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Autonomous Driving Simulation Industry Chain Report, 2020-2021 (II)

May 2021

Abstract

In addition to simulation closed-loop platform and vehicle dynamics simulation mentioned in the Autonomous Driving Simulation Industry Chain Report, 2020-2021 (I), autonomous driving simulation also involves traffic flow simulation, scenario simulation and sensor simulation modules. The Autonomous Driving Simulation Industry Chain Report, 2020-2021 (II) sorts through companies in these areas.

Company	Simulation Products			
	Sensor	Vehicle Dynamics	Traffic Flow	Scenario
ANSYS 1970, the US	Closed-loop platform: VRXPERIENCE (co-developed with AVSimulation in 2019, supported by SCANer)			
	Optics (acquired in 2018)	Ansys Motion	SCANer Studio	SCANer Studio
Siemens 1847, Germany	Closed-loop platform: TASS Prescan (acquired in 2017)			
	Prescan	AMESim	Aimsun (acquired in 2019)	Prescan
NVIDIA 1993, the US	Closed-loop platform: DRIVE Constellation			
	DRIVE Sim (supported by NVIDIA Omniverse)			
AVSimulation 2017, France	Closed-loop platform: SCANer Studio			
	Physics Based Sensors Pack	CALLAS VEHICLE DYNAMICS MODEL	Foundation Pack	Foundation Pack
Spectris plc 1915, the UK	Closed-loop platform: VI-grade VI-DIM (acquired in 2018)			
	RightHook (acquired in 2019)	VI-grade VI-CarRealTime	VI-grade STATIC Simulator	VI-grade WorldSim
MathWorks 1984, the US	Closed-loop platform: Automated Driving Toolbox			
	Automated Driving Toolbox	Vehicle Dynamics Blockset	Automated Driving Toolbox	RoadRunner (acquired VectorZero in 2020) Driving Scenario Designer
PanoSim 2014, China	Closed-loop platform: PanoSim			
	SensorBuilder	VehicleBuilder	WorldBuilder	WorldBuilder
51WORLD 2015, China	Closed-loop platform: 51Sim-One			
	Sensor simulation model	51Sim-One	OpenSCENARIO Editor	WorldEditor

Product Distribution of Some Autonomous Driving Simulation Companies

Others	NI 1976, the US	monoDrive			
		ADAS Sensor Fusion HIL			
	Foretellix 2017, Israel	Metamoto		Foretify Platform	
	IPG Automotive 1984, Germany		CarMaker		
	Mechanical Simulation 1996, the US		CarSim		
	Vector 1988, Germany		TESIS DYNAware (acquired in 2019)		
	PTV Group 1979, Germany			PTV VISSIM	
	Systra 1957, France			PARAMICS (acquired in 2005)	
	Caliper 1983, the US			Transmodeler	
	MSC Software 1863, the US			v-TRAFFIC v-SCENARIO (acquired VIREs VTD in 2017)	Road Designer (acquired VIREs VTD in 2017)
	Cognata 2016, Israel				Cognata Simulation Platform
	ESI Group 1973, France				ESI Pro-SiVIC (merged and acquired CIVITEC in 2015)
	AB Dynamics 1982, the UK				rFPro (acquired in 2019)
	Applied Intuition 2017, the US				Simulate
Parallel Domain 2017, the US				Batch, Step, Stream	
Note: the listed above are not the full range of products of these simulation companies			Orange background—self-developed products	Blue background—acquired products	Green background—co-developed products

Acquisitions (or mergers and acquisitions) are, beyond doubt, a shortcut for companies to better technology layout. Autonomous driving simulation is no exception. Ansys' acquisition of the optical simulation software provider OPTIS and Siemens' purchase of TASS have been milestones in their development histories of autonomous driving simulation technology.

The more mature the autonomous driving simulation industry becomes, the higher barriers the industry poses. Technology and capital walls put up by simulation giants have been a big hindrance to the growth of start-ups. Players that just specialize in their own field may end up with being acquired or introducing external support. They cannot escape from tycoons at last.

Acquiring these specialized leaders has been an easy way for giants to perfect their layout

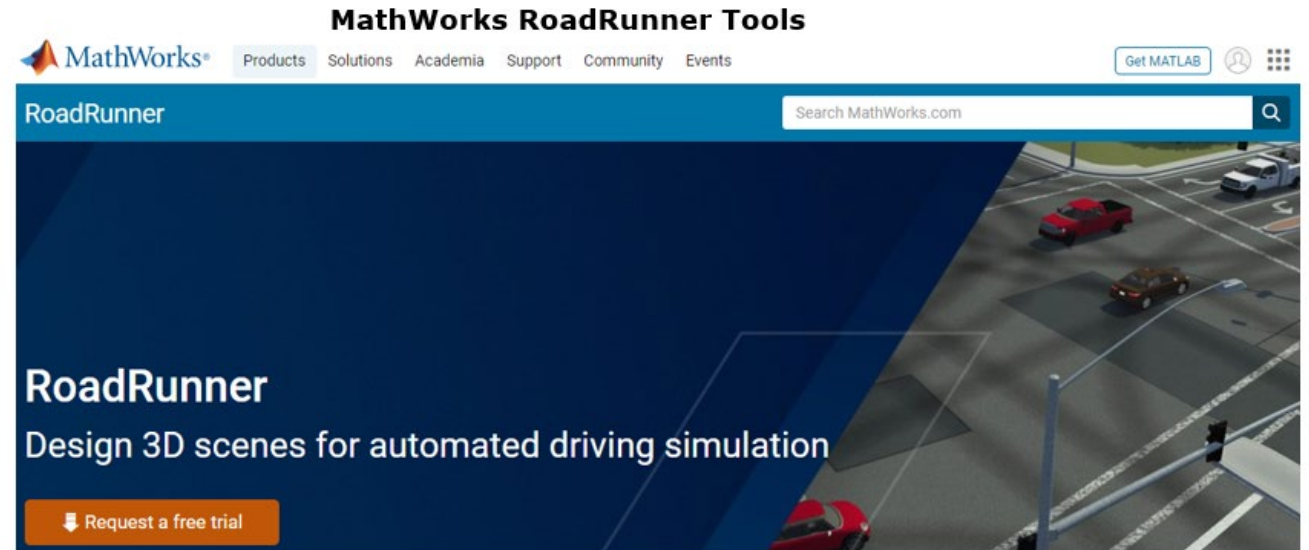
1. VectorZero, the owner of the scenario editor RoadRunner, was acquired by MathWorks, an integrated simulation platform, and its simulation tools were included in MATLAB/Simulink product system.

RoadRunner owned by VectorZero is a scene editor. It can create environments and roads, generate complex road networks composed of roundabouts, intersections and bridges, and custom traffic signs and markings.

Benefits of RoadRunner:

- ① A variety of editing tools: road tools, junction tools, lane tools, marking tools, prop tools, etc.;
- ② Quick 3D scene modeling: RoadRunner Asset Library lets users quickly populate their 3D scenes with 3D models.

MathWorks just settles on RoadRunner's 3D scene capabilities. In April 2020, the integrated simulation platform MathWorks acquired VectorZero, and brought RoadRunner tools for designing 3D scenes for automated driving simulation, into its MATLAB/Simulink product system.



In May 2020, MATLAB R2020a Version added RoadRunner tools to Automated Driving Toolbox.

2. The integrated simulation platform Spectris plc acquired VI-grade (vehicle dynamics simulation) and RightHook (sensor simulation).

In July 2018, Spectris plc acquired VI-grade, a vehicle dynamics and driving simulator player, for a foray into the vehicle testing and simulation field.

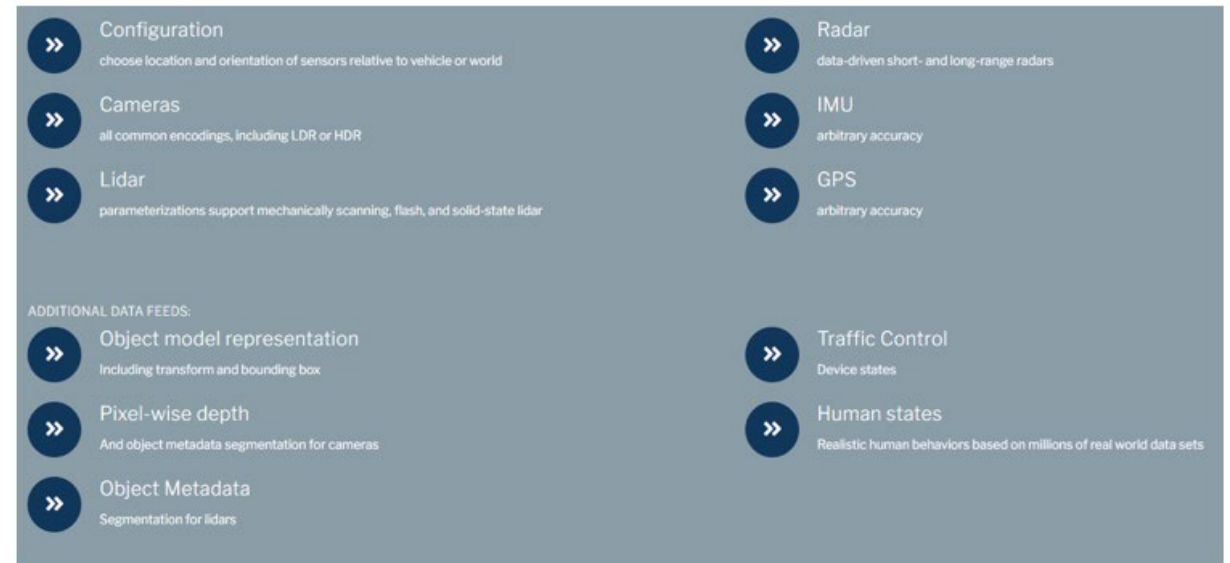
In February 2019, Spectris plc bought RightHook, a sensor simulation firm, and then merged it into VI-grade.

Benefits of RightHook:

① Provide a complete simulation tool chain including RightWorld and RightWorldHD, RightWorldHIL;

② Enable HD map-based simulation, and rebuild the whole simulation environment according to the HD maps used by autonomous driving companies. The test environment is real driving environment.

Sensors Supported by RightHook



VI-CarRealTime, VI-grade's vehicle dynamics model, provides a set of dynamics simulation services such as hardware/software in the loop.

In November 2020, VI-grade introduced VI-WorldSim that provides urban and public road test environments for ADAS and autonomous vehicles. VI-WorldSim features include traffic, pedestrians, lighting, weather, and sensors to enable users to create and test scenarios for vehicle development programs through an intuitive and easy-to-use desktop editor.

Noticeably, for this product, RightHook provides integrated visual environment for driving simulators, which means the two companies have merged in terms of operation and products.

Start-ups double down on financing, hoping to change the fate of “being acquired”.

1. Applied Intuition raised USD125 million.

Applied Intuition was founded by Qasar Younis and Peter Ludwig (former workers of Google) in 2017. The company recorded roughly USD26 million in revenue in 2020. The edge of Applied Intuition lies in the ability to use real/synthesized data to build complex scene interactions in a short time and generate thousands of permutations to cover edge scenarios. Meanwhile, in the simulation process, the dashboard of the virtual vehicle can display “the impact of virtual intersections and obstacles on vehicle acceleration and passenger comfort”, and other information.

On October 22, 2020, Applied Intuition raised USD125 million in a Series C funding round led by Lux Capital, Andreessen Horowitz, and General Catalyst, which took its market capitalization to USD1.25 billion.

Financing Course of Applied Intuition

Time	Round	Amount	Investors
Sept. 2018	A	USD11.5 mln	Andreessen Horowitz, Lux Capital, Liquid2, Naval Ravikant, Haystack, Floodgate
Sept. 2019	B	USD40 mln	Kleiner Perkins, Microsoft M12, Sozo Ventures and La Famiglia
Oct. 2020	C	USD125 mln	Led by Lux Capital, Andreessen Horowitz and General Catalyst

Background of Applied Intuition's Team Members

Automotive x Software

Our team has software and automotive experts from the top companies in the world



2. The scenario simulation startup Parallel Domain raised USD11 million in a Series A funding round where Toyota was a co-investor.

Parallel Domain was founded by Kevin McNamara (with a background in Apple autonomous driving technology) in 2017. Parallel Domain can synthesize a variety of scenes (e.g., day, night, fog, rain and city) for sensors (including LiDAR and camera), and also can embed complex elements (e.g., traffic lights, vehicles, pedestrians and animals) in scenes. Its simulation platform provides abundant metadata for users to test various new sensors and technical configurations.

In October 2020, Parallel Domain raised USD11 million in a Series A funding round led by Foundry Group and co-invested by Calibrate Ventures, Costanoa Ventures, Ubiquity Ventures and Toyota AI Ventures.

Financing Course of Parallel Domain

Time	Round	Amount	Investors
Dec. 2018	Seed	USD2.5 mln	Costanoa Ventures (leading investor), Ubiquity Ventures, etc. (co-investors)
Dec. 2020	A	USD11 mln	Foundry Group (leading investor), Calibrate Ventures, Costanoa Ventures, Ubiquity Ventures and Toyota AI Ventures (co-investors)

3. The scenario simulation company Cognata added partners including Hyundai Mobis, Atlatec and Ouster between 2020 and 2021 for accelerating commercialization of products.

Combining artificial intelligence, deep learning and computer vision, Cognata reproduces cities on its 3D simulation platform, providing customers with a range of test scenarios that simulate real-world test driving. In 2020, Cognata increased several partners, gathering pace in product application and variety.

- ① In November 2020, Cognata teamed up with Atlatec to support Atlatec's HD maps on the Cognata simulation platform, providing customers with the ability to extend the catalogs of accurate environments available for large-scale virtual validation;
- ② In January 2021, Cognata and Ouster partnered up in order to develop an accurate virtual LiDAR model in Cognata's simulation software.

According to the 2020 Blue Paper on Autonomous Driving Simulation of China, the current distribution of autonomous driving algorithm tests is as follows: around 90% tests are completed on simulation platforms, 9% in test fields and 1% on public roads. As simulation technology advances and becomes widespread, the industry aims at 99.9% tests carried out on simulation platforms, 0.09% in closed scenarios and 0.01% on real roads. In the second half of autonomous driving, the commercial use will bring soaring demand for testing, which may catalyze a new round of shuffle in the simulation industry.

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Beijing Headquarters

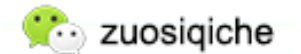
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