



a new approach for human-machine  
interaction research for closing the out-of-the-loop unfamiliarity

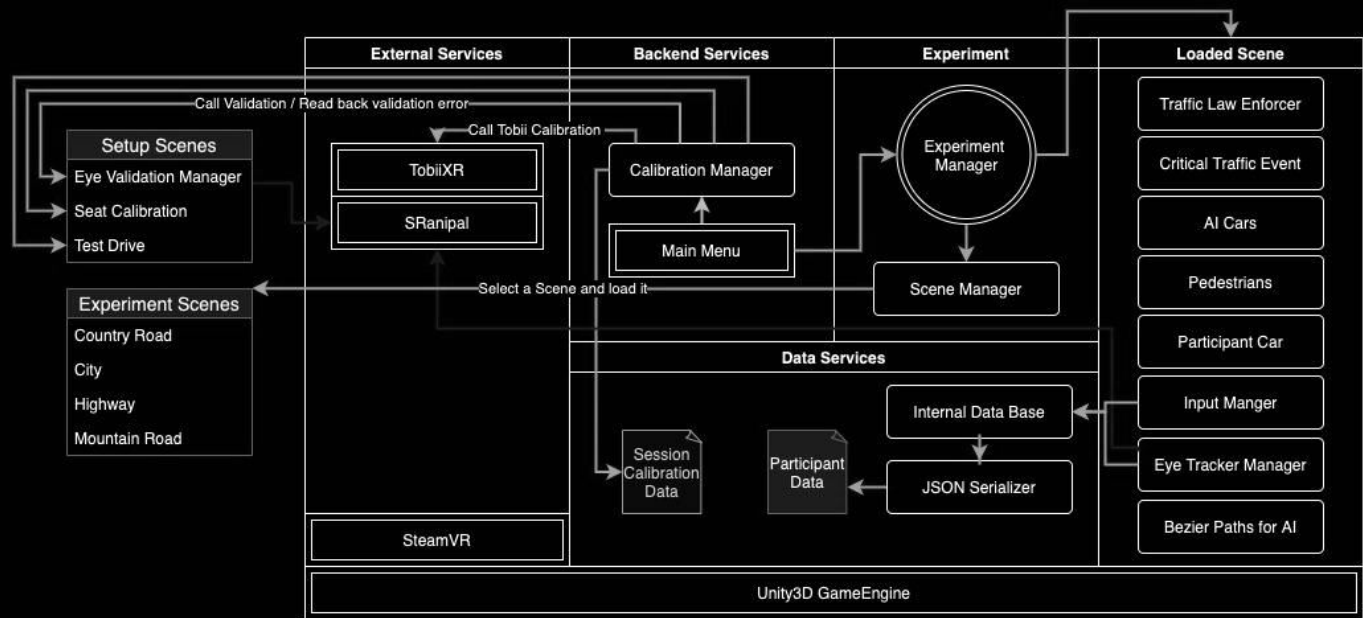


# Virtual Reality

We are using virtual reality headsets for a high presence perception and the psychological sensation of being in an alternate space.

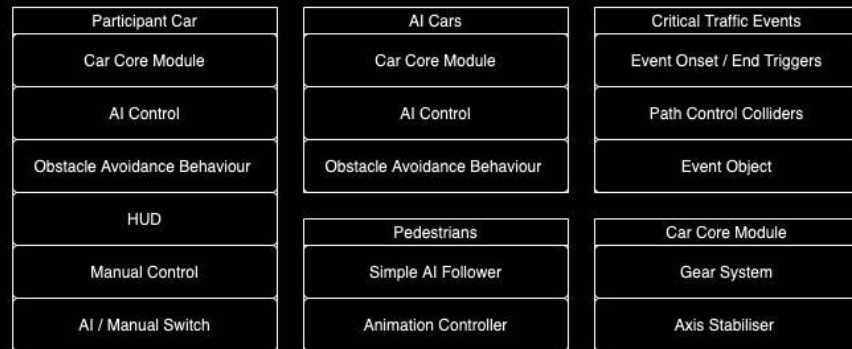
The HTC Vive Pro comes with the Tobii Eye Tracking system and allows monitoring the eye movement of the participant.





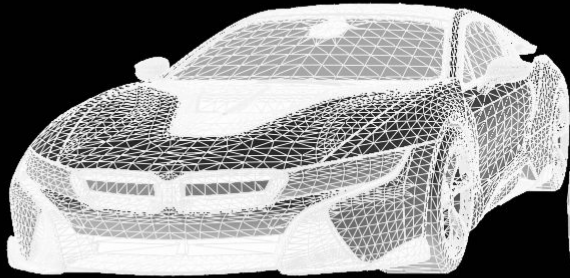
All components and functionalities working together in the Unity3D game engine with different modules for traffic behavior.

Modules Overview

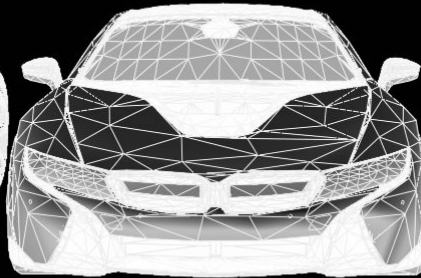


## Level of detail (LOD)

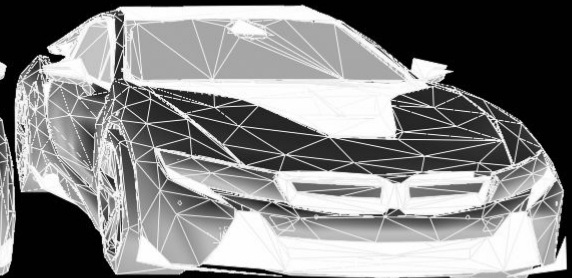
One of the most common techniques for increasing hardware performance. Based on the ratio of the objects screen space height to the total screen height, different LODs will be activated. The objects geometry will be reduced in relation to the participant distance.



LOD\_0  
80k vertices

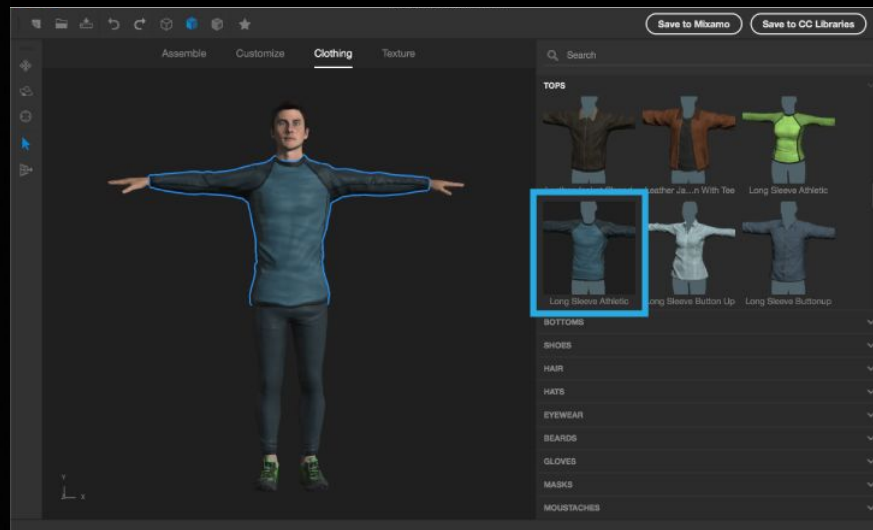
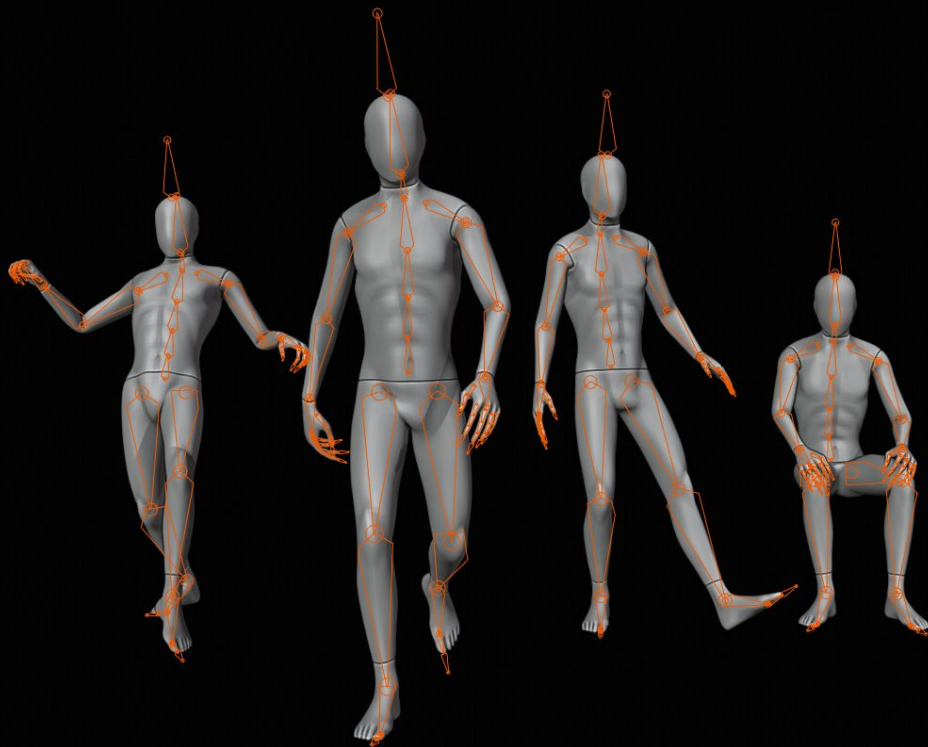


LOD\_1  
40k vertices



LOD\_2  
10k vertices

All pedestrians were created with Adobe Fuse Character Creator and animated with the Mixamo motion capture library.



## List of assets

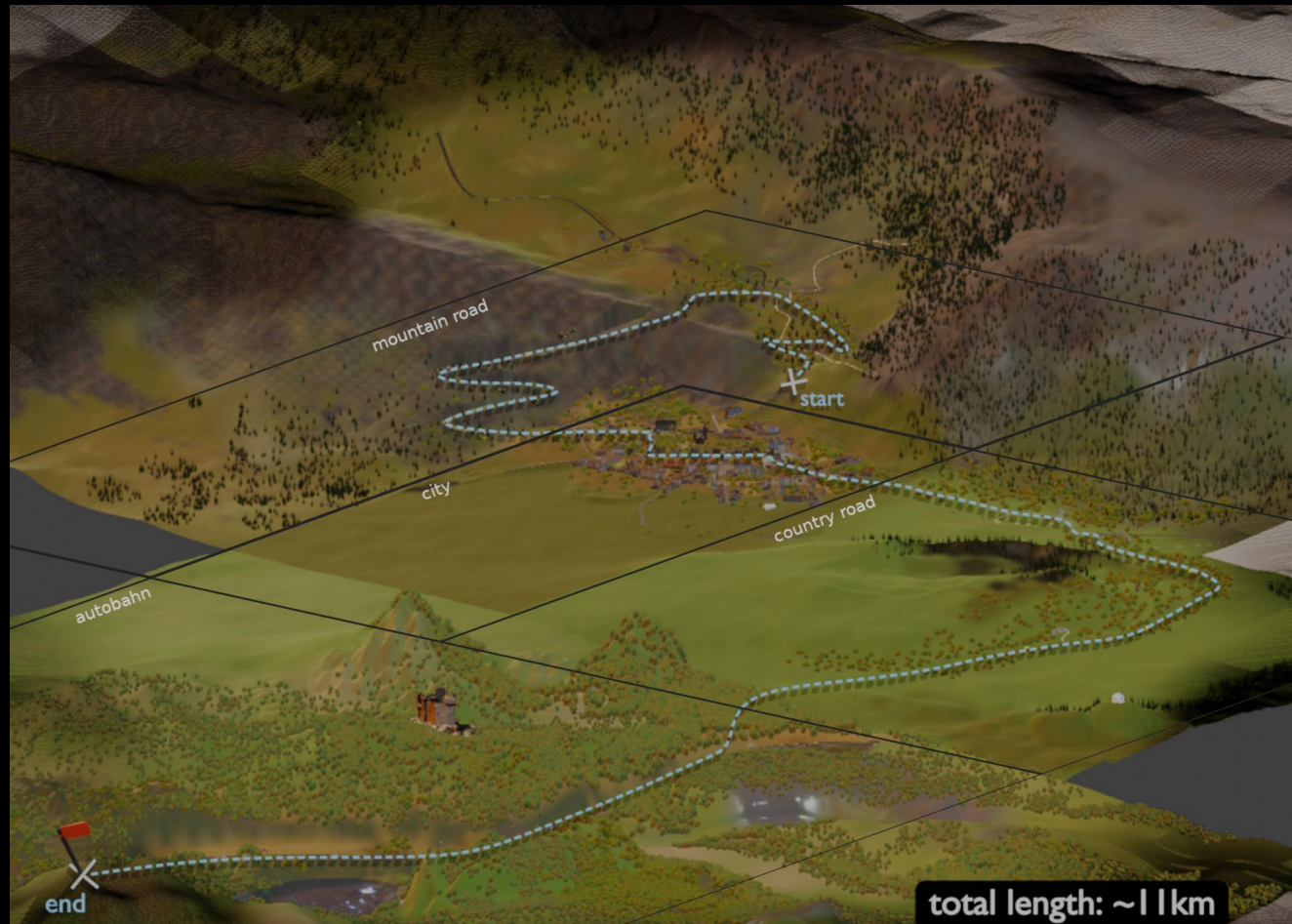
Asset Name	Link on Asset Store	Description	Paid / Free	Essential / Optional
+ SteamVR	SteamVR Plugin	main api to use HTV Vive/ Vive Pro HMDs in Unity3d	free	<a href="#">note</a> Essential
* SS07	Unlock super sport car #07	one of the car assets used in the project	paid	<a href="#">note</a> Optional
* EasyRoads3D v3 pro	EasyRoads3D v3 pro	Create unique road networks directly in Unity with both built-in customizable dynamic crossing prefabs and custom crossing prefabs based on your own imported models	paid	<a href="#">note</a> Essential
Conifers [BOTD]	Conifers	this package contains 4 conifers derived from Unity's Book of the Dead Demo – reworked, optimized and imported using the Custom Tree Importer to make them compatible with the "legacy" rendering pipeline.	free	<a href="#">note</a> Optional
Standard Assets	Standard Assets	This collection of assets, scripts, and example scenes can be used to kickstart your Unity learning or be used as the basis for your own projects.	free	<a href="#">note</a> Optional
Grass Flowers Pack Free	Grass Flowers Pack Free	This pack contains 12 grass and flower textures(Resolution 1024x1024,Alpha Channel).	free	<a href="#">note</a> Optional
Rocky Hills Environment - light pack	Rocky Hills Environment - light pack	High quality, low poly model pack, good for any kind of platform, mobile friendly and very aesthetic for higher quality game development. Includes models from a early project. Each model from the Legacy project comes with 2 Lod levels.	free	<a href="#">note</a> Optional
Terrain Tools Sample Asset Pack	Terrain Tools Sample Asset Pack	The Terrain Tools Sample Asset Pack contains a collection of Assets to jump-start development for users interested in utilizing Unity's growing Terrain system.	free	<a href="#">note</a> Optional
Farm Machinery	Farm Machinery	This is a low poly style model pack of a farm tractor and a planter.	free	<a href="#">note</a> Optional
Wooden Box	Wooden Box	This package contains a wooden box in four states: One intact and three destroyed versions.	free	<a href="#">note</a> Optional

With a high variety of graphical assets we build an authentic environment for collecting scientific data.

The Unity Store and the platform SketchFab provide a high variety of free 3D models for all different kinds of virtual experimental setups.

Large terrain with  
continues road network of  
the length of roughly 11  
kilometers

Main terrain  
includes a city, a  
mountain road, a country  
road and a highway



A screenshot of the Unity3D engine's Hierarchy, Inspector, and Console panels. The Hierarchy panel on the left shows a tree structure of objects, with 'MarketPlaceEvent' selected. The Inspector panel on the right displays the properties of the 'MarketPlaceEvent' component, including its Transform (Position, Rotation, Scale) and the 'Critical Event Controller (Script)' component. The Console panel at the bottom shows a project view with folders for 'Assets' and 'Scenes', and a list of scene assets like 'Animation', 'Autobahn', 'Baumes\_01', and 'countryro...'.

**Hierarchy**

- Connection Objects
  - Cars
  - Traffic
  - Nature
  - City Details
  - Street modifications
  - Landmarks
  - Countryroad\_Terrain
  - Directional Light
  - Background
- Functionalities
  - VRcam
  - ChaseCam
  - ExperimentManager
  - EyeTrackingManager
  - TrafficEventSystem
  - ManagerGroup
  - Participant'sCar
  - Pedestrians
  - AICars
  - Paths
  - ActivationTriggers
  - SpeedLimitTriggers
  - MVPCriticalTrafficEvents
    - MarketPlaceEvent
      - StageEvent
      - BrokenCarEvent
        - ConsistentEventObjects
          - EventObjects

**Inspector**

Inspector   GitHub   Lighting

MarketPlaceEvent   Static

Tag Untagged   Layer Default

**Transform**

Position	X -3.62085	Y -0.553268	Z -3.596558
Rotation	X 0.008	Y 0.203	Z -0.039
Scale	X 1	Y 1	Z 1

**Critical Event Controller (Script)**

Script CriticalEventController

**Consistent Event Objects**

Start Trigger	Trigger (TrafficEventTrigger)
End Trigger	Trigger (TrafficEventTrigger)
Consistent Event Objects	ConsistentEventObjects

**Event Objects**

Event Object Parent	EventObjects
Event Objects	
Respawn Point	RespawnPoint

**Event Setting**

Event Idle Duration	10
Event Object Active	<input type="checkbox"/>

Add Component

**Console**

Project

Assets > Scenes

- SRF
- osmRefe
- Plugins
- Prefabs
- Samples
- Terral
  - 0.1
    - T
- Scenes
- Scripts
  - Analyt
  - Calibr
  - Cars
    - AIB
    - Car
    - Eve
    - Mai
    - Visit
    - Conne

functional experiment scene (country road) in the Unity3D engine

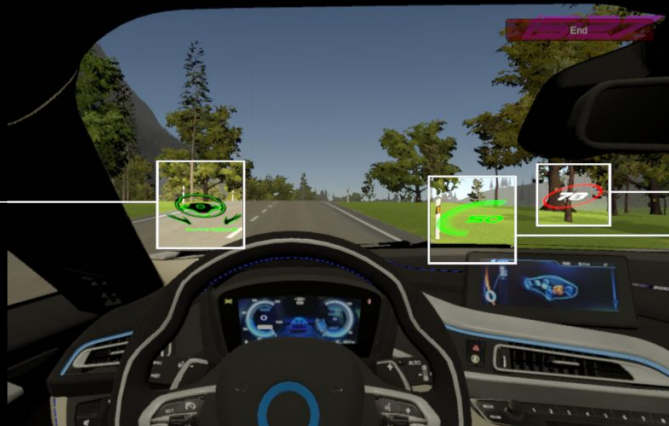


Fully customizable in augmented reality head up display on the car's windshield.

Highlighting the speed limit, current speed, critical event and objects of interest as well as car's working mode.



warning sign



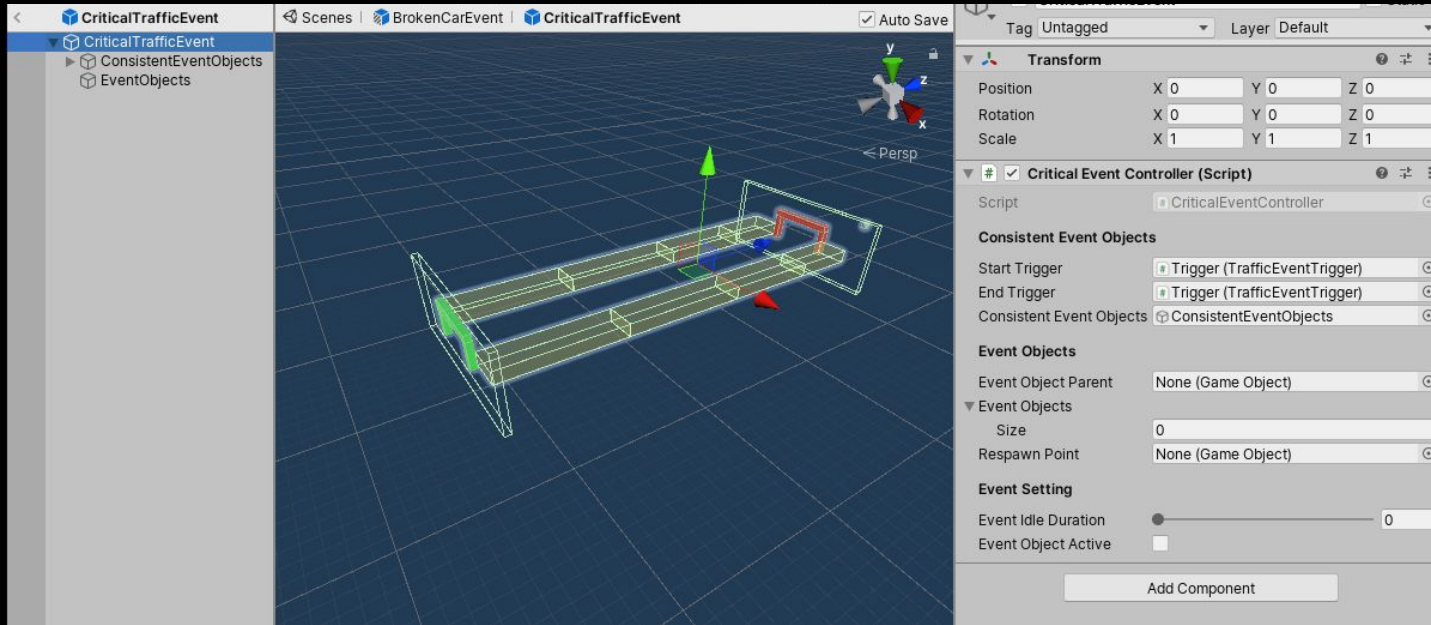
local speed limit

auto/manual drive

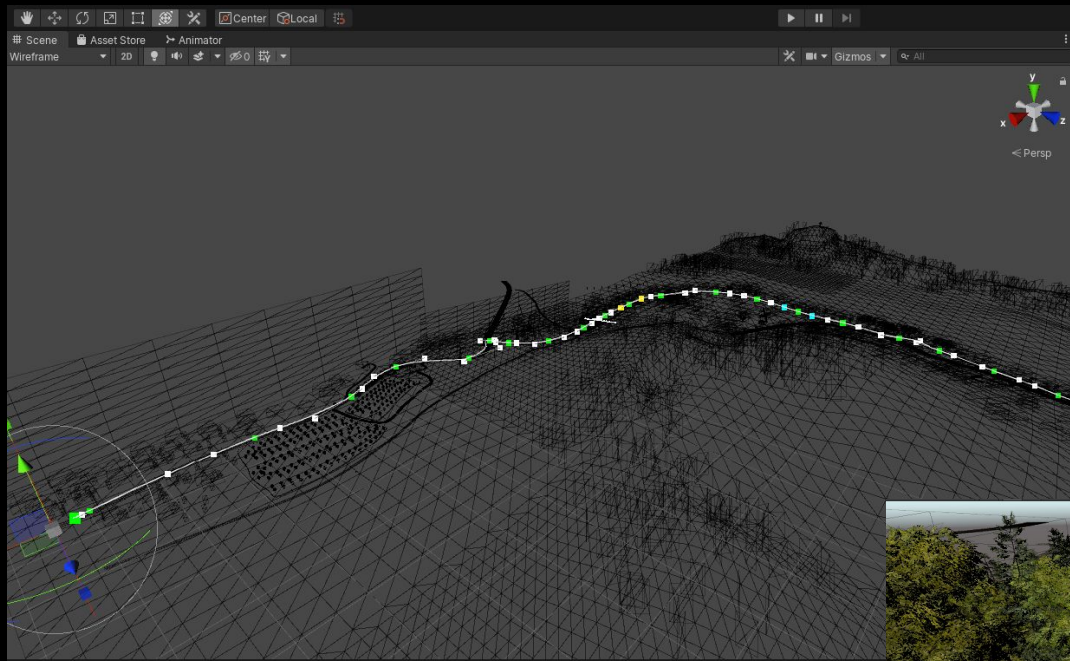


HUD visual components

vehicle speed



Custom prefabricated event system with editor visuals to facilitate creation of time sensitive and traffic related events.



car path based on bezier curve in the Unity3D engine

Bezier curve path creation system with full control on nodes to create custom path for dynamic objects including cars, pedestrians and event objects





the mountain road scene in Unity3D engine



the city scene in Unity3D engine



the autobahn scene in Unity3D engine



For future VR research, we tried to build the LoopAR project as easy to use toolkit inside of Unity3D, to easily produce further virtual reality experiments.