CAMERA PLACEMENT STANDARD FOR VIDEO ANALYTICS

Ver. 1.2

INDEX

CAMERA PLACEMENT STANDARD FOR VIDEO ANALYTICS

1 INTRODUCTION

This standard specifies the camera location requirements for complete video analytics coverage for business intelligence.

Location specification is included for:

- **Entrances to shops:** to count people at the doors of commercial premises
- **Checkout queues, returns and fitting rooms:** to monitor waiting times
- **Commercial areas:** to make analyses about the products in each space

Concepts to be taken into account such as occlusion and obstacles, and the optimal coverage radius for a camera are also covered.

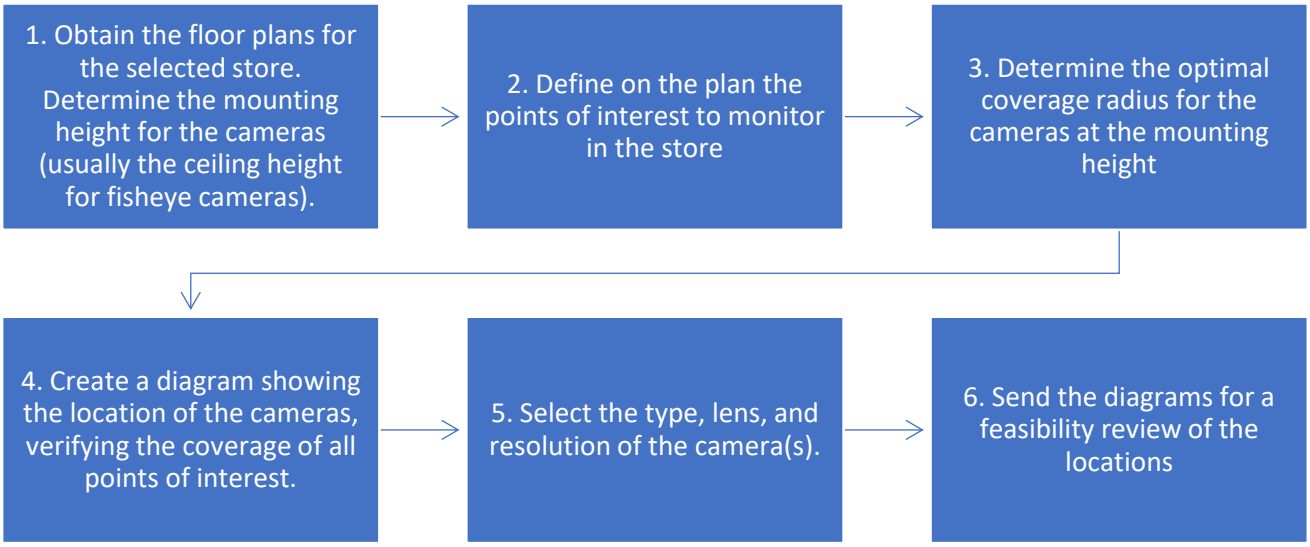
This document also sets out criteria for the selection of:

- Selecting the type of camera and lens
- Criteria for the infrastructure to be installed to be compatible with other uses, such as security

A method for determining the location and type of cameras will also be presented, and finally, the rationale for determining the methodology and criteria set out.

2 METHOD FOR DETERMINING LOCATION, QUANTITY, AND TYPE OF CAMERAS FOR A STORE

The following method applies **for each store**:



2.1 STEP 1: PREPARATION

Purchase the blueprints for the selected store. Determine **Mounting height** that the cameras will have (usually the ceiling height for fisheye cameras)

Mounting height: 4 meters

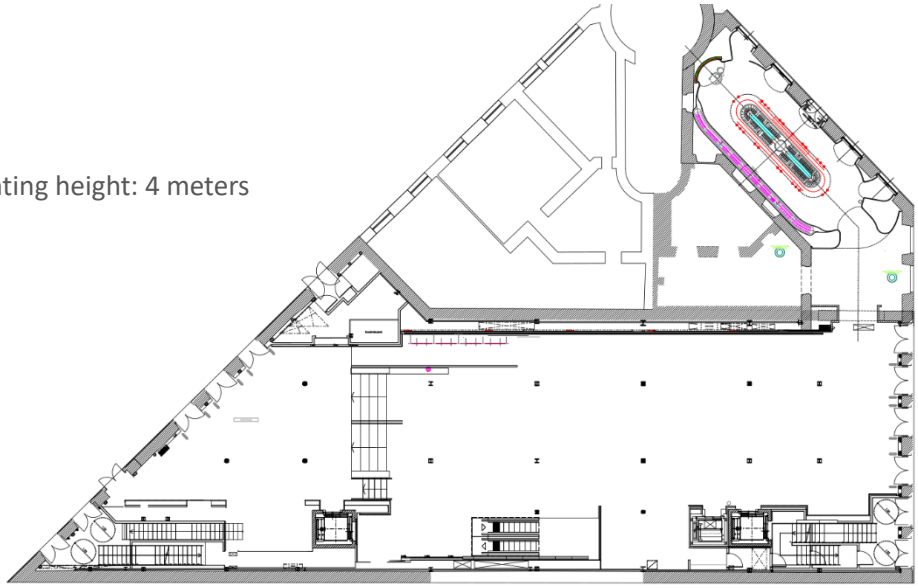


Illustration 1: Preparation. Obtaining the drawings and installation heights

2.2 STEP 2: DEFINE POINTS OF INTEREST

The following must be identified on the plan:

- **Entrances to shops:** the people counting areas at the doors of commercial premises
- **Interchange stairs or elevators between floors:** the points where customers can move from one floor to another. Note that in the case of stairs it is only necessary to monitor one of its ends.
- **Checkout queues, returns, and fitting rooms:** to monitor wait times in the store
- **Commercial areas:** to make analytics about the products in each space (for example, Money Mapping areas)

Mounting height: 4 meters

Illustration 2: Defining Points of Interest

2.3 STEP 3: CALCULATE COVERAGE RADIUS

2.3.1 Multiplication Factor Method:

It consists of assuming that **The coverage radius is equal to the height of the camera, multiplied by a constant that depends on the use case**. For example, to do precision counting with high flow of people, a multiplication constant = 1 is recommended. This method is recommended for on-site use and for quick estimates.

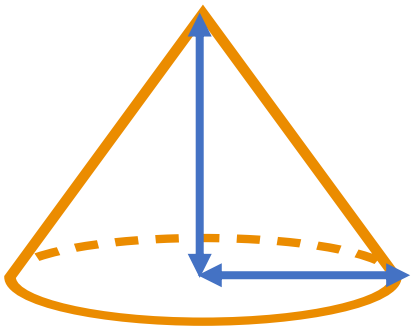


Illustration 3: Simple method to calculate coverage radius for precision counting:

Coverage radius = Mounting height

Use Case	Multiplier
Precision Counting	1
Monitoring of checkout queues and returns	1.5
Monitoring of waiting queues, fitting rooms and self-checkout	2
Monitoring of commercial areas	2

2.3.2 Method with Conversion Tables (recommended):

The height of the camera location defines a detection radius where the occlusion is low enough to provide good performance. In the following table you can determine this radius, based on the mounting height of the camera (note that this method is more conservative than the previous one):

Mounting height	Optimal coverage radius			
	Precision Counting	Monitoring of checkout queues and returns	Monitoring of waiting queues, fitting rooms and self-checkout	Monitoring of commercial areas
2.5-2.8 m	1.4 m	2.1 m	2.8 m	2.8 m
2.8-3.1 m	1.7 m	2.6 m	3.4 m	3.4 m
3.1-3.4 m	2.0 m	3.0 m	4.0 m	4.0 m
3.4-3.7 m	2.3 m	3.5 m	4.6 m	4.6 m
3.7-4.0 m	2.6 m	3.9 m	5.2 m	5.2 m
4.0-4.5 m	2.9 m	4.4 m	5.8 m	5.8 m
4.5-5.0 m	3.4 m	5.1 m	6.8 m	6.8 m
5-6 m	4.0 m	6.0 m	8.0 m	8.0 m
6-7 m	5.0 m	7.5 m	10.0 m	10.0 m
7-8 m	6.0 m	9.0 m	12.0 m	12.0 m

8-9 m	7.0 m	10.5 m	14.0 m	14.0 m
9-10 m	8.0 m	12.0 m	16.0 m	16.0 m

Note that the optimal coverage radius **only depends on the mounting height;** it does not depend on the type of camera or its angles of view (FOV). There may be cameras that cover more range than the optimal coverage radius. It is also possible that there are cameras that cover less range. **The area where the people count will be carried out must be within the optimal coverage radius**.

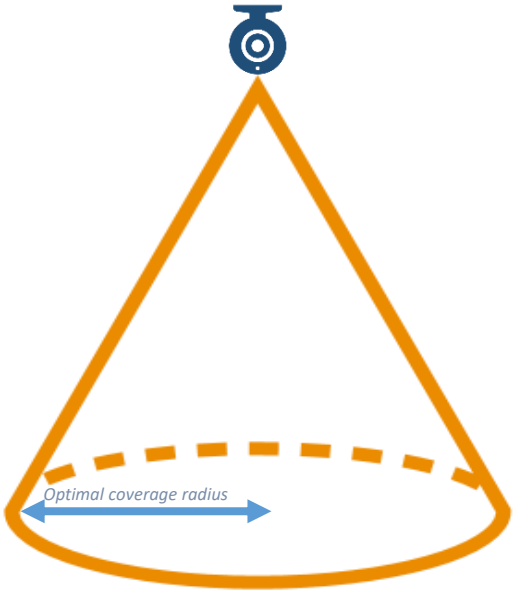


Illustration 5: Side view of the optimal coverage radius of a camera

Illustration 5: View from above of the optimal coverage radius of a camera

2.4 STEP 4: DIAGRAM OF CAMERA LOCATIONS

Once the optimal coverage radius have been determined, the camera's angular aperture should be selected to ensure that the area of interest is covered. To do this, it must be verified that the entire area of interest falls within the coverage radius**.** A diagram should be made with the points of interest including:

- The areas of interest
- The location of the proposed cameras with their respective coverage radius

Mounting height: 4 meters

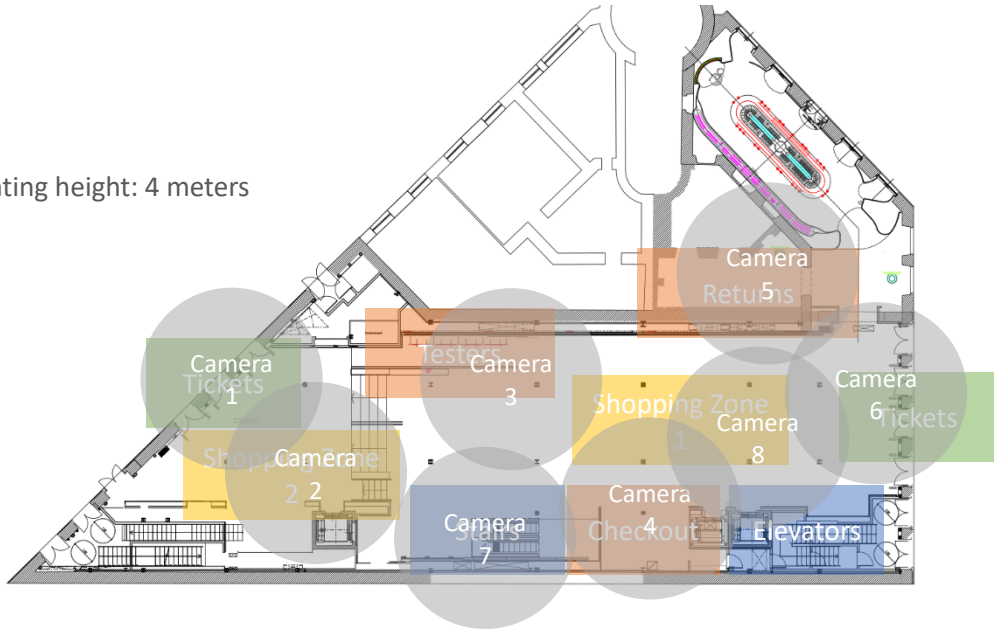


Illustration 6: Example of camera locations diagram (not intended to be a real case)

2.4.1 Things to consider

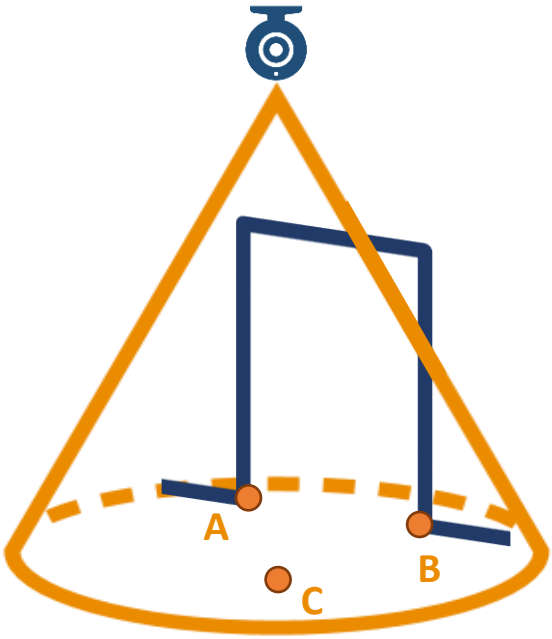


Illustration 8: Side view of the optimal coverage radius of a camera

Illustration 7: Diagram with points of interest of points within the optimal coverage radius. All points (A, B and C) must be within the coverage radius, or in other words, ***The distance from each point to the camera must be less than the optimal coverage radius***

Important: Points A, B, C, and D must be within the camera's coverage radius

For counting people at doors, it should be noted that **a completely side view is not advisable**. If possible, **the cameras should be placed at least one meter away from the wall** where the door is located.

In the event that the optimal coverage radius is not sufficient to cover the points of interest, more cameras should be placed on the diagram, and combined to increase the coverage radius.

The context where the camera will be used must be taken into account to take into account possible elements that generate occlusion (for example, posters or decorative elements), and include them in the diagram.

Illustration 9: Examples of elements that can cause occlusion

2.5 STEP 5: SELECTING THE LENS AND RESOLUTION OF THE CAMERAS

Once the location of the camera has been verified, it must be ensured that the camera has the necessary angular aperture and resolution to cover the areas of interest. In terms **of resolution, in general all cameras with full HD resolution or higher are suitable for heights of 5 meters or less**. The other variable to select is the angular specification (FOV), which determines the available field of view. **It must be ensured that the angular aperture of the camera is sufficient to cover the areas of interest.**

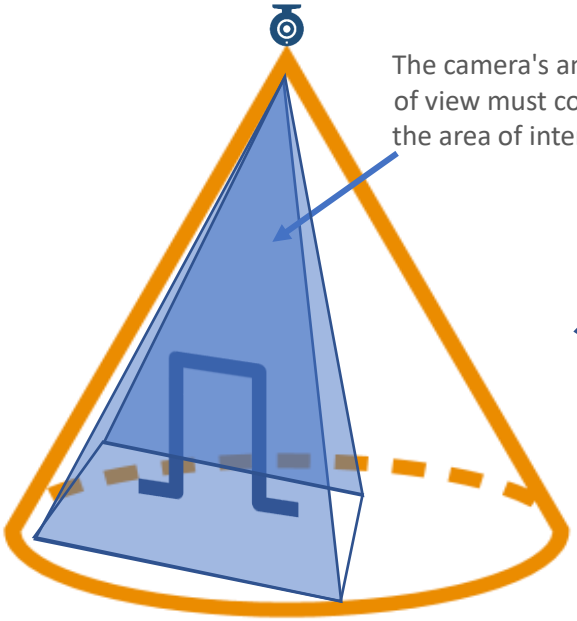


Illustration 11: The lens must be chosen so that the camera's angle of view covers the area of interest

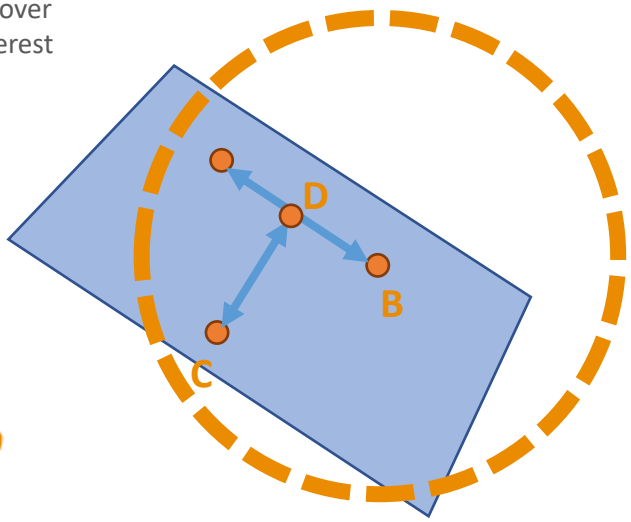


Illustration 10: Aerial view of camera coverage within optimal coverage radius

Some practical tips:

- It is recommended to use cameras that have the ability to perform video "substreams" and manage users and permissions. They allow streams to be sent to multiple devices at the same time with different resolutions and FPS settings.
- If the streams are extracted through a DVR or similar, it must be verified that it can re-stream video.
- Full HD resolution or higher is recommended,
- 10 FPS or higher is recommended.
- Choosing the option of cameras with the largest available wide-angle aperture will generally be sufficient to meet coverage requirements.
- Due to their angular aperture, zenithal fisheye cameras cover the entire coverage radius, making them a practical option to implement.
- Implementing 360º fisheye cameras, in addition to looking good aesthetically, represents the option with the greatest coverage. These cameras provide the greatest possible coverage, and are useful to be used for CCTV surveillance, because they can be "dewrapped" in multiple views in their 360º range, obtaining the same functionality that would imply having several cameras, or a robotic camera.

Illustration 12: Top left: Original image of a ceiling-mounted fisheye camera. All others: Images "de-wrapped" from the original image

2.5.1 OTHER USES: SECURITY

For the cameras to also be optimal for use in CCTV security, the following considerations can be taken into account:

- If feasible, use 360º fisheye cameras. These will provide a very wide coverage of the corridors and entrances of the premises
- If using common cameras, position them so that the entrances can be seen
- Cameras with good resolution will be more useful when performing forensic analysis, and/or using the cameras for security analytics functionalities (e.g. facial recognition)

2.6 STEP 6: FEASIBILITY ANALYSIS

At the end of the process, the diagrams must be sent for a feasibility review of the locations, because it is not always possible to locate the cameras in the indicated places. From this analysis there may be some changes in the locations to adapt to the reality of the store.

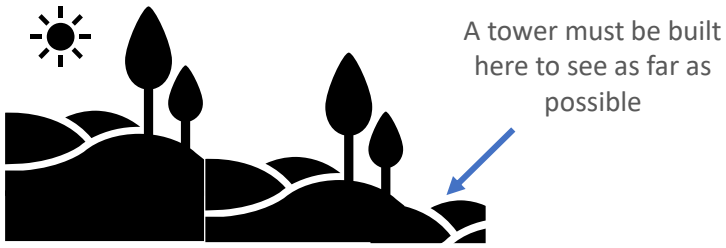
3 ANNEXES: EXPLANATION OF COVERAGE RADIUS

3.1 OCCLUSION

Occlusion occurs when a person is hidden from the point of view of the camera or sensor because they have an object or another person in front of them. Occlusion is the main phenomenon that generates a degradation in the performance of the people count in a location. This effect is present in all types of people counting sensors (including cameras, 3D sensors, etc.). The exception to this problem is counting methods that do not use spatial information (e.g., WiFi), but have other limitations associated with them.

3.2 EXPLANATION CALCULATION OF THE OPTIMAL COVERAGE RADIUS

To understand what the optimal coverage radius is, imagine a fictitious situation in which you must **build a tower to see as far as possible**:



As a result of the occlusion phenomenon, if you build a very low tower, the coverage radius that you will be able to visualize is low:

On the other hand, if the tower to be built is high, the coverage radius will also be high:

Now let's transfer this concept to a commercial environment with cameras: as in the previous example, the optimal coverage radius to take measurements (taking into account the occlusion phenomenon), is only determined by the height of the camera. Note that the optimal coverage area grows quadratically with height, so it is advisable to place the cameras as high as possible to have greater coverage.

> Note that occlusion does not depend on the technology you use to observe, whether it is a person, a camera, a 3D sensor, **they will all have the same coverage limitation per occlusion**

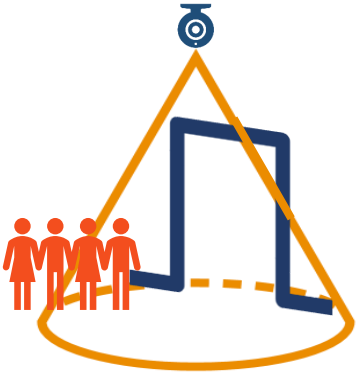


Illustration 13: Side view of a door and the optimal coverage radius of a camera

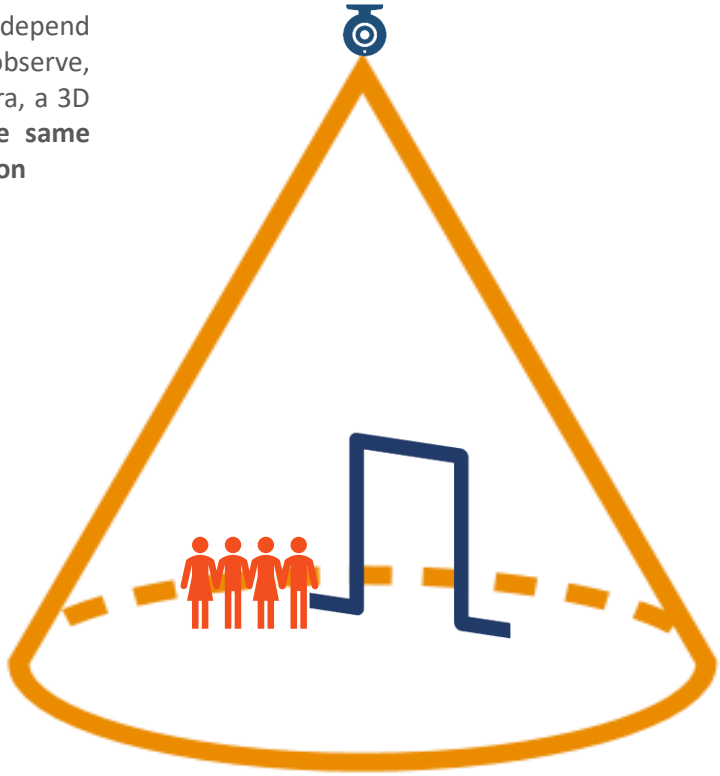


Illustration 14: The same example as the Illustration 13, but twice as tall. The coverage area increases much more, since it grows quadratically

It is important to understand that:

- The coverage radius only depends on the height of the observation point
- The coverage radius is the same for any observation method. Whether it's a camera, a 3D sensor, or a person watching, they all have the same coverage radius
- The coverage radius is not related to the angle of view of the camera or sensor. The coverage radius is a radius where the occlusion is small enough to have good visibility to make measurements
- If you want to cover the entire coverage radius, the use of fisheye cameras is recommended.