



WE BRIDGE THE GAP  
BETWEEN TESTING AND SIMULATION  
TO ACCELERATE PRODUCT DEVELOPMENT



VI-WorldSim Sensor Simulation for ADAS / AV

# Warren Ahner



- Co-Founder / CEO of RightHook, Inc.
  - 5 Years
  - Acquired by VI-grade
- Cyber Security Ford R&A – Level 4 AV
- 20+ years in Silicon Valley
- SCCA racing license



# A Simple Challenge



## Consumers Demand New Features At An Affordable Price

## Overconfident Drivers Raise the Safety Stakes

The problem with today's driverless c technology is the drivers

Published: Feb 24, 2018 10:29 a.m. ET

Waymo's driverless cars have driven 6.1 million miles in Arizona, including 65,000 miles without a driver through the first nine months of 2020. The report Waymo published today that analyzed a portion of collisions involving the robo-taxi service Waymo One, which launched in 2018. In total, Waymo's vehicles

*2 Killed in Driverless Tesla Car Crash, Officials Say*

"No one was driving the vehicle" when the car crashed and burst into flames, killing two men, a constable said.

**Uber's self-driving operator charged over fatal crash**

© 16 September 2020

**Artificial Intelligence and Autonomous Driving; The Brave New World of Driving**

Self-driving cars with 'remote' drivers could test on Calif roads

**This self-driving SUV has former Google and Tesla experts on-board**

Chinese newcomer Byton is working with a firm of ex-Google, Tesla and Uber self-

**Uber puts self-driving cars on**

General Motors said Thursday that by the end of 2019 it will be mass-producing fully autonomous electric cars.

Elaine Herzberg, 49, died after she was hit in March 2018 by a Volvo SUV, which had an operator in the driver's seat and was traveling at about 40 mph in autonomous mode at night in Tempe.

TECH

**Waymo driver hit a scooter in San Francisco, no injuries reported**

PUBLISHED THU, JUN 17 2021-1:27 PM EDT | UPDATED THU, JUN 17 2021-5:09 PM EDT

Ex-Googlers create a self-driving delivery service to deliver your groceries

**Hyundai: Fuel cells best bet for self-driving cars**

# ADAS Market Keeps Growing



Lane Keeping

Pre-Collision Alert

Super Cruise

Digital Lighting

AEBS

Pilot Assist

Intel Speed Assist

Lane Departure

Traffic Jam Assist

Self-Park Steering

Blind Spot Warning

Adaptive Cruise

Driver Monitoring

DSRC/V2X

Wrong-way Warn

Turning Assist

FCW

Lane Change Assist

Surround View

Intersection Assist

# Why Simulation?



# High Level Sensors



Object Sensor



Road / Lane Sensor



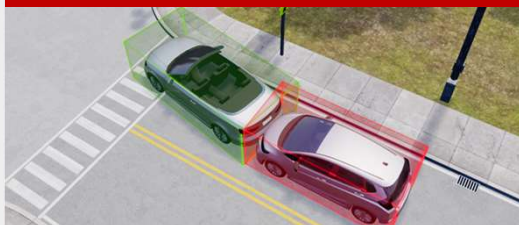
Objects by Lane Sensor



Traffic Sign Sensor



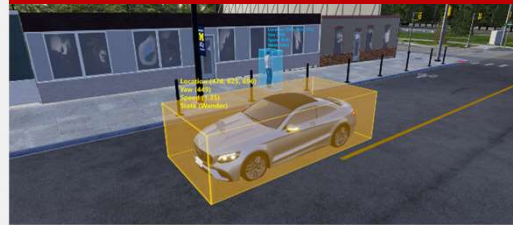
Collision Sensor



Telemetry Sensor



Ground Truth Sensor



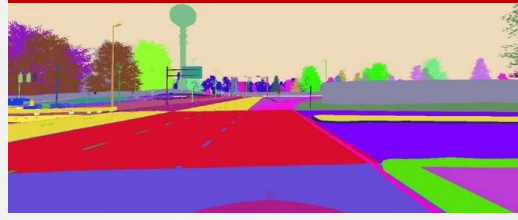
Free Space Sensor



Enhanc'd Free Spac Sensor



Instance Segmentation Sensor



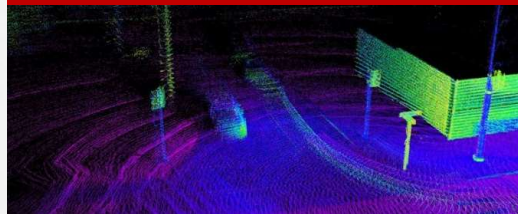
# Low Level Sensors



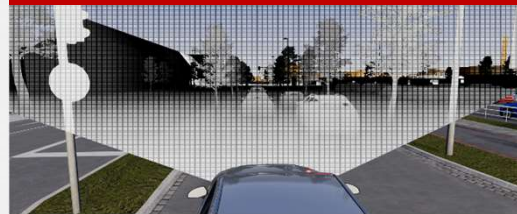
**Radar Sensor**



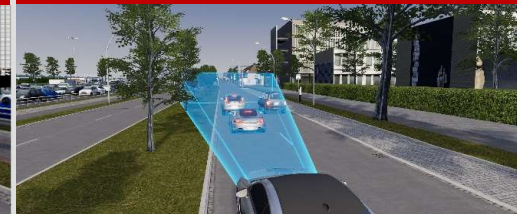
**Rotational Lidar Sensor**



**Solid State Lidar Sensor**



**Camera Sensor**



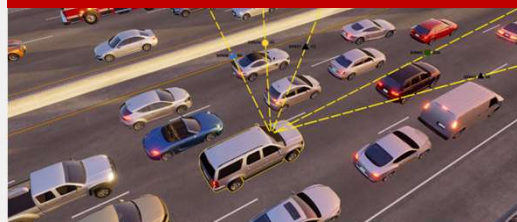
**IMU Sensor**



**Depth Sensor**



**GPS Sensor**



**Ultrasonic Sensor**



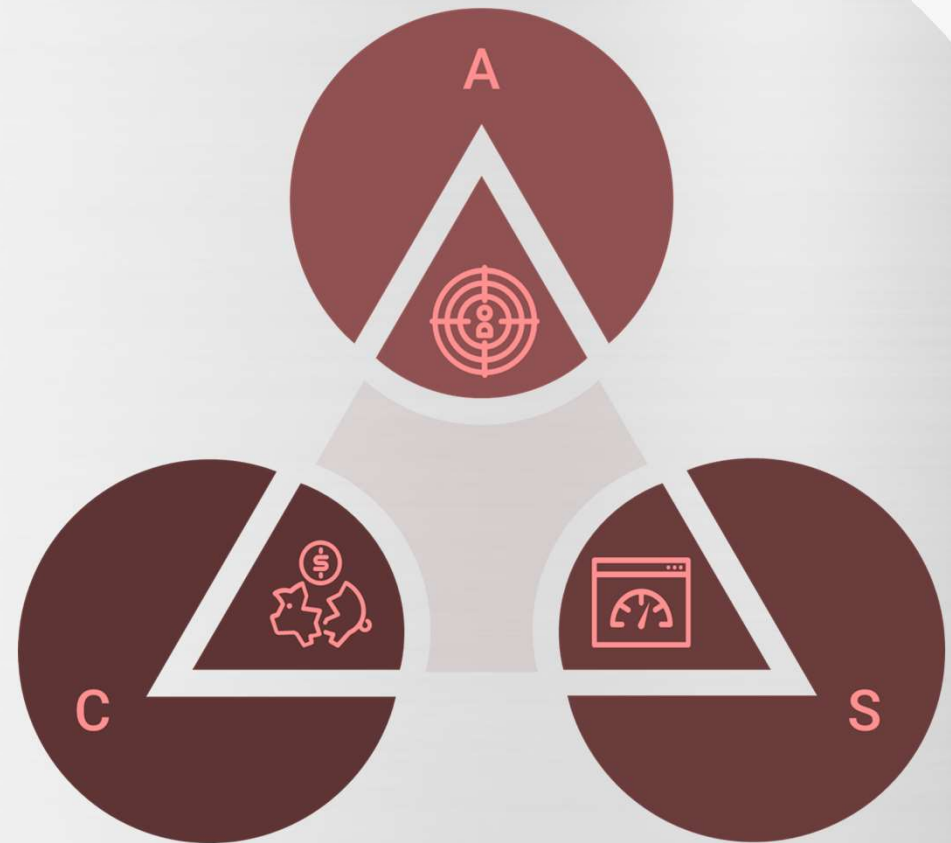
# Why Physical Sensor Simulation



**Accuracy** – Easy for our customers to get accurate results for the systems that matter most. If a sensor parameterization model doesn't meet their needs, it is easy for them to accurately extend the functionality of our platform.

**Cost** – Much lower cost than setting up a lab a building an empirical simulation for all variances they may encounter.

**Speed** – Changes to experiments are instant, no recollection, no re-test, no empirical inference.





# Creating a Realistic World



Work with partners to scan and map the real world



Build a library of sensor data from the real world



Recreate the world in simulation with meta data



Apply our knowledge of real-world materials to the scene



Allow for our users to customize their interactions with our digital twin

VI-WorldSim

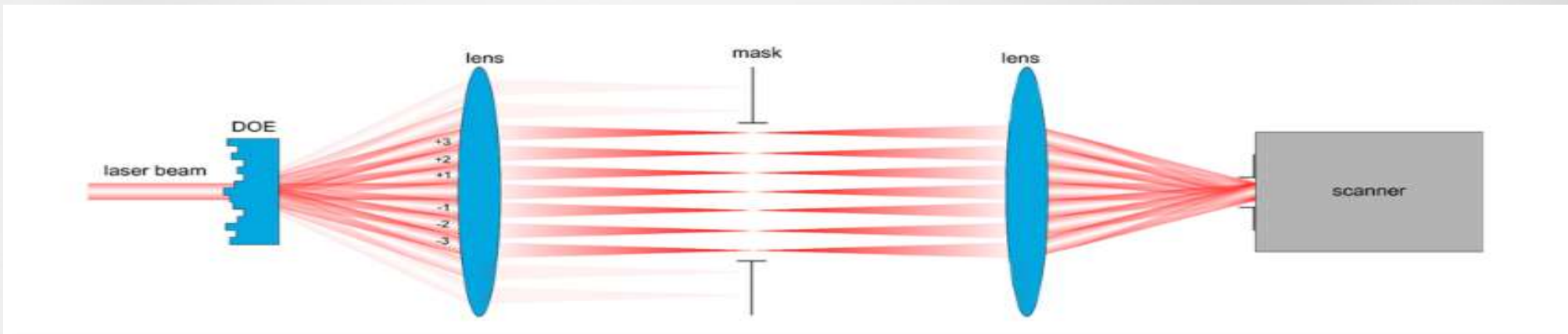
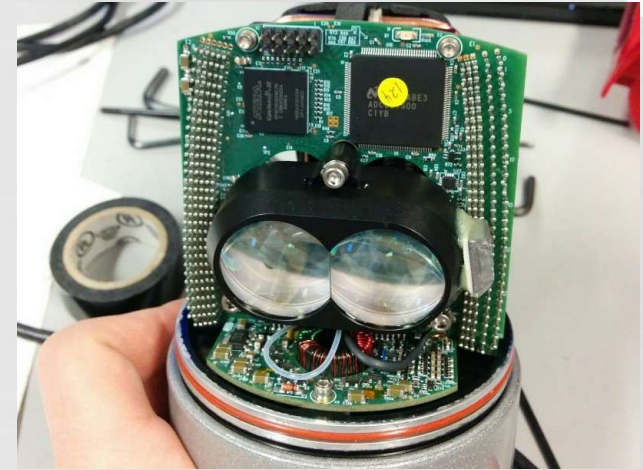


# Rotational LIDAR 101



Time of Flight (ToF) distance measurement sensor.

Emits an IR laser(s) and measures the time and energy of the returning light pulse.



# LIDAR – Single Return



# LIDAR – Single Return



**Single return** – When a laser pulse hits a solid object a single measurement or return is obtained. This is considered both the latest and strongest return.



# LIDAR - Dual Returns



# LIDAR - Dual Returns



**Dual Returns** – When a laser pulse travels over an extended distance is grows larger. Eventually the pulse can become large enough that it strikes multiple objects. In this example the light pole returns the strongest signal, however the advertisement returns the last signal (remember time of flight).



# LIDAR - Dual Returns



# LIDAR - Dual Returns



Dual Returns – In this example a similar effects happen, however more of the beam lands on the sign. This causes the sign to be the strongest return signal and the last datapoint returned. It is still possible that the advertisement might be far enough away that even with the majority of the beam's energy striking it, it may not return the strongest return (inverse square law applies here).





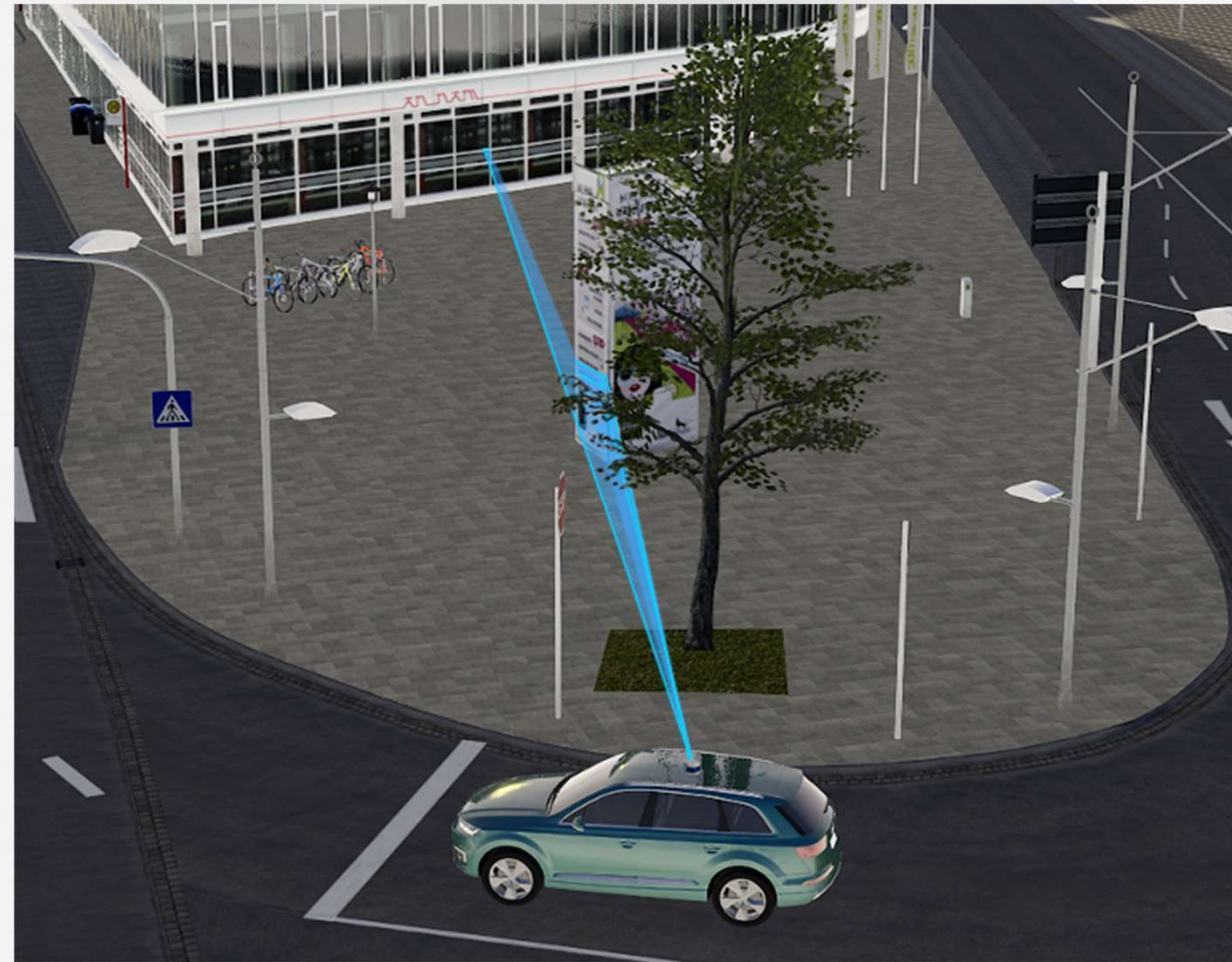
# LIDAR - Dual Returns



# LIDAR - Dual Returns



**Dual Returns** – In this example only a small amount of the beam goes past the sign and strikes the building. How-ever in this situation it is possible the return from the building will be indicated as the strongest, due to the of the beam's strike and the material being glass.



**ENVIRONMENT CUSTOMIZATION**  
Select or import an environment



**CONFIGURE SENSORS**  
Position, calibrate and aim sensors



**SCENARIO CREATION**  
Configure interesting interactions between the world and traffic



Execute test case with perception system or algorithm in the loop  
**RUN TEST**

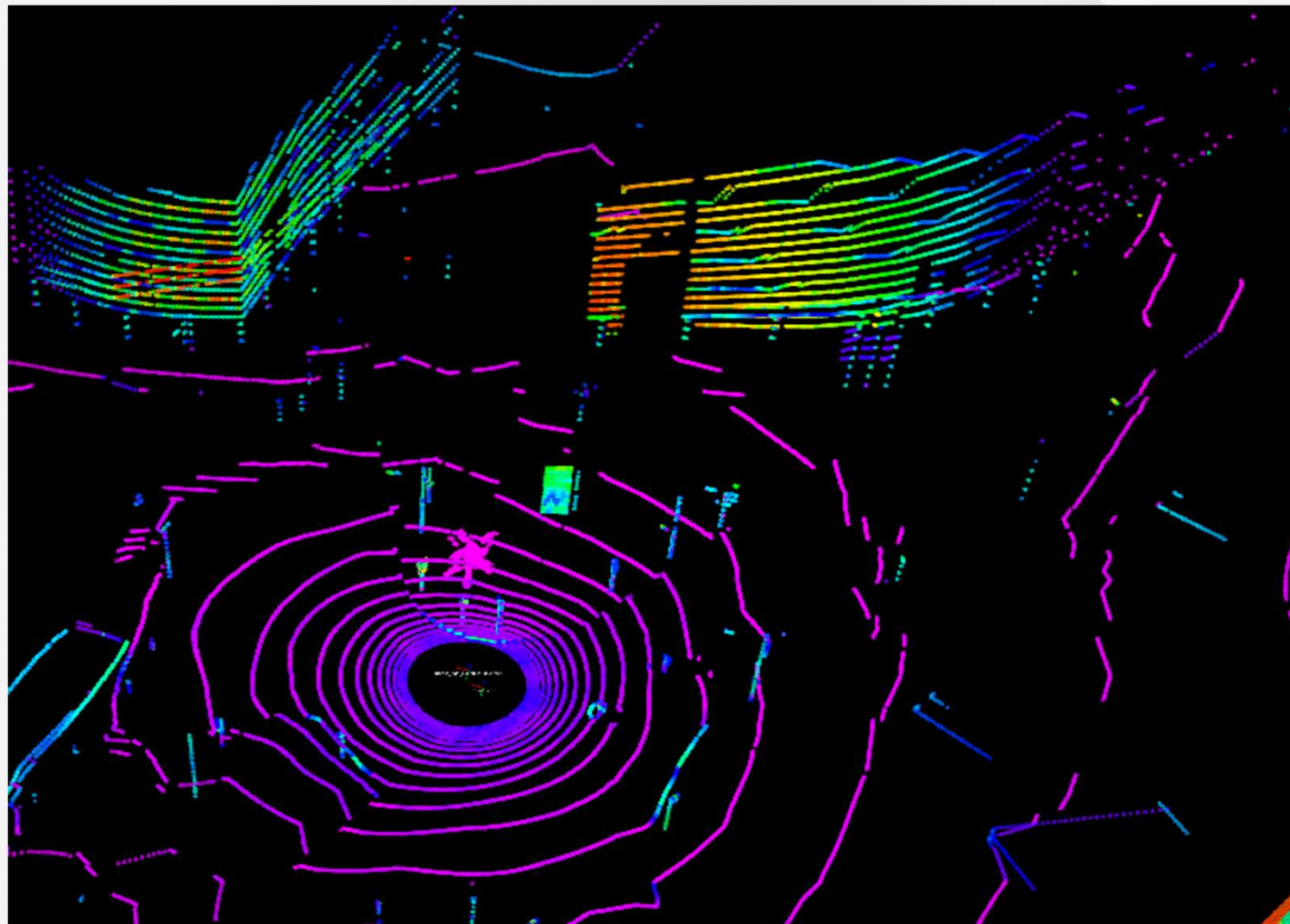
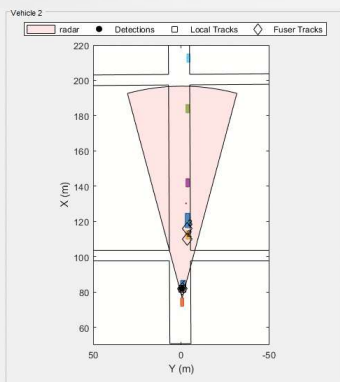
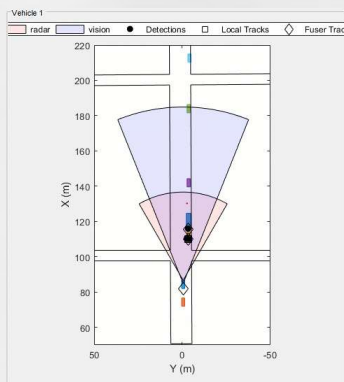


**PLAN AN EXPERIMENT**

# Sensor Data



- Native ROS
- SDK -
  - C++
  - Python
- Concurrent SimWB
  - Shared memory
- Simulink





TOMORROW

WE'LL HELP YOU BUILD  
THE BEST CAR EVER



## LET'S PLAN A DEMO WITH OUR TECHNICAL TEAM

to understand how we can help you  
streamline and accelerate your  
development process

[www.vi-grade.com/adas](http://www.vi-grade.com/adas)  
[info@vi-grade.com](mailto:info@vi-grade.com)