Choice of a suitable lens
- Choice of suitable camera masts (height, stability)
- Rules for light measuring
- System planning: number and characteristics of the hardware components

2 Analytics Modules versus Applications

The following table shows which application the individual analytics module covers.

Application / Analytics module	Indoor application	Outdoor application	Camera monitoring	Open area monitoring	Fence monitoring	Building monitoring	Entrance monitoring	Corridor monitoring	Room monitoring
IPS Motion Detection	●	●		●				●	●
IPS Sabotage Detection	●	●	●						
IPS Indoor Detection	●							●	●
IPS Loitering Detection	●	●		●	●	●			●
IPS Intrusion Detection		●		●	●	●	●		

3 Specific Guidelines

3.1 Camera Monitoring

For camera monitoring (sabotage detection) no specific guidelines have to be observed.
For other analytics modules besides the **General Guidelines** additionally specific guidelines apply depending on the application.

3.2 Open Area Monitoring

Parameter	Value			
Camera layout				
	Angle of view	4:3	16:9	
Max. detection range for colour cameras 1)	90°	14 m	12 m	
	60°	23 m	21 m	
	30°	48 m	43 m	
Max. detection range for thermal cameras 1)	15°	96 m		
	10°	144 m		
Mounting height	4 m or higher			
Tilt angle	10° - 45°			
Maximum height of a person in foreground	40% of the image height			
Camera parameter				
Minimum image resolution for colour | b/w cameras	352 x 288 pixels			
Minimum image resolution for thermal cameras	160 x 128 pixels			
Minimum frame rate	8 fps			
Shutter speed	1/25 s			
Special requirements				
• The image should not contain elements of the sky				

1) Object height: minimum 7% of image height; object width: minimum 2% of image width
(for a “norm object” which is a person with 1.7 m height and 0.7 m width)

Important note: These values do not depend upon the image resolution, as the size of an object on the screen (relative width and height) is equal for different resolutions.

3.3 Fence Monitoring

Parameter	Value			
Camera layout				
	Angle of view	4:3	16:9	
Max. detection range for colour cameras 1)	90°	14 m	12 m	
	60°	23 m	21 m	
	30°	48 m	43 m	
Max. detection range for thermal cameras 1)	15°	96 m	-	
	10°	144 m	-	
Mounting height	4 m or higher			
Tilt angle	10° - 45°			
Minimum field of vision for detection	2.5 m offset to the fence (inside or outside)			
Maximum height of a person in foreground	40% of the image height			
Camera parameter				
Minimum image resolution for colour | b/w cameras	352 x 288 pixels			
Minimum image resolution for thermal cameras	160 x 128 pixels			
Minimum frame rate	8 fps			
Shutter speed	1/25 s			
Special requirements				
• No detection through fence possible				
• The image should not contain elements of the sky				
Disturbances				
• At fence corners motion outside of the fence where the camera looks through the fence				

1) Object height: minimum 7% of image height; object width: minimum 2% of image width (for a “norm object” which is a person with 1.7 m height and 0.7 m width)

Important note: These values do not depend upon the image resolution, as the size of an object on the screen (relative width and height) is equal for different resolutions.

Illustrations

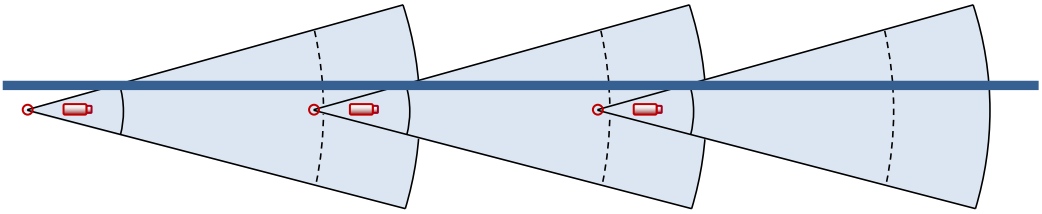


Figure 1: Cameras located along the fence, 2.5 m inside

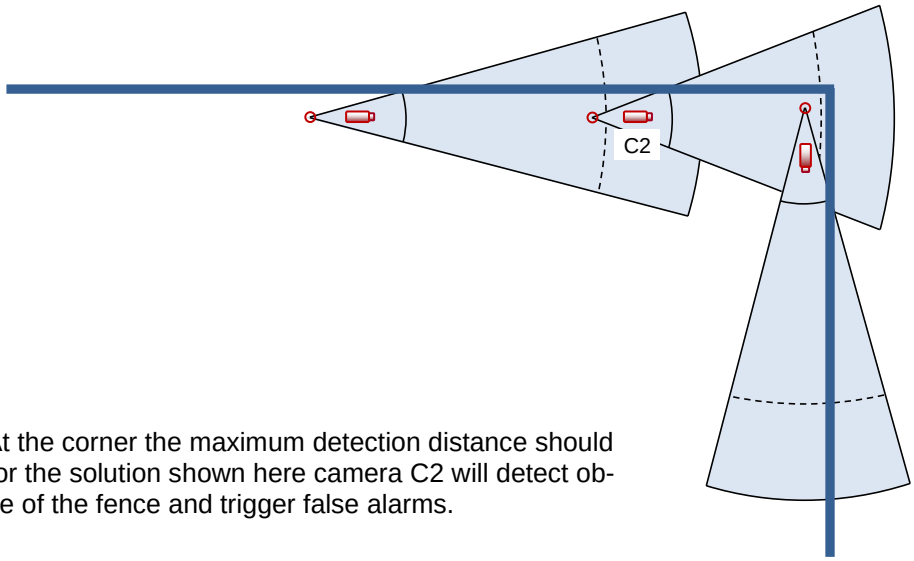


Figure 2: At the corner the maximum detection distance should be 25 m. For the solution shown here camera C2 will detect objects outside of the fence and trigger false alarms.

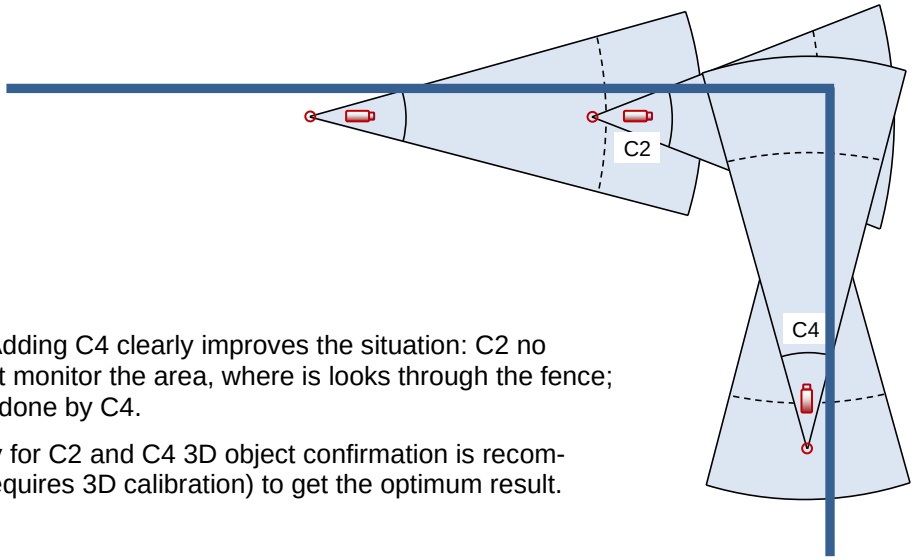


Figure 3: Adding C4 clearly improves the situation: C2 no longer must monitor the area, where is looks through the fence; this is now done by C4.

Additionally for C2 and C4 3D object confirmation is recommended (requires 3D calibration) to get the optimum result.

3.4 Building Monitoring

Parameter	Value			
Camera layout				
	Angle of view	4:3	16:9	
Max. detection range for colour cameras 1)	90°	14 m	12 m	
	60°	23 m	21 m	
	30°	48 m	43 m	
Max. detection range for thermal cameras 1)	15°	96 m	-	
	10°	144 m	-	
Mounting height	4 m or higher			
Tilt angle	10° - 45°			
Minimum field of vision for detection	2 m offset to the building			
Maximum height of a person in foreground	40% of the image height			
Camera parameter				
Minimum image resolution for colour | b/w cameras	352 x 288 pixels			
Minimum image resolution for thermal cameras	160 x 128 pixels			
Minimum frame rate	8 fps			
Shutter speed	1/25 s			
Special requirements				
• Cameras are directed away from the building				
• Complete detection will require 2 cameras per façade in order to eliminate blind spots				
• Alternatively cameras may be offset from the building (mounted on masts)				
• Allow for generous overlaps at building corners				
• The image should not contain elements of the sky				

1) Object height: minimum 7% of image height; object width: minimum 2% of image width (for a “norm object” which is a person with 1.7 m height and 0.7 m width)

Important note: These values do not depend upon the image resolution, as the size of an object on the screen (relative width and height) is equal for different resolutions.

Illustration

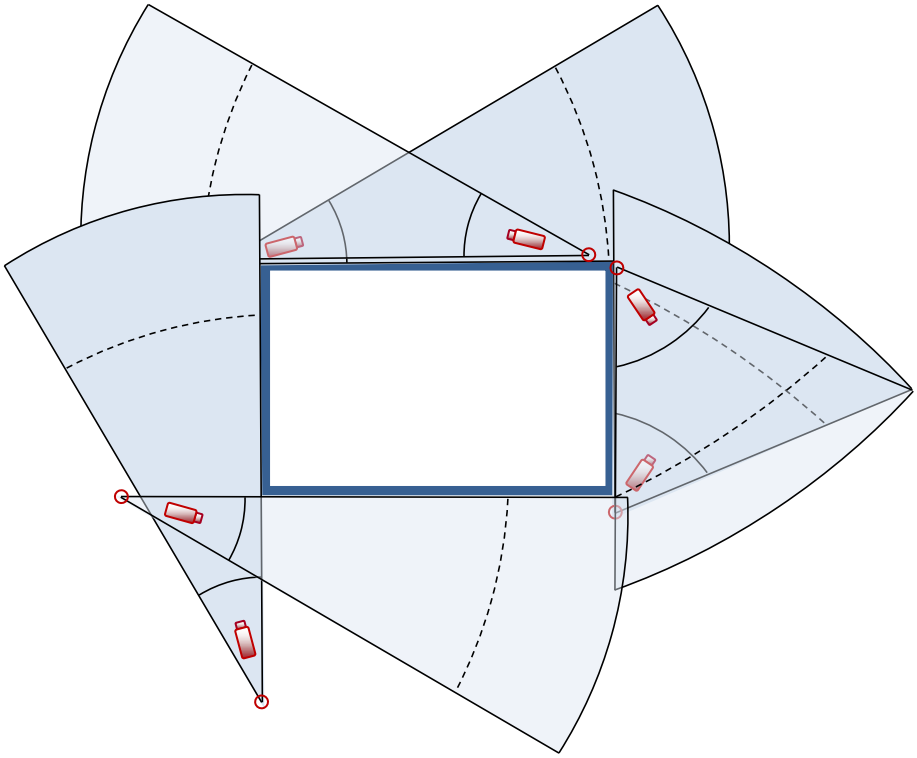


Figure 1: Cameras located along the building, 2 of them on masts offset from the building

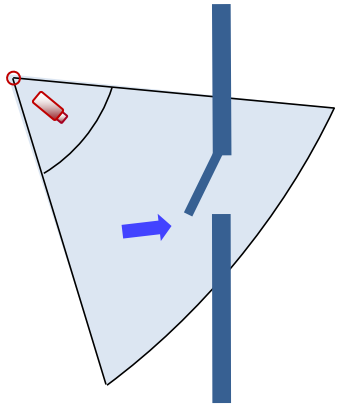
3.5 Entrance Monitoring

Parameter	Value			
Camera layout				
	Angle of view	4:3	16:9	
Max. detection range for colour cameras 1)	90°	14 m	12 m	
	60°	23 m	21 m	
	30°	48 m	43 m	
Mounting height	4 m or higher			
Tilt angle	10° - 45°			
Minimum field of vision for detection	Height of the entrance should be between 20 - 50 % of the image height			
Maximum height of a person in foreground	40% of the image height			
Camera parameter				
Minimum image resolution for colour | b/w cameras	352 x 288 pixels			
Minimum image resolution for thermal cameras	160 x 128 pixels			
Minimum frame rate	8 fps			
Shutter speed	1/25 s			
Special requirements				
• Suitable only for entrances in sterile areas; for exceptions see **Disturbances**				
• Entrance must be clearly visible in the image				
Disturbances				
• Passing people: raised levels (staircases, ramps) enable detection even while people passing				

1) Object height: minimum 7% of image height; object width: minimum 2% of image width (for a “norm object” which is a person with 1.7 m height and 0.7 m width)

Important note: These values do not depend upon the image resolution, as the size of an object on the screen (relative width and height) is equal for different resolutions.

Illustration



3.6 Corridor Monitoring

Parameter	Value			
Camera layout				
	Angle of view	4:3	16:9	
Max. detection range for colour cameras 1)	90°	14 m	12 m	
	60°	23 m	21 m	
	30°	48 m	43 m	
Mounting height	at the ceiling or at a wall close to the ceiling (minimum 2.3 m above ground)			
Minimum field of vision for detection	room width minimum 1.5 m			
Maximum height of a person in foreground	40% of the image height			
Camera parameter | Analytics parameter				
Minimum image resolution for colour | b/w cameras	352 x 288 pixels			
Minimum frame rate	8 fps			
Shutter speed	1/25 s			
Special requirements				
• none				
Disturbances				
• Switching the lights on or off • Moving shadows • Continuous motion e.g. by a fan				

1) Object height: minimum 7% of image height; object width: minimum 2% of image width (for a “norm object” which is a person with 1.7 m height and 0.7 m width)

Important note: These values do not depend upon the image resolution, as the size of an object on the screen (relative width and height) is equal for different resolutions.

3.7 Room Monitoring

Parameter	Value			
Camera layout				
	Angle of view	4:3	16:9	
Max. detection range for colour cameras 1)	90°	14 m	12 m	
	60°	23 m	21 m	
	30°	48 m	43 m	
Mounting height	at the ceiling or at a wall close to the ceiling (minimum 2.3 m above ground)			
Minimum field of vision for detection	room width minimum 1.5 m			
Maximum height of a person in foreground	40% of the image height			
Camera parameter | Analytics parameter				
Minimum image resolution for colour | b/w cameras	352 x 288 pixels			
Minimum frame rate	8 fps			
Shutter speed	1/25 s			
Special requirements				
• none				
Disturbances				
• Switching the lights on or off				

1) Object height: minimum 7% of image height; object width: minimum 2% of image width (for a “norm object” which is a person with 1.7 m height and 0.7 m width)

Important note: These values do not depend upon the image resolution, as the size of an object on the screen (relative width and height) is equal for different resolutions.