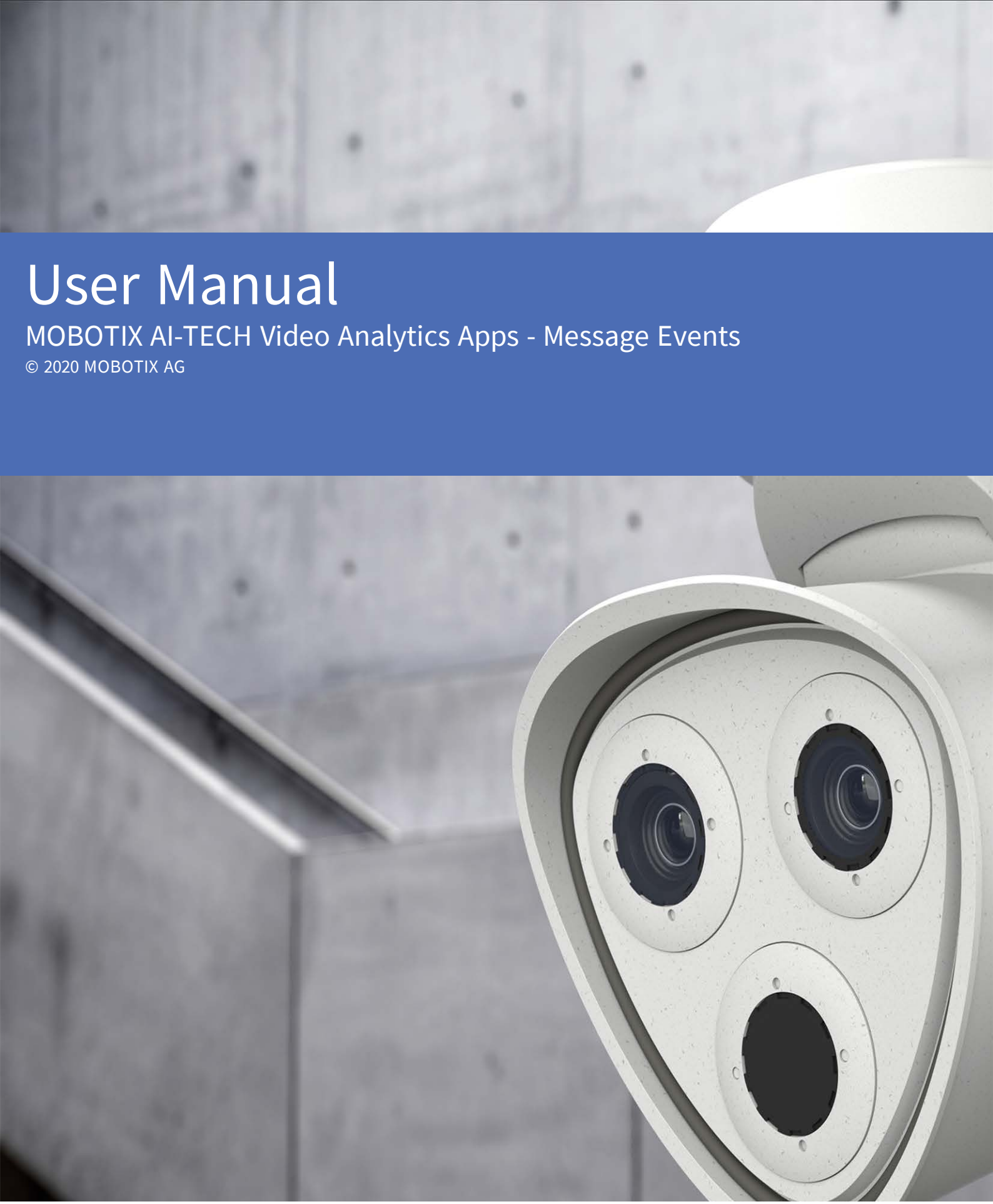

User Manual

MOBOTIX AI-TECH Video Analytics Apps - Message Events

BeyondHumanVision

MOBOTIX

V2.07_01.12.2020 Order code: Mx-M73A/B

Table of Contents

Support

If you need technical support, please contact your MOBOTIX dealer. If your dealer cannot help you, he will contact the support channel to get an answer for you as quickly as possible.

If you have internet access, you can open the MOBOTIX help desk to find additional information and software updates. Please visit:

www.mobotix.com > Support > Help Desk

Imprint

This document is part of the camera manufactured by MOBOTIX AG (called manufacturer in the following); the document describes how to use and to configure the camera and its components.

Subject to change without notice.

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Patent and Copy Protection

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Legal Notes

Special Export Regulations!

Cameras with thermal image sensors ("thermal cameras") are subject to the special export regulations of the U.S.A. and including the ITAR (International Traffic in Arms Regulation):

- According to the currently applicable export regulations of the U.S.A. and the ITAR, cameras with thermal image sensors or parts thereof must not be exported to countries embargoed by the U.S.A., except if a special permit can be presented. At present, this applies to the following countries: Crimea region of Ukraine, Cuba, Iran, North Korea, Sudan, and Syria. The same export ban applies to all persons and institutions listed in "The Denied Persons List" (see www.bis.doc.gov, "Policy Guidance > Lists of Parties of Concern"; https://www.treasury.gov/resource-center/sanctions/sdn-list/pages/default.aspx).
- Under no circumstances must the camera itself or its thermal image sensors be used in the design, the development or in the production of nuclear, biological or chemical weapons or in the weapons themselves.

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You must comply with all data protection regulations for video and sound monitoring when using MOBOTIX AG products. Depending on national laws and the installation location of the AI-TECH Video Analytics App, the recording of video and sound data may be subject to special documentation or it may be prohibited. All users of MOBOTIX products are therefore required to familiarize themselves with all applicable regulations and to comply with these laws. MOBOTIX AG is not liable for any illegal use of its products.

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4

AI-Dashboard embedded for data management

The data generated by AI-PEOPLE, AI-CROWD andAI-OVERCROWD can be stored on board on the SD card of the camera through AI-Dashboard embedded.
The data can be visualized in two different ways:

- In tabular form, as a sequence of events. In this case (optionally) a sequence of images associated to the events is available (not for AI-CROWD).
- The graphics related to the events generated by the plug-ins, with the possibility to personalize the time interval and the time resolution.

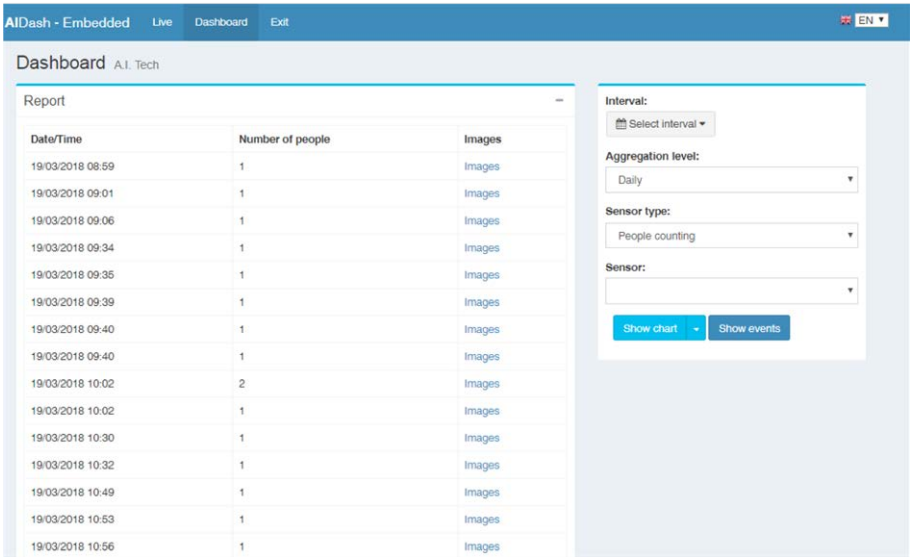


Fig. 1: Sequence of events

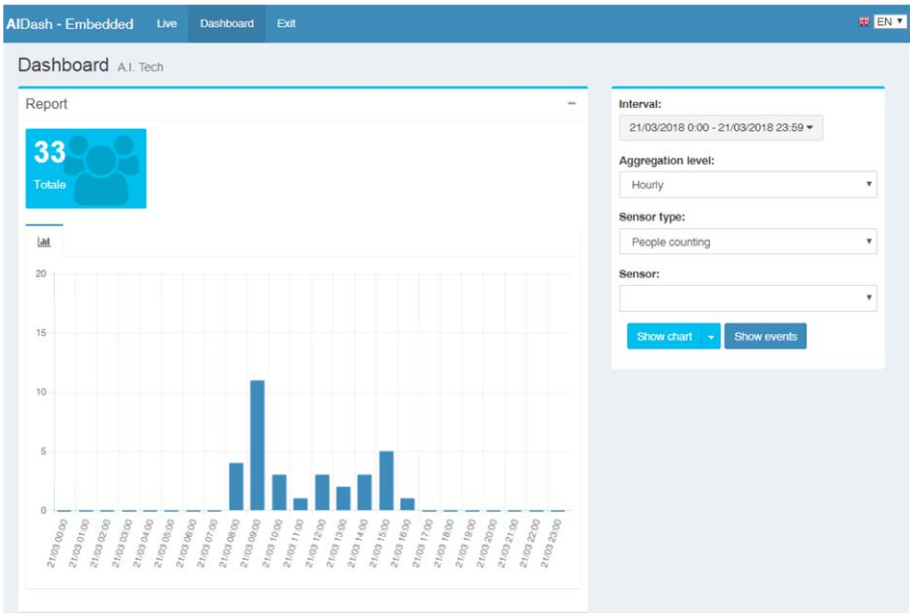


Fig. 2: Graphic

AI-Dash - configuration overview

The dashboard in general is divided into the following sections:

- The main menu on top
- The live view area on the left
- The parameter section on the right

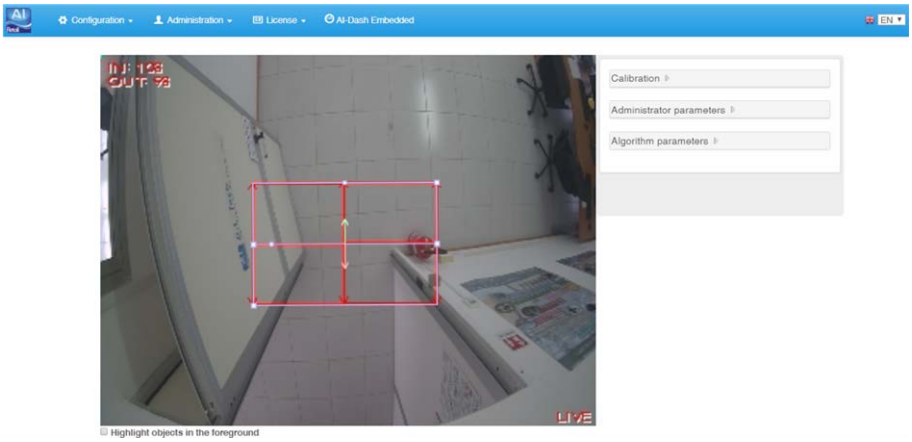


Fig. 3: Overview of the dashboard

Menu configuration

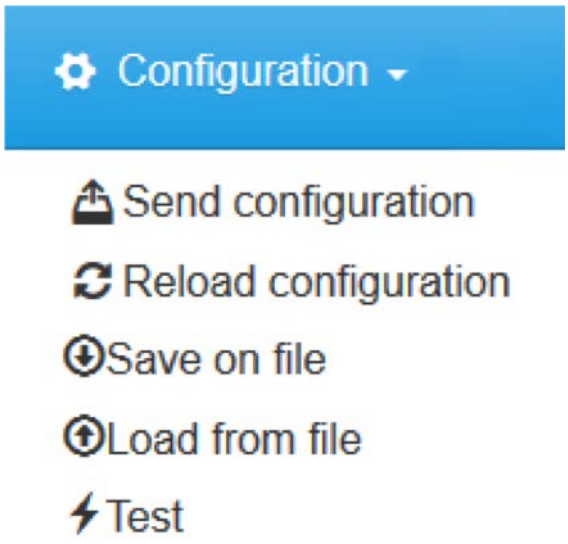


Fig. 4: Menu configuration

> **Note**:
> Any changes made via AI-Config will only be applied to the application after the configuration has been sent using the function in this panel.

The following functions are available:

Send configuration: the configuration will be send and stored to the application.

Reload configuration: the current configuration will be loaded from the application .

Save on file: The configuration can be downloaded an saved as file in JSON format.

Load from file: The saved configuration can be loaded from a file in JSON format.

Test: sends a test event to all the enabled channels in order to verify that the configuration of the channels has been successful. Once clicked, simply click on the "Test" button in the window that will appear next. To exit the test mode, simply click anywhere on the screen.

Menu Administration

ALWAYS STORE THE ADMINISTRATOR PASSWORD IN A SAFE PLACE!
If you have lost the administrator password and no other users with administrative privileges have been added in the meantime, accessing the system configuration settings will not be possible. The administrator password cannot be restored.

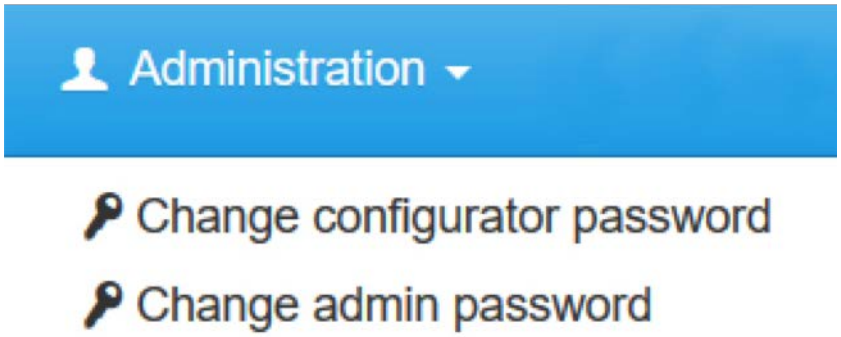


Fig. 5: Menu Administration

The following functions are available:

Change configurator password: a configurator can load a configuration but cannot edit the parameters.

Change admin password: an administrator can fully edit all parameters.

Menu License

Note
Licensing is available in MxManagementCenter only .

Highlight objects in the foreground

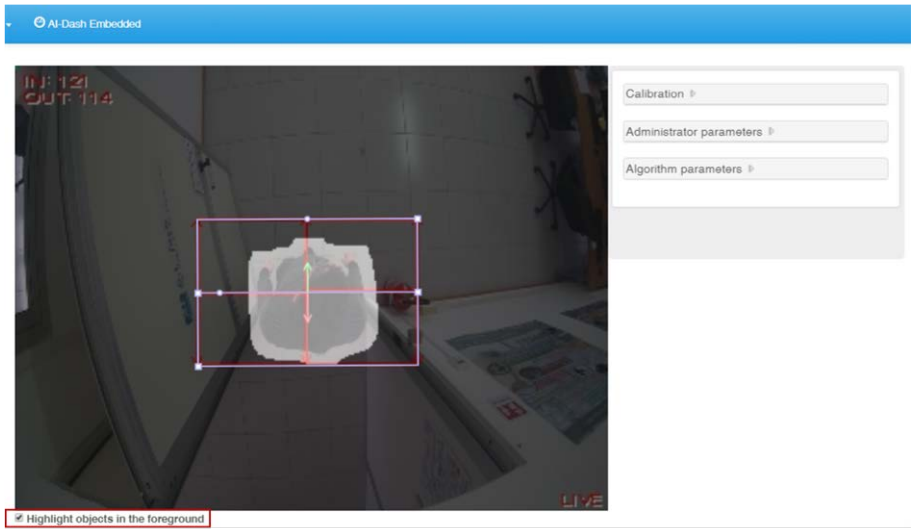


Fig. 6: Highlight objects in foreground

1. Activate Highlights objects in the foreground to verify if the configuration of the low level parameters is correct.

Scheduler

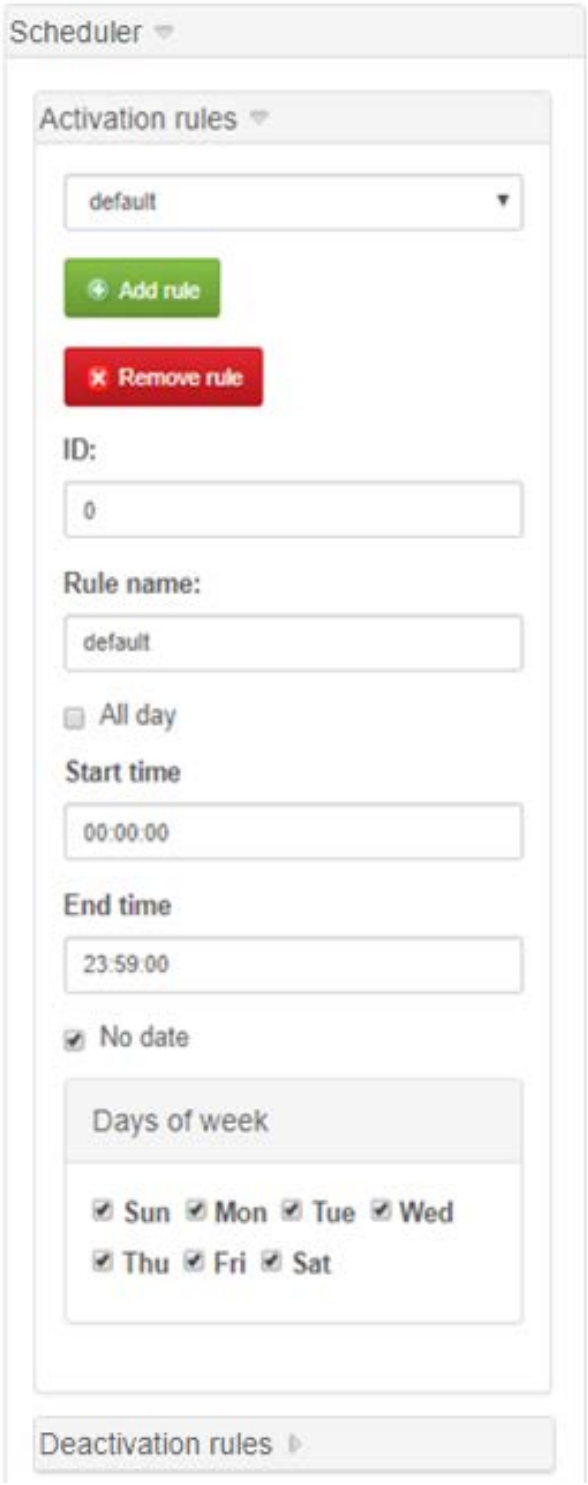


Fig. 7: Scheduler

In many real installations, applications do not always need to be active. It may be required, for example, to enable the processing only from Monday to Friday, or every day at a certain time interval.

For this reason AI-RETAIL can be scheduled by configuring the periods in which they must be active and those in which they do not.

AI-Dash - Administrator parameters

For more experienced users, it is also possible to change the administrator parameters.

In this section, you can modify the low-level parameters that are required for background updating and extraction of the foreground mask. It is generally suggested that you do not change these parameters. However, the modification of these requires significant experience, so it was decided to protect this configuration with a password.

ALWAYS STORE THE ADMINISTRATOR PASSWORD IN A SAFE PLACE!
If you have lost the administrator password and no other users with administrative privileges have been added in the meantime, accessing the system configuration settings will not be possible. The administrator password cannot be restored.

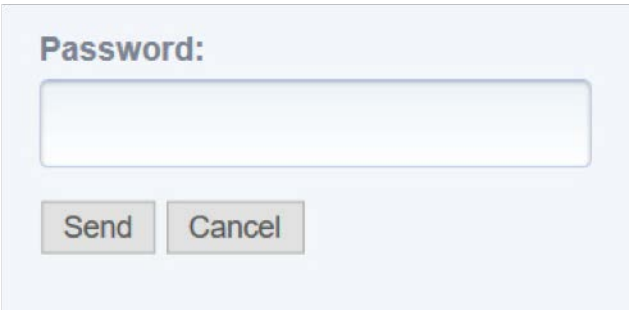


Fig. 8: Administrator log in with password

Face detection (AI-BIO only)

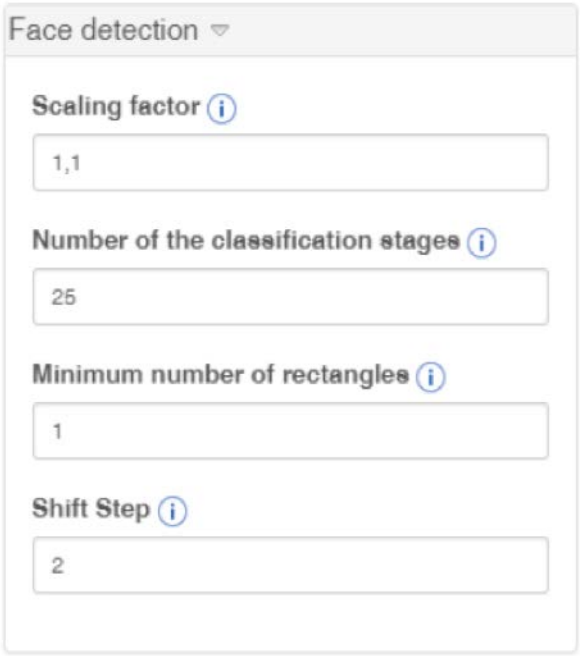


Fig. 9: AI-BIO Face detection

Scaling factor: Growing factor of the window for the face detection (default 1,1). By increasing the value of this parameter (max 2,0) you will make the algorithm faster but on the other hand it will became less sensible. Vice versa, by decreasing this value (min 1,01) the algorithm will become more sensible but also slower.

Number of classification stages: (default 25): Decreasing this value (it's suggested to not set it less than 18), the algorithm sensitivity is increased, but also the false positive rate is increased.

Minimum number of rectangles: Minimum number of rectangles to consider an object as a detected face (default 1 - maximum sensibility). Decreasing this value, the algorithm sensitivity is increased, but also increase the false positive (min 1) rate is increased. On the other hand, if this value is excessively increased, the miss rate may increase (it's suggested to not go further the value 10).

Shift step: Shift in pixels of the window for the face detection (default 2). Decreasing this value, the algorithm sensitivity and the processing time are increased(min 1). On the other hand, increasing this value, the sensitivity and the processing time may be reduced (it's suggested to not go further the value 10).

Gaussian filtering

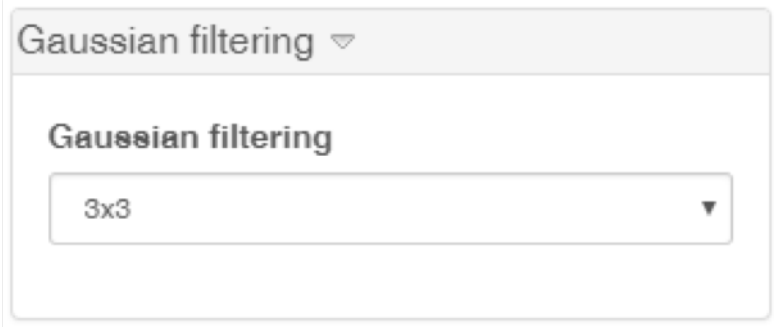


Fig. 10: Gaussian filtering

Image pre-processing by gaussian filtering eliminates the acquisition noise on the image and makes subsequent operations for object detection easier and more effective. The

default kernel is 3x3, while other possible values are 5x5 and 7x7.

Gaussian filtering can also deactivated.

Background

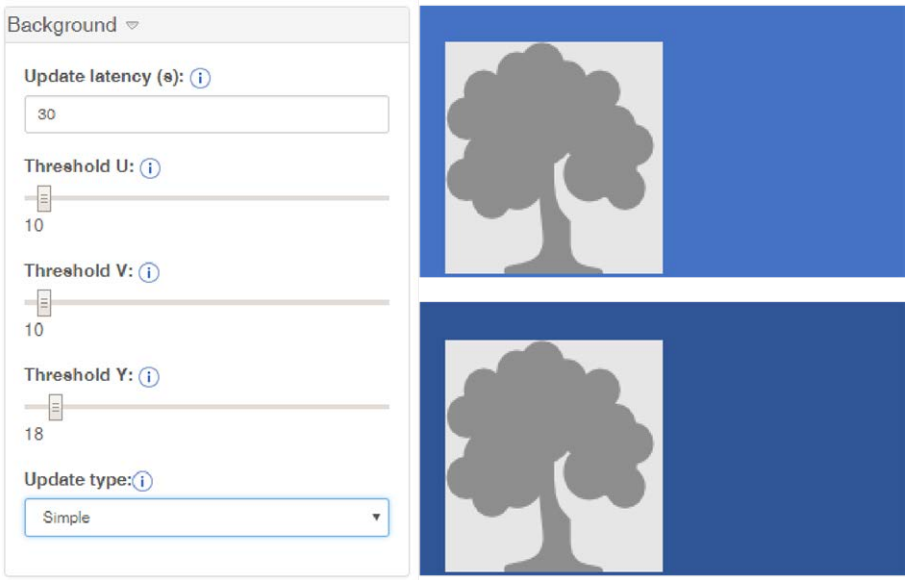


Fig. 11: Background

The background settings allow modeling and updating the background by setting the entry time of an object in the background

The output is an image in the YUV420 color space which represents the static part of the scene shot; it is then used to determine the dynamic part of the current frame, that is the foreground mask.

Update latency (s): Time period in seconds after a change in the scene must definitely become part of the background

Threshold (YUV): A comparison is made between the current frame and the background image of the previous instant: if the pixel of the frame is "close" to the corresponding pixel of the background, then it is not a foreground pixel; otherwise, that pixel will be white in the foreground mask. The comparison is made separately on each of the three YUV channels

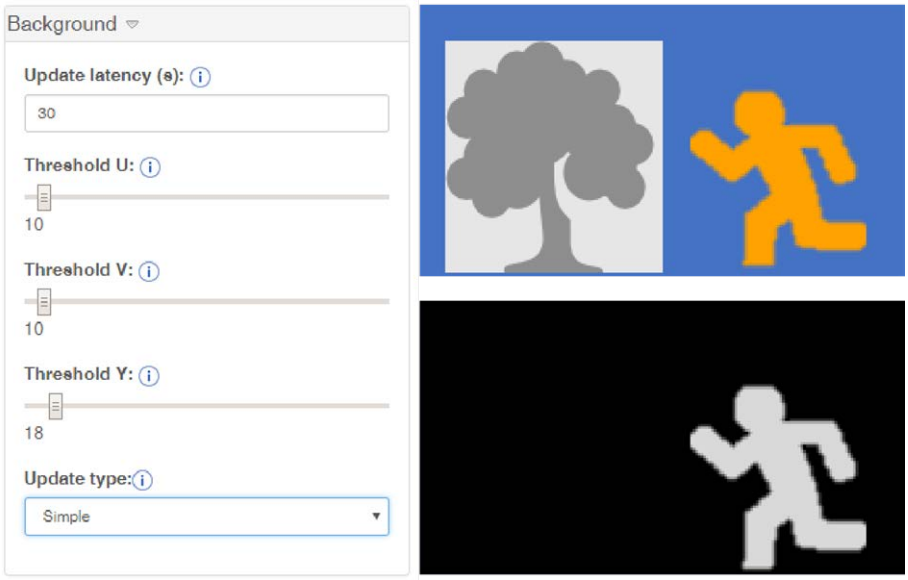


Fig. 12: Example background extraction using a threshold for each of the three YUV channels.

Update type: By specifying «Accurate (grayscale)» or «Accurate (color)» as background update type, it is possible to use a state of the art self learning algorithm for extracting the foreground mask. The «grayscale» version uses only the Y color channel, while the «color» version uses all the channels; of course, the first is more efficient, while the second is more effective. Moreover, the shadow removal can be enabled only with the color version.

Morphological filtering

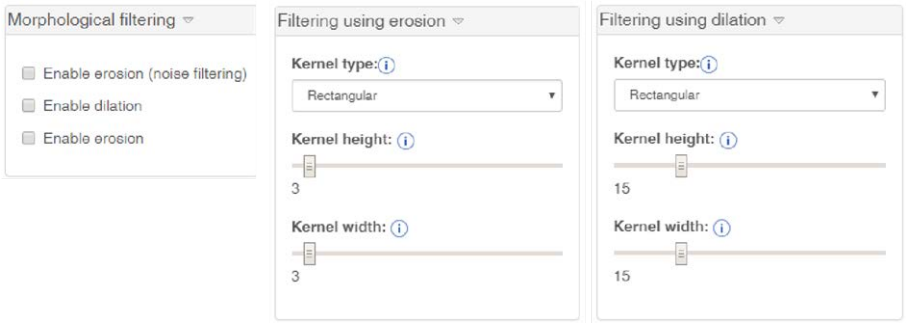


Fig. 13: Morphological filtering

Application of morphological erosion, dilation and another erosion operators to improve the foreground mask

Enable erosion (noise filtering): eliminates the spurious white pixels caused by noise

Enable dilation: fills holes and reinforces the union of weakly connected regions.

Enable erosion: allows to recover the original size of the objects.

It is possible to choose the shape of the kernel to be used (rectangular, diamond, octagon, disk), as well as the dimension in terms of width and height (rectangular) or radius (diamond, octagon, disk).

Tracking (AI-BIO, AI-SECURITY only)

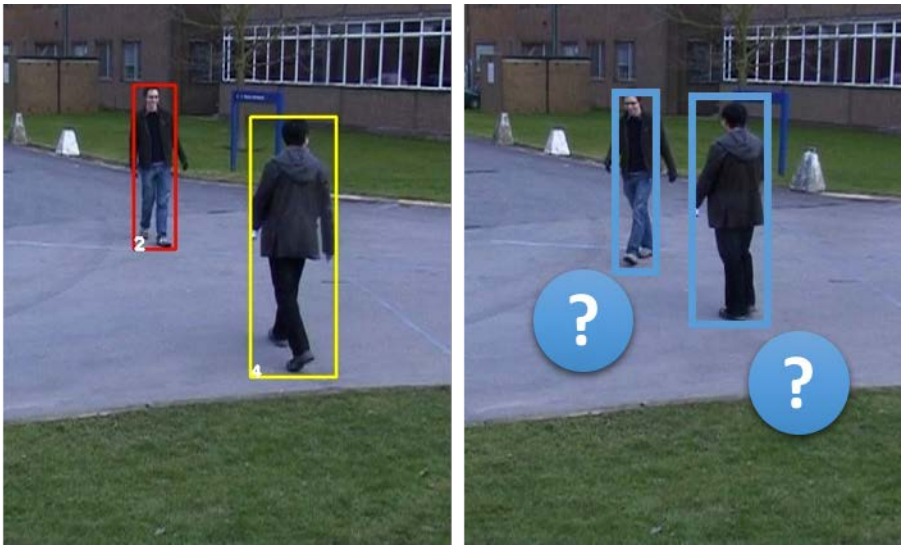


Fig. 14: Object tracking

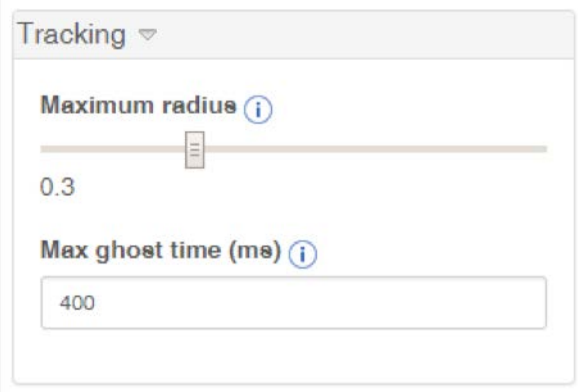


Fig. 15: Tracking (AI-BIO and AI-SECURITY only)

Tracking of objects in different frames depending on the position in the image
The objective is to find the correspondence between the detected object to the preceding frame (t-1) and the blob identified at the current frame (t), solving, in this way, problems related to occlusions (for example trees)

Maximum radius: Maximum movement of an object between two successive frames. A too small value may cause frequent switches of the ID, while a too large value may cause the assignment of the same ID to different objects. The value is expressed as a fraction of the frame diagonal.

Max ghost time (ms): Maximum time (in milliseconds) for which a detected object can assume the status of ghost, namely it can be stored and retrieved in case of occlusion.

Small objects filtering (AI-SECURITY only)

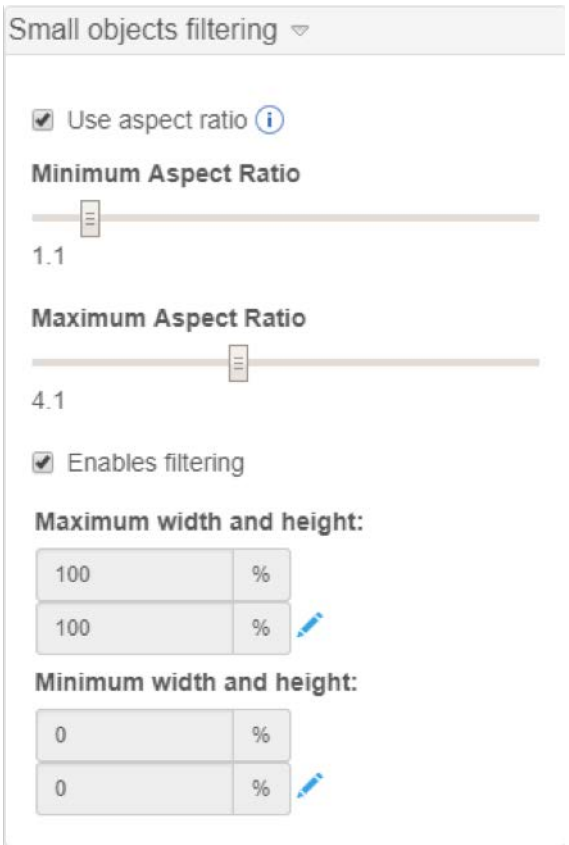


Fig. 16: Small objects filtering (AI-SECURITY only)

Elimination of blobs that are too small, too large or abnormally shaped based on pixel dimensions

Use aspect ratio: Check to activate the aspect ration settings. The settings allow to detect, for example, only people or just cars.

Minimum Aspect Ratio: define the minimum value of the relationship between height and width.

Maximum Aspect Ratio: define the maximum value of the relationship between height and width.

Enable filtering: Check to activate the filtering settings.You can define minimum and maximum values for the height and width of a blob by drawing a couple of rectangles on the image.

Maximum width and height: define the maximum value of the object size.

Minimum width and height: define the minimum value of the object size.

Filtering actual size (AI-SECURITY only)

To use this filter it is necessary first to calibrate the camera and the algorithm, to be able to calculate the relation that allows to deduce the real dimensions of an object starting from the pixel dimensions (see Camera Calibration (AI-SECURITY only), p. 21)

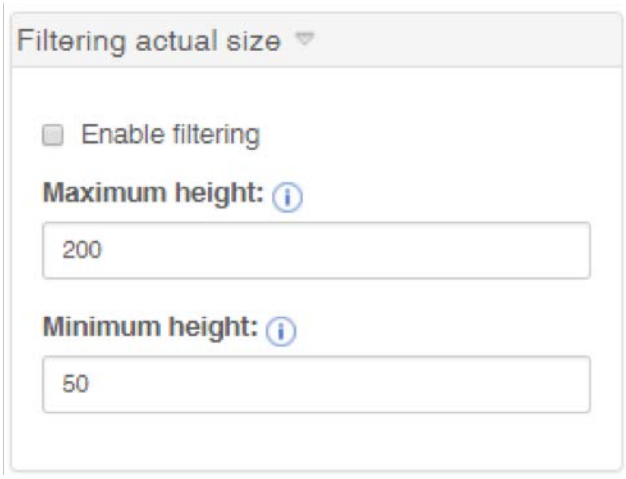


Fig. 17: Filtering actual size (AI-SECURITY only)

This filter allows the elimination of blobs that are too short or too tall based on actual size

Enable filtering: Check to activate the filtering settings.You can define minimum and maximum values for the height and width of a blob.

Maximum height: define the maximum height of a blob.

Minimum height: define the minimum height of a blob.

Camera Calibration (AI-SECURITY only)

The camera calibration has to be done before filtering the actual size (see Filtering actual size (AI-SECURITY only), p. 21)

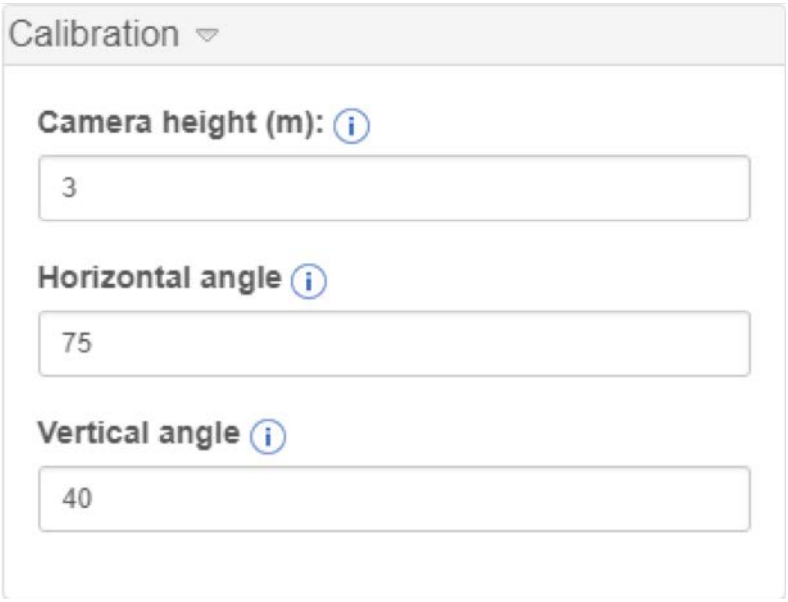


Fig. 18: Camera Calibration (AI-SECURITY only)

This filter allows the elimination of blobs that are too short or too tall based on actual size.

Camera height (m): mounting height of the camera in meters.

Horizontal angle: cameras horizontal angle of view in degree. It is available on the data-sheet of a fixed focal cameras, to be calculated for varifocal cameras.

Vertical angle: cameras vertical angle of view in degree. It is available on the data-sheet of a fixed focal cameras, to be calculated for varifocal cameras.

Algorithm parameters (AI-SECURITY) only

Algorithm calibration

Algorithm calibration provides a collection of samples to train an algorithm that calculates the actual dimensions from those in pixels

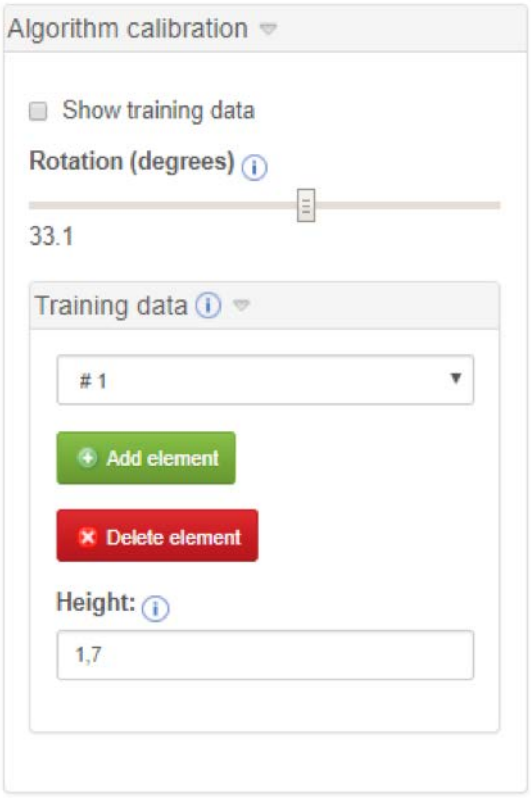


Fig. 19: Algorithm calibration (AI-SECURITY only)

This filter allows the elimination of blobs that are too short or too tall based on actual size.

Show training data: Check to show training data in the preview image.

Rotation (degrees): Camera rotation in reference to the horizontal plane.

Add element: ask a person of known height to move in different positions in the scene and at different distances from the camera. Drawing a rectangle around the person every time he stops.

Delete element: Click to delete the selected element.

Height (m): Height of the element in meters.

Shadow removal(AI-SECURITY only)

The algorithm for shadow removal is based on the analysis of the chromaticity difference between the background and the current frame, since the shadows typically make the pixels darker.

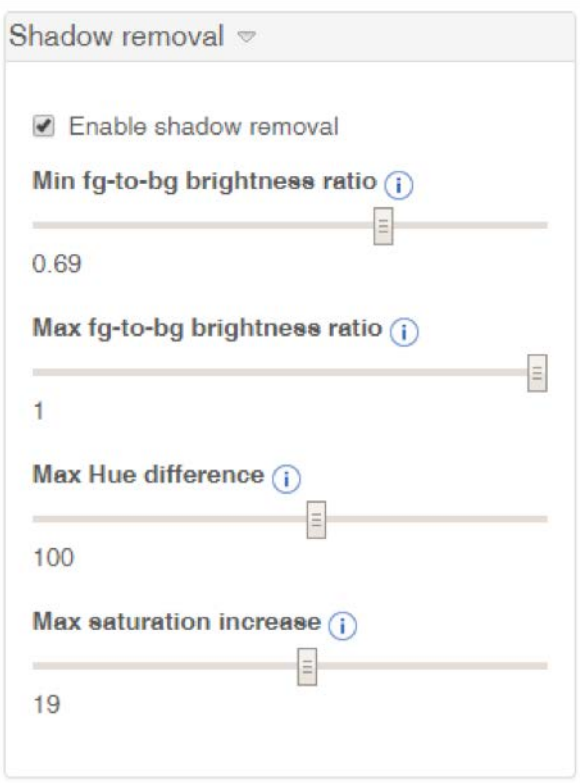


Fig. 20: Shadow removal (AI-SECURITY only)

Enable shadow removal: Check to activate the shadow removal settings.

Min fg-to-bg brightness ratio: Decreasing this value means the algorithm gets more sensitive.

Max fg-to-bg brightness ratio: Increasing this value means the algorithm gets more sensitive.

Max hue difference: Increasing this value means the algorithm gets more sensitive and therefore removes also strong shadows.

Max saturation increase: Increasing this value means the algorithm gets more sensitive and therefore removes also strong shadows.

Brightness control

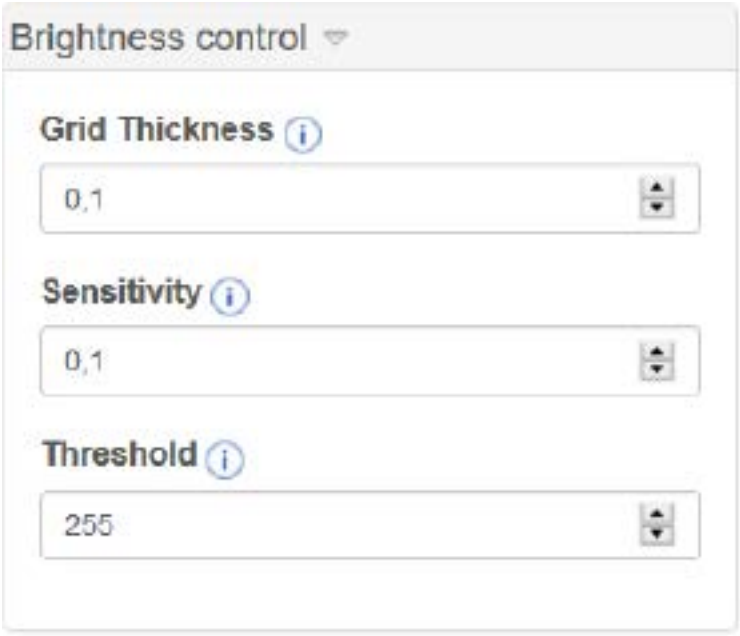


Fig. 21: Brightness control

When sudden changes in brightness occur in the scene, the difference between the current frame and the background instantly becomes very high, generating a lot of noise on the foreground mask. The detection of this abnormal situation allows application to stop for a few moments the processing, allowing the background to automatically adapt to the brightness of the scene change.

For efficiency reasons the algorithm works on a grid built on the image and evaluates the differences in brightness only in grid intersections.

Performance

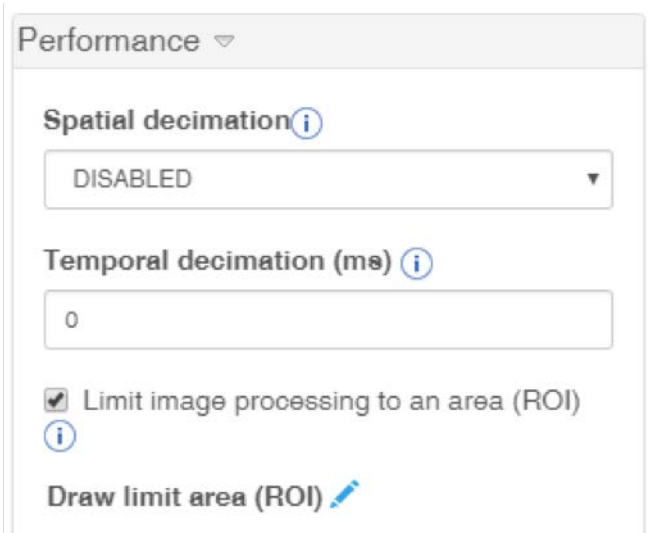


Fig. 22: Performance

Performance optimizations to make the algorithms more efficient.

Spatial decimation: consists in reducing the resolution at which the algorithm processes images. It is possible to reduce the size by a factor of 2 or 4, processing an image that is respectively a quarter or a sixteenth compared to the initial one.

Temporal decimation: allows to "discard" some frames, processing a picture every K milliseconds.

ROI: allows to perform the image processing only in the region drawn by the user.

Blob detection (AI-SECURITY only)

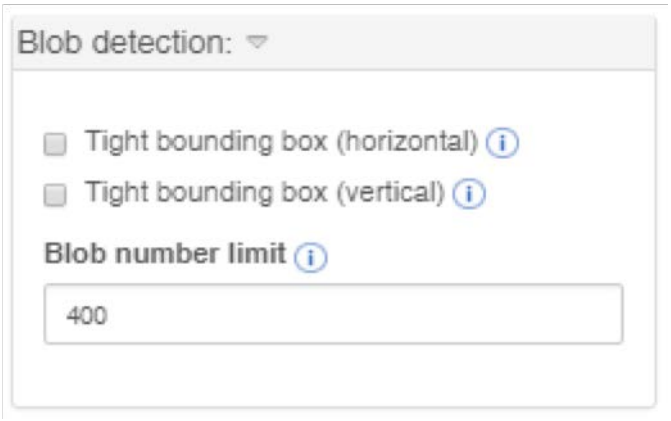


Fig. 23: Blob detection (AI-SECURITY) only

Tight bounding box (horizontal): consists in reducing the horizontal dimension of the bounding box by centering it with respect to the centroid.

Tight bounding box (vertical): consists in reducing the vertical dimension of the bounding box by centering it with respect to the centroid.

Blob number limit: allows to limit the number of blobs detected by the plug-in in a single frame.

Stream

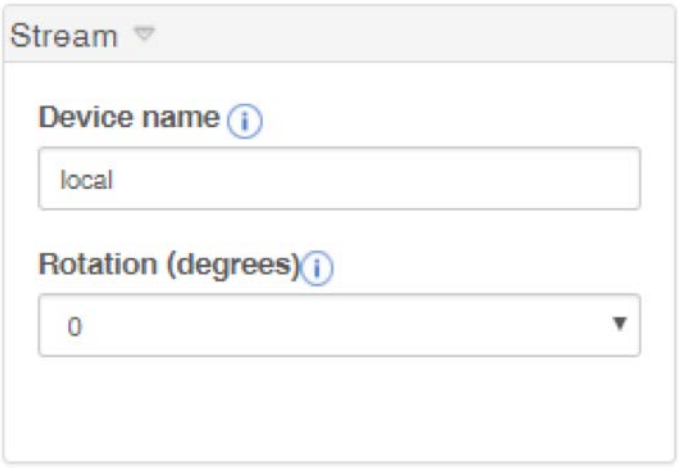


Fig. 24: Stream

Ability to process a rotated image compared to that acquired by the camera. This operation, however, it may be interesting in the case where, for example, you want to install a camera in portrait mode, so as to take advantage of the horizontal opening angle of the camera to frame a person standing.

Device name: change the name of the stream

Rotation (degrees): image can be rotated by 90 °, 180 ° and 270 °.

Event notification

All AI-Apps can notify each event simultaneously to multiple recipients. You can enable and configure each recipient in the specific section of the events panel.

You can also specify for each event the channel on which you want to be notified. In the configuration section it is possible to enable the sending of only the desired events. This way you can completely customize the events sending. You can choose which event to send for each channel.

AI-RETAIL Events

Counting event is generated every time a person crosses a people counting sensor. The event gives information about the number of persons which crossed the sensor simultaneously and related to the total number of crossings counted by the sensor since the last reset. It can be sent with and without images.

Aggregate event is generated when the number of persons (IN-OUT) is greater than a threshold configured by the user. Such event can be used as an alarm or like an advertisement of overcrowding, in case of a single entrance/exit gate. It can be sent with and without images.

Crowd event is generated periodically, with a period specified by the user during plug-in configuration, giving an estimation of the average number of persons in the considered period. Such event can be used for collecting statistics about the retail shop. It can be sent ONLY without images.

Overcrowd event is generated when the estimated number of persons in the sensor is greater than a threshold configured by the user. Such event can be used as an alarm or like an advertisement of overcrowding. It can be sent with and without images.

Test event is generated by the user, clicking on the specific button on AI-Config. It can be used to verify the communication with the event collectors.

AI-BIO Events

Bio event is generated when a person, which face has been detected, leaves the scene. The event gives information about the gender, the age category and the persistence time of each person in front of the camera. It can be sent with and without images.

Digital_Signage event is generated when persons are detected in front of the camera, after a minimum period of persistence. The event gives information about the average gender and age of the persons . It can be sent with and without images.

Test event is generated by the user, clicking on the specific button on AI-Config. It can be used to verify the communication with the event collectors.

AI-SECURITY Events

Sterile_Zone is generated when an intruder persists in a sterile zone. The event gives information about the position of the object which generated the alarm. It can be sent with and without images.

Crossing_Line eventis generated when an object crosses a line. The event gives information about the position of the object which generated the alarm. It can be sent with and without images.

Intrusion_Pro eventis generated when an object crosses a multiple line. The event gives information about the position of the object which generated the alarm. It can be sent with and without images.

Lost event is generated when an object is abandoned or removed in a lost sensor. The event gives information about the position of the object which generated the alarm. It can be sent with and without images.

Loitering event is generated when a loitering behavior is detected in a loitering sensor. The event gives information about the position of the object which generated the alarm. It can be sent with and without images.

Test event is generated by the user, clicking on the specific button on AI-Config. It can be used to verify the communication with the event collectors.

AI-TRAFFIC Events

Sterile_Zone is generated when an intruder persists in a sterile zone. The event gives information about the position of the object which generated the alarm. It can be sent with and without images.

Crossing_Line eventis generated when an object crosses a line. The event gives information about the position of the object which generated the alarm. It can be sent with and without images.

Intrusion_Pro eventis generated when an object crosses a multiple line. The event gives information about the position of the object which generated the alarm. It can be sent with and without images.

Lost event is generated when an object is abandoned or removed in a lost sensor. The event gives information about the position of the object which generated the alarm. It can be sent with and without images.

Loitering event is generated when a loitering behavior is detected in a loitering sensor. The event gives information about the position of the object which generated the alarm. It can be sent with and without images.

Test event event is generated by the user, clicking on the specific button on AI-Config. It can be used to verify the communication with the event collectors.

Image saving options

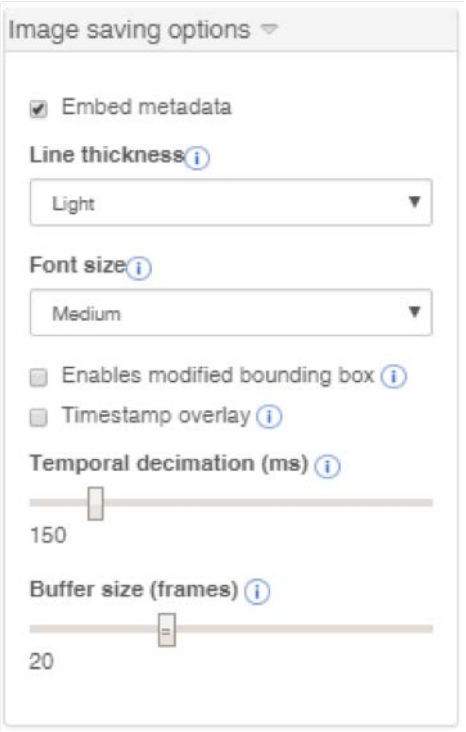


Fig. 25: Images saving options

Embed metadata:activate to enable the sending of annotated images (with sensors and bounding boxes for example) associated to the events.

Line thickness: specify the thickness of bounding boxes and the font size of the superimposed strings.

Font size: specify the font size of the superimposed strings.

Modified bounding box: when enabled a bounding box is drawn, which allows to observe the object orientation in the image.

Timestamp overlay: shows the date and hour overlay on the top right of the image.

Finally, since many event managers allows to send images in a time interval pre and post event, it is possible to specify the buffer size in frames and the time interval between consecutive frames saved in the buffer.

ATTENTION – The **buffer size** configuration and the **temporal decimation** with whom the frames are stored impose a limit on the number to PRE and POST seconds of images that can be associated to the events

Embedded AI-Dash

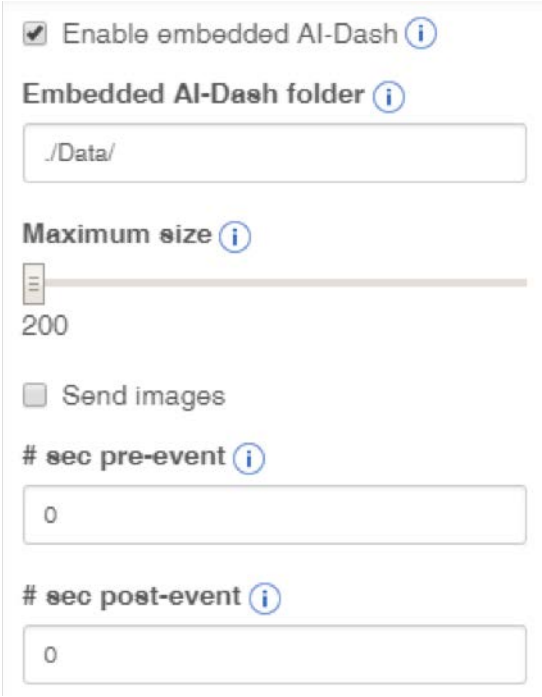


Fig. 26: Embedded AI-Dash

Enable AI-Dashboard embedded: activate to send events to AI-Dashboard embedded.

Embedded AI-Dash folder: folder in which theAI-Dashboard embedded database is created.

Maximum size:maximum size (in MB) that AI-Dashboard embedded can occupy on the device.

Send images: activate to send event images to AI-Dashboard embedded database

 # Sec pre-event: Number of seconds of images before event.

 # Sec post-event: Number of seconds of images after event.

External AI-Dash

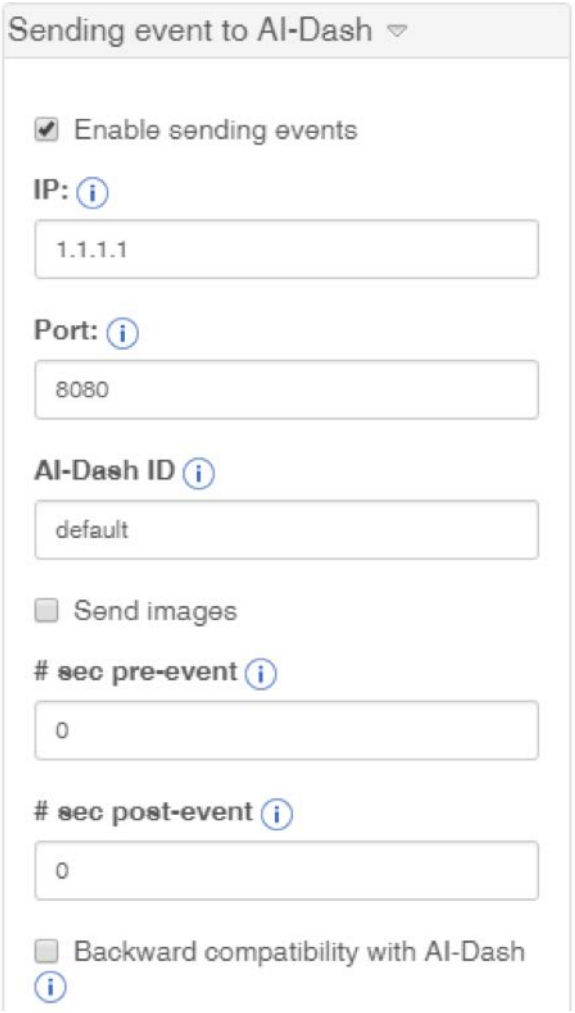


Fig. 27: External AI-Dash

Enable send sending events: activate to send events to external AI-Dash.

IP: IP address of the server on which AI-Dash is installed (both server version and a cloud version).

Port: Port on which AI-Dashlistens.

AI-Dash ID: Once created on AI-Dash PRO the identifier related to your site and company, you can insert it in this field. For more detail, please refer to the documentation of AI-Dash PRO.

Backward compatibility with AI-Dash: Enable this field if you have AI-Dash and not the new AI-Dash PRO (for more details please refer to the custom server notification in the following).

Send images: activate to send event images to AI-Dash database

 # Sec pre-event: Number of seconds of images before event.

 # Sec post-event: Number of seconds of images after event.

ATTENTION! To receive events, it may be necessary to disable the firewall

Wisenet WAVE

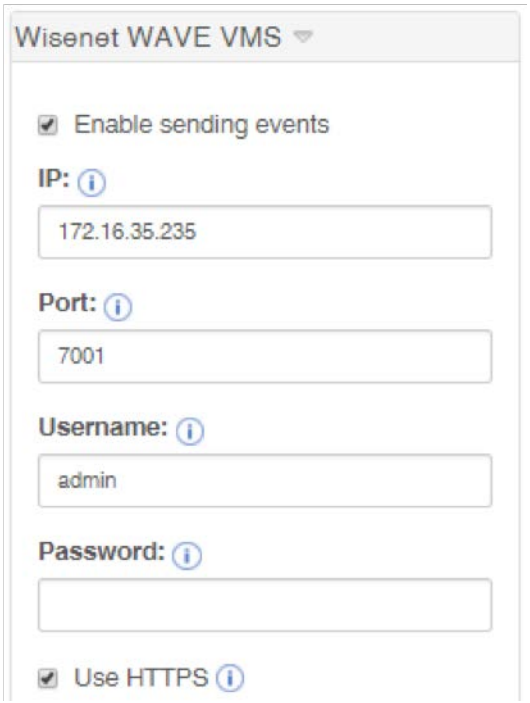


Fig. 28: Wisenet WAVE

Enable send sending events: activate to send events to Wisenet Wave.
IP: IP address of Wisenet WAVE VMS.
Port: Port number of the Wisenet WAVE VMS.
Username: Username to authenticate the Wisenet WAVE VMS.
Password: Password to authenticate to the Wisenet WAVE VMS.
Use HTTPS: activate to send events through https

The event sending to Wisenet WAVE is not supported for Crowd events

Hanwha SSM

Fig. 29: Hanwha SSM

Enable send sending events: activate to send events to Hanwha SSM.
IP: IP address of the server on which SSM is installed
Port: Port number of the SSM.
Device GUID: device identifier to read on SSM.
Set the server timezone:SSM server timezone.

The sending of events to Wisenet SSM is not supported for Crowd events.

Text Sender Configuration

This mechanism makes the app integrated with the Wisenet NVR.

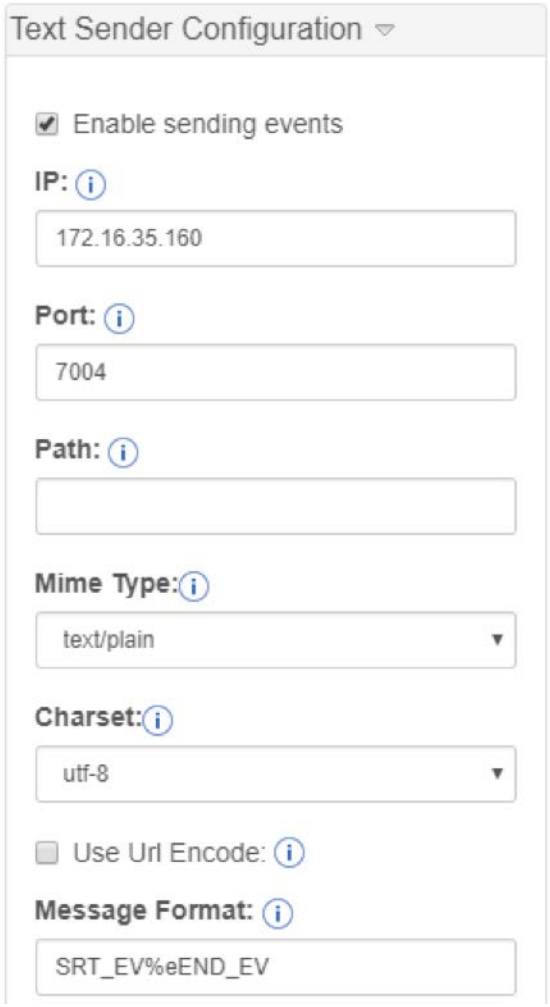


Fig. 30: Text sender configuration

Enable send sending events: activate to send events.
IP: IP address of the server on which AI-Dash is installed in both the server version and a cloud version.
Port: Port number.
Path: Path for the POST to the receiving server;.
MIME type: MIME Type with which the message will be transmitted.
Charset: Character set for the message text.
Use URL Encode: indicates that the message is encoded using URL Encode for sending.
Message Format: message text sent to the server. These placeholders can be used in the message text

- **event name:** %e
- **device name:** %d
- **sensor name:** %s
- **date:** %t (format DD / MM / YYYY

Use URL Encode: indicates that the message is encoded using URL Encode for sending.

Note
The sending of text events is not supported for Crowd events.

Digital output

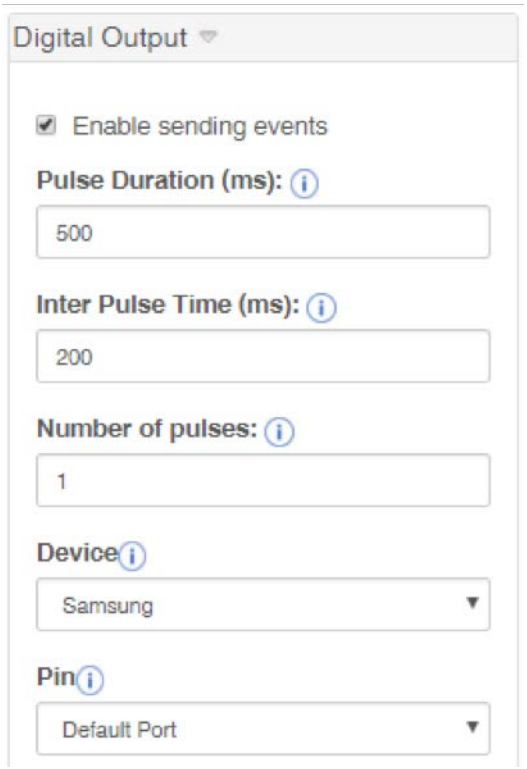


Fig. 31: Digital output

Enable send sending events: activate to send event via a digital output.
Single pulse duration (ms): duration of a single pulse in milliseconds.
Pulse Interval (ms): Time in ms between two pulses.
Number of pulses: Number of pulses sent through the alarm out port.
Device: Device on which the application is running.
Pin: Incoming port you want to use on the device.

Sending of events to digital inputs is not supported for Crowd events.

HTTP I/O

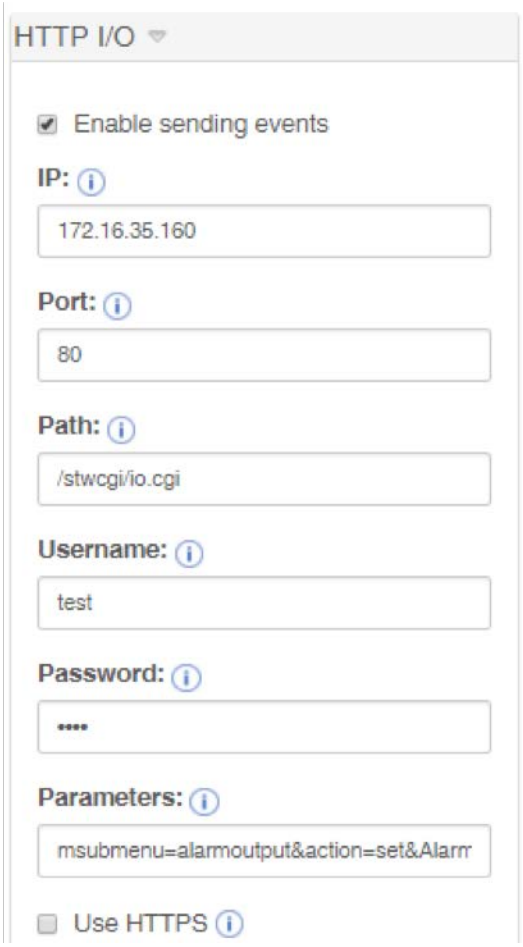


Fig. 32: HTTP I/O

Enable send sending events: activate to send event via generic I / O (for example to call the CGIs of the Wisenet NVR).

IP: IP address of the remote I / O.

Port: port on which is listening on the remote I / O.

Path: Path of the remote I / O.

Username: user name to connect to the remote I / O.

Password: Password to connect to the remote I / O.

Parameters: query string with all the required parameters. The format allows to add information about the event. It's necessary to add the following tags to the message

- **event name:** %e
- **device name:** %d
- **sensor name:** %s
- **date:** %t (format DD / MM / YYYY

Use HTTPS: : if checked, send through HTTPS.

example to set 10 seconds of duration of an alarm on the Hanwha NVR by using Hanwha SUNAPI: htt-
p://172.16.35.160/st-
wcgi/io.c-
gi?m-
sub-
menu-
u=alarmoutput&action=set&AlarmOutput.1.IdleState=NormallyOpen&AlarmOutput.1.ManualDuration=10s

Sending event to E-mail

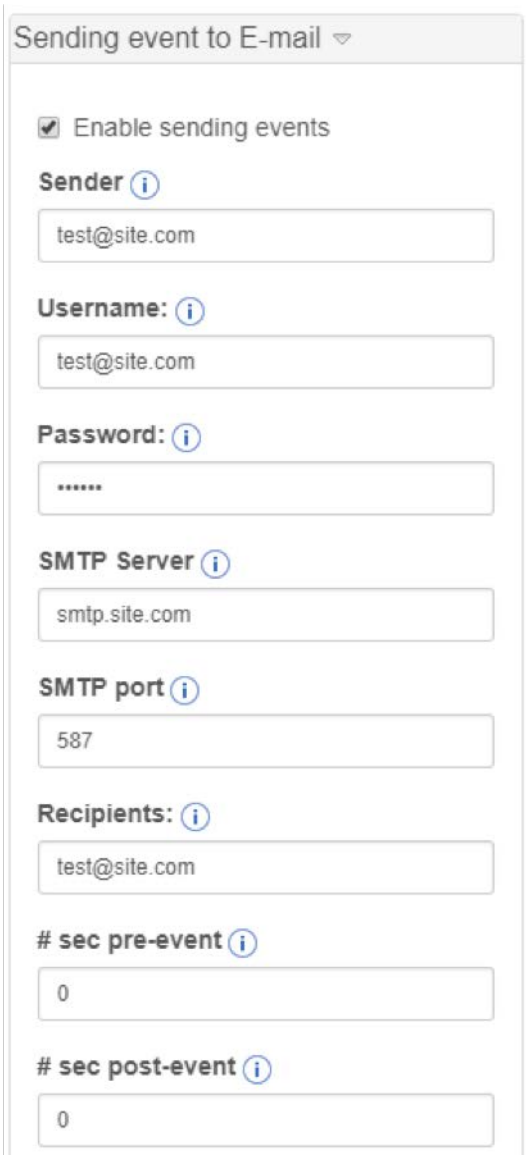


Fig. 33: Sending event to E-mail

Enable send sending events: activate to send event via email.
Sender: e-mail address of the sender.
Username:sender's user name for SMTP server access.

Password: sender's password for SMTP server access.
SMTP Server: address of the SMTP server.
SMTP port: port number of the SMTP server.
Recipients: You can enter multiple email addresses separated by a semicolon.
 # Sec pre-event: Number of seconds of images before event.
 # Sec post-event: Number of seconds of images after event.

The sending of events by e-mail is not supported for Crowd events

Sending event to Milestone

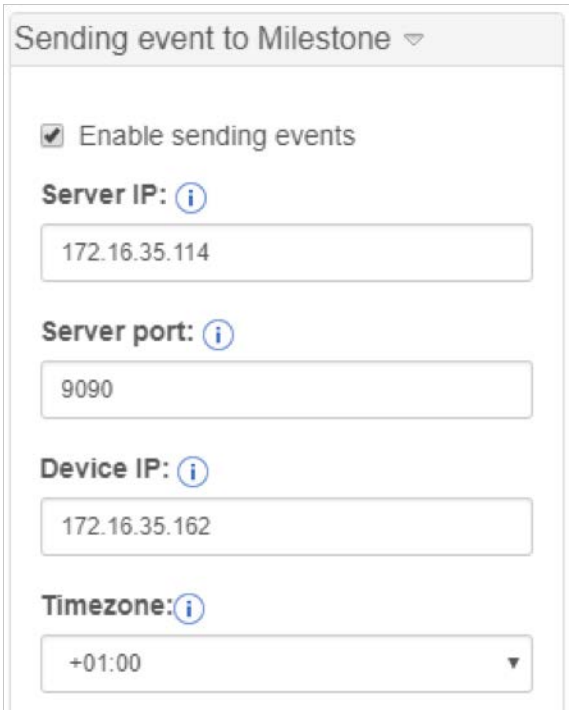


Fig. 34: Sending event to Milestone

Enable send sending events: activate to send event to Milestone XProtect®
Server IP: IP address of the server on which you installed Milestone XProtect®, both server version and a cloud version.
Server port: Port number to listen for Milestone XProtect® events.
Device IP: IP address of the device.
Timezone: Timezone of Milestone XProtect® servers.

Note
The sending of events to Milestone XProtect® is not supported for Crowd events.

Sending event to Arteco EVERYWHERE

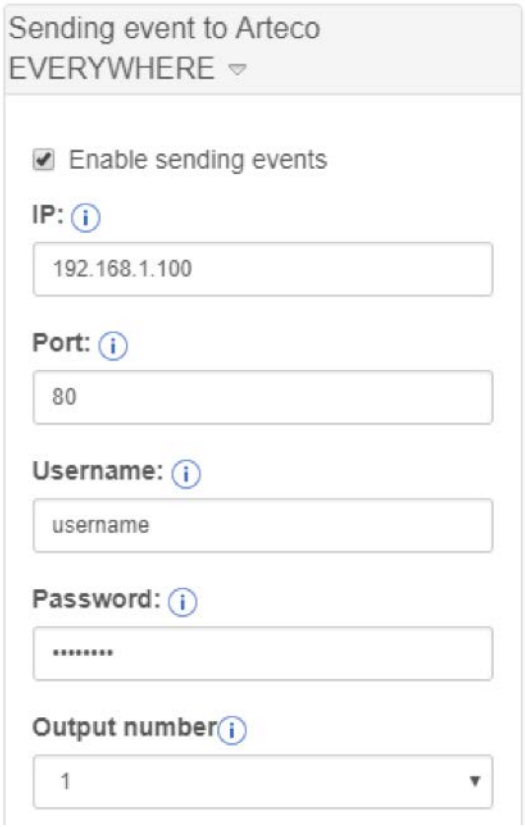


Fig. 35: Sending event to Arteco EVERYWHERE

Enable send sending events: activate to send event to Arteco EVERYWHERE.

IP: IP address of the server on which you installed Milestone Arteco EVERYWHERE, both server version and a cloud version.

Server port: Port number to listen for Arteco EVERYWHERE.

Username: Username for legion to Arteco EVERYWHERE server.

Password: Password for lo-gin to Arteco EVERYWHERE server.

Number of output: Output number associated with the event.

Note

The sending of events to Arteco EVERYWHERE is not supported for Crowd events.

Sending event to Arteco NEXT

Fig. 36: Sending event to Arteco NEXT

Enable send sending events: activate to send event to Arteco NEXT.

IP: IP address of the server on which you installed Milestone Arteco NEXT, both server version and a cloud version.

Server port: Port number to listen for Arteco NEXT server.

Username: Username for lo-gin to Arteco NEXT server.

Password: Password for lo-gin to Arteco NEXTserver.

Connector ID: Identification of the connector defined in Arteco NEXT for sending event notifications.

Camera ID: Identification of the camera defined in Arteco NEXT for sending event notifications.

Description: Information that will be displayed in Arteco NEXT related to the application of video analysis.

Note

The sending of events to Arteco NEXT is not supported for Crowd events.

Sending event to Avigilon POS

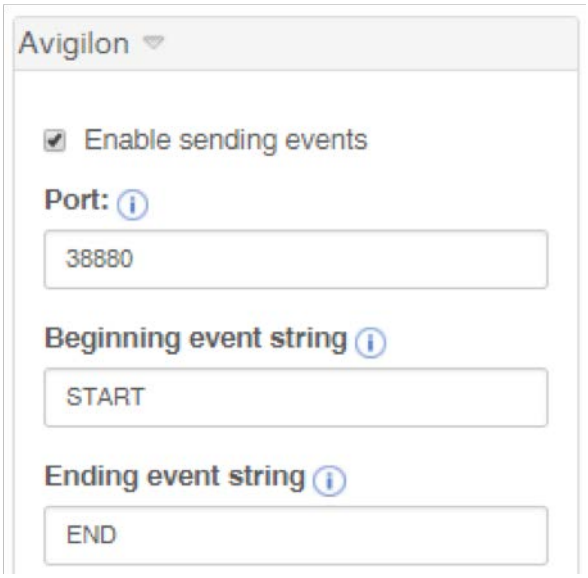


Fig. 37: Sending event to Avigilon POS

Enable send sending events: activate to send event to Avigilon POS.
Port: Port number on which the Avigilon server is listening.
Beginning event string: characters at the beginning of the event.
Ending event string: characters at the end of the event.

Note
The sending of events to Avigilon POS is not supported for Crowd events.

Sending event to FTP server

Fig. 38: Sending event to FTP server

Enable send sending events: activate to send event to a FTP server.
IP: IP address of the FTP server.
Port: port number of the FTP server.
Username: Username to authenticate to the FTP server.
Password: Password to authenticate to the FTP server.
Target Path: Path, defined from the root folder, FTP, to transfer the files to the server.
Send images: check to include images in the event sent.

Remote server

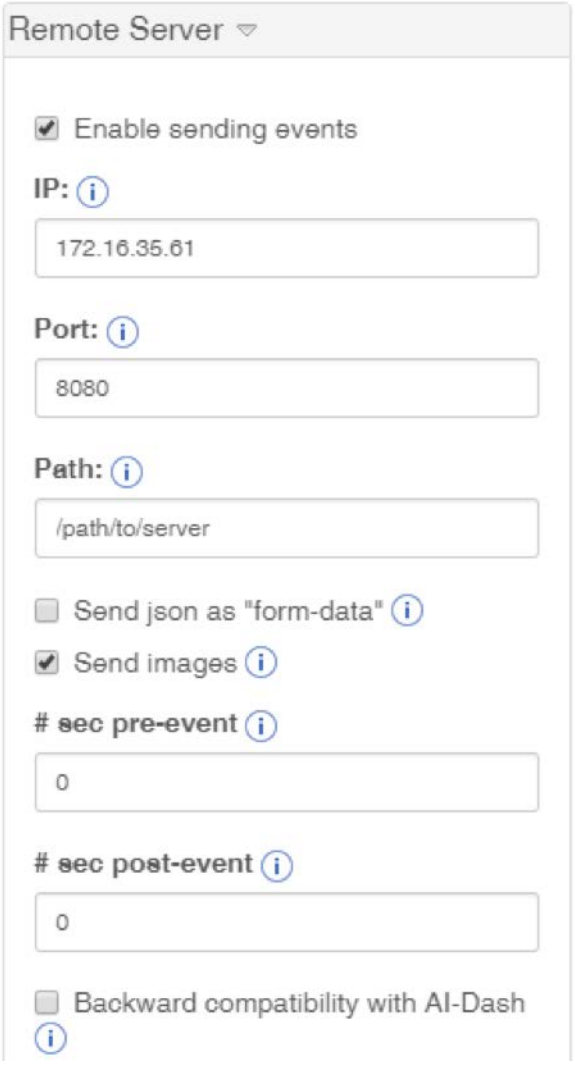


Fig. 39: Sending event to Remote server

Enable send sending events: activate to send event to remote server.

IP Server: IP address of the remote server.

Port: port number of the remote server.

Path: Path for the POST to the receiving server.

Send json as “form-data”: Enables url encoding for the message sent.

Send images: check to include images in the event sent.

 # Sec pre-event: Number of seconds of images before event.

 # Sec post-event: Number of seconds of images after event.

Backward compatibility with AI-Dash: Enable this field if you want to receive events compliant with AI-Dash and not the new AI-Dash PRO (for more details please refer to the custom server notification in the following).

Input by web request

The event notification triggering through web request event_switch.cgi is available for all applications on all platforms.

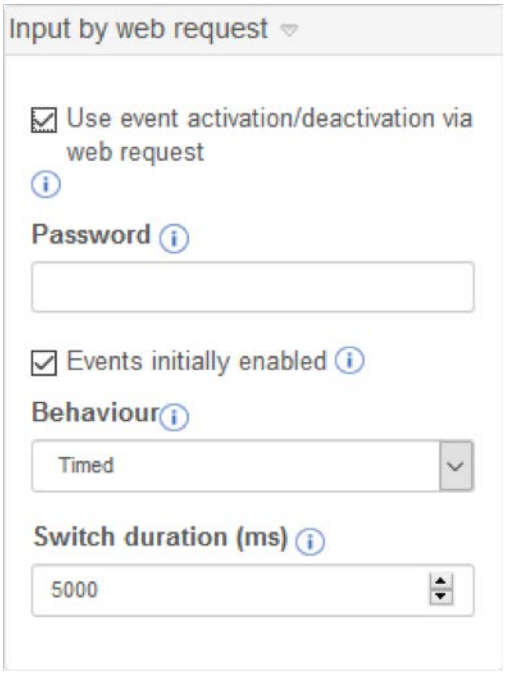


Fig. 40: Input by web request

Use event activation/deactivation via web request: activate to manage the input via web request.

Password: Required to avoid fraudulent activation/deactivation.

Events initially enabled: If enabled, the events are initially activated and in presence of web inputs are inhibited. Otherwise, events are initially inhibited and will be activated in presence of web inputs.

Behavior: Possible values are: timed or on/off. An on/off input enables/disables the sending of events on the rising edge. A time input enables / disables the sending of events for a certain time interval, specified by the "Switch duration" parameter.

EXAMPLE:
disable events (because they are initially enabled) on a device with ip 192.168.1.1 and password «foo». If the behavior is Timed, the events will be disabled for Switch duration ms
http://192.168.1.1:8080/local/AIRetail3/event_switch.cgi?mode=toggle&password=foo

HTTP request sequence

The plug-in also allows to send sequences of HTTP requests, interspersed with a configurable time interval. As an example, you may think to move a PTZ camera on different presets or create your custom sequence to drive remote I/O devices. It is possible to configure an unlimited number of requests in the sequence.

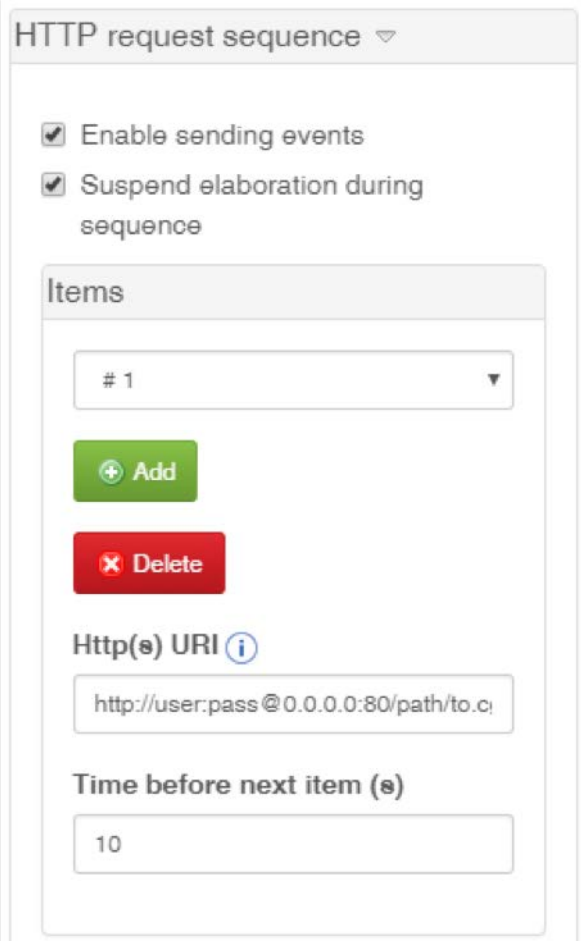


Fig. 41: HTTP request sequence

Enable sending events: activate to send events via HTTP request sequence.
Suspend elaboration during sequence: Enable it to suspend the elaboration during the sequence.
Http(s) URI: The path of the HTTP(s) request.
Time before next item (s): Time interval in seconds to call the next request in the sequence.

Custom server compliant event notification

Custom server compliant with AI-Dash

Events without images: POST with application/json

```
POST /pathOnServer HTTP/1.1

Accept: application/json

Host: 172.16.35.75:8080
```

```
Content-Type: application/json

Content-Length: 157

json_data:{"id_source": " people_sensor", "sensor_id": 4, "sensor_name":
"S1", "event_type": "Counting", "mac_address": "b827ebc42838", "timestamp":
1510761996, "actual_count": 35, "people_number": 1, "dash_id": "Site#Com-
pany"}
```

Events with images: POST with custom multipart/x-mixed-replace

```
POST /pathOnServer HTTP/1.1

Accept: */*

Host: 172.16.35.75:8080

Content-length: 3844500

Content-Type: multipart/x-mixed-replace; boundary=gc0p4Jq0M2Yt08jU534c0p


--gc0p4Jq0M2Yt08jU534c0p

Content-Type: application/json

Content-Length: 157


{"id_source": " people_sensor", "sensor_id": 4, "sensor_name": "S1",
"event_type": "Counting", "mac_address": "b827ebc42838", "timestamp":
1510761996, "actual_count": 35, "people_number": 1, "dash_id": "Site#Com-
pany"}


--gc0p4Jq0M2Yt08jU534c0p

Content-Type: image/jpeg

Content-length: 11146


JPEG DATA

…
```

Custom server compliant with AI-Dash PRO

Events without images: POST with application/json

```
POST /pathOnServer HTTP/1.1

Accept: application/json

Host: 172.16.35.75:8080

Content-Type: application/json

Content-Length: 157

{"id_source": " people_sensor", "sensor_id": 4, "sensor_name": "S1",
"event_type": "Counting", "mac_address": "b827ebc42838", "timestamp":
1510761996, "actual_count": 35, "people_number": 1, "dash_id": "Site#Com-
pany"}
```

The headers are case insensitive as stated in HTTP standard. The number of images is variable. This value will be different based on images and event size. Note that the transfer encoding is set to chunked: HTTP 1.1 support is required. On the raw socket each chunk will follow a row with the number of bytes and followed by a new row.
See https://tools.ietf.org/html/rfc7230#section-4.1 for details on chunked encoding.
See https://www.w3.org/Protocols/rfc1341/7_2_Multipart.html for details on multipart/mixed content type.

Events with images: POST with custom multipart/x-mixed-replace

```
POST /www/prova.php

HTTP/1.1Host: 172.16.35.28:80

Accept: tex-
t/html,app-
lication/json,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8

User-agent: axia_http_client/2.6.1

Content-Type: multipart/mixed;boundary=gc0p4Jq0M2Yt08jU534c0p

Transfer-encoding: chunked


--gc0p4Jq0M2Yt08jU534c0p
```

```
Content-Disposition: form-data;

name="json"

Content-Type: application/json

Content-Length: 157


{"id_source": " people_sensor", "sensor_id": 4, "sensor_name": "S1",
"event_type": "Counting", "mac_address": "b827ebc42838", "timestamp":
1510761996, "actual_count": 35, "people_number": 1, "dash_id": "Site#Com-
pany"}

--gc0p4Jq0M2Yt08jU534c0p

Content-Disposition: form-data;

name="jpeg"

Content-Type: image/jpeg

Content-length: 60155

################## BINARY JPEG DATA (60155 bytes total) ##################

--gc0p4Jq0M2Yt08jU534c0p--
```

Custom server –JSON event format

JSON field	Value type	Description	Type of events
id_source	string	Name of the device, specified in the plug-in configuration	All
event_ type	string	Type of event. It can assume values: Counting, Aggregate, Crowd, Overcrowd	All
timestamp	string	Value which represents the number of seconds passed since 00:00 of the 1st January 1970 UTC (for instance, a Unix timestamp)	All
sensor_id	integer	Id associated to the sensor which generated the event	All
sensor_ name	string	Name associated to the sensor which generated the event	All
mac_ address	string	MAC address of the device that generated the event	All
dash_id	string	An identifier of the site and the company, specified in the plug-in configuration	All

JSON field	Value type	Description	Type of events
people_number	integer	For Counting events, represents the number of persons crossing simultaneously the sensor. For Aggregate events, represents the current IN-OUT value. For Crowd and Overcrowd events, represents the number of estimated persons in the sensor.	All
actual_count	integer	For Counting events, represents the total number of persons counted by the sensor since the last reset. For Aggregate events, represents the current IN-OUT value.	Counting, Aggregate
period	integer	For Crowd events, interval between two consecutive events	Crowd

AI-Dash - troubleshooting

In case of low bandwidth (e. g. because of huge network-load or undersized systems) or the camera is overloaded, the live screen may be loading slowly or not to show live. In addition, some browsers may activate filters that block streaming by default (usually Chrome, Firefox and Safari do not have locks).
In these cases:

- Reloading the page and wait for the live image
- Use a different web-browser

If image is displayed is green try to perform the following operations:

- Restart the camera, or alternatively reset to the initial settings (except those related to the application);
- Verify that the latest firmware is installed on the camera
- Contact technical support (see Support, p. 5)

5

AI-SECURITY

AI-SECURITY is a bundle including three different products, simultaneously installed on board of your camera.

- **AI-INTRUSION**: Intrusion detection in sterile zone and virtual line crossing
- **AI-LOST**: Abandoned or removed objects detection
- **AI-LOITERING**: Loitering detection in forbidden areas

AI-SECURITY - camera positions

- Make sure the size of the target (person, object, animal, vehicle) is at least 10x10 pixels.
- If necessary, the camera should be mounted with external illuminators, to distinguish the targets with natural or artificial illumination.
- The camera should be mounted at a height between 3 and 5 meters
- The precision of the plug-ins can be reduced if there are occlusions, waving objects, vehicles which project light in interest areas and any other noise that continuously modifies the image

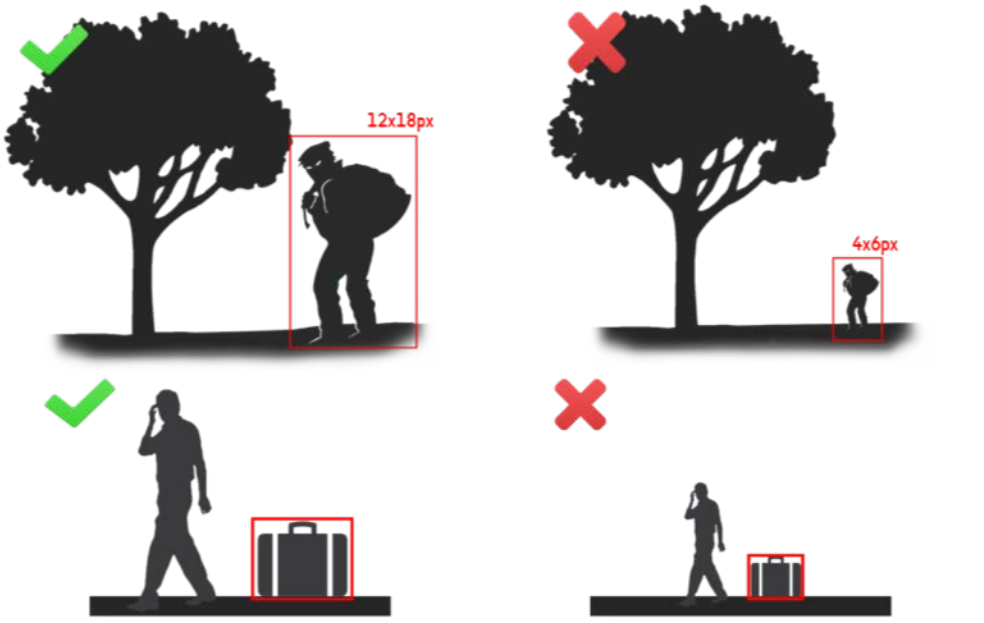


Fig. 42: Camera positions

AI-INTRUSION

AI-INTRUSION is a video analytic app that is able to detect intruders in indoor and outdoor environments; thus, the environmental conditions will affect the performance of the application.

The accuracy to be expected is under ideal environmental and installation conditions

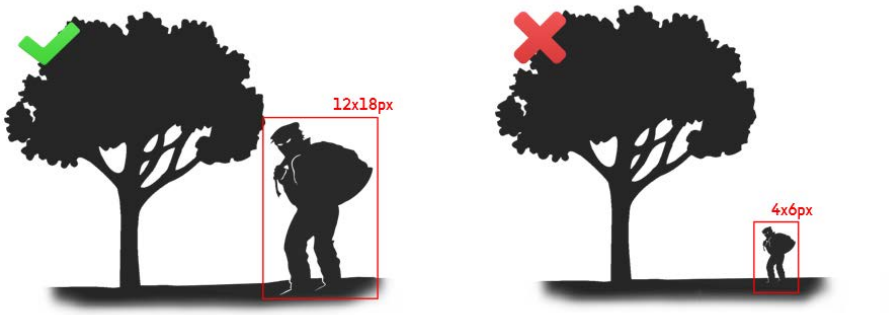
- Recall: 95%

AI-INTRUSION

Environment conditions

The position of the camera and the environmental conditions affect the performance of the application. Performance is best under the following conditions:

- The image must not present flickering, severe noise or artifacts.
- Image must have a resolution of 640x360, 640x480, 320x180, 320x240.
- Rotating (PTZ) security cameras are supported only if they are not moved when the application is enabled. If the camera is moved, the application must be reconfigured.
- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.
- Absence of conditions of high crowding or stopped people that do not allow to count the individuals.
- Absence of stationary or slow-moving people for long periods in the counting area (e.g. Sales people that encourage customers to enter).
- There must be no fog, clouds or other moving objects whose appearance is similar to the target in the areas of interest.
- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Absence of "waving objects" (e.g. Meadow with tall grass, trees, sliding doors, etc.) or any other type of disturbance that causes the continuous modification of the images (moving pixels) in the areas of interest.
- Camera placement must be stable and solid in a way that wind or external disturbances of other types will not cause movement of the camera that appears on the image.
- Absence of vehicles with lights projected in areas of interest.
- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image. If necessary, the camera must be installed with external illuminators that make it possible to distinguish the people in all natural or artificial lighting conditions.
- The people must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the people are similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.
- The target must stay in the interested area for a time of at least 1 second.
  The target must have a minimum area of 100 pixels.
- The target must move at a maximum speed of half their width on the image per frame. For example, a target that is 40 pixels wide at 10 frames per second must move at a speed of no more than 20 pixels per frame, that is 200 pixel per second.
- The scene must be predominantly non-reflective.
- No hard lights must be present that cast shadows in a way that the background brightness is reduced to less than 50% of the original value in the image.
- In case of thermal cameras, the image must be not colored but in grayscale (white for “hot” pixels, black for “cold” pixels). The camera, thermal or monocular, must be always configured in order to avoid continuous changes of brightness.



AI-INTRUSION - target size

Intrusion sensors

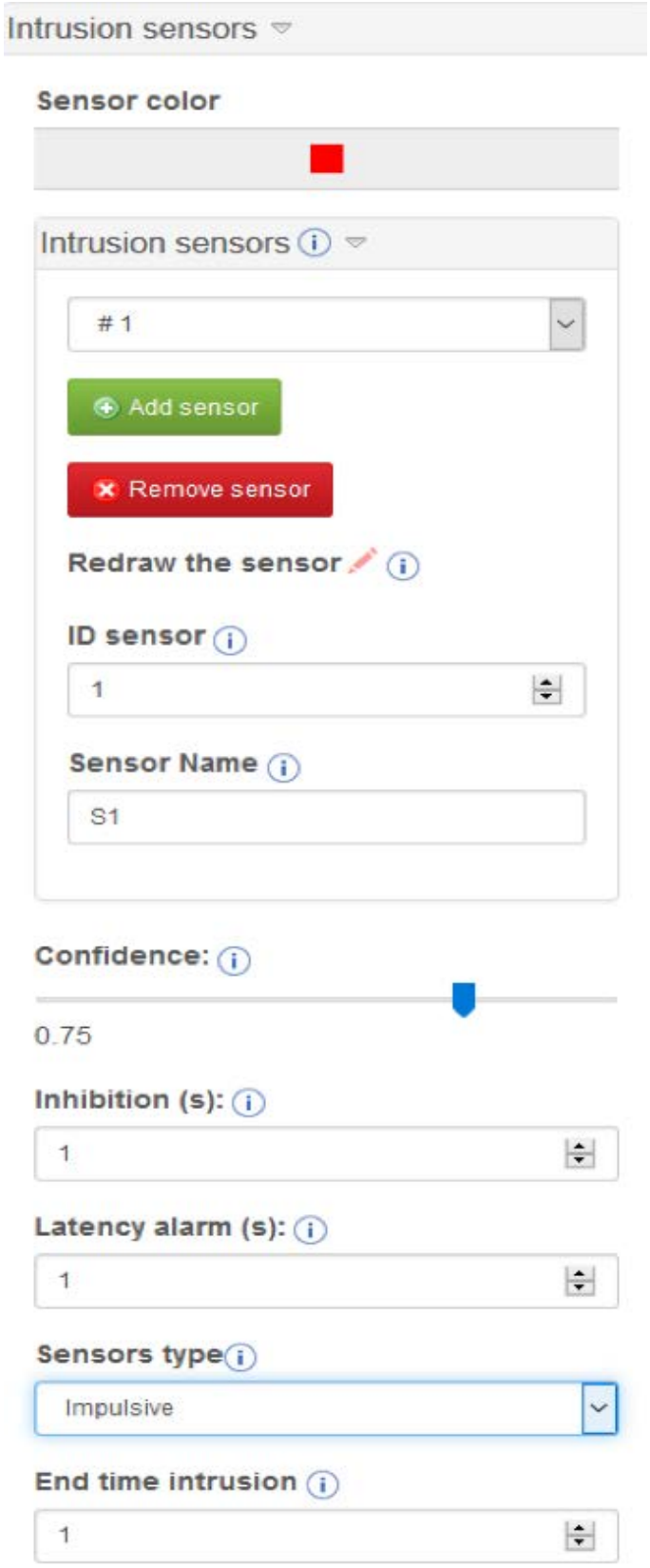


Fig. 43: Configuration of AI-INTRUSION Intrusion sensors

The configuration section provides the following functions:

Add Sensor: Click this button to draw the area of interest directly on the live image on the left. The area of interest it's a polygon with no limits to the number of sides.

Remove sensor: Click this button to remove the selected sensor from the configuration.

Redraw sensor: Click this button to redraw the current sensor. The current area of interest will be deleted.

ID sensor: define a numeric ID for the sensor.

Sensor name: this name uniquely identifies the main counting sensor (green arrow); is used to generate counting events, sent, for example, to AI-Dash.

Confidence: A small value will make the algorithm very sensitive, instead with a value too large the algorithm could not generate the alarms.

Inhibition (s): Inhibition time in seconds of the sensor after an alarm has been generated. If an alarm is generated by the same sensor before the inhibition time is passed, it will be ignored by the system.

Latency alarm (s): Minimum intrusion time (seconds of permanence in the area of interest) before an alarm is generate. Time in seconds. Subjects who stay in the area of interest for less time than the set latency, won't generate any alarm.

Sensor type: there are two types of sensors:

- **Impulsive:** generates a single event for the whole duration of the intrusion.
- **Levels:** generates several types of event: beginning of the intrusion, intrusion continuation (every "Inhibition" seconds) and end of intrusion.

End time intrusion: after this amount of seconds, if none is in the level sensor, an event of "end of intrusion" will be sent.

Crossing the line

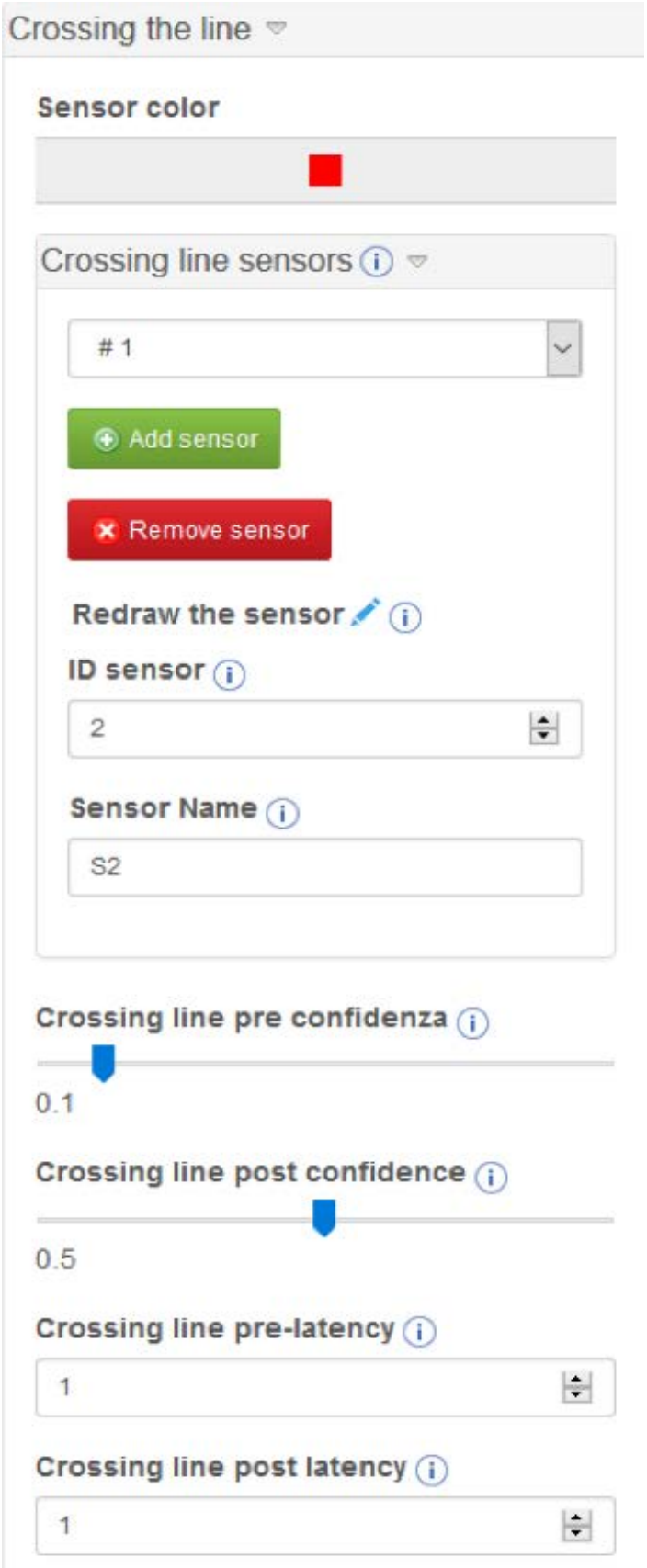


Fig. 44: Configuration of AI-INTRUSION Crossing line sensors

The configuration section provides the following functions:

Add Sensor: Click this button to draw the area of interest directly on the live image on the left. The area of interest it's a polygon with no limits to the number of sides.

Remove sensor: Click this button to remove the selected sensor from the configuration.

Redraw sensor: Click this button to redraw the current sensor. The current area of interest will be deleted.

ID sensor: define a numeric ID for the sensor.

Sensor name: this name uniquely identifies the sensor, it is used to generate events to be sent for example to AI-Dash.

Crossing line pre confidence: confidence relative to the object before it crosses the line (pre alarm).

Crossing line post confidence: confidence relative to the activation of the alarm (crossing the line) on a object already considered in a pre-alarm state.

Crossing line pre latency: time of latency of an object that is in the scene before it crosses the line (pre-alarm). Time in seconds.

Crossing line post latency: time of latency of an object already considered in pre-alarm state that it spends in the scene after it crosses the line. Time in seconds.

Multiple crossing lines

A multiple crossing line sensor is an aggregate sensor inside the scene consisting of a set of crossing lines (see Crossing the line, p. 55). If the subject crosses all the lines specified in the scene, the alarm will be generated.

Fig. 45: Configuration of AI-INTRUSION - Multiple crossing line sensors

The configuration section provides the following functions:

Add aggregate sensor: Click this button to draw the area of interest directly on the live image on the left. The area of interest it's a polygon with no limits to the number of sides. The aggregate sensor can contain multiple crossing lines.

Remove aggregate sensor: Click this button to remove the selected aggregate sensor from the configuration.

ID sensor: define a numeric ID for the aggregate sensor.

Sensor name: this name uniquely identifies the aggregate sensor, it is used to generate events to be sent for example to AI-Dash.

Crossing time (s): maximum crossing time in seconds between two successive crossing lines.

It is required to add crossing line sensors within the aggregate sensor (See Crossing the line, p. 55).

AI-LOITERING

AI-LOITERING is a video analytic app that is able to detect loitering in indoor and outdoor environments; thus, the environmental conditions will affect the performance of the application, FTP servers and third party servers.

The accuracy to be expected is under ideal environmental and installation conditions

- Recall: 95%

Fig. 46: AI-LOITERING: configuration

Environment conditions

The position of the camera and the environmental conditions affect the performance of the application. Performance is best under the following conditions:

- The image must not present flickering, severe noise or artifacts.
- Image must have a resolution of 640x360, 640x480, 320x180, 320x240.

- Rotating (PTZ) security cameras are supported only if they are not moved when the application is enabled. If the camera is moved, the application must be reconfigured.
- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.
- Absence of conditions of high crowding or stopped people that do not allow to count the individuals.
- There must be no fog, clouds or other moving objects whose appearance is similar to the target in the areas of interest.
- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Absence of "waving objects" (e.g. Meadow with tall grass, trees, sliding doors, etc.) or any other type of disturbance that causes the continuous modification of the images (moving pixels) in the areas of interest.
- Camera placement must be stable and solid in a way that wind or external disturbances of other types will not cause movement of the camera that appears on the image
- Absence of vehicles with lights projected in areas of interest.
- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image. If necessary, the camera must be installed with external illuminators that make it possible to distinguish the people in all natural or artificial lighting conditions.
- The target must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the target is similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.
- The target must stay in the interested area for a time of at least 5 seconds.
- The target must have a minimum area of 100 pixels.
- The target must move at a maximum speed of half their width on the image per frame. For example, a target that is 40 pixels wide at 10 frames per second must move at a speed of no more than 20 pixels per frame, that is 200 pixel per second.
- The scene must be predominantly non-reflective.
- No hard lights must be present that cast shadows in a way that the background brightness is reduced to less than 50% of the original value in the image.
- In case of thermal cameras, the image must be not colored but in grayscale (white for “hot” pixels, black for “cold” pixels). The camera, thermal or monocular, must be always configured in order to avoid continuous changes of brightness.

Installation constraints

A camera that can be used to detect loitering with AI-LOITERING must comply with the following installation restrictions (in addition to the respect of the environmental conditions):

- It must be installed in such a way that the framed targets (people, vehicles, animals) have a minimum area of 100 pixels.

- If necessary, it must be installed with external illuminators that make it possible to distinguish the targets in all natural or artificial lighting conditions.

Configuration of AI-LOITERING sensors

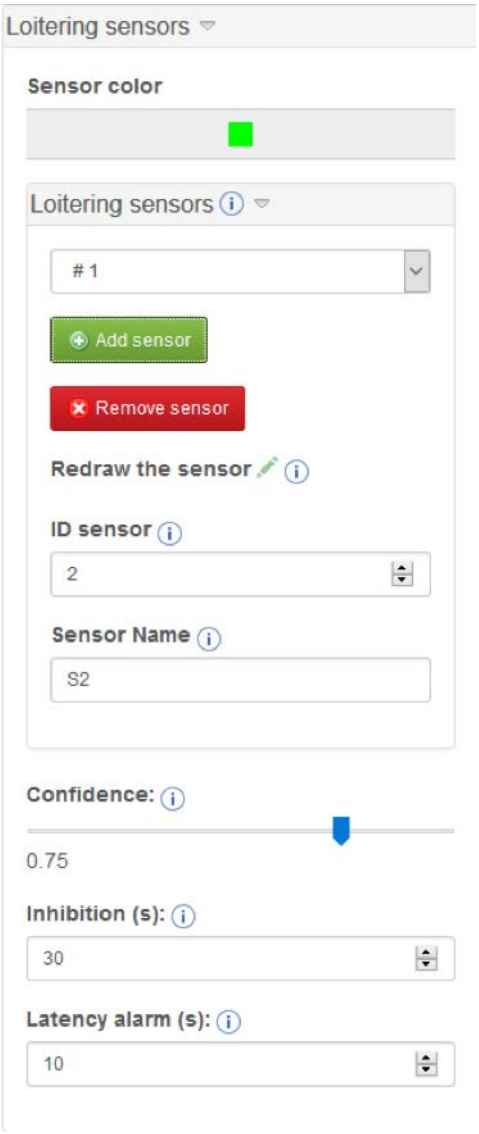


Fig. 47: Configuration of AI-LOITERING sensors

The configuration section provides the following functions:

Add Sensor: Click this button to draw the area of interest directly on the live image on the left. The area of interest it's a polygon with no limits to the number of sides.

Remove sensor: Click this button to remove the selected sensor from the configuration.

Redraw the sensor: Click to delete the current sensor and draw a new one.

ID sensor: define an ID number for the sensor.

Sensor name: this name uniquely identifies the sensor.

Confidence: A small value will make the algorithm very sensitive, instead with a value too large the algorithm could not generate the alarms.

Inhibition (s): Inhibition time in seconds of the sensor after an alarm has been generated. If an alarm is generated by the same sensor before the inhibition time is passed, it will be ignored by the system.

Latency alarm (s): Minimum intrusion time (seconds of permanence in the area of interest) before an alarm is generate. Time in seconds. Subjects who stay in the area of interest for less time than the set latency, won't generate any alarm.

AI-LOST

AI-LOST is a video analytic app that is able to detect abandoned or removed objects in indoor and outdoor environments; thus, the environmental conditions will affect the performance of the application.

The accuracy to be expected is under ideal environmental and installation conditions

- Recall: 90%

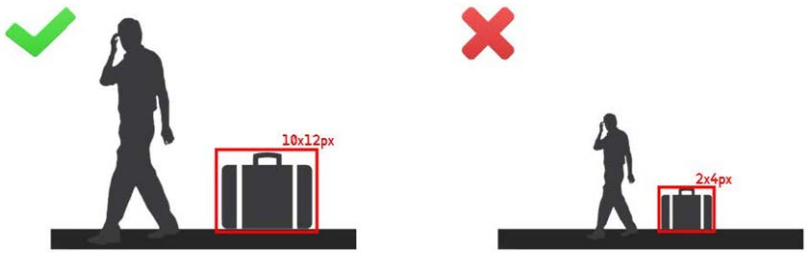
Fig. 48: AI-LOST: configuration

Environment conditions

The position of the camera and the environmental conditions affect the performance of the application. Performance is best under the following conditions:

- The image must not present flickering, severe noise or artifacts.
- Image must have a resolution of 640x360, 640x480, 320x180, 320x240.
- Rotating (PTZ) security cameras are supported only if they are not moved when the application is enabled. If the camera is moved, the application must be reconfigured.
- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.
- Absence of conditions of high crowding or stopped people that do not allow to count the individuals.
- There must be no fog, clouds or other moving objects whose appearance is similar to the target in the areas of interest.

- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Absence of "waving objects" (e.g. Meadow with tall grass, trees, sliding doors, etc.) or any other type of disturbance that causes the continuous modification of the images (moving pixels) in the areas of interest.
- Camera placement must be stable and solid in a way that wind or external disturbances of other types will not cause movement of the camera that appears on the image
- Absence of vehicles with lights projected in areas of interest.
- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image. If necessary, the camera must be installed with external illuminators that make it possible to distinguish the people in all natural or artificial lighting conditions.
- The target must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the target is similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.
- The target must stay in the interested area for a time of at least 5 seconds.
- The target must have a minimum area of 100 pixels.
- The target must move at a maximum speed of half their width on the image per frame. For example, a target that is 40 pixels wide at 10 frames per second must move at a speed of no more than 20 pixels per frame, that is 200 pixel per second.
- The scene must be predominantly non-reflective.
- No hard lights must be present that cast shadows in a way that the background brightness is reduced to less than 50% of the original value in the image.
- In case of thermal cameras, the image must be not colored but in grayscale (white for “hot” pixels, black for “cold” pixels). The camera, thermal or monocular, must be always configured in order to avoid continuous changes of brightness.



AI-LOST - target size

Installation constraints

A camera that can be used to detect loitering with AI-LOITERING must comply with the following installation restrictions (in addition to the respect of the environmental conditions):

- It must be installed in such a way that the framed targets (people, vehicles, animals) have a minimum area of 100 pixels.
- If necessary, it must be installed with external illuminators that make it possible to distinguish the targets in all natural or artificial lighting conditions.

Configuration of AI-LOST sensors

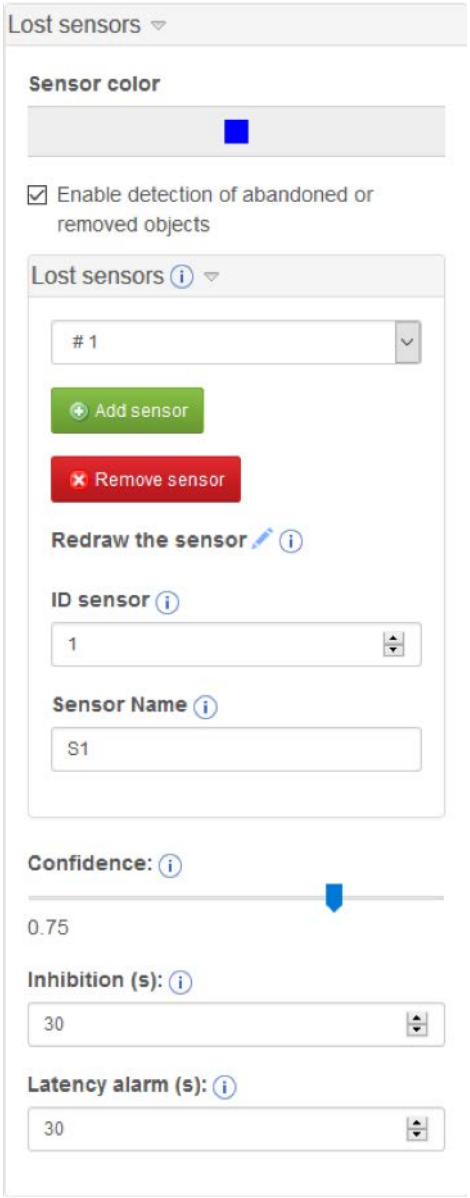


Fig. 49: Configuration of AI-LOST sensors

The configuration section provides the following functions:

Add Sensor: Click this button to draw the area of interest directly on the live image on the left. The area of interest it's a polygon with no limits to the number of sides.

Remove sensor: Click this button to remove the selected sensor from the configuration.

Redraw the sensor: Click to delete the current sensor and draw a new one.

ID sensor: define an ID number for the sensor.

Sensor name: this name uniquely identifies the sensor.

Confidence: A small value will make the algorithm very sensitive, instead with a value too large the algorithm could not generate the alarms.

Inhibition (s): Inhibition time in seconds of the sensor after an alarm has been generated. If an alarm is generated by the same sensor before the inhibition time is passed, it will be ignored by the system.

Latency alarm (s): Minimum intrusion time (seconds of permanence in the area of interest) before an alarm is generate. Time in seconds. Subjects who stay in the area of interest for less time than the set latency, won't generate any alarm.

Configuration of AI-LOST Entrance areas

In order to reduce the number of false positives and to consider only the objects which enters from specific parts of the image, it is possible to draw an unlimited number of entrance areas.

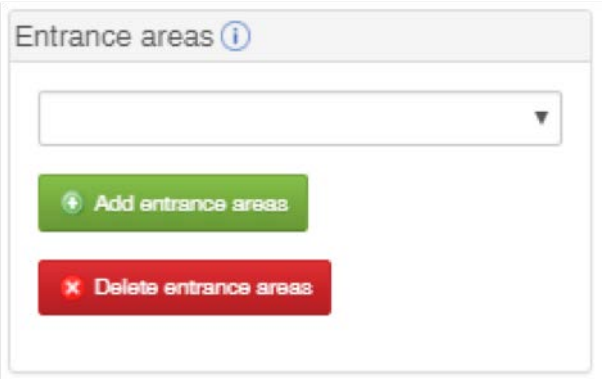


Fig. 50: Configuration of AI-LOST entrance areas

The configuration section provides the following functions:

Add entrance area: Click this button to draw an entrance area of directly on the live image on the left. The entrance area is a polygon with no limits to the number of sides.

Delete entrance area: Click this button to remove the selected entrance area from the configuration.

AI-CROWD-DEEP

AI-CROWD-DEEP is the video analysis plug in based on deep neural networks, that allows to analyze the people in an area, even in very crowded situations. The solution, not being based on the analysis of the movement, does not suffer from disturbances due to the movement of the camera that takes the scene.

AI-CROWD-DEEP

AI-CROWD-DEEP is the video analysis plug in based on deep neural networks, that allows to analyze the people in an area, even in very crowded situations. The solution, not being based on the analysis of the movement, does not suffer from disturbances due to the movement of the camera that takes the scene.

AI-CROWD-DEEP allows to estimate the number of people in an area, generate an alarm when a threshold is exceeded, as well as generate an alarm if social distancing between people is not respected.

The app can be used in indoor environments, for example in retail or business intelligence, but also in outdoor environments, for example in smart cities or in transportation.

The accuracy to be expected is 90% under ideal environmental and installation conditions.

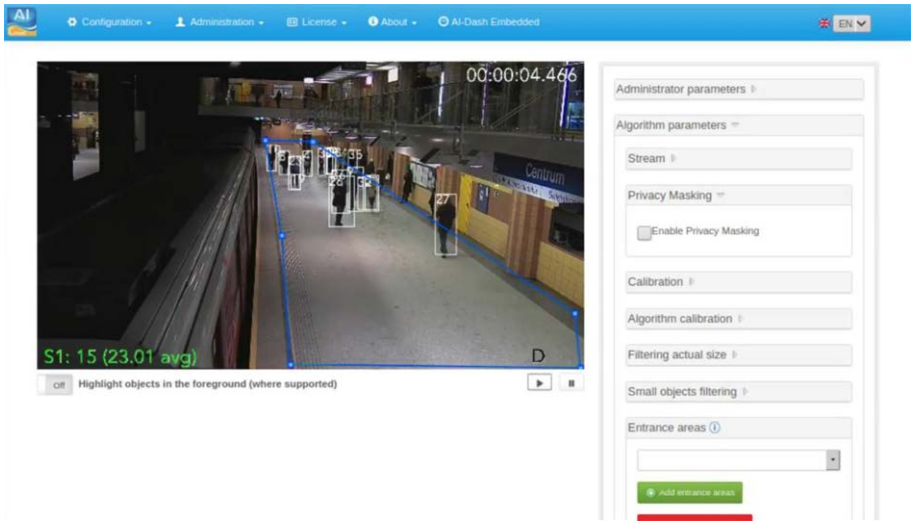


Fig. 51: AI-CROWD-DEEP: configuration

Environment conditions

AI-CROWD-DEEP is a video analytic plug in optimized to estimate the number of persons inside one or more areas of interest in typical retail scenarios, as well as smart cities and transportation or security and safety. The correct positioning of the camera and the environmental conditions represent two factors that affects the performance of the application.

- The image must not present flickering, severe noise or artifacts.
- The image must have a minimum resolution of 512 x 288 px.

- A person must have a minimum height of 30 pixels.
- A persons height must be at least 1/10 of the image height.
- The image must be in landscape orientation with 16:9 aspect ratio.
- The camera is fixed. Rotating security cameras are not supported for social distance analysis and for analytics that include multiple sensors drawn on the image. If the camera is moved, the application must be reconfigured.
- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.
- Absence of conditions of high crowding or occlusion that do not allow to count the individuals.
- Absence of sensors configured exactly under the camera (bird view): the plug in is not able to detect people from an overhead view.
- The body of a person must be visible for at least 3/4 of its height.
- The camera must be installed in a way that it provides a frontal/side view of the persons.
- The use of cameras pointed towards the ground, giving a view from the top is not supported since the head and the shoulders may be not sufficient to recognize a person.
- There must be no fog, clouds, other objects or strong shadows whose appearance is similar to the people in the areas of interest.
- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Absence of "waving objects" (e.g. Meadow with tall grass, trees, sliding doors, etc.) or any other type of disturbance that causes the continuous modification of the images (moving pixels) in the areas of interest.
- Persons must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the people are similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.
- Absence of vehicles with lights projected in areas of interest.
- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image.
- If necessary, the camera must be installed with external illuminators that make it possible to distinguish the people in all natural or artificial lighting conditions.
- Persons must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the people are similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.
- The scene must be a predominantly non-reflective surface.

Configuration

AI-CROWD requires the following configurations:

Basic configuration

1. Draw the crowd estimation sensor
   - avoiding the region under the camera. The person should be not framed overhead, a frontal view is required.
   - The sensor must be drawn on areas where people are expected to walk, i.e. in such a way that the feet of people are in the sensor. The sensor must not include portions of the sky.
2. Configure at least one event manager to collect the events
3. If needed configure the overcrowding threshold and enable overcrowd detection.

For social distance analysis

1. Draw an additional “distance analysis sensor” following the same rules as for the crowd estimation sensor described above.
2. Configure at least one event manager to collect the events
3. 3D calibration is an additional mandatory step. Many tips for that are available on our web site.
   - Draw two pair of parallel lines where one pair is perpendicular to the other
   - Specify the height and the focal length of the camera
   - Fine tune the calibration before turning off the visualization of calibration data.

Additional configurations

- If you need to configure the period between the sending of two consecutive crowd events; the default works just fine in the most cases
- Optionally you can fine tune latency, confidence and inhibition for the overoccupancy analytic
- Optionally you can configure the minimum and maximum pixel size of an object of interest
- If real size filtering (in meters) is required: calibrate the camera by correctly specifying height, horizontal angle of view and vertical angle of view, then complete the calibration of the algorithm by correctly specifying the inclination angle of the camera and the training samples
- If needed, schedule the applications in specific time intervals

AI-CROWD-PLUS

AI-CROWD-PLUS is a bundle including two different products, simultaneously installed on board of your camera.

- **AI-CROWD**: Crowd estimation
- **AI-OVERCROWD**: Overcrowding detection for queue management

Camera positions

- The camera should be mounted with a reduced focal length and an horizontal field of view in the range between 60° and 120°, chosen with respect to the gate.
- The camera must be mounted in a overhead position considering an 90° angle measured to ground.
- The camera should be mounted at a height between 3 and 5 meters
- The precision of the results is maximum when people are recorded from the top without distorsion on the sides

Example of gate width	
Camera at 3 meters	
FOV	**Gate width**
120°	10 meters
90°	6 meters
60°	3,5 meters
Camera at 4 meters	
FOV	**Gate width**
120°	14 meters
90°	8 meters
60°	4,5 meters

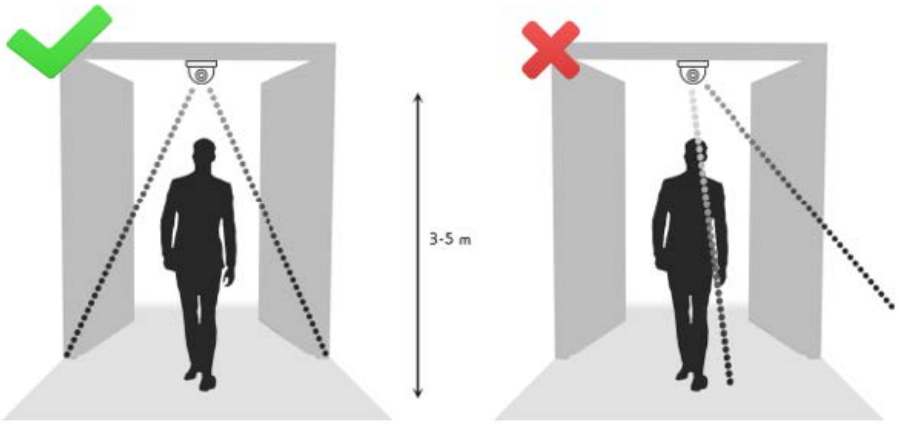


Fig. 52: camera position

Recommended distances

Camera height (m)	Maximum gate width (m)
3	6
3,5	7,5

Camera height (m)	Maximum gate width (m)
4	9
4,5	10
5	12

AI-CROWD

AI-CROWD is the plug in that can be used in crowded areas where persons can stop or move slowly, even determining queuing situations. It allows to estimate the number of persons inside one or more areas of interest. It generates events that can be managed by AI-Dash, FTP servers and third party servers.

The accuracy to be expected is 90% under ideal environmental and installation conditions.

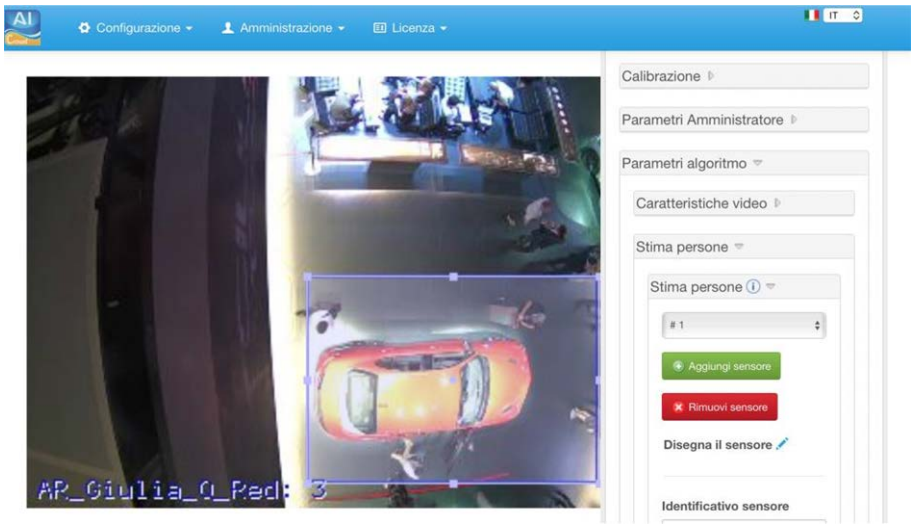


Fig. 53: AI-CROWD: configuration

Environment conditions

The position of the camera and the environmental conditions affect the performance of the application. Performance is best under the following conditions:

- The image must not present flickering, severe noise or artifacts.
- Image must have a resolution of 640x360, 640x480, 320x180, 320x240.
- Rotating (PTZ) security cameras are supported only if they are not moved when the application is enabled. If the camera is moved, the application must be reconfigured.
- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.
- Absence of conditions of high crowding or stopped people that do not allow to count the individuals.

- Absence of stationary or slow-moving people for long periods in the counting area (e.g. Sales people that encourage customers to enter).
- There must be no other moving objects whose appearance is similar to the people in the areas of interest.
- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Absence of "waving objects" (e.g. Meadow with tall grass, trees, sliding doors, etc.) or any other type of disturbance that causes the continuous modification of the images (moving pixels) in the areas of interest.
- Camera placement must be stable and solid in a way that wind or external disturbances of other types will not cause movement of the camera that appears on the image.
- Absence of vehicles with lights projected in areas of interest.
- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image. If necessary, the camera must be installed with external illuminators that make it possible to distinguish the people in all natural or artificial lighting conditions.
- The people must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the people are similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.
- The people must have a minimum area of 200 pixels (e.g. 10x20, 5x40, ...).
- The floor must be a predominantly non-reflective surface.
- No hard lights must be present that cast shadows in a way that the background brightness is reduced to less than 50% of the original value in the image.

Drawing the sensor for AI-CROWD

When drawing the crowd estimation sensor consider the following guideline:

- Configure the minimum area occupied by a person by drawing a rectangle around the shoulders.

Fig. 54: Drawing sensor for AI-CROWD

Configuration of AI-CROWD

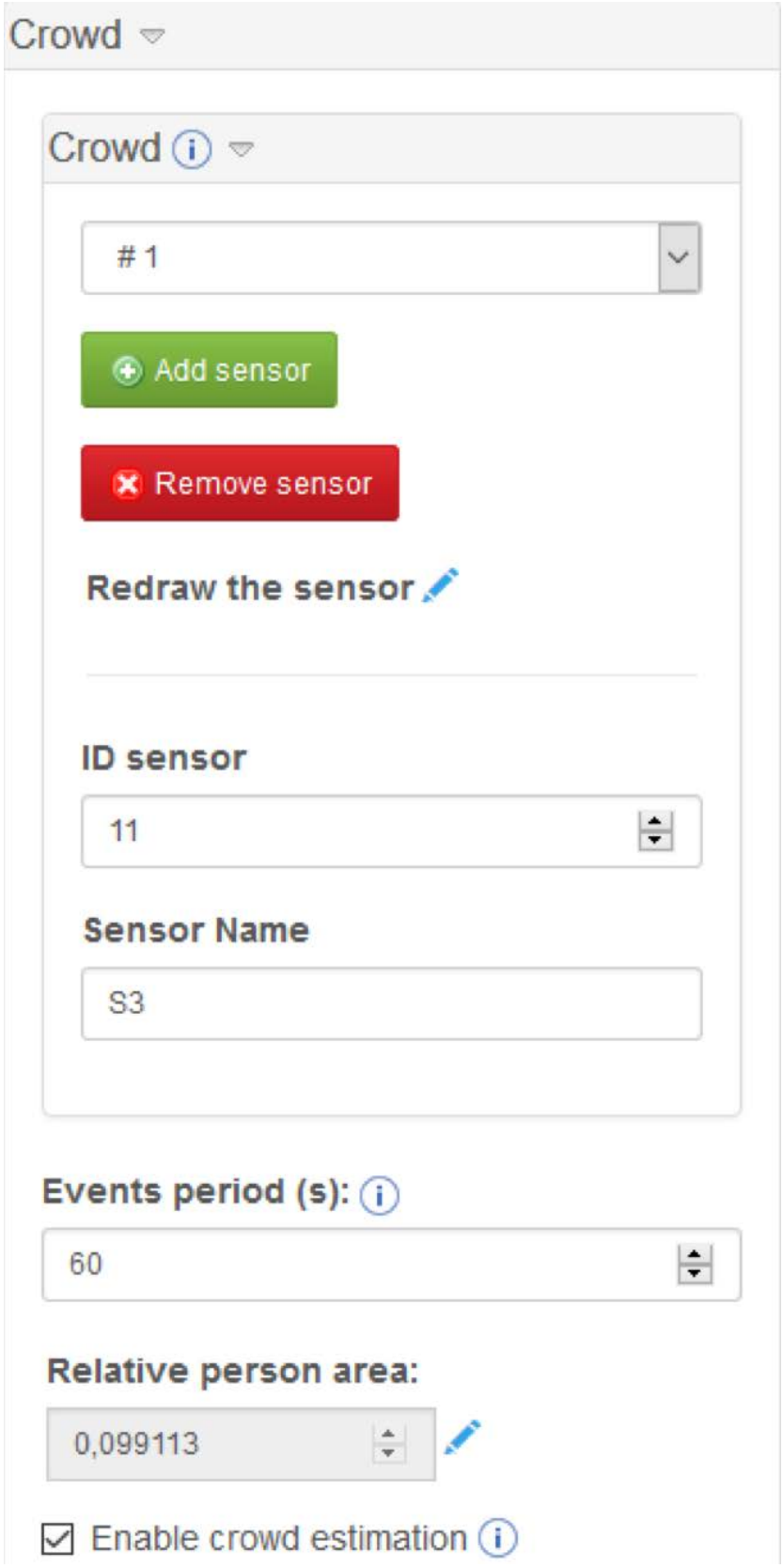


Fig. 55: Configuration of AI-CROWD

The configuration section provides the following functions:

Add Sensor: Click this button to draw a virtual sensor with the mouse method “click and drag”. The sensor can be moved and changed in its size, by dragging the nodes. You can direct the sensor (the counting direction is given by the arrow), for example rotating the sensor until the arrow points to the desired direction, or specify if the sensor is unidirectional rather than bidirectional .

Remove sensor: Click this button to remove the selected sensor from the configuration.

Redraw the sensor: Click to delete the current sensor and draw a new one.

ID sensor: define an ID number for the sensor.

Sensor name: this name uniquely identifies the main counting sensor (green arrow); is used to generate counting events, sent, for example, to AI-Dash.

Event period(s): interval in seconds between two consecutive events that need to be sent to an external server.

Enable crowd estimation:check to activate AI-CROWD.

AI-OVERCROWD

AI-OVERCROWD is a video analytic app that can be used to detect overcrowding inside one or more areas of interest in typical retail scenarios; of course, the position of the camera and the environmental conditions will affect the performance of the application.

The accuracy to be expected is 90% under ideal environmental and installation conditions.

Fig. 56: AI-OVERCROWD

Environment conditions

The position of the camera and the environmental conditions affect the performance of the application. Performance is best under the following conditions:

- The image must not present flickering, severe noise or artifacts.
- Image must have a resolution of 640x360, 640x480, 320x180, 320x240.
- Rotating (PTZ) security cameras are supported only if they are not moved when the application is enabled. If the camera is moved, the application must be reconfigured.
- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.
- Absence of conditions of high crowding or stopped people that do not allow to count the individuals.
- Absence of stationary or slow-moving people for long periods in the counting area (e.g. Sales people that encourage customers to enter).
- There must be no other moving objects whose appearance is similar to the people in the areas of interest.
- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Absence of "waving objects" (e.g. Meadow with tall grass, trees, sliding doors, etc.) or any other type of disturbance that causes the continuous modification of the images (moving pixels) in the areas of interest.
- Camera placement must be stable and solid in a way that wind or external disturbances of other types will not cause movement of the camera that appears on the image.
- Absence of vehicles with lights projected in areas of interest.
- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image. If necessary, the camera must be installed with external illuminators that make it possible to distinguish the people in all natural or artificial lighting conditions.
- The people must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the people are similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.
- The people must have a minimum area of 200 pixels (e.g. 10x20, 5x40, ...).
- The floor must be a predominantly non-reflective surface.
- No hard lights must be present that cast shadows in a way that the background brightness is reduced to less than 50% of the original value in the image.

Drawing the sensor for AI-OVERCROWD

When drawing the crowd estimation sensor consider the following guideline:

- Configure the minimum area occupied by a person by drawing a rectangle around the shoulders.

Fig. 57: Drawing sensor for AI-CROWD

Configuration of AI-OVERCROWD

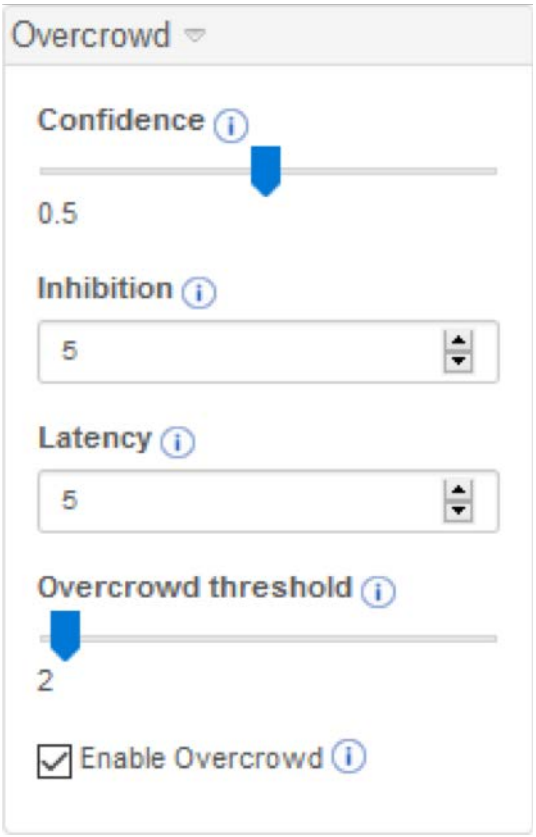


Fig. 58: Configuration of AI-OVERCROWD

The configuration section provides the following functions:

Confidence: A small value (< 0,5) will make the algorithm very sensitive, instead with a value too large (> 0,8) the algorithm could not generate the alarms. It's suggested to use a value between 0,5 and 0,75.

Inhibition(s): inhibition time of the sensor in seconds after an alarm has been generated. If an alarm is generated by the same sensor before the inhibition time is passed, will be ignored by the system.

Latency(s): Minimum crowding time in seconds (number of people over the configured threshold) before an alarm is generate.

Overcrowd threshold: If the number of the persons in the region of interest exceeds the selected threshold, the application creates a new overcrowd event.

AI-FACEDETECT-DEEP

AI-FACEDETECT-DEEP is the video analytics app able to detect the faces of the persons inside the scene. It is also able to distinguish faces with mask from faces without mask. It implies that the plug in can be used for both statistical (in order to know the number of persons inside an area) and security purposes (by opening a door only if the face of the person is well visible).

AI-FACEDETECT-DEEP - camera positions

- The camera must be frontal with respect to people faces, at an height about 1,8 m
- The camera must be installed at a distance from the faces so that the face area is at least 600 pixels.
- It must be installed in a place sufficiently illuminated, so that the facial landmarks are perfectly visible.
- The camera must be installed on a pole or, more in general, in a place completely steady; otherwise, the camera vibrations can have a negative impact on the performance.
- The camera must be positioned in a place which attracts the glance of the people, so that the faces are framed in frontal position.

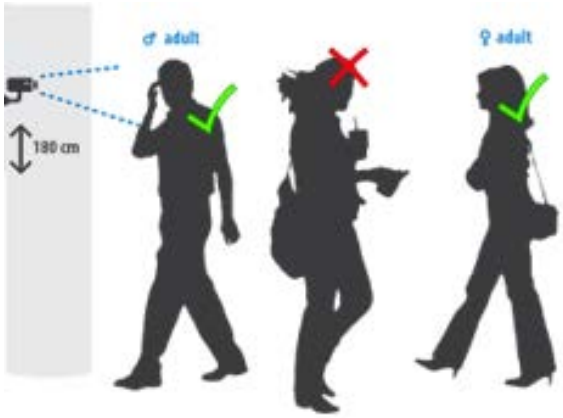
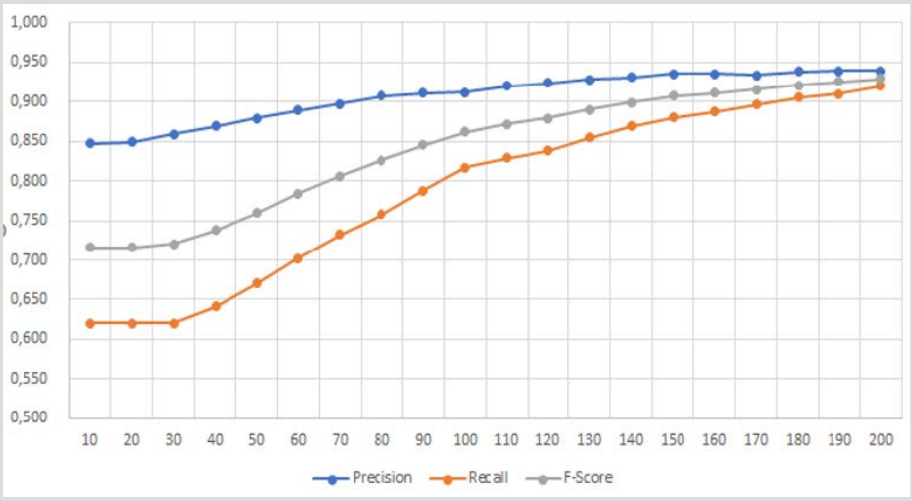


Fig. 59: AI-FACEDETECT-DEEP Camera positions

AI-FACEDETECT-DEEP

AI-FACEDETECT-DEEP is the plug in for detecting all the faces in the image, verifying if the face is masked or not. The user can configure whether is interested to face not masked, masked or both. The plug in generates events that can be managed by all the notification channels.

Whether the environmental conditions and the installation constraints are respected, the expected performance of AI-FACEDETECT-DEEP is variable depending on the face size in the image.
See the following diagram (on the x-axis it is reported the height of the face image in pixels):



The recall is expected to grow over 90% whether a single face is present very close to the camera (e.g. face verification for access control).

Environment conditions

AI-FACEDETECT-DEEP is a video analytic plug-in optimized to detect the faces in indoor and outdoor scenarios; of course, the position of the camera and the environmental conditions will affect the performance of the application.

- The image must not present flickering, severe noise or artifacts.
- Image must have a resolution of 640x360, 640x480, 320x180, 320x240.
- Rotating security cameras are not supported; PTZ cameras are supported only if they are not moved when the application is enabled. If the camera is moved, the application must be reconfigured.
- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.
- Absence of conditions of high crowding or occlusion that do not allow to count the individuals.
- There must be no other objects whose appearance is similar to faces in the areas of interest.
- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Camera placement must be stable and solid in a way that wind or external disturbances of other types will not cause movement of the camera that appears on the image.
- Absence of lights projected in areas of interest.
- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image.

- Persons must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the people are similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.
- The face must have a minimum area of 600 pixels (e.g. 20x30, 15x40, ...).
- No hard lights must be present that cast shadows in a way that the background brightness is reduced to less than 50% of the original value in the image.

Configuration

AI-FACEDETECT-DEEP requires the following configurations:

Basic configuration

1. Draw the sensor for face analysis.

   Note
   For improving the performance of the face detector, draw a sensor with an aspect ratio (width:height) equal to 4:3.
   The smaller the sensor, the higher the resolution of the detected face.

2. Configure the minimum and maximum pixel size of the faces to detect.
3. Configure the “Deep” detection algorithm.
4. Configure the minimum confidence.
5. Configure the type of event and face you are interested in.
6. Configure at least one event manager to collect the events.
7. If needed, schedule the applications in specific time intervals.

6

AI-RETAIL3

AI-RETAIL3 is a bundle including three different products, simultaneously installed on board of your camera.

- **AI-PEOPLE**: People counting through gates
- **AI-CROWD**: Crowd estimation
- **AI-OVERCROWD**: Overcrowding detection for queue management

Camera positions

- The camera should be mounted with a reduced focal length and an horizontal field of view in the range between 60° and 120°, chosen with respect to the gate.
- The camera must be mounted in a overhead position considering an 90° angle measured to ground.
- The camera should be mounted at a height between 3 and 5 meters
- The precision of the results is maximum when people are recorded from the top without distorsion on the sides

Example of gate width	
Camera at 3 meters	
FOV	Gate width
120°	10 meters
90°	6 meters
60°	3,5 meters
Camera at 4 meters	
FOV	Gate width
120°	14 meters
90°	8 meters
60°	4,5 meters

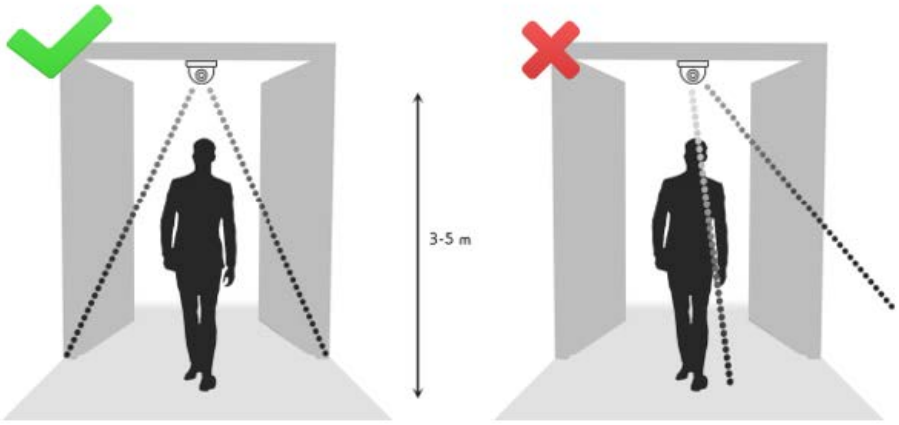


Fig. 60: camera position

Recommended distances

Camera height (m)	Maximum gate width (m)
3	6
3,5	7,5
4	9
4,5	10
5	12

AI-PEOPLE

AI-PEOPLE is a video analytic app optimized to count people crossing a gate in typical retail scenarios. It generates events that can be managed by all the notification channels.

The accuracy to be expected is under ideal environmental and installation conditions

Indoor:

- Recall: 85%
- Precision: 95%

Outdoor:

- Recall: 85%
- Precision: 85%

Environment conditions

The position of the camera and the environmental conditions affect the performance of the application. Performance is best under the following conditions:

- The image must not present flickering, severe noise or artifacts.
- Image must have a resolution of 640x360, 640x480, 320x180, 320x240.
- Rotating (PTZ) security cameras are supported only if they are not moved when the application is enabled. If the camera is moved, the application must be reconfigured.
- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.
- Absence of conditions of high crowding or stopped people that do not allow to count the individuals.
- Absence of stationary or slow-moving people for long periods in the counting area (e.g. Sales people that encourage customers to enter).
- There must be no other moving objects whose appearance is similar to the people in the areas of interest.
- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Absence of "waving objects" (e.g. Meadow with tall grass, trees, sliding doors, etc.) or any other type of disturbance that causes the continuous modification of the images (moving pixels) in the areas of interest.
- Camera placement must be stable and solid in a way that wind or external disturbances of other types will not cause movement of the camera that appears on the image.
- Absence of vehicles with lights projected in areas of interest.
- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image. If necessary, the camera must be installed with external illuminators that make it possible to distinguish the people in all natural or artificial lighting conditions.
- The people must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the people are similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.
- The people must have a minimum area of 600 pixels (e.g. 20x30, 15x40, ...).
- The floor must be a predominantly non-reflective surface.
- No hard lights must be present that cast shadows in a way that the background brightness is reduced to less than 50% of the original value in the image.

Drawing the people counting sensor

When drawing the counting sensor the following 3 guidelines must be considered:

- **Correct width:** It must occupy the entire area of the gate horizontally
- **Correct height:** The vertical half of the sensor should include head and shoulders
- **Correct position:** the sensor must be parallel to the gate, so that people crossing it from top to bottom or vice versa, and must not include moving objects in its area (doors, sliding or not, screens etc.)

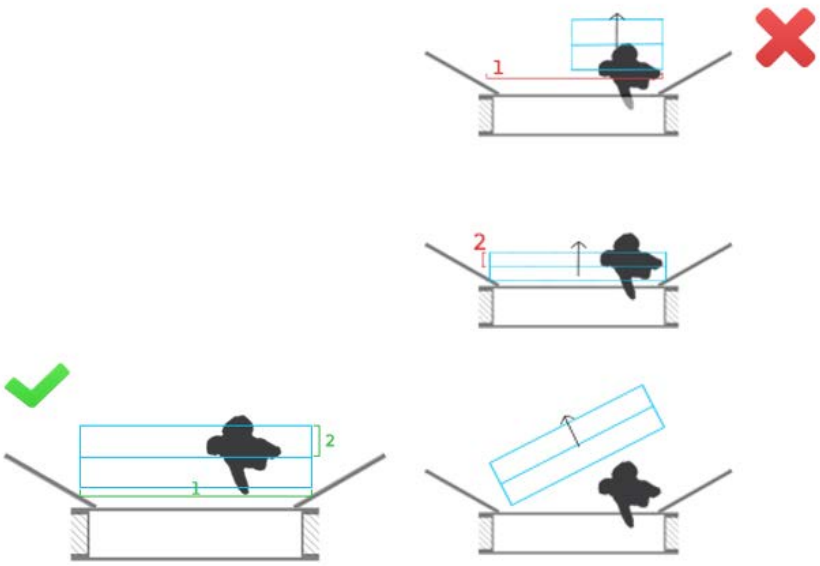


Fig. 61: Examples of correct and wrong sensor drawing

Configuring people counting

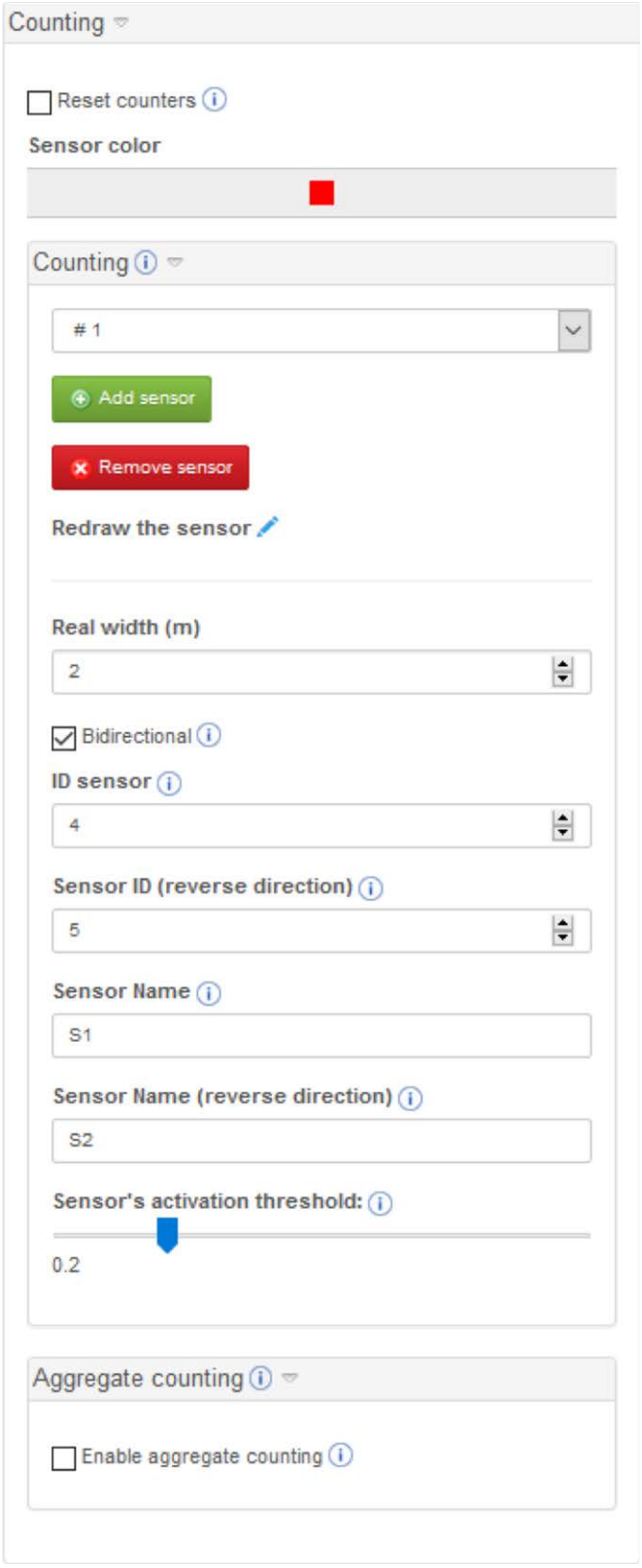


Fig. 62: Configuration of AI-PEOPLE

The configuration section provides the following functions:

Reset counters: when checked the counters associated to the counting sensors will be reset when the application is restarted.

Add Sensor: Click this button to draw a virtual sensor with the mouse method “click and drag”. The sensor can be moved and changed in its size, by dragging the nodes. You can direct the sensor (the counting direction is given by the arrow), for example rotating the sensor until the arrow points to the desired direction, or specify if the sensor is mono directional rather than bidirectional .

Remove sensor: Click this button to remove the selected sensor from the configuration.

Real width (m): real width of the sensor in meters. The empirical rule to specify this value, used when the real dimension is not measurable, suggests to compute the maximum number of people who can cross the gate at the same time multiplied for 0.75. However, it approximates the real condition and may not be precise enough.

Bidirectional: specify if the sensor is mono or bidirectional.

Sensor name: this name uniquely identifies the main counting sensor (green arrow); is used to generate counting events, sent, for example, to AI-Dash.

Sensor name (reverse direction): this name uniquely identifies the counting sensor in the reverse direction (red arrow); is used to generate counting events, sent ,for example, to AI-Dash;

Sensor activation threshold: A value too small (< 0,1) would make the sensor very sensitive and the sensor could give false positive in this case. A value too big (> 0,6) would make the sensor not very sensitive and in this case, the sensor could miss some person crossing.

After checking **Enable aggregate counting**, it’s possible to send the events if the difference between entrances and exits is over a certain threshold (see AI-PEOPLE: Aggregate counting, p. 84).

AI-PEOPLE: Aggregate counting

Configuring aggregate counting

Before configuring aggregate counting make sure the basic AI-PEOPLE, p. 80 is ready configured.

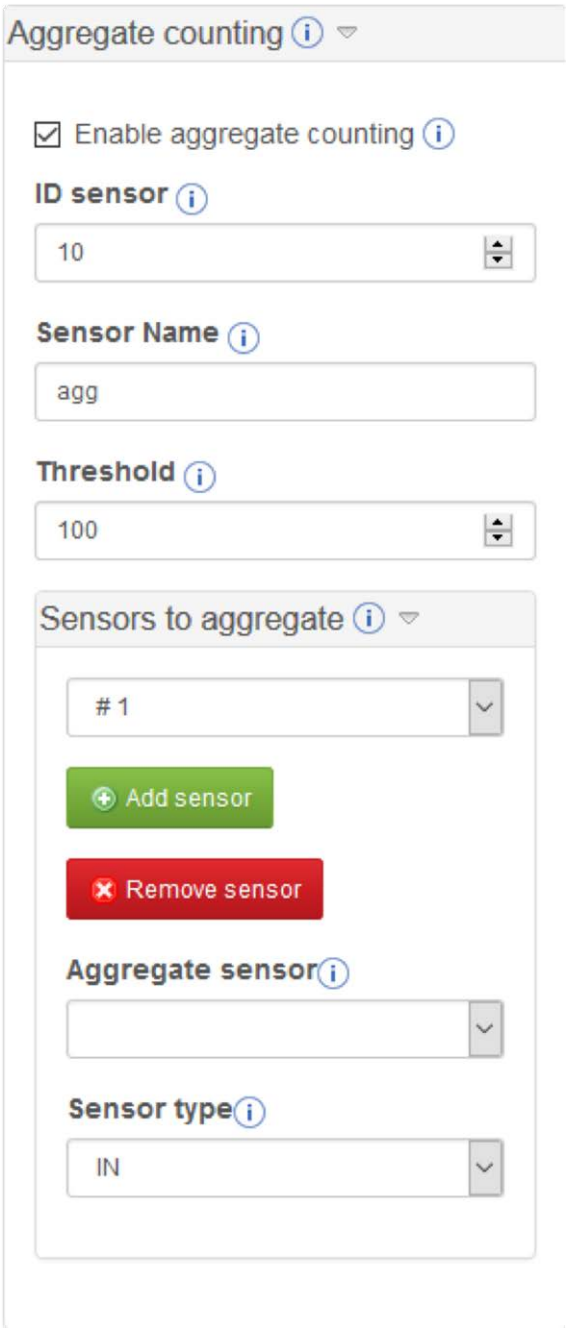


Fig. 63: Aggregate counting

After checking **Enable aggregate counting**, it's possible to send the events if the difference between entrances and exits is over a certain threshold

The following parameters are to be configures to use this functionality:

ID sensor: univocal ID automatically generated;

Sensor name: this name uniquely identifies the aggregate sensor; is used to generate counting events, sent, for example, to AI-Dash;

Threshold: The event will be generated when the difference between entries and excites will be above this value (threshold).

In section **Sensors to aggregate**you can add the desired number of sensors which will form the aggregate sensor:

Aggregate sensor: drop down menu that permit to select the name of the sensor just created in the section “Counting” (BE AWARE: if you created a Bidirectional sensor, in the section “Counting”, the generated sensors will be two with the respective name and identifier);

Sensor type: specifies if the selected sensor in the previous drop down menu counts entries (IN) or exits (OUT).

AI-CROWD

AI-CROWD is the plug in that can be used in crowded areas where persons can stop or move slowly, even determining queuing situations. It allows to estimate the number of persons inside one or more areas of interest. It generates events that can be managed by AI-Dash, FTP servers and third party servers.

The accuracy to be expected is 90% under ideal environmental and installation conditions.

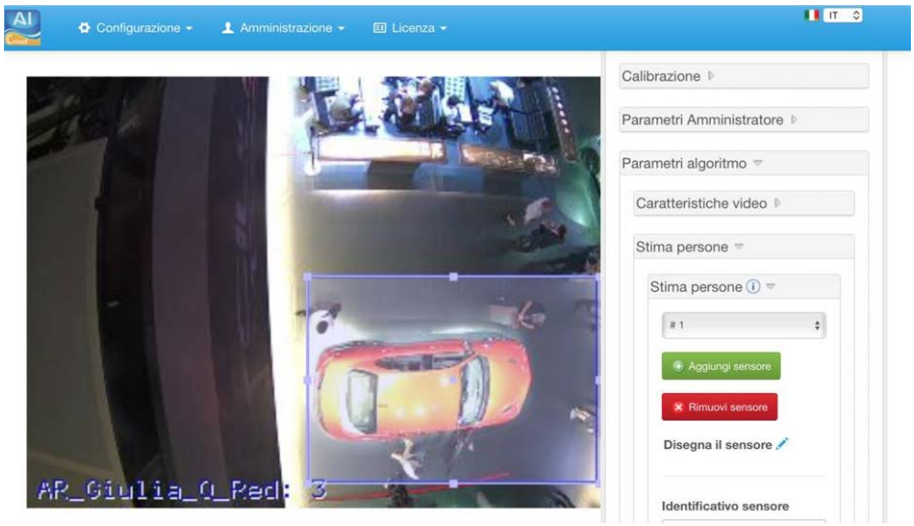


Fig. 64: AI-CROWD: configuration

Environment conditions

The position of the camera and the environmental conditions affect the performance of the application. Performance is best under the following conditions:

- The image must not present flickering, severe noise or artifacts.
- Image must have a resolution of 640x360, 640x480, 320x180, 320x240.
- Rotating (PTZ) security cameras are supported only if they are not moved when the application is enabled. If the camera is moved, the application must be reconfigured.
- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.
- Absence of conditions of high crowding or stopped people that do not allow to count the individuals.

- Absence of stationary or slow-moving people for long periods in the counting area (e.g. Sales people that encourage customers to enter).
- There must be no other moving objects whose appearance is similar to the people in the areas of interest.
- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Absence of "waving objects" (e.g. Meadow with tall grass, trees, sliding doors, etc.) or any other type of disturbance that causes the continuous modification of the images (moving pixels) in the areas of interest.
- Camera placement must be stable and solid in a way that wind or external disturbances of other types will not cause movement of the camera that appears on the image.
- Absence of vehicles with lights projected in areas of interest.
- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image. If necessary, the camera must be installed with external illuminators that make it possible to distinguish the people in all natural or artificial lighting conditions.
- The people must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the people are similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.
- The people must have a minimum area of 200 pixels (e.g. 10x20, 5x40, ...).
- The floor must be a predominantly non-reflective surface.
- No hard lights must be present that cast shadows in a way that the background brightness is reduced to less than 50% of the original value in the image.

Drawing the sensor for AI-CROWD

When drawing the crowd estimation sensor consider the following guideline:

- Configure the minimum area occupied by a person by drawing a rectangle around the shoulders.

Fig. 65: Drawing sensor for AI-CROWD

Configuration of AI-CROWD

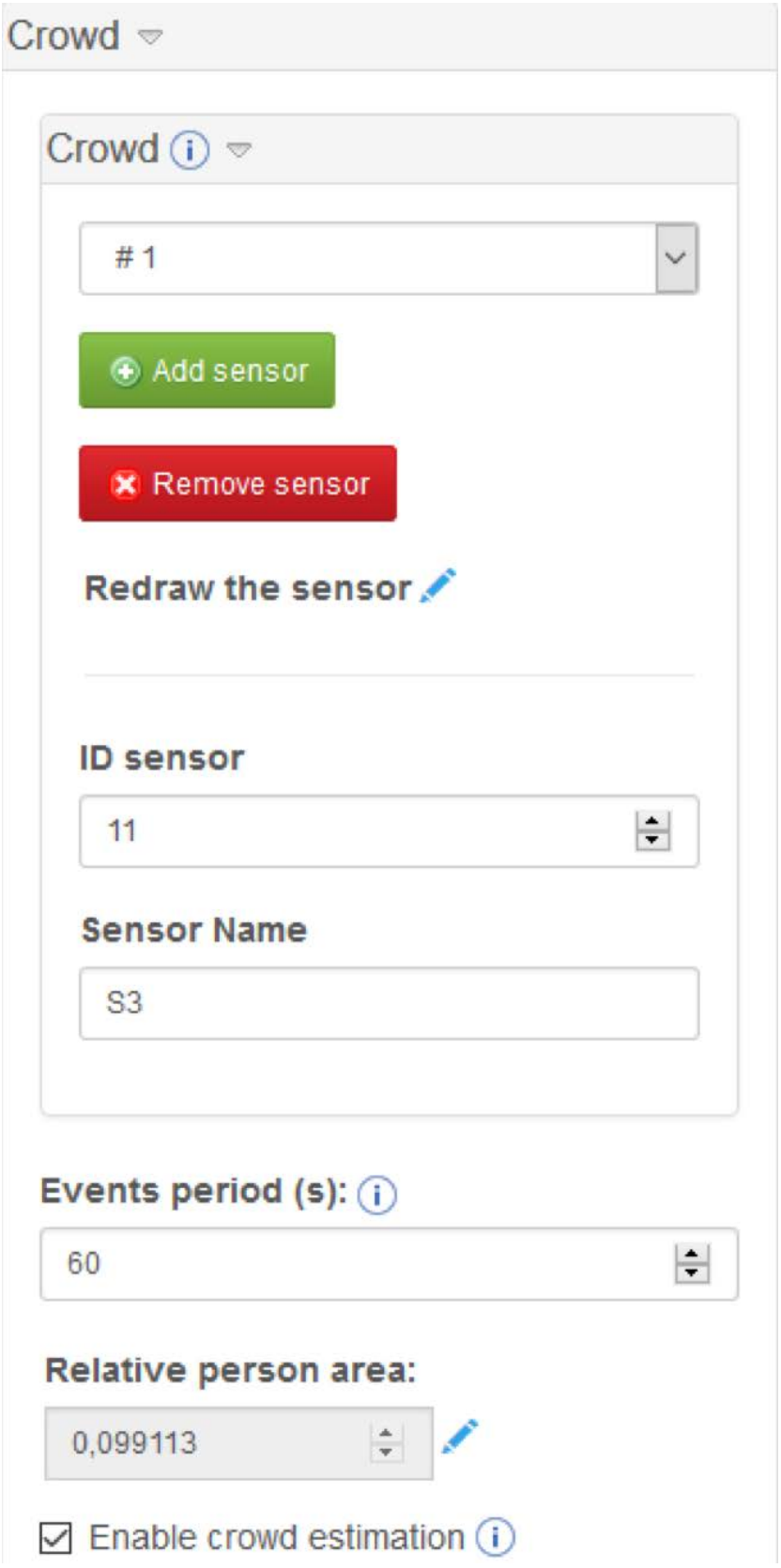


Fig. 66: Configuration of AI-CROWD

The configuration section provides the following functions:

Add Sensor: Click this button to draw a virtual sensor with the mouse method “click and drag”. The sensor can be moved and changed in its size, by dragging the nodes. You can direct the sensor (the counting direction is given by the arrow), for example rotating the sensor until the arrow points to the desired direction, or specify if the sensor is unidirectional rather than bidirectional .

Remove sensor: Click this button to remove the selected sensor from the configuration.

Redraw the sensor: Click to delete the current sensor and draw a new one.

ID sensor: define an ID number for the sensor.

Sensor name: this name uniquely identifies the main counting sensor (green arrow); is used to generate counting events, sent, for example, to AI-Dash.

Event period(s): interval in seconds between two consecutive events that need to be sent to an external server.

Enable crowd estimation:check to activate AI-CROWD.

AI-OVERCROWD

AI-OVERCROWD is a video analytic app that can be used to detect overcrowding inside one or more areas of interest in typical retail scenarios; of course, the position of the camera and the environmental conditions will affect the performance of the application.

The accuracy to be expected is 90% under ideal environmental and installation conditions.

Fig. 67: AI-OVERCROWD

Environment conditions

The position of the camera and the environmental conditions affect the performance of the application. Performance is best under the following conditions:

- The image must not present flickering, severe noise or artifacts.
- Image must have a resolution of 640x360, 640x480, 320x180, 320x240.

- Rotating (PTZ) security cameras are supported only if they are not moved when the application is enabled. If the camera is moved, the application must be reconfigured.
- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.
- Absence of conditions of high crowding or stopped people that do not allow to count the individuals.
- Absence of stationary or slow-moving people for long periods in the counting area (e.g. Sales people that encourage customers to enter).
- There must be no other moving objects whose appearance is similar to the people in the areas of interest.
- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Absence of "waving objects" (e.g. Meadow with tall grass, trees, sliding doors, etc.) or any other type of disturbance that causes the continuous modification of the images (moving pixels) in the areas of interest.
- Camera placement must be stable and solid in a way that wind or external disturbances of other types will not cause movement of the camera that appears on the image.
- Absence of vehicles with lights projected in areas of interest.
- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image. If necessary, the camera must be installed with external illuminators that make it possible to distinguish the people in all natural or artificial lighting conditions.
- The people must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the people are similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.
- The people must have a minimum area of 200 pixels (e.g. 10x20, 5x40, ...).
- The floor must be a predominantly non-reflective surface.
- No hard lights must be present that cast shadows in a way that the background brightness is reduced to less than 50% of the original value in the image.

Drawing the sensor for AI-OVERCROWD

When drawing the crowd estimation sensor consider the following guideline:

- Configure the minimum area occupied by a person by drawing a rectangle around the shoulders.

Fig. 68: Drawing sensor for AI-CROWD

Configuration of AI-OVERCROWD

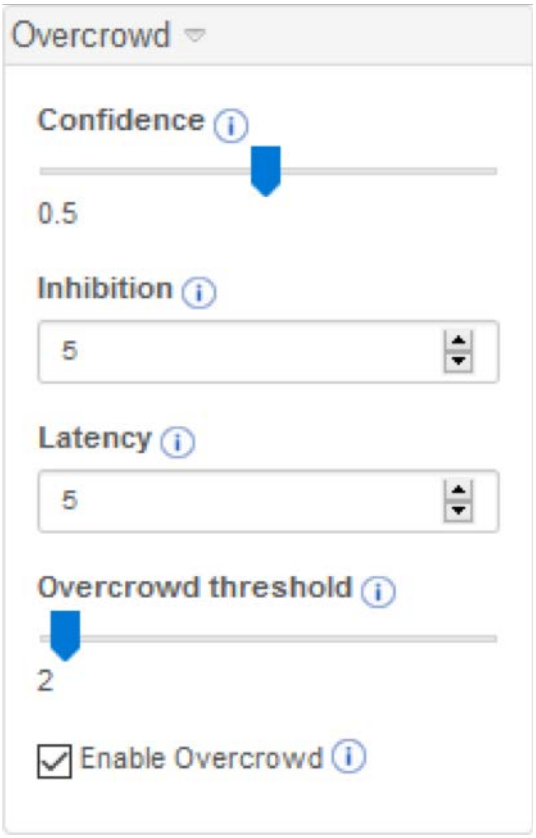


Fig. 69: Configuration of AI-OVERCROWD

The configuration section provides the following functions:

Confidence: A small value (< 0,5) will make the algorithm very sensitive, instead with a value too large (> 0,8) the algorithm could not generate the alarms. It's suggested to use a value between 0,5 and 0,75.

Inhibition(s): inhibition time of the sensor in seconds after an alarm has been generated. If an alarm is generated by the same sensor before the inhibition time is passed, will be ignored by the system.

Latency(s): Minimum crowding time in seconds (number of people over the configured threshold) before an alarm is generate.

Overcrowd threshold: If the number of the persons in the region of interest exceeds the selected threshold, the application creates a new overcrowd event.

7

AI-TRAFFIC

AI-TRAFFIC is a bundle including two different products, simultaneously installed on board of your camera.

- **AI-ROAD 3D**: gathering of traffic statistics
- **AI-INCIDENT**: road monitoring for security purposes

Configuration of AI-TRAFFIC analysis

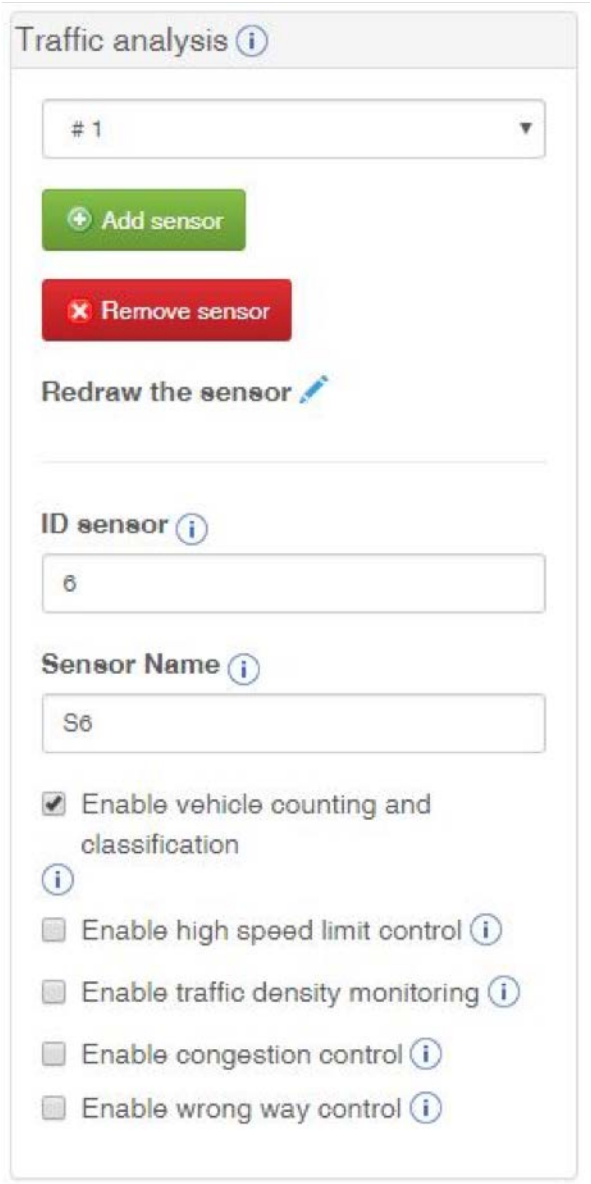


Fig. 70: Configuration of AI-LOST sensors

The configuration section provides the following functions:

Add Sensor: Click this button to draw the area of interest directly on the live image on the left. The area of interest it's a polygon with no limits to the number of sides.

Remove sensor: Click this button to remove the selected sensor from the configuration.

Redraw the sensor: Click to delete the current sensor and draw a new one.

ID sensor: define an ID number for the sensor.

Sensor name: this name uniquely identifies the sensor.

Enable vehicle counting and classification: It is enabled by default and allows to count and classify vehicles, collecting also information about the average speed and color of each vehicle. Available in AI-ROAD 3D.

Enable high speed limit control: Allows to send a notification for each vehicle which overcome the speed limit, specified during the configuration. Available in AI-ROAD 3D.

Enable traffic density monitoring: Allows to send a periodical notification, with a period specified during the configuration, along with the information about the traffic density. Available in AI-ROAD 3D.

Enable congestion control: Allows to send a notification in case of congestion. Available in AI-INCIDENT.

Enable wrong way control: Allows to send a notification for each vehicle which crosses the sensor in the wrong direction. Available in AI-INCIDENT.

AI-TRAFFIC- stopped vehicle or pedestrian

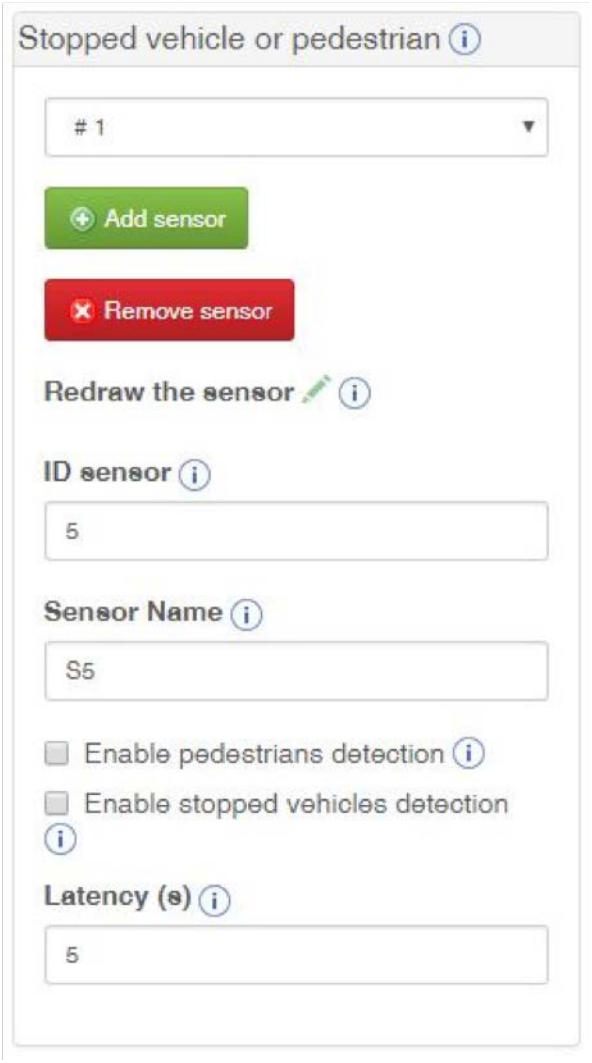


Fig. 71: Configuration of AI-TRAFFIC stopped vehicle or pedestrian

The configuration section provides the following functions:

Add Sensor: Click this button to draw the area of interest directly on the live image on the left. The area of interest it's a polygon with no limits to the number of sides.

Remove sensor: Click this button to remove the selected sensor from the configuration.

Redraw the sensor: Click to delete the current sensor and draw a new one.

ID sensor: define an ID number for the sensor.

Sensor name: this name uniquely identifies the sensor.

Enable pedestrians detection: It is enabled by default and allows to count and classify pedestrians, collecting also information about the average speed and color of each vehicle. Available in AI-INCIDENT.

Enable stopped vehicles detection: Allows to send a notification if a vehicle spends more than “Latency” seconds in the sensor. Available in AI-ROAD 3D.

Enable traffic density monitoring: Allows to send a periodical notification, with a period specified during the configuration, along with the information about the traffic density. Available in AI-ROAD 3D.

Latency (s): Define a latency value in seconds.

Configuration of AI-TRAFFIC Entrance areas

In order to reduce the number of false positives and to consider only the objects which enters from specific parts of the image, it is possible to draw an unlimited number of entrance areas.

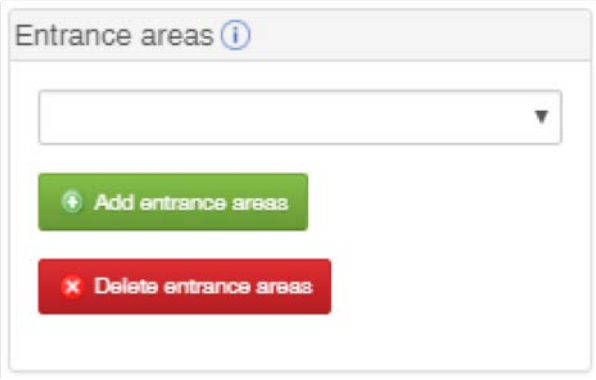


Fig. 72: Configuration of AI-TRAFFIC entrance areas

The configuration section provides the following functions:

Add entrance area: Click this button to draw an entrance area of directly on the live image on the left. The entrance area is a polygon with no limits to the number of sides.

Delete entrance area: Click this button to remove the selected entrance area from the configuration.

AI-TRAFFIC - camera positions

- The camera must be mounted in order to assure that the maximum angle between it and the road is 30°.
- The camera should frame the vehicles from behind, so as to avoid the negative effect of the headlights.
- The camera should be varifocal for outdoor environments.
- The camera must be installed on a pole or, more in general, in a place completely steady; otherwise, the camera vibrations can have a negative impact on the performance.
- The camera must be mounted at a minimum height of 5 meters; in any case, it is important to avoid occlusions between vehicles.
- The camera must be mounted with a minimum inclination angle of 15°; in any case, it is important to avoid occlusions between vehicles.

- The minimum area in pixels of a vehicle must be 50x50; the zoom must be configured according to this constrain.

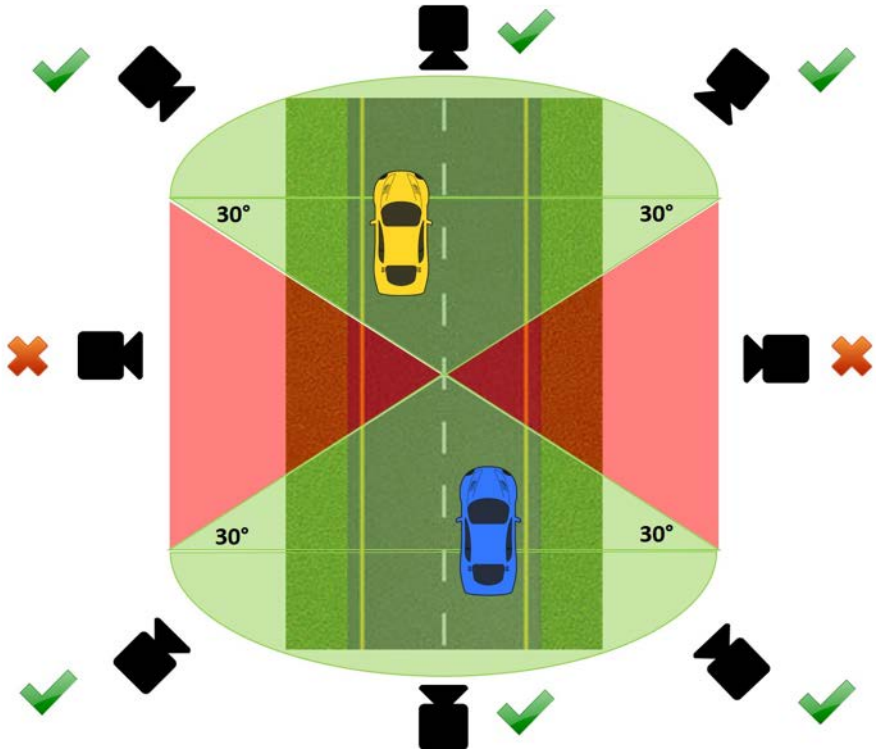


Fig. 73: AI-TRAFFIC Camera positions 1

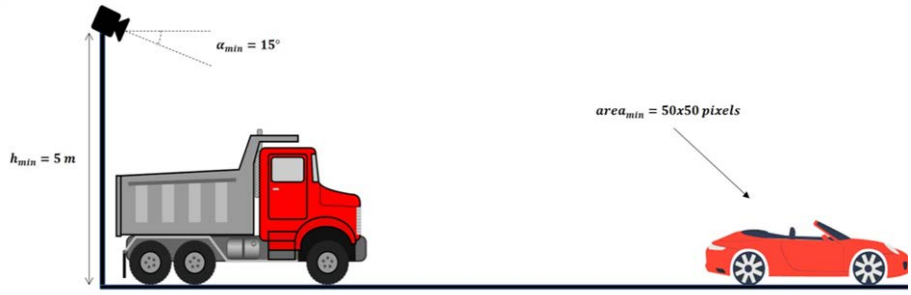


Fig. 74: AI-TRAFFIC Camera positions 2

AI-ROAD 3D

AI-ROAD 3D is a video analytic app optimized to monitor the road traffic in real-time; thus, the environmental conditions will affect the performance of the application.

The accuracy to be expected is under ideal environmental and installation conditions
Vehicle Detection:

- Recall: 90%
- Precision: 95%

Vehicle Classification:

- Motorcycle Accuracy: 75%
- Car Accuracy: 95%
- Truck Accuracy: 85%

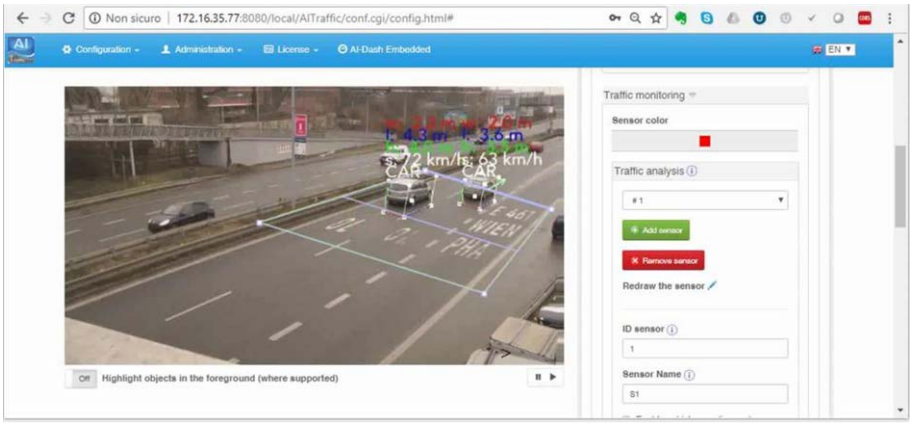


Fig. 75: AI-ROAD 3D: configuration

Environment conditions

The position of the camera and the environmental conditions affect the performance of the application. Performance is best under the following conditions:

- The image must not present flickering, severe noise or artifacts.
- Image must have a resolution of 640x360, 640x480, 320x180, 320x240.
- Rotating (PTZ) security cameras are supported only if they are not moved when the application is enabled. If the camera is moved, the application must be reconfigured.
- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.
- Absence of conditions of high crowding or stopped people that do not allow to count the individuals.
- There must be no fog, clouds or other moving objects whose appearance is similar to the target in the areas of interest.
- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Absence of "waving objects" (e.g. Meadow with tall grass, trees, sliding.
- Absence of vehicles with lights projected towards the camera.
- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be

monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image. If necessary, the camera must be installed with external illuminators that make it possible to distinguish the target in all natural or artificial lighting conditions.

- The target must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the target is similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.
- Absence of vehicles with lights projected in areas of interest.
- The target must stay in the interested area for a time of at least 1 second.
- The target must have a minimum area of 2500 pixels (e.g. 50x50).
- The target must move at a maximum speed of half their width on the image per frame. For example, a target that is 40 pixels wide at 10 frames per second must move at a speed of no more than 20 pixels per frame, that is 200 pixel per second.
- The scene must be predominantly non-reflective.
- No hard lights must be present that cast shadows in a way that the background brightness is reduced to less than 50% of the original value in the image.
- In case of thermal cameras, the image must be not colored but in grayscale (white for “hot” pixels, black for “cold” pixels). The camera, thermal or monocular, must be always configured in order to avoid continuous changes of brightness.

Drawing the people counting sensor

When drawing the counting sensor the following guidelines must be considered:

- Sensors can be configured only on straight roads
- Sensors can be configured only on roads or lanes oriented in the same direction of the reference lines, not in different ones

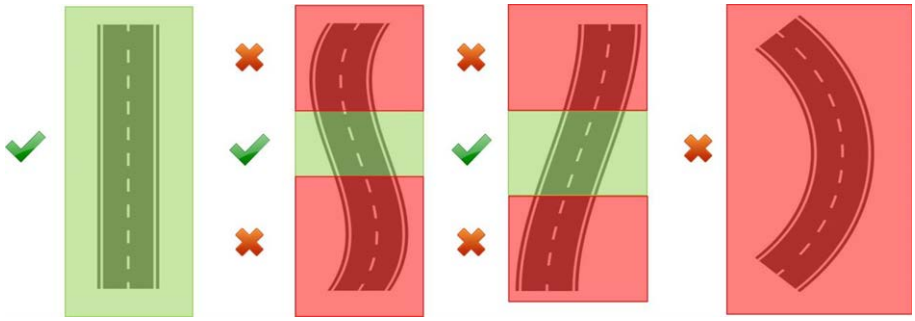


Fig. 76: AI-ROAD 3D Sensor drawing

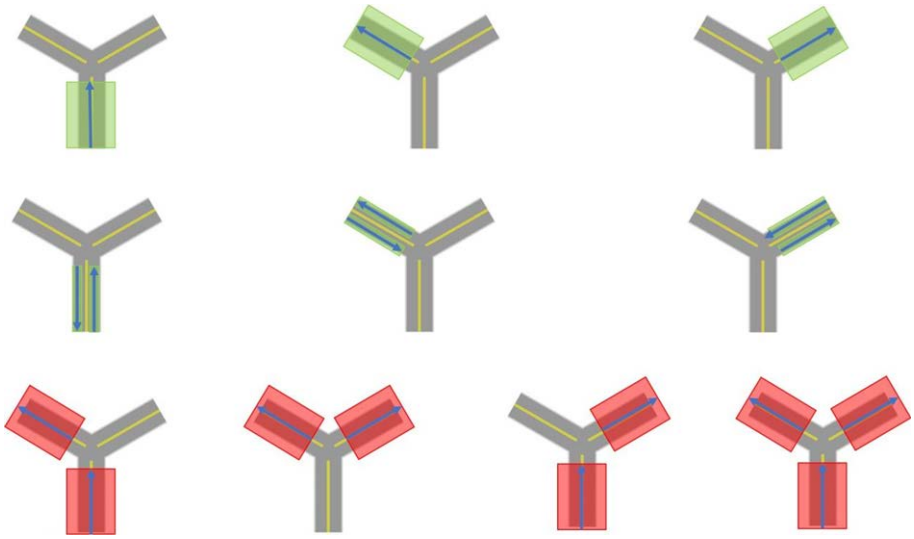


Fig. 77: AI-ROAD 3D Lane direction

AI-ROAD 3D - 3D Calibration

The 3D calibration is a procedure mandatory to enable the functionalities available in AI-Traffic. Since it is a crucial step of the configuration, it has been designed to be very easy for the user. All the parameters regarding the calibration are in the tabs “Calibration” and “3D calibration”.

IMPORTANT: set the real height of the camera (with respect to the road) in meters; an error on the configuration of this field negatively affects the results of the calibration procedure.

Then, the procedure includes the following three steps:

Step 1: Drawing of parallel lines along the road

Step 2: Drawing of parallel lines vertical (**Case A**) or crossroad (**Case B**)

Step 3: Configuration of camera parameters (**Case A**) or drawing of a reference line (**Case B**)

it may be comfortable to pause the video stream to simplify the configuration.

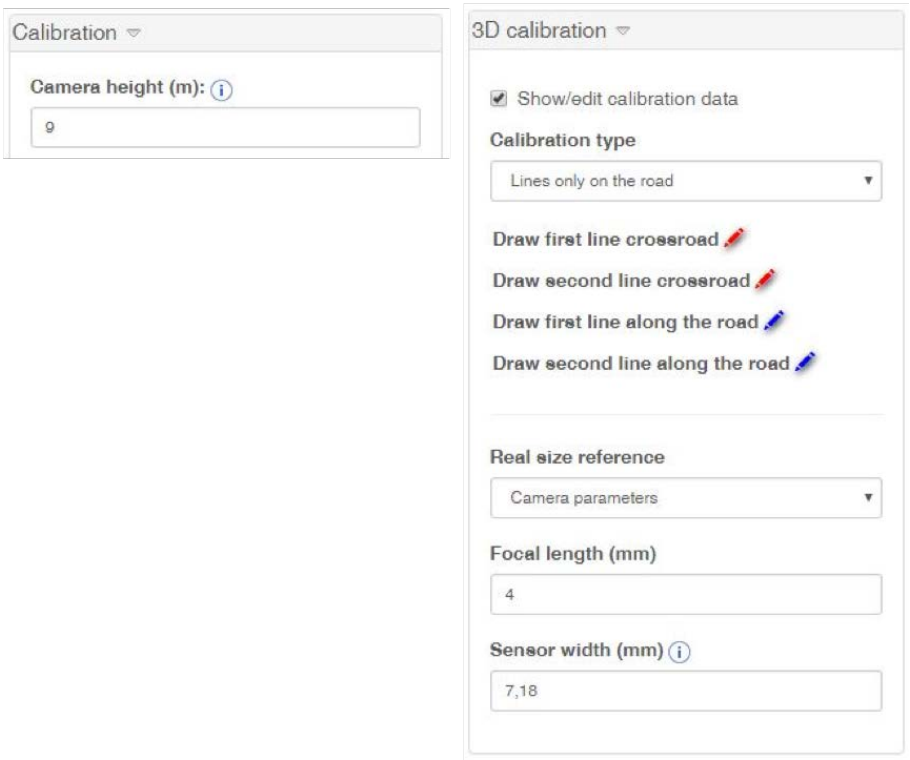


Fig. 78: 3D Calibration for AI-ROAD 3D

AI-ROAD 3D: 3D calibration – Step 1

Draw the parallel lines along the road (blue)

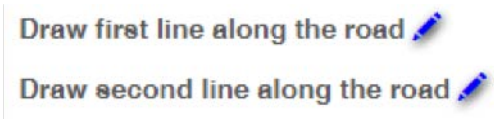


Fig. 79: Draw lines along the road

As shown in the image below, you can use the boundary lines of the carriageway or any other line parallel to the motion direction.

Be careful that the lines are drawn with accuracy, since an error in this step may negatively affect the results of the calibration.

Fig. 80: Draw parallel lines to define the road

AI-ROAD 3D: 3D calibration – Step 2 - Case A

Draw the parallel vertical lines (green)

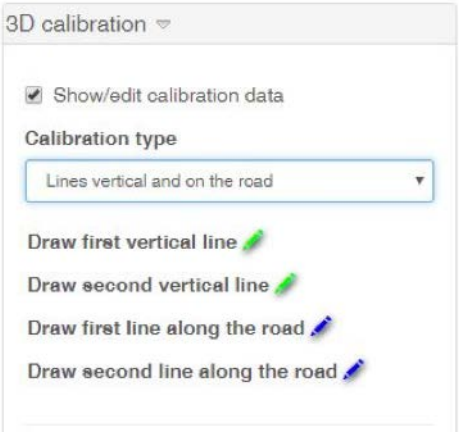


Fig. 81: Draw vertical lines for calibration

As shown in the image below, if there are vertical parallel lines (e.g. street lamps, buildings) you can use them to perform the step 2 of the calibration.

Be careful that the lines are drawn with accuracy, since an error in this step may negatively affect the results of the calibration.

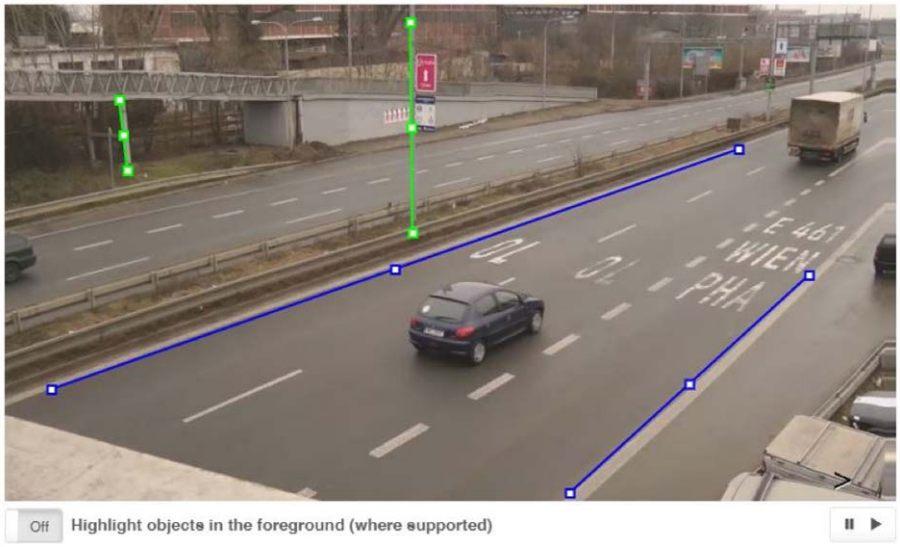


Fig. 82: Draw vertical lines to define the road

AI-ROAD 3D: 3D calibration – Step 2 - Case B

Draw the parallel lines crossroad (red)

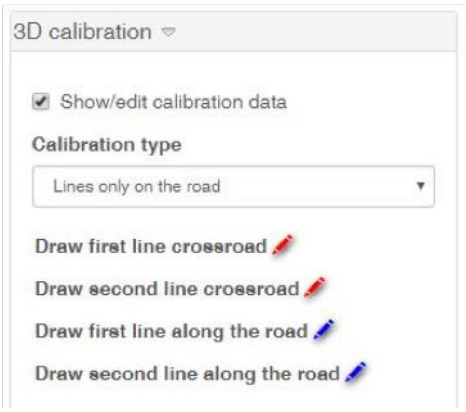


Fig. 83: Draw crossroad lines for calibration

In some cases are no vertical parallel lines available in the scene; thus, the plug-in must provide an alternative way to complete the calibration. As shown in the image on the right, in this case you can use parallel lines crossroad to perform the step 2 of the calibration. The easier way is to pause the video stream and to use the back of two vehicles as a reference; of course, if crossroad lines are available, it is better to use them.

Be careful that the lines are drawn with accuracy, since an error in this step may negatively affect the results of the calibration.

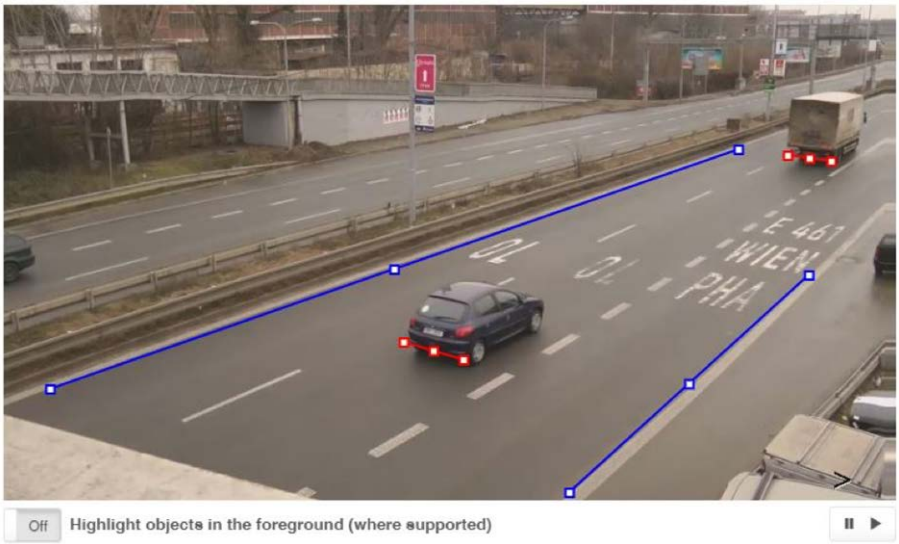


Fig. 84: Draw crossroad lines to define the road

AI-ROAD 3D: 3D calibration – Step 3 - Case A

This way to perform the calibration is the most accurate but it requires some attempts to find the right value of the focal length. Therefore AI-ROAD 3D: 3D calibration – Step 3 - Case B, p. 105 might be more comfortable.

Provide the camera lens parameters

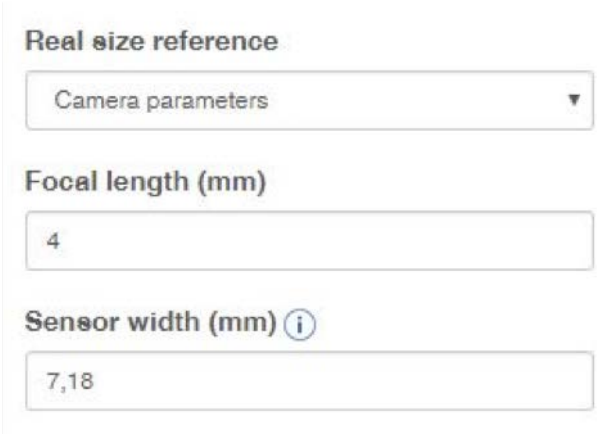


Fig. 85: Provide the camera lens parameters

Focal length: this value normally is provided on the cameras data sheet as a range between the minimum and the maximum focal length (e.g. 5.2-62.4 mm. For varifocal cameras the specific value depends on the zoom. Therefore, it is necessary to make a few attempts until you can find the right value in the.

Sensor width: This value can be obtained from the cameras data sheet and is given as a fraction of inches (e.g. 1/1.8’ is 7.18 mm)

A table for the conversion in millimeters is available here: https://en.wikipedia.org/wiki/Image_sensor_format.

AI-ROAD 3D: 3D calibration – Step 3 - Case B

This way to perform the calibration is the most comfortable but AI-ROAD 3D: 3D calibration – Step 3 - Case A, p. 104 in general is more accurate.

Draw a reference line (yellow) and give a reference length

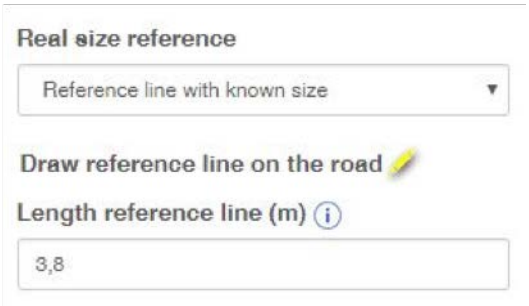


Fig. 86: Draw a reference line (yellow) and give a reference length

As shown in the image below, you can draw a reference line parallel to the motion direction and give the real length in meters of the line

Be careful that the lines are drawn with accuracy, since an error in this step may negatively affect the results of the calibration.

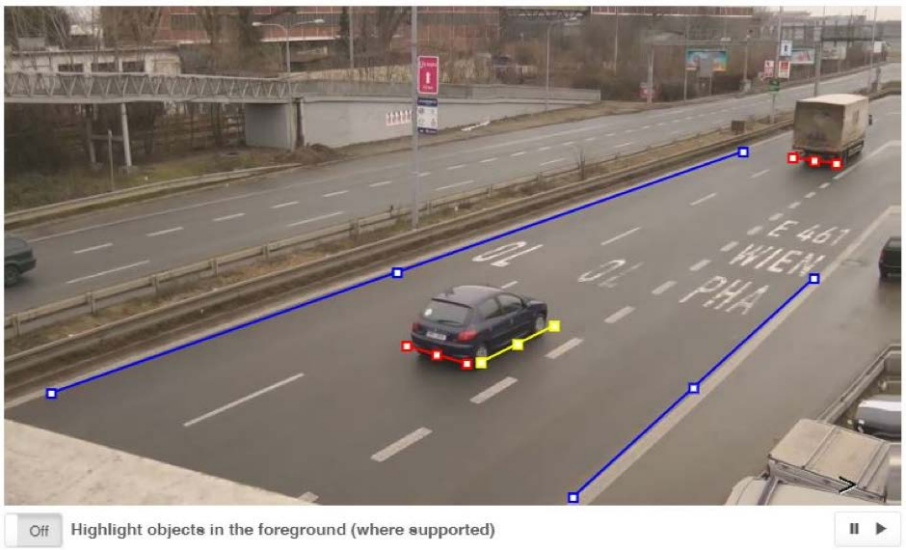


Fig. 87: Draw a reference line (yellow) and give a reference length

AI-ROAD 3D: 3D calibration examples

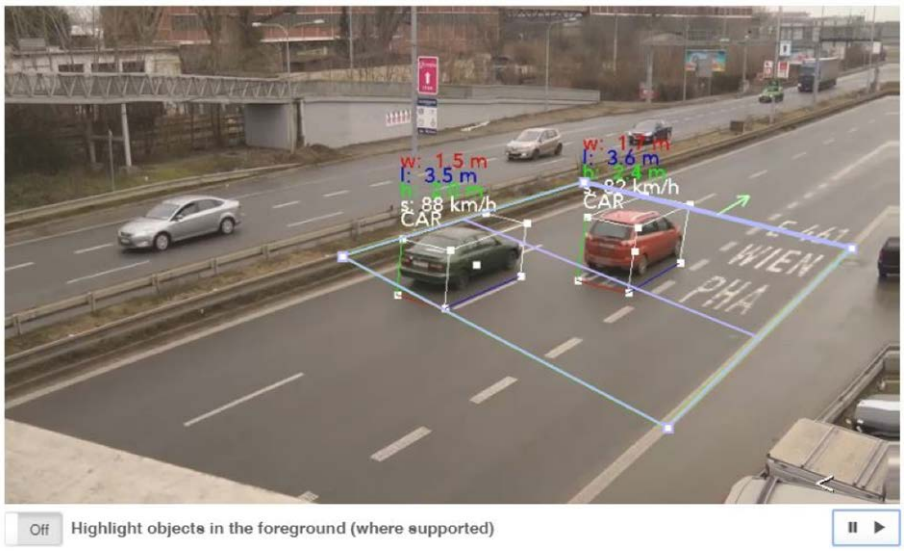


Fig. 88: AI-ROAD 3D calibration example 1

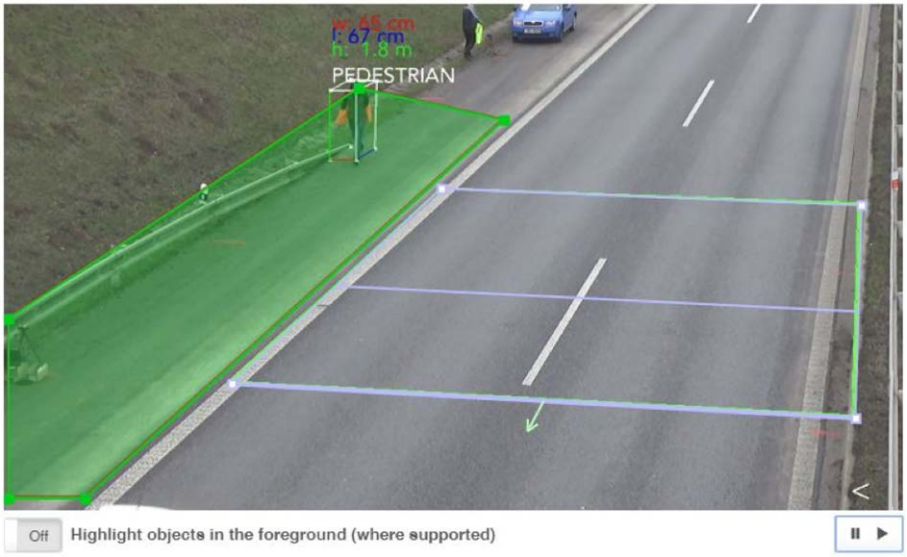


Fig. 89: AI-ROAD 3D calibration example 2

AI-ROAD 3D: 3D - troubleshooting

The considerations reported below allow to solve calibration issues only if the camera height is correct and all reference lines have been configured correctly. Otherwise it is necessary to rectify the configuration of these items.

Underestimation of values

Underestimation of the length, the width and the speed of the vehicle are typically due to an underestimation of the focal length.In this case **increase the value of the focal length**, remaining in the range reported on the camera data-sheet.

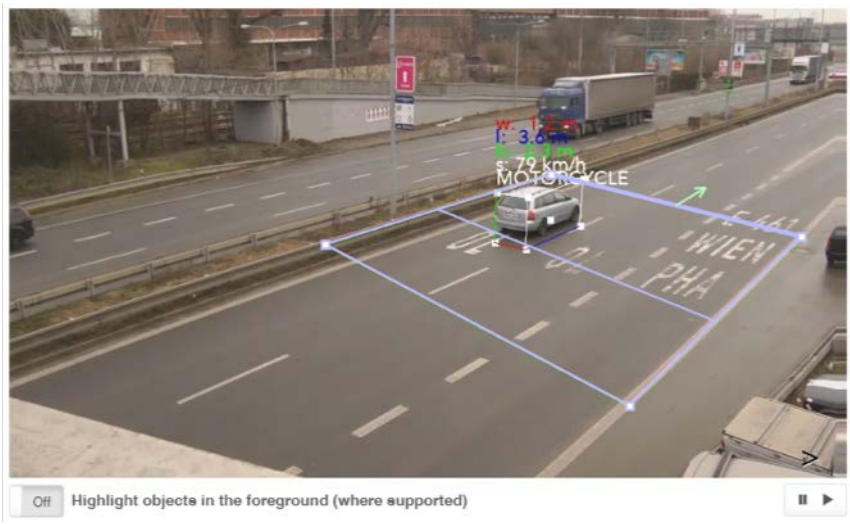


Fig. 90: AI-ROAD 3D underestimation of values

Overestimation of values

Overestimation of the length, the width and the speed of the vehicle are typically due to an overestimation of the focal length. In this case **decrease the value of the focal length**, remaining in the range reported on the camera data-sheet.

Fig. 91: AI-ROAD 3D overestimation of values

AI-INCIDENT

AI-INCIDENT is a video analytics app for monitoring the road traffic in real-time; thus, the environmental conditions will affect the performance of the application. It is able to detect the presence of pedestrians, stopped vehicles, queuing or vehicles crossing a road in the wrong direction. It generates events that can be managed by all the notification channels.

The accuracy to be expected is under ideal environmental and installation conditions

- Recall: 90%
- Precision: 95%

In our experiments, a vehicle crossing the road in the wrong way, a stopped vehicle, a pedestrian or a queue correctly detected by AI-Incident is considered a true positive; vice versa, it is a false negative. On the other hand, all these real events not detected by the algorithm are false positives.

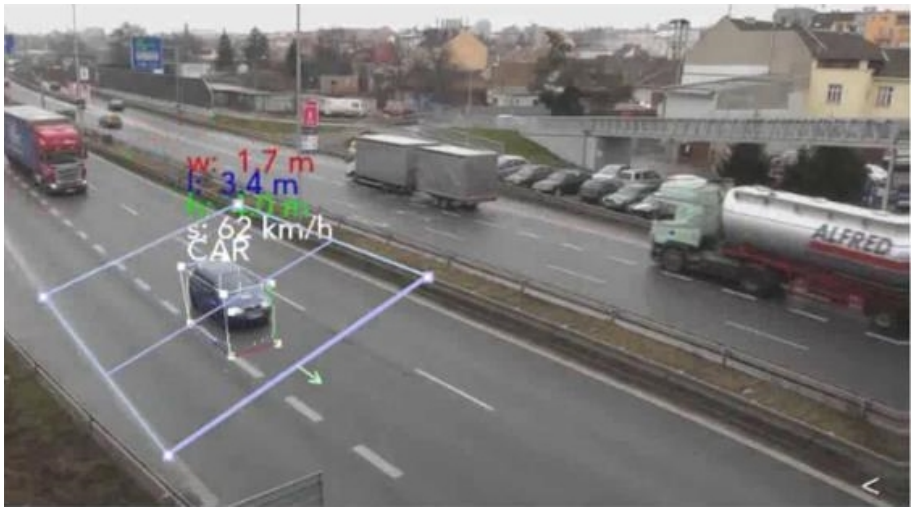


Fig. 92: AI-INCIDENT: configuration

Environment conditions

The position of the camera and the environmental conditions affect the performance of the application. Performance is best under the following conditions:

- The image must not present flickering, severe noise or artifacts.
- Image must have a resolution of 640x360, 640x480.
- Rotating (PTZ) security cameras are supported only if they are not moved when the application is enabled. If the camera is moved, the application must be reconfigured.
- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.
- Absence of conditions of high crowding or stopped people that do not allow to count the individuals.
- There must be no fog, clouds or other moving objects whose appearance is similar to the target in the areas of interest.

- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Absence of "waving objects" (e.g. Meadow with tall grass, trees, sliding doors, etc.) or any other type of disturbance that causes the continuous modification of the images (moving pixels) in the areas of interest.
- Camera placement must be stable and solid in a way that wind or external disturbances of other types will not cause movement of the camera that appears on the image
- Absence of vehicles with lights projected in areas of interest.
- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image. If necessary, the camera must be installed with external illuminators that make it possible to distinguish the people in all natural or artificial lighting conditions.
- The target must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the target is similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.
- The target must stay in the interested area for a time of at least 1 second.
- A vehicle must have a minimum area of 2500 pixels (e.g. 50x50), while a pedestrian must have a minimum area of 600 pixels (e.g. 15x40)s.
- The target must move at a maximum speed of half their width on the image per frame. For example, a target that is 40 pixels wide at 10 frames per second must move at a speed of no more than 20 pixels per frame, that is 200 pixel per second.
- The scene must be predominantly non-reflective.
- No hard lights must be present that cast shadows in a way that the background brightness is reduced to less than 50% of the original value in the image.
- In case of thermal cameras, the image must be not colored but in grayscale (white for “hot” pixels, black for “cold” pixels). The camera, thermal or monocular, must be always configured in order to avoid continuous changes of brightness.

Installation constraints

A camera usable for traffic monitoring with AI-INCIDENT must be installed as defined in AI-TRAFFIC - camera positions, p. 96.

8

AI-PARKING

AI-PARKING is the video analysis solution for monitoring parking areas, perimeter and non-perimeter. It assesses whether a parking spot is free or occupied. It needs information about the color, so a thermal camera is not suitable for this app. It generates events that can be managed by all the notification channels.

AI-PARKING - camera positions

A camera usable for traffic monitoring with AI-ROAD 3D (see AI-ROAD 3D, p. 97) must respect the following constraints:

1. The portion of each parking spot, without any occlusion due to other vehicles, must have minimum dimensions of 30x30px.

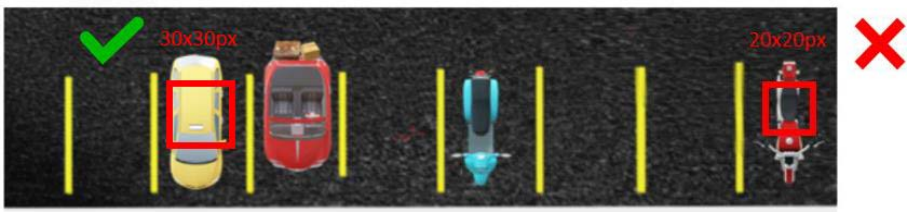


Fig. 93: AI-PARKING - Configuration of parking spots

AI-PARKING

The performance to be expected is under ideal environmental and installation conditions
Parking Spot (busy or free):

- Accuracy: 85%

Parking Lot (number of spots correctly classified):

- Accuracy: 90%

Fig. 94: AI-PARKING

Environment conditions

AI-PARKING is a video analytic app for monitoring outdoor parking areas; thus, the environmental conditions will affect the performance of the application:

- The image must not present flickering, severe noise or artifacts.
- Image must have a resolution of 640x360, 640x480.
- Rotating (PTZ) security cameras are supported only if they are not moved when the application is enabled. If the camera is moved, the application must be reconfigured.
- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.
- Absence of conditions of high crowding or stopped people that do not allow to count the individuals.
- There must be no fog, clouds or other moving objects whose appearance is similar to the smoke (e.g. white powder raised by the wind) in the areas of interest.

- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Absence of "waving objects" (e.g. Meadow with tall grass, trees, sliding doors, etc.) or any other type of disturbance that causes the continuous modification of the images (moving pixels) in the areas of interest.
- Camera placement must be stable and solid in a way that wind or external disturbances of other types will not cause movement of the camera that appears on the image.
- Absence of strong lights (e. g. vehicle lights) projected in areas of interest.
- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image. If necessary, the camera must be installed with external illuminators that make it possible to distinguish the people in all natural or artificial lighting conditions.
- The target must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the target is similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.
- The target must stay in the interested area for a time of at least 10 seconds.
- The target, or a piece of it, must have a minimum area of 900 pixels (e.g. 30x30) without occlusions.
- The scene must be predominantly non-reflective.
- No hard lights must be present that cast shadows in a way that the background brightness is reduced to less than 50% of the original value in the image.
- The camera must be always configured in order to avoid continuous changes of brightness.

Required configuration

AI-PARKING must be configured according to the following guidelines:

1. Draw a square sensor for each parking spot, being careful that every area can not be occluded by vehicles parked in different spots.
2. Specify the confidence, the latency and the inhibition for the detection of parked vehicles.
3. Configure at least one event manager to collect the events.
4. If needed, schedule the applications in specific time intervals.

Fig. 95: Example of AI-PARKING output

9

AI-BIO

AI-BIO is an app for recognizing the gender and estimating the age of a person by analyzing the face. The plug ins also provides information about the persistence time of an individual in front of the camera and it is able to send notifications useful for digital signage. It generates events that can be managed by all the notification channels.

AI-BIO - camera positions

- Install the camera in front of the person at a recommended height of 1.8 m.
- Install the camera in a place that attracts the glance of the person, in order to obtain a frontal view of the face.
- Install the camera at a distance that allows to obtain the face on the image with an horizontal resolution at least of 30 pixels.
- Install the camera with a good lighting in order to obtain well visible facial landmarks

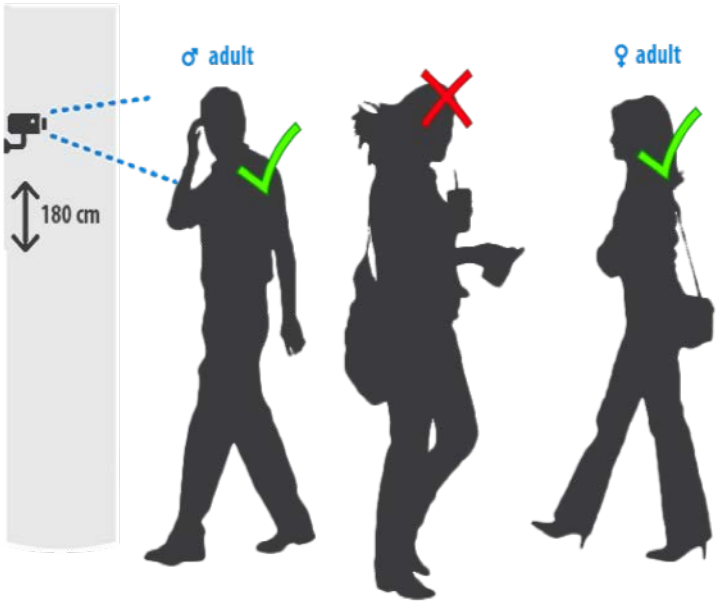


Fig. 96: Camera position

Recommended distances

Distance (cm)	Real width (cm)	Pixel / cm	Face width (cm)
100	140,0	2,3	37
200	280,1	1,1	18
300	420,1	0,8	12
400	560,2	0,6	9
500	700,2	0,5	7
600	840,2	0,4	6
700	980,3	0,3	5
800	1120,3	0,3	5
900	1260,4	0,3	4
1000	1400,4	0,2	4

AI-BIO

AI-BIO is an app for recognizing the gender and estimating the age of a person by analyzing the face. The plug ins also provides information about the persistence time of an individual in front of the camera and it is able to send notifications useful for digital signage. It generates events that can be managed by all the notification channels.

AI-BIO is a video analytic app optimized to analyze the faces in typical retail scenarios; of course, the position of the camera and the environmental conditions will affect the performance of the application.

The performance to be expected is under ideal environmental and installation conditions

Gender recognition:

- Accuracy: 90%

Age estimation:

- MAE (Mean Average Error): 10 years
- Accuracy (age groups child, young, adult, elder): 80%

Environment conditions

The position of the camera and the environmental conditions affect the performance of the application. Performance is best under the following conditions:

- The image must not present flickering, severe noise or artifacts.
- Image must have a resolution of 640x360, 640x480, 320x180, 320x240.
- Rotating (PTZ) security cameras are supported only if they are not moved when the application is enabled. If the camera is moved, the application must be reconfigured.
- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.
- Absence of conditions of high crowding or stopped people that do not allow to count the individuals.
- Absence of stationary or slow-moving people for long periods in the counting area (e.g. Sales people that encourage customers to enter).
- There must be no other moving objects whose appearance is similar to the people in the areas of interest.
- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Absence of "waving objects" (e.g. Meadow with tall grass, trees, sliding doors, etc.) or any other type of disturbance that causes the continuous modification of the images (moving pixels) in the areas of interest.
- Camera placement must be stable and solid in a way that wind or external disturbances of other types will not cause movement of the camera that appears on the image.
- Absence of vehicles with lights projected in areas of interest.

- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image. If necessary, the camera must be installed with external illuminators that make it possible to distinguish the people in all natural or artificial lighting conditions.
- The people must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the people are similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.
- The people must have a minimum area of 600 pixels (e.g. 20x30, 15x40, ...).
- The floor must be a predominantly non-reflective surface.
- No hard lights must be present that cast shadows in a way that the background brightness is reduced to less than 50% of the original value in the image.

10

AI-OCCUPANCY

AI-OCCUPANCY is the video analysis app for the determination of the occupancy percentage of one or more areas inside the scene, thus allowing to distinguish between the most visited areas (hot spots) and the less crowded ones (dead areas) in indoor and outdoor environments. It generates periodic events that can be managed by AI-Dash, AI-Dashboard embedded, FTP servers and Third-Party servers. It can be used also with thermal cameras.

AI-OCCUPANCY - camera positions

A camera that can be used to determine the occupancy percentage using AI-OCCUPANCY must respect the following constraints:

- Make sure the size of the targets (people, vehicles, animals) have a minimum area of 100 pixels.
- If necessary, the camera should be mounted with external illuminators, to distinguish the targets with natural or artificial illumination.

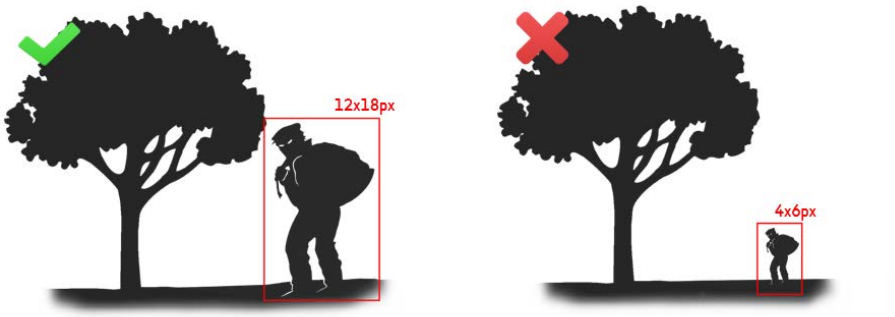


Fig. 97: Camera positions

AI-OCCUPANCY

Fig. 98: AI-OCCUPANCY

Environment conditions

AI-OCCUPANCY is a video analytic app for monitoring outdoor parking areas; thus, the environmental conditions will affect the performance of the application:

- The image must not present flickering, severe noise or artifacts.
- Image must have a resolution of 640x360, 640x480, 320x240, 320x180.
- Rotating (PTZ) security cameras are supported only if they are not moved when the application is enabled. If the camera is moved, the application must be reconfigured.
- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.

- There must be no fog, clouds or other moving objects whose appearance is similar to the smoke (e.g. white powder raised by the wind) in the areas of interest.
- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Absence of "waving objects" (e.g. Meadow with tall grass, trees, sliding doors, etc.) or any other type of disturbance that causes the continuous modification of the images (moving pixels) in the areas of interest.
- Camera placement must be stable and solid in a way that wind or external disturbances of other types will not cause movement of the camera that appears on the image.
- Absence of strong lights (e. g. vehicle lights) projected in areas of interest.
- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image. If necessary, the camera must be installed with external illuminators that make it possible to distinguish the people in all natural or artificial lighting conditions.
- The target must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the target is similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.
- The scene must be predominantly non-reflective.
- No hard lights must be present that cast shadows in a way that the background brightness is reduced to less than 50% of the original value in the image.
- In case of thermal cameras, the image must be not colored but in grayscale (white for “hot” pixels, black for “cold” pixels). The camera, thermal or monocular, must be always configured in order to avoid continuous changes of brightness.

Required configuration

AI-OCCUPANCY must be configured according to the following guidelines:

1. Draw a sensor.
2. Configure the sensors so as to include only "walkable" areas, namely those areas of the image where people, objects or animals may be present. The presence of inanimate objects in the areas of interest, in fact, causes an inevitable underestimation of the occupancy percentage.
3. Configuration of the observation period (please consult the manual for further information).
4. Configure the parameters for background updating, for the application of the morphological operators, for detecting brightness changes and for removing shadows, in order to detect the objects of interest.

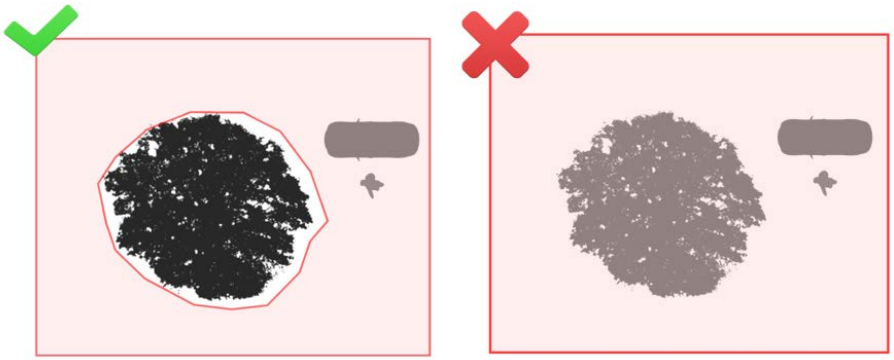


Fig. 99: Example of correct and wrong sensor positioning

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AI-OVEROCCUPANCY

AI-OVEROCCUPANCY is the video analysis app for the detection of overoccupancy in one or more areas inside the scene in indoor and outdoor environments. It generates events that can be managed by all the event notifiers. It can be used also with thermal cameras.

AI-OVEROCCUPANCY - camera positions

A camera that can be used to determine the occupancy percentage using AI-OVEROCCUPANCY must respect the following constraints:

- Make sure the size of the targets (people, vehicles, animals) have a minimum area of 100 pixels.
- If necessary, the camera should be mounted with external illuminators, to distinguish the targets with natural or artificial illumination.

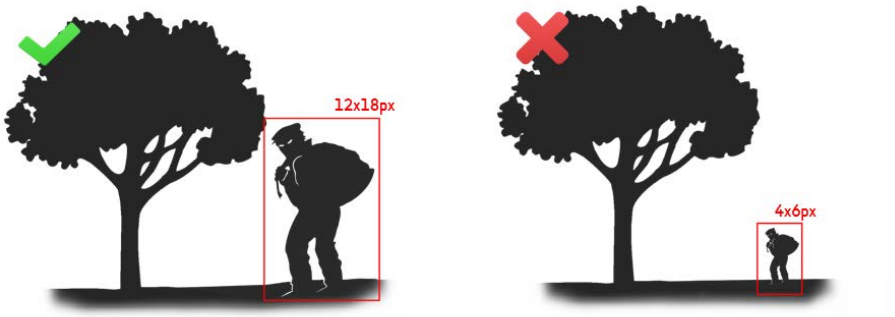
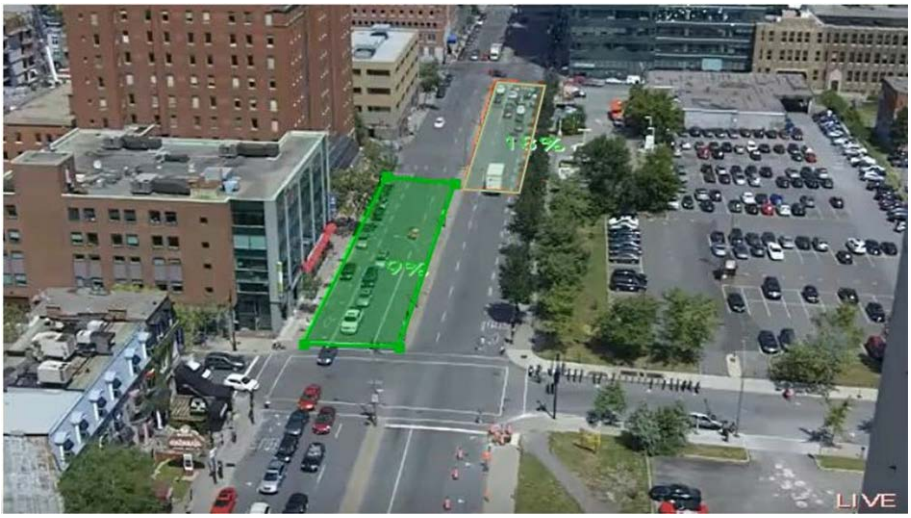


Fig. 100: Camera positions

AI-OVEROCCUPANCY



AI-OVEROCCUPANCY

Environment conditions

AI-OVEROCCUPANCY is a video analytic app for monitoring outdoor parking areas; thus, the environmental conditions will affect the performance of the application:

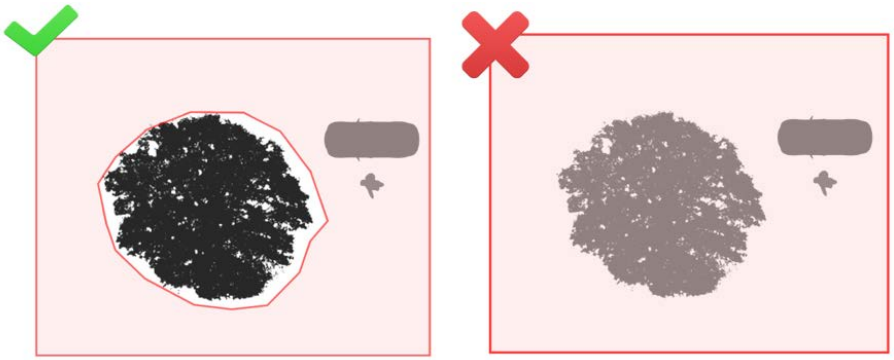
- The image must not present flickering, severe noise or artifacts.
- Image must have a resolution of 640x360, 640x480, 320x240, 320x180.
- Rotating (PTZ) security cameras are supported only if they are not moved when the application is enabled. If the camera is moved, the application must be reconfigured.
- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.

- There must be no fog, clouds or other moving objects whose appearance is similar to the smoke (e.g. white powder raised by the wind) in the areas of interest.
- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Absence of "waving objects" (e.g. Meadow with tall grass, trees, sliding doors, etc.) or any other type of disturbance that causes the continuous modification of the images (moving pixels) in the areas of interest.
- Camera placement must be stable and solid in a way that wind or external disturbances of other types will not cause movement of the camera that appears on the image.
- Absence of strong lights (e. g. vehicle lights) projected in areas of interest.
- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image. If necessary, the camera must be installed with external illuminators that make it possible to distinguish the people in all natural or artificial lighting conditions.
- The target must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the target is similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.
- The scene must be predominantly non-reflective.
- No hard lights must be present that cast shadows in a way that the background brightness is reduced to less than 50% of the original value in the image.
- In case of thermal cameras, the image must be not colored but in grayscale (white for “hot” pixels, black for “cold” pixels). The camera, thermal or monocular, must be always configured in order to avoid continuous changes of brightness.

Required configuration

AI-OVEROCCUPANCY must be configured according to the following guidelines:

1. Draw a sensor.
2. Configure the sensors so as to include only "walkable" areas, namely those areas of the image where people, objects or animals may be present. The presence of inanimate objects in the areas of interest, in fact, causes an inevitable underestimation of the occupancy percentage.
3. Configuration of the observation period (please consult the manual for further information).
4. Configure the parameters for background updating, for the application of the morphological operators, for detecting brightness changes and for removing shadows, in order to detect the objects of interest.



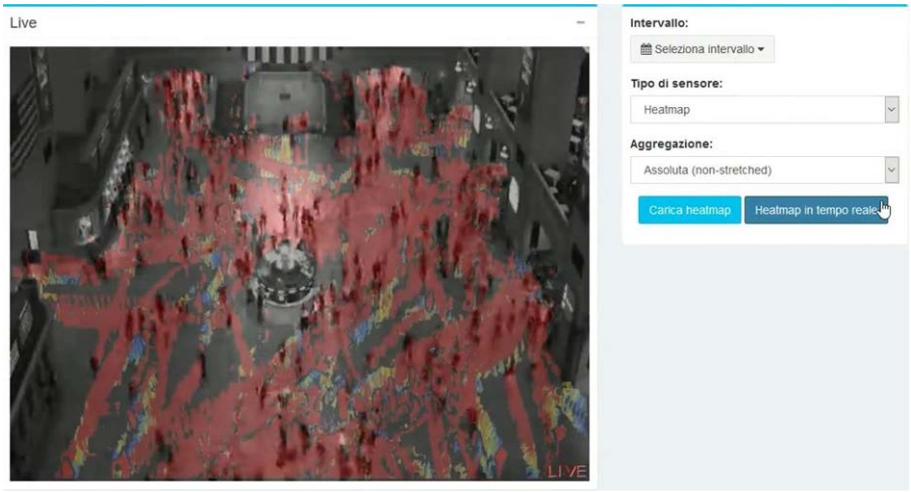
Example of correct and wrong sensor positioning

12

AI-HEAT

AI-HEAT is an app for classifying the areas depending on the time spent by moving people inside the areas of interest, thus allowing to distinguish between the most visited areas (hot spots) and the less crowded ones (dead areas) in indoor and outdoor environments. It generates periodic heat maps that can be managed by AI-Dash and AI-Dash Embedded. It can be used also with thermal and fish eye cameras.

AI-HEAT



AI-HEAT

Environment conditions

AI-HEAT is a video analytic plug-in able to compute the heat map in indoor and outdoor environments. Performance is best under the following conditions:

- The image must not present flickering, severe noise or artifacts.
- Image must have a resolution of 640x360, 640x480, 320x240, 320x180.
- Rotating (PTZ) security cameras are supported only if they are not moved when the application is enabled. If the camera is moved, the application must be reconfigured.
- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.
- There must be no fog, clouds or other moving objects whose appearance is similar to the smoke (e.g. white powder raised by the wind) in the areas of interest.
- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Absence of "waving objects" (e.g. Meadow with tall grass, trees, sliding doors, etc.) or any other type of disturbance that causes the continuous modification of the images (moving pixels) in the areas of interest.
- Camera placement must be stable and solid in a way that wind or external disturbances of other types will not cause movement of the camera that appears on the image.
- Absence of strong lights (e. g. vehicle lights) projected in areas of interest.
- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image. If necessary, the camera must be installed with external

illuminators that make it possible to distinguish the people in all natural or artificial lighting conditions.

- The target must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the target is similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.
- The scene must be predominantly non-reflective.
- No hard lights must be present that cast shadows in a way that the background brightness is reduced to less than 50% of the original value in the image.
- In case of thermal cameras, the image must be not colored but in grayscale (white for “hot” pixels, black for “cold” pixels). The camera, thermal or monocular, must be always configured in order to avoid continuous changes of brightness.

If necessary, the camera must be installed with external illuminators that make it possible to distinguish the targets in all natural or artificial lighting conditions.

Required configuration

AI-HEAT must be configured according to the following guidelines:

1. Draw non interest areas, so as to exclude regions in constant motion (screen, cash and so on).
2. Configuration of the time interval between consecutive events.
3. Configuration of the heating and cooling time.
4. Configure the parameters for background updating, for the application of the morphological operators, for detecting brightness changes and for removing shadows, in order to detect the objects of interest.

13

AI-SPILL

AI-SPILL is an app for detecting falls in indoor environments like hospitals or apartments. It generates events that can be managed by all the notification channels. Since the plug-in uses information about the color, thermal cameras are not allowed.

AI-SPILL

The performance to be expected is under ideal environmental and installation conditions

- Recall: 90%

Environment conditions

AI-Spill is a video analytic plug-in able to detect falls in indoor environments. Performance is best under the following conditions:

- The image must not present flickering, severe noise or artifacts.
- Image must have a resolution of 640x360, 640x480, 320x240, 320x180.
- Rotating (PTZ) security cameras are supported only if they are not moved when the application is enabled. If the camera is moved, the application must be reconfigured.

- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.
- Absence of conditions of high crowding or stopped people that do not allow to count the individuals.
- There must not be moving objects whose appearance is similar to the target in the areas of interest.
- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Absence of "waving objects" (e.g. Meadow with tall grass, trees, sliding doors, etc.) or any other type of disturbance that causes the continuous modification of the images (moving pixels) in the areas of interest.
- Camera placement must be stable and solid in a way that wind or external disturbances of other types will not cause movement of the camera that appears on the image.
- Absence of strong lights projected in areas of interest.
- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image. If necessary, the camera must be installed with external illuminators that make it possible to distinguish the people in all natural or artificial lighting conditions.
- The people must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the people are similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.
- The target must stay in the interested area for a time of at least 5 seconds.
- The target must have a minimum area of 600 pixels (e.g. 15x40).
- The target must move at a maximum speed of half their width on the image per frame. For example, a target that is 40 pixels wide at 10 frames per second must move at a speed of no more than 20 pixels per frame, that is 200 pixel per second.
- The floor must be a predominantly non-reflective surface.
- No hard lights must be present that cast shadows in a way that the background brightness is reduced to less than 50% of the original value in the image.
- The camera must be always configured in order to avoid continuous changes of brightness.

Required configurations

AI-SPILL must be configured according to the following guidelines:

1. Draw a sensor
2. If you want to avoid multiple alarms for the same event, increase the inhibition time
3. Configure the entrance areas so as to consider only the objects that pass through specific areas of the image
4. Configure the minimum and maximum pixel size of an object of interest
5. Calibrate the camera by correctly specifying height, horizontal angle of view and vertical angle of view

6. Calibrate the algorithm by correctly specifying the inclination angle of the camera and the training samples
7. Configure the parameters for background updating, for the application of the morphological operators, for detecting brightness changes and for removing shadows, in order to detect the objects of interest
8. Configure at least one event manager to collect the events
9. If needed, schedule the applications in specific time intervals

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AI-SMOKE

AI-SMOKE is an app for the detection of smoke in outdoor environments, such as urban forests, parks and so on. It generates events that can be managed by all the notification channels. It uses information about the color, so it cannot be used with thermal cameras; for the same reason, the performance may decrease during the night.

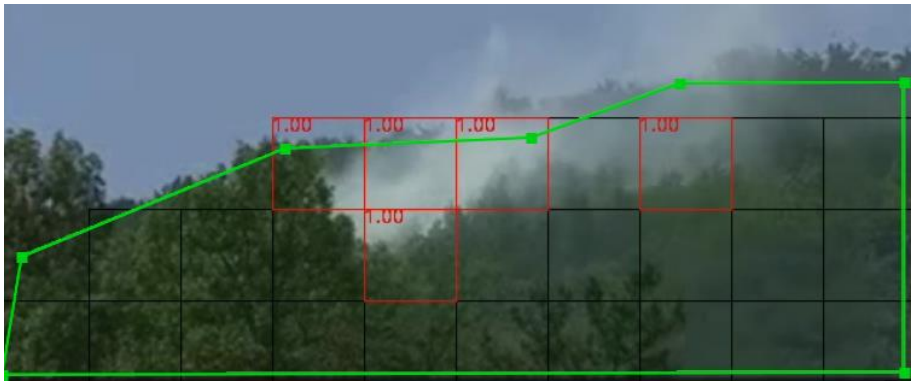
AI-SMOKE

The video-wise performance to be expected is under ideal environmental and installation conditions

- Recall: 95%
- Precision: 75%

Video-wise means that a smoke detected in a video in which there is smoke is considered a true positive; vice versa, a smoke not detected it is considered a false negative. On the other hand, a smoke detected in a video where there is not a smoke is considered a false positive; vice versa, a smoke not detected is considered a true negative.

Recall and Precision have been computed following this experimental protocol.



AI-SMOKE

Environment conditions

AI-SMOKE is an app for the detection of smoke in outdoor environments, such as urban forests, parks etc.. Performance is best under the following conditions:

- The image must not present flickering, severe noise or artifacts.
- Image must have a resolution of 640x360 or 640x480.
- Rotating (PTZ) security cameras are supported only if they are not moved when the application is enabled. If the camera is moved, the application must be reconfigured.
- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.
- Absence of conditions of high crowding or stopped people that do not allow to count the individuals.
- There must be no fog, clouds or other moving objects whose appearance is similar to the smoke (e.g. white powder raised by the wind) in the areas of interest.
- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Absence of "waving objects" (e.g. Meadow with tall grass, trees, sliding doors, etc.) or any other type of disturbance that causes the continuous modification of the images (moving pixels) in the areas of interest.
- Camera placement must be stable and solid in a way that wind or external disturbances of other types will not cause movement of the camera that appears on the image.
- Absence of strong lights (e. g. vehicle lights) projected in areas of interest.
- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image. If necessary, the camera must be installed with external illuminators that make it possible to distinguish the people in all natural or artificial lighting conditions.
- The smoke must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the smoke is similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.

- The smoke must stay in the interested area for a time of at least 5 seconds.
- The smoke must have a minimum area of 600 pixels (15% of the cell of the grid).
- The smoke must move at a maximum speed of half their width on the image per frame. For example, a smoke that is 40 pixels wide at 10 frames per second must move at a speed of no more than 20 pixels per frame, that is 200 pixel per second.
- The scene must be predominantly non-reflective.
- No hard lights must be present that cast shadows in a way that the background brightness is reduced to less than 50% of the original value in the image.

Required configuration

AI-SMOKE must be configured according to the following guidelines:

1. Draw a sensor and configure a latency time of at least 5 seconds.
2. If you want to avoid multiple alarms for the same smoke, increase the inhibition time.
3. Enable the flag “Verify smoke”.
4. Configure the movement threshold (recommended value 0.15) and the classification sensitivity (recommended value 0.85).
5. Configure the parameters for background updating, for the application of the morphological operators, the RGB threshold (recommended value 18) and the saturation threshold (recommended value 51) to detect moving objects like smoke.
6. Configure at least one event manager to collect the events.
7. If needed, schedule the applications in specific time intervals

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AI-FIRE

AI-FIRE is an app for the detection of flames in outdoor environments, such as urban forests, parks and so on. It generates events that can be managed by all the notification channels. It uses information about the color, so it cannot be used with thermal cameras; for the same reason, the performance may decrease during the night.

AI-FIRE

The video wise performance to be expected is under ideal environmental and installation conditions

- Recall: 95%
- Precision: 80%

Video-wise means that a flame detected in a video in which there is flame is considered a true positive; vice versa, a flame not detected it is considered a false negative. On the other hand, a flame detected in a video where there is not a flame is considered a false positive; vice versa, a flame not detected is considered a true negative.

Recall and Precision have been computed following this experimental protocol.

AI-FIRE

Environment conditions

AI-Spill is a video analytic plug-in able to detect falls in indoor environments. Performance is best under the following conditions:

- The image must not present flickering, severe noise or artifacts.
- Image must have a resolution of 640x360 or 640x480.
- Rotating (PTZ) security cameras are supported only if they are not moved when the application is enabled. If the camera is moved, the application must be reconfigured.
- Absence of occlusions (E. g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the people.
- Absence of conditions of high crowding or stopped people that do not allow to count the individuals.
- There must be no fog, clouds or other moving objects whose appearance is similar to the smoke (e.g. white powder raised by the wind) in the areas of interest.
- Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.
- Absence of "waving objects" (e.g. Meadow with tall grass, trees, sliding doors, etc.) or any other type of disturbance that causes the continuous modification of the images (moving pixels) in the areas of interest.
- Camera placement must be stable and solid in a way that wind or external disturbances of other types will not cause movement of the camera that appears on the image.
- Absence of strong lights (e. g. vehicle lights) projected in areas of interest.
- Correct exposition of the camera: camera must not be in backlight, the framed area must not have heterogeneous illumination, i.e. partially indoor or partially outdoor. In general, no areas to be monitored must be almost white or almost black, i.e. the dynamic range must be sufficient to correctly show detail of objects in the image. If necessary, the camera must be installed with external illuminators that make it possible to distinguish the people in all natural or artificial lighting conditions.
- The smoke must have a sufficient dissimilarity from the background, i.e. there is no explicit camouflage, where the smoke is similar to the background in color and texture. Sufficient dissimilarity means at least a color difference of at least 5% or a brightness difference of at least 10%.

- The smoke must stay in the interested area for a time of at least 5 seconds.
- The smoke must have a minimum area of 600 pixels (15% of the cell of the grid).
- The smoke must move at a maximum speed of half their width on the image per frame. For example, a smoke that is 40 pixels wide at 10 frames per second must move at a speed of no more than 20 pixels per frame, that is 200 pixel per second.
- The scene must be predominantly non-reflective.
- No hard lights must be present that cast shadows in a way that the background brightness is reduced to less than 50% of the original value in the image.

Required configuration

AI-FIRE must be configured according to the following guidelines:

1. Draw a sensor and configure a latency time of at least 5 seconds.
2. If you want to avoid multiple alarms for the same smoke, increase the inhibition time.
3. Enable the flag “Verify fire”.
4. Configure the verification sensitivity (recommended value 0.85).
5. Configure the parameters for background updating, for the application of the morphological operators, and the fire detection threshold (recommended value 40) to detect moving objects like flames.
6. Configure the minimum and the maximum size in pixels of a flame.
7. if you are framing a scene with an extended depth of field, calibrate the camera and the algorithm and configure the minimum and maximum real size of a flame.
8. Configure at least one event manager to collect the events.
9. If needed, schedule the applications in specific time intervals.

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List of figures