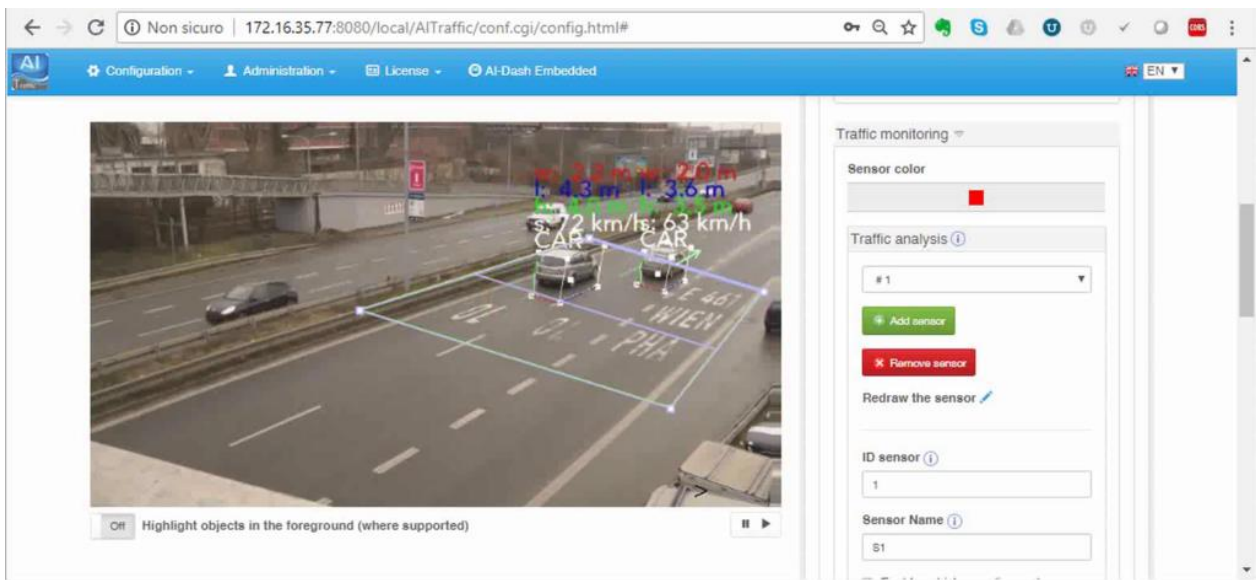# AI-ROAD 3D

AI-Road 3D is the plugin for the collection of the statistics about the traffic of vehicles on a road. It detects, counts and classifies vehicles, estimates their speed and the traffic density. It generates events that can be managed by all the notification channels.

Environmental conditions

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

Therefore, the performance is maximum in the following conditions:

1. The image must not present flickering, severe noise or artifacts. Image must have a resolution of 640x360, 640x480.
2. 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.
3. Absence of occlusions (E.g. Trees, pillars, buildings, furniture elements etc.) that do not allow to see the target.
4. Absence of conditions of high crowding that do not allow to distinguish the target from the rest of the scene.
5. There must be no fog, clouds or other moving objects whose appearance is similar to the target in the areas of interest.
6. Camera lens must not be dirty, wet or covered in rain or water drops. Camera lens must not be steamy.

7. Absence of "waving objects" (e.g. Meadow with tall grass, trees etc.) or any other type of disturbance that causes the continuous modification of the images (moving pixels) in the areas of interest.

8. Camera placement must be stable and solid in a way that wind or external disturbances of other types will cause movement of the camera that appears on the image.

9. Absence of vehicles with lights projected towards the camera

10. 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

11. 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%.

12. The target must stay in the interested area for a time of at least 1 second.

13. The target must have a minimum area of 2500 pixels (e.g. 50x50).

14. 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.

15. The scene must be predominantly non-reflective.

16. 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.

17. In case of thermal cameras, the image must be not coloured 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-Road 3D must respect the following constraints:

1. It must be installed respecting the constraints represented in Figure 1
2. It must be installed respecting the constraints represented in Figure 2
3. It 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.
4. It should be a varifocal camera for outdoor environments.
5. It should frame the vehicles from behind, so as to avoid the negative effect of the headlights.
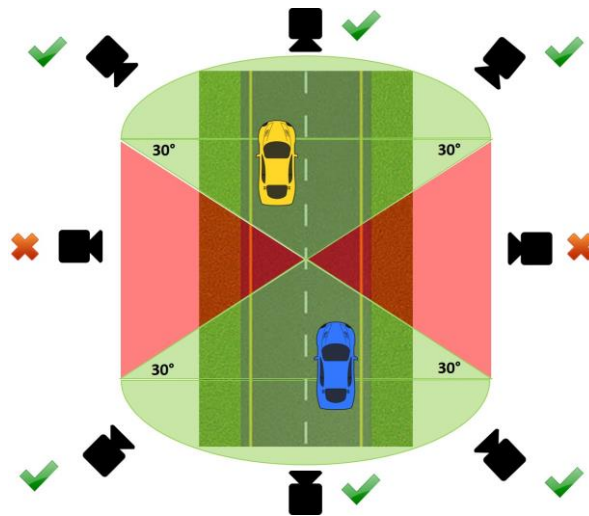
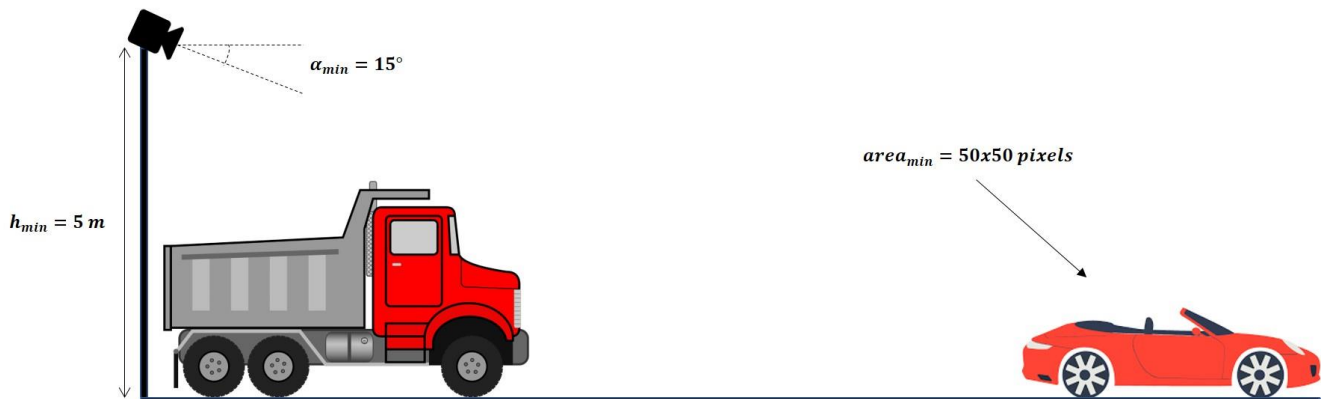*Figure 1 – Correct and wrong camera installation examples (green correct, red wrong)*

Figure 2 – Constrains on the camera installation, in terms of minimum height and inclination angle

Required configurations

AI-Road 3D must be configured according to the following guidelines:

1. Configuration of the sensors and enabling of the desired functionalities (counting and classification, high speed control, traffic density estimation)
2. Configure the minimum and maximum pixel size of a vehicle
3. Calibration of the camera by correctly specifying the height
4. 3D Calibration of the algorithm by correctly drawing the reference lines and/or properly setting the focal length and the sensor dimension

5. Configuration of the parameters for background updating, for the extraction of the foreground mask, for the application of morphological operators, for tracking, for detecting brightness changes and for removing shadows in order to detect objects of interest
6. Sensors can be configured only on straight roads (Figure 3)
7. Sensors can be configured only on roads or lanes oriented in the same direction of the reference lines, not in different ones (Figure 4)
8. Configure at least one event manager to collect the events
9. If needed, schedule the applications in specific time intervals
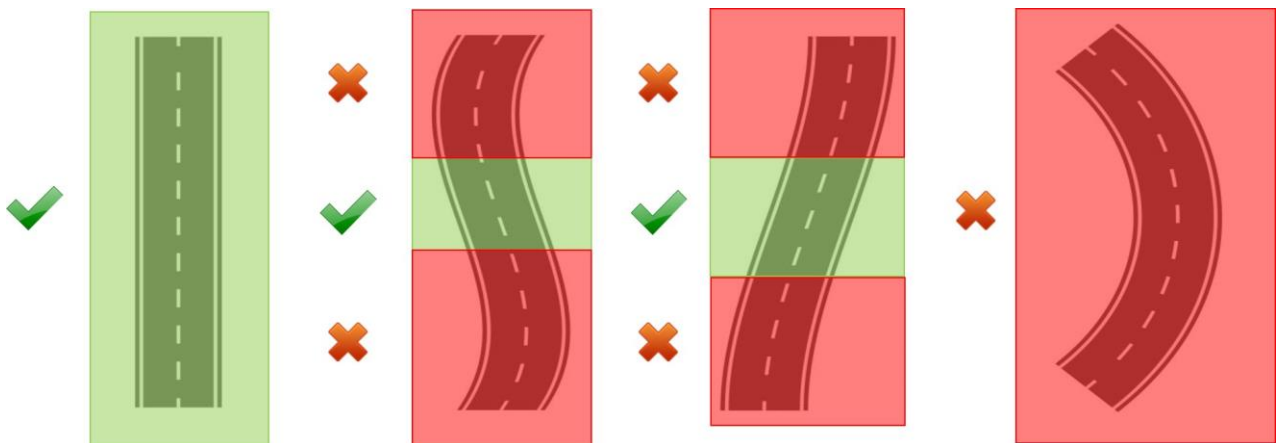
Figura 3 – Configuration of sensors on straight roads (green correct, red wrong)
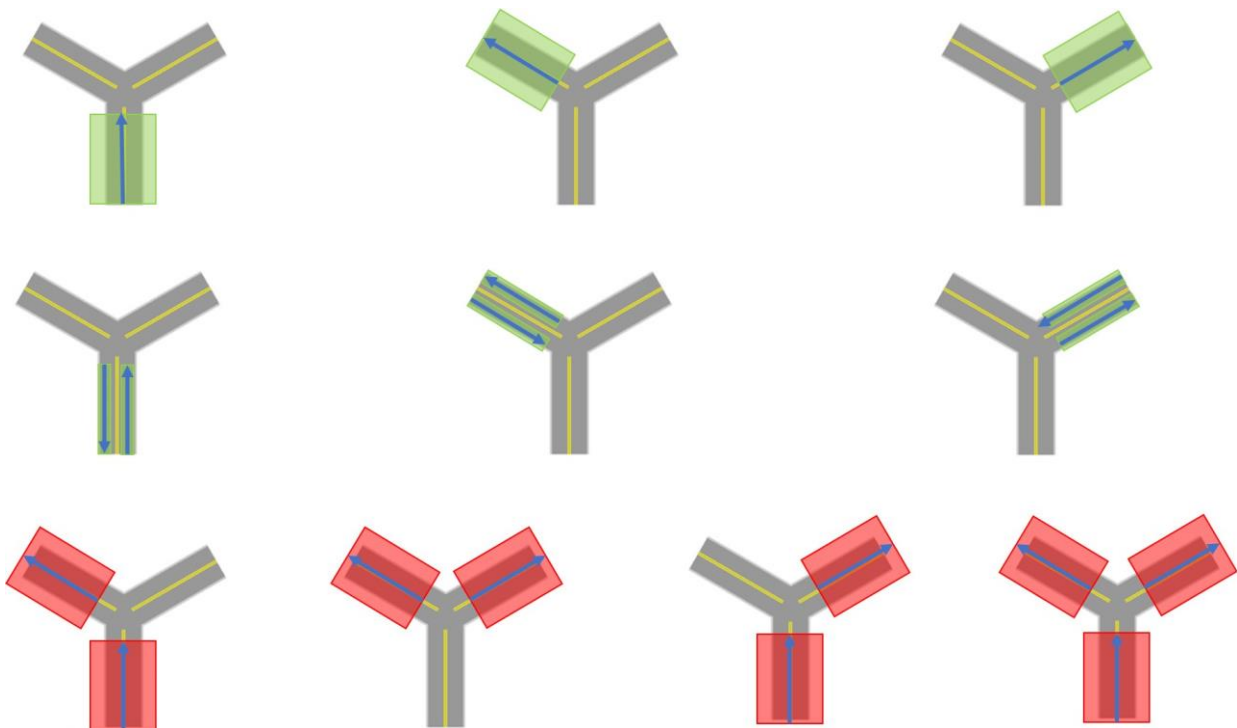
Figura 4 – Configuration of sensors on different roads or lanes (green correct, red wrong)

Expected performance

Whether the environmental conditions and the installation constraints are respected, the expected performance of AI-Road 3D is the following:

- Vehicle Detection:
  - Recall: 90%
  - Precision: 95%
- Vehicle Classification:
  - Motorcycle Accuracy: 75%
  - Car Accuracy: 95%
  - Truck Accuracy: 85%

In our experiments, a vehicle passed through the sensor and counted by AI-Road 3D is considered a true positive; viceversa, it is a false negative. On the other hand, a vehicle counted by the algorithm but not passed through the sensor is a false positive.

Declaration of responsibility

A.I. Tech is responsible only for the defects of the software delivered by A.I. Tech. A.I. Tech is not responsible for third party software and hardware. In particular, A.I. Tech disclaims any responsibility related to the infrastructure and the hardware of the systems: any defect related to power supply, network infrastructure, physical installation of cameras and processing units is under the responsibility the hardware manufacturer and the installer of the system.

In edge-side installations, all the issues and defects related to the cameras (anomalous restarts, video streaming suddenly not available and recognizable on the app as green images, corrupted images, firmware updates that prevent the application from restarting or that involve sudden system errors etc.) are in charge of the camera manufacturers.

In server-side installations, any infrastructural issues (lack of network communication between servers and cameras, power supply fluctuations etc.) and hardware defects (anomalous server restarts, faults, slowdowns) are in charge of the maintainers of the system.

A.I. Tech disclaims any responsibility about possible variations with respect to the performance declared in the document, whether the camera installation does not respect all the above mentioned environmental conditions and installation constraints.