Manual for Vehicle Exposedness Simulator

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How does the Simulation Work

This application allows you to simulate the exposedness of up to fifteen different vehicles in a variety of position and camera configurations.

Simulation Hierarchy

The simulation can be divided into a hierarchy made of five levels, each made up of the ones after:

Simulation Run

The highest level, where the user provides the program with the parameters that it will use during the simulation. These include:

- The driving direction of the road.
- The type of vehicle used.
- The set of *Camera Positions* that will be used to capture the information, along with the possible *Camera Directions* that may be used at each.
- The positions that the *Target Vehicle* may occupy. This is the vehicle that is being measured, where the exposedness of the camera is projected on.
- The positions that the *Blocking Vehicles* may occupy. These are other vehicles placed on the scene that do not record data, and only exist to block the view of the *Target Vehicle* from the camera.
- The number of vehicles in the scenario, including the *Target Vehicle* and *Blocking Vehicles*. There will always be one and only one *Target Vehicle* in any given simulation. There may never be more *Blocking Vehicles* in the road than there are positions for it.
- The minimum and maximum distance that a point on the *Target Vehicle* may be from the camera for it to be recorded.

Based on these parameters, the software will instantiate a Target Vehicle in the pre-made environment, calculate all possible permutations of the *Target Vehicle* and the *Blocking Vehicles* in their possible positions, then cycle through each of these *Scenarios* using the specified settings.

Scenario

Represents a combination of different placements on the road for the *Target Vehicle* and other *Blocking Vehicles* on the road. Since we want to find the points of the *Target Vehicle* that are visible the most often, we want to cycle through all possible combinations of *Blocking Vehicle* placements to simulate the ways in which other vehicles on the road may block the view of the pedestrian.

Camera Position

For each scenario, the camera will move through each of the *Camera Positions* selected by the user. At each position, the camera's vertical position will be one of five different vertical distances from the floor: 1m, 1.2m, 1.4m, 1.6m, and 1.8m.

Camera Direction

At each *Camera Position*, and each of the vertical distances of each, the camera will cycle through each of the directions selected for that *Camera Position* and take a *Data Capture*.

Data Capture

At each, the camera simulates a series of ray-casts in a grid pattern coming from the camera to replicate where it is observing the Target Vehicle. Each ray-cast starts at the minimum distance away from the camera, and ends at its maximum distance.

Ray-casting allows us to find the intersection point between an origin point (the camera) and a destination point (the point it sees), as well as the details of the first collider hit this way. We use this to record the points of the *Target Vehicle* seen by the camera.

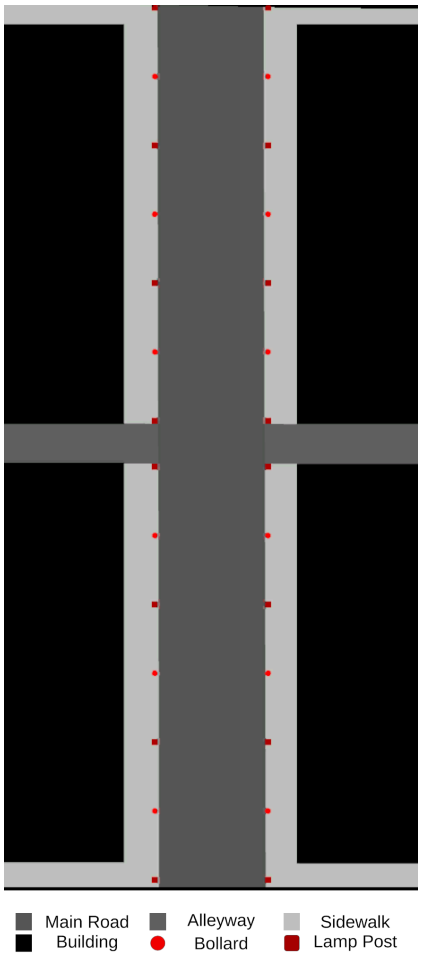
At any given time, one and only one of the vehicles currently in the environment may record the points where it is being observed by the recording camera, this is considered the *Target Vehicle*. In each Scenario, the rest of the spaces that are occupied

by vehicles are all filled with Blocking Vehicles that use the same model as the Target

Vehicle, but do not record any data.

How to Use the Custom Road Simulation:

The geometry of the scene for the simulation is static and non-changing. This is a top-down view of it:



You can change different parameters of the simulation you want to run, however. A custom simulation code is divided into 9 parts, separated by vertical bars, like this:

SMALL,US|Carryall|S_1,S_2,S_3|1|Carryall|S_1,S_2,S_3,S_4|A-1,2;B-1,2,3|0|5								
a	b	c	d	e	f	g	h	i

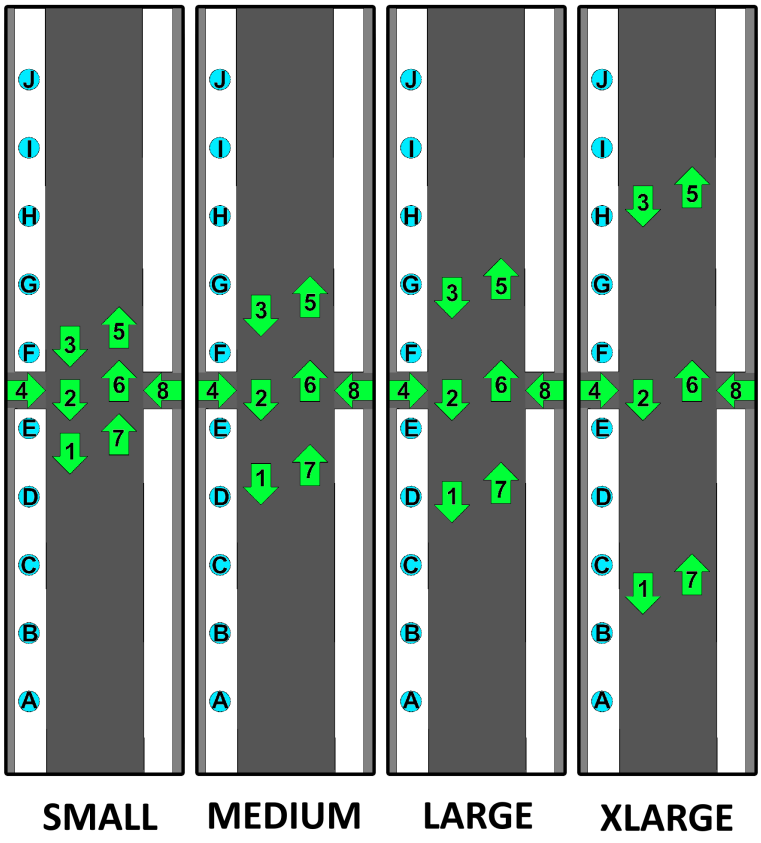
Each part is written into a separate field of the simulation options, seen in the following pages.

(a) Setup ID:

Following the structure “[Position Distance,[Driving Direction]”. This part is divided into two elements by a comma:

Position Distance

This determines the spacing between vehicle positions on the scene, as seen below. The available options are **SMALL**, **MEDIUM**, **LARGE**, and **XLARGE**. The spacing between positions is universal, and used by both the Target Vehicle and Blocking Vehicles, regardless of the vehicles used.



These are the size categories for each vehicle type. It is not recommended to select a Position Distance smaller than the size of the selected Target Vehicle or Blocking Vehicle model:

Category	Vehicle Type
SMALL	Motorcycle
SMALL	Smart Car
SMALL	Carryall Car
MEDIUM	Sedan
MEDIUM	SUV
MEDIUM	Panel Van
MEDIUM	Topless Convertible
MEDIUM	Station Wagon

LARGE	Four wheel Truck
LARGE	Minibus
LARGE	Pickup Truck
LARGE	Moving Truck
XLARGE	Motor home
XLARGE	Double Decker Bus
XLARGE	Single Decker Bus

Driving Direction

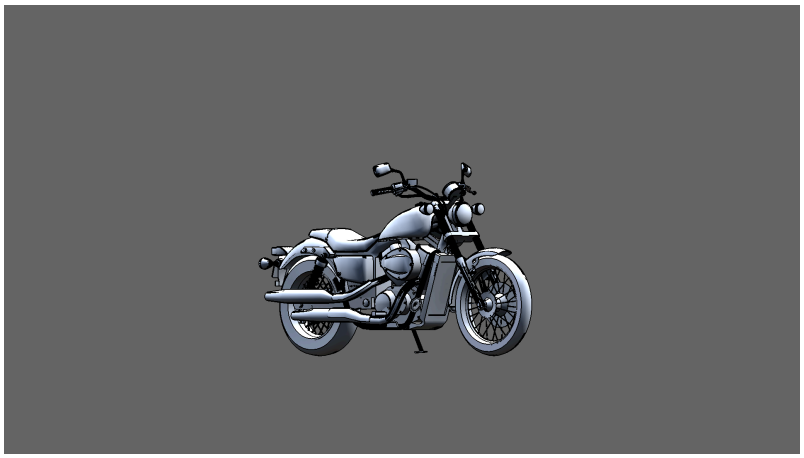
This option is for selecting whether the vehicles are driving north on the right lane or the left lane. At the time of writing, the only available option is **US** for right-hand driving.

(b) Target Vehicle Model:

This lets you choose the 3D model of the vehicle used for the simulation, based on the type, by writing its keyword. Here is a list of every available vehicle type, the keyword to use it, and the vehicle it's based on:

Motorcycle (**Motorcycle**)

Based on the Honda Shadow RS 2010

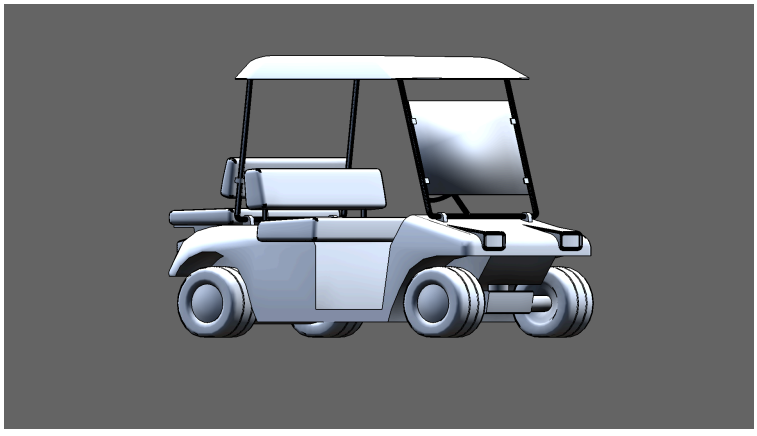


Smart Car (**SmartCar**)

Based on the Smart Fortwo

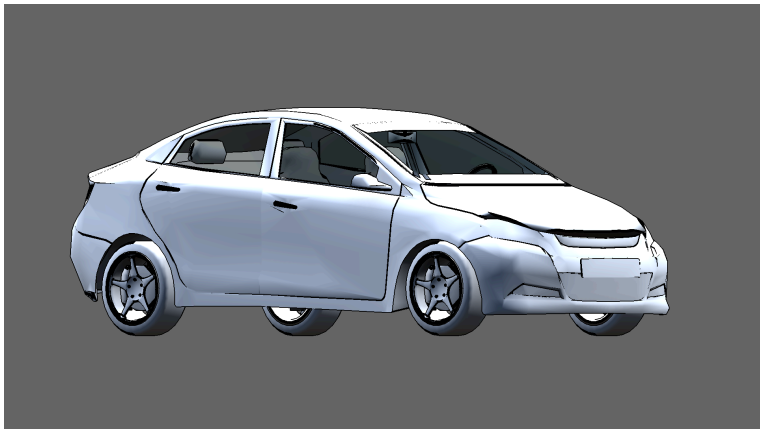
Carryall Car (**Carryall**)

Designed as a generic golf cart. No specific model inspiration.



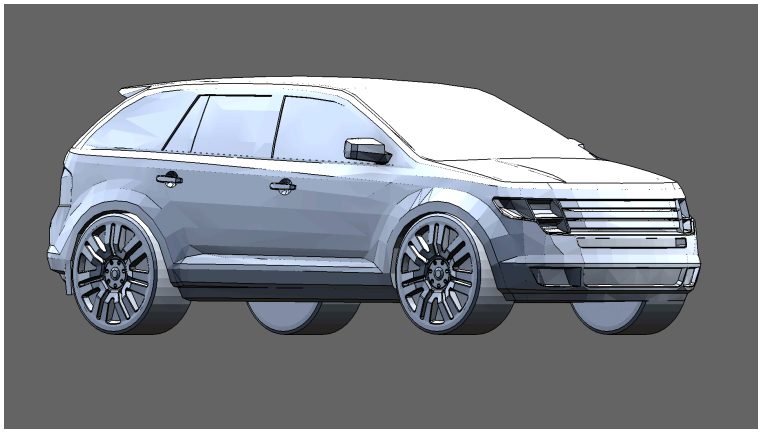
Sedan (**Sedan**)

Made to look like Japanese and Korean sedans from the 2010s. No specific model inspiration.



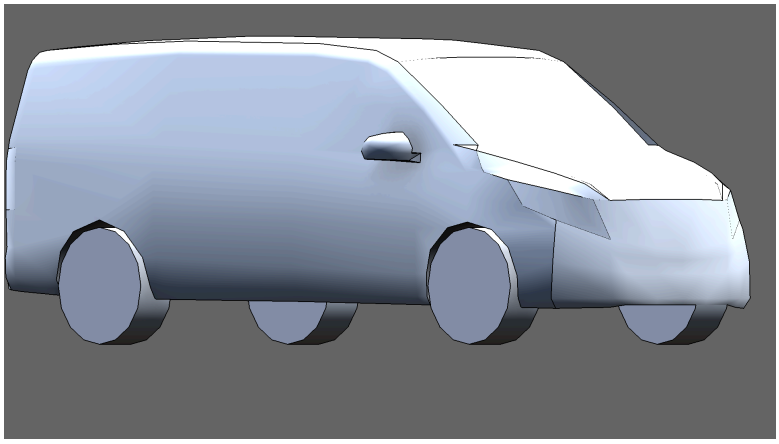
SUV (**SUV**)

Based on the Ford Edge 2006



Panel Van (**PanelVan**)

Based on the D3S MB Vito Panel Van (W447) 2015



Topless Convertible (**Topless**)

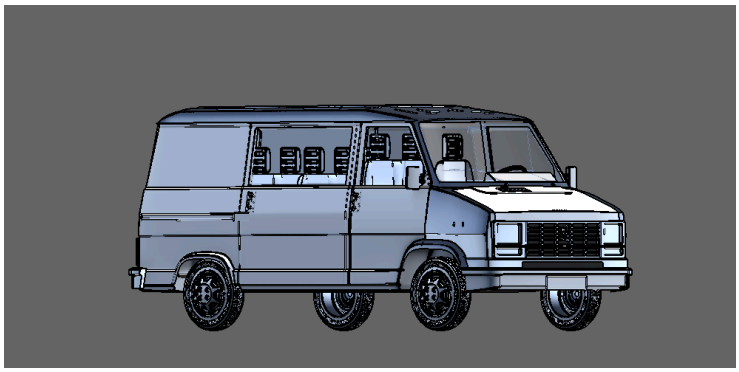
Based on the Chrysler Sebring Convertible

Station Wagon (**StationWagon**)

Based on the 80s Lincoln Zephyr Mercury

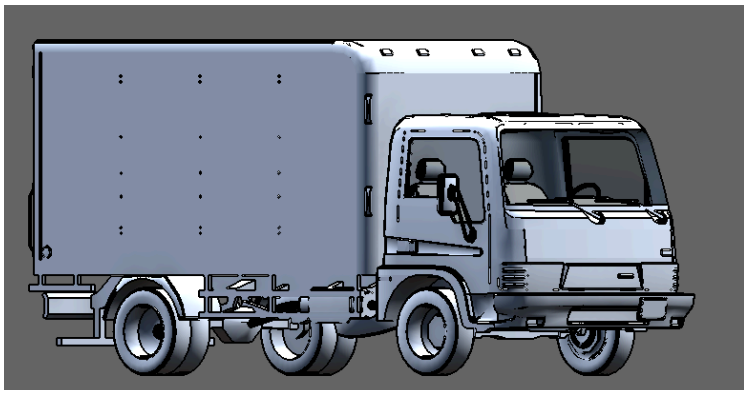
Minibus (**Minibus**)

Based on the Peugeot J5



Four wheel Truck (**FourWheel**)

Inspired by Japanese-made small-cabin commercial trucks from the 1990s.

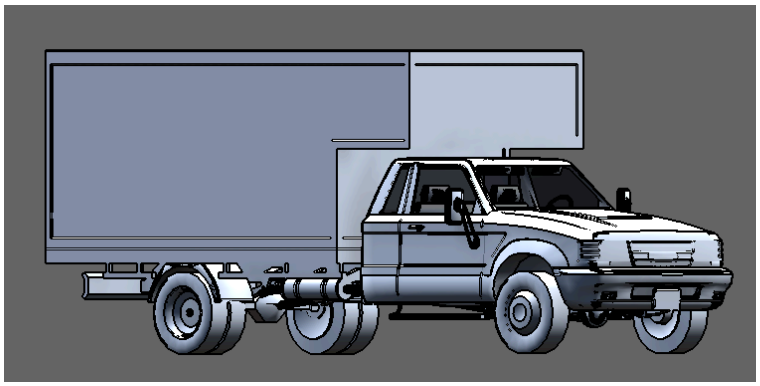


Pickup Truck (**Pickup**)

Based on the 2015 Ford F150 King Ranch Edition

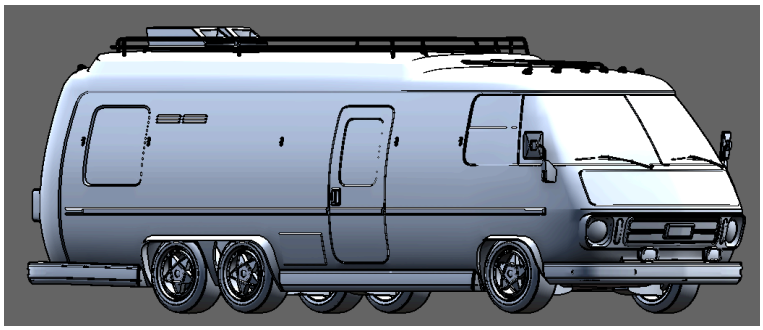
Moving Truck (**MovingTruck**)

Non real life counterpart. Based on Japanese-made 2-door pickup-cabin box trucks.



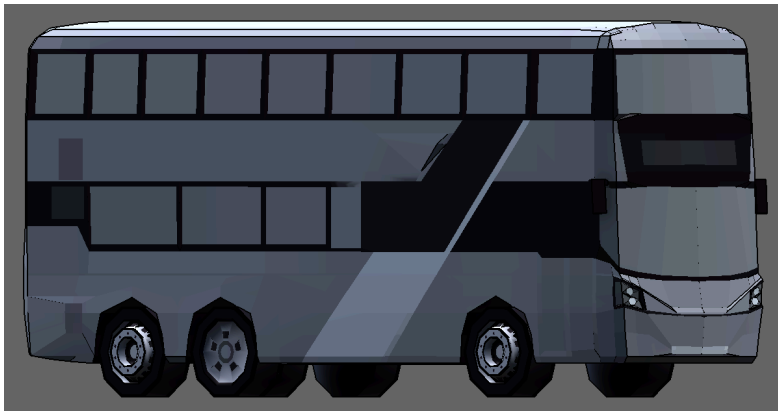
Motor home (**Motorhome**)

Based on a non-specified GMC Motorhome.



Double Decker Bus (**DoubleDecker**)

Inspired by the Volvo B8L.

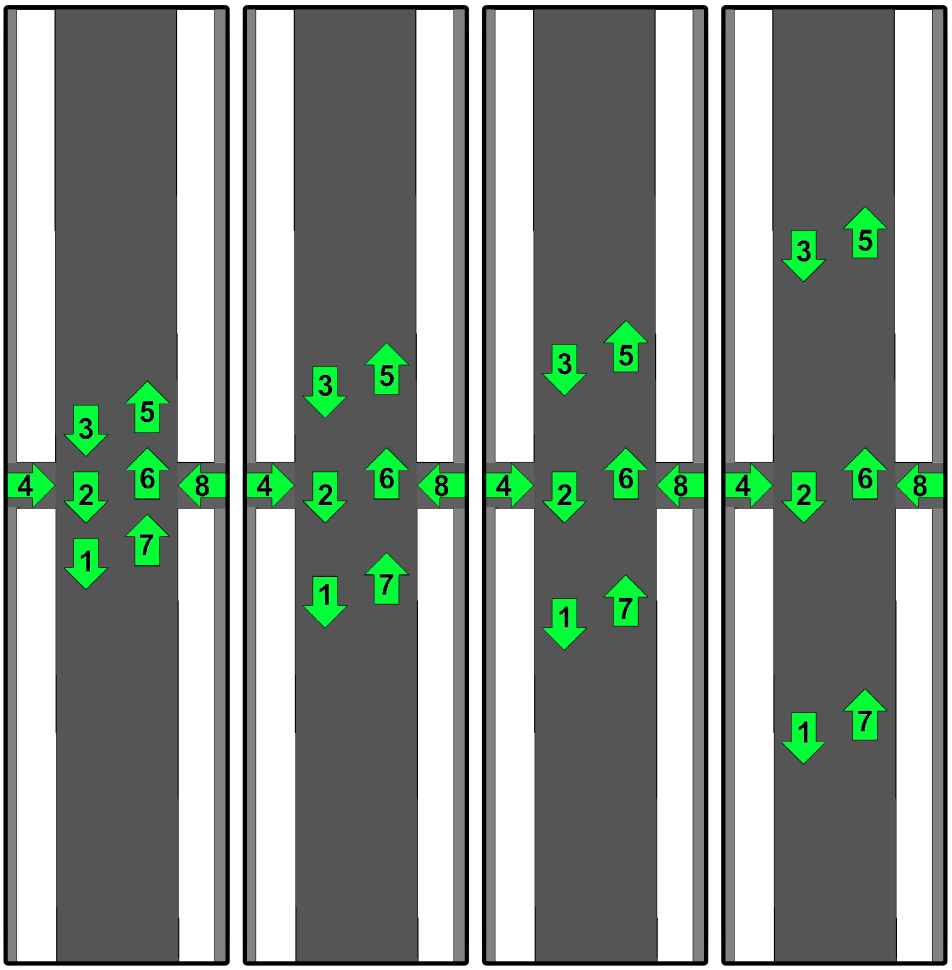


Single Decker Bus (**SingleDecker**)

No specified real life counterpart.

(c) Target Vehicle Positions:

Here you choose what positions you want to test the Target Vehicle in. You must list each position with a prefix corresponding to the *Position Distance* selected in the *Setup ID*, separated by commas.



For example, if the distance is SMALL and the Target Vehicle may be found at position 3 and 5, then you should write “S_3,S_5”

(d) Number of Vehicles in Simulation:

The number of vehicles for this *Simulation Run*, including the *Target Vehicle* and any *Blocking Vehicles*. This value should never be lower than 1 or higher than 8.

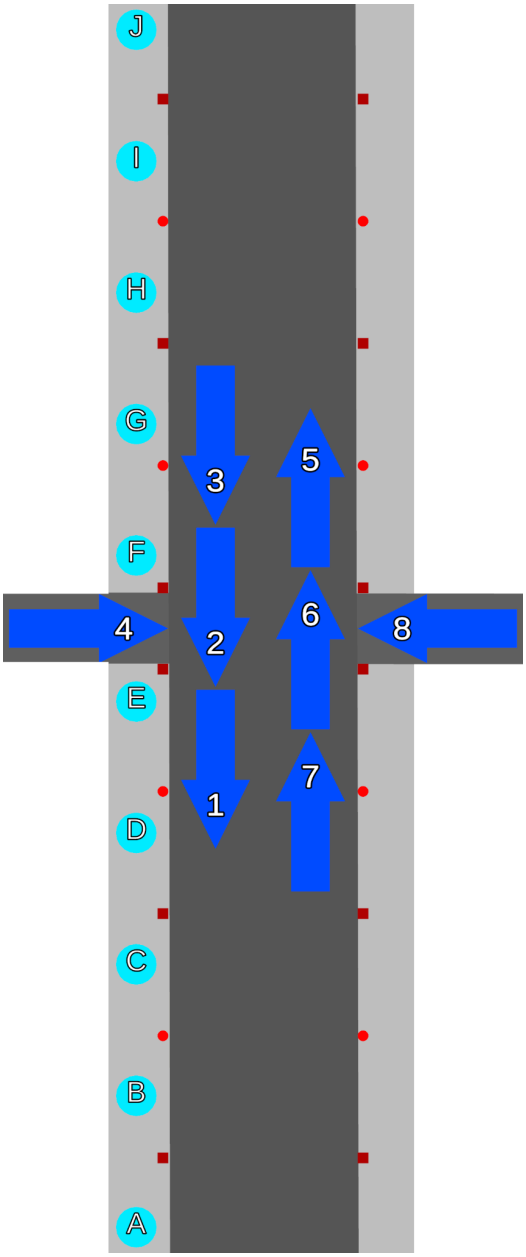
(e) Blocking Vehicle Model:

This lets you choose the 3D model of the *Blocking Vehicles* on the road that may block the *Target Vehicle*. These vehicles do not capture any data, and just serve as visual obstacles. The available options for this element are the same as for the Target Vehicle Model.

(f) Blocking Vehicle Positions:

Here you choose what positions the Blocking Vehicles may be in, using the same structure as with the Target Vehicle Positions.

(g) Camera Positions and Directions:

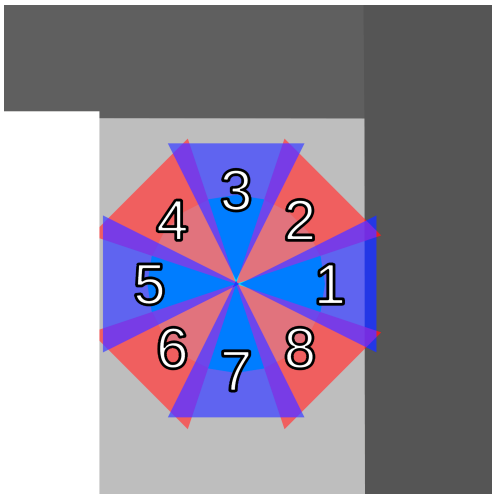


Here you chose what are the *Camera Positions* and *Camera Directions* for this *Simulation Run*. During the simulation, the program will take *Data Captures* at each *Camera Position* and *Camera Direction,* at five different heights. The structure of each specified position and direction is “[Camera Position]-[Camera Direction 1],[Camera Direction 2],...”, separated by semicolons (;).

A Camera Position can be:

- A Pedestrian, in which case the ID for that position is the letter seen on the illustration on the right (e.g. G).
- A Vehicle, in which case the ID for that position is what it would be for the Target Vehicle Positions and the Blocking Vehicle Positions of this *Simulation Run* (e.g. M_6).

Camera Directions are numbered 1 thru 8, starting from the East and going counterclockwise to the South-East, as in the following illustration



Each must be written following each position, separated by commas (e.g. M_7-2,7) will make it so the camera may be at the vehicle position 7, with medium distance from vehicle position 6, and take *Data Captures* in the North and South directions.

(h) Minimum Recording Distance:

The minimum distance from the camera before a point is recorded in a *Data Capture*. Points closer to the camera will not be recorded. This does not prevent obstacle occlusion. The minimum number is 0, the maximum number is the Maximum Recording Distance.

(i) Maximum Recording Distance:

The maximum distance from the camera for a point to be recorded in a *Data Capture*. Points farther to the camera than this distance will not be recorded.The minimum value is the Minimum Recording Distance.