Árpád Takács

Artificial intelligence for self-driving cars

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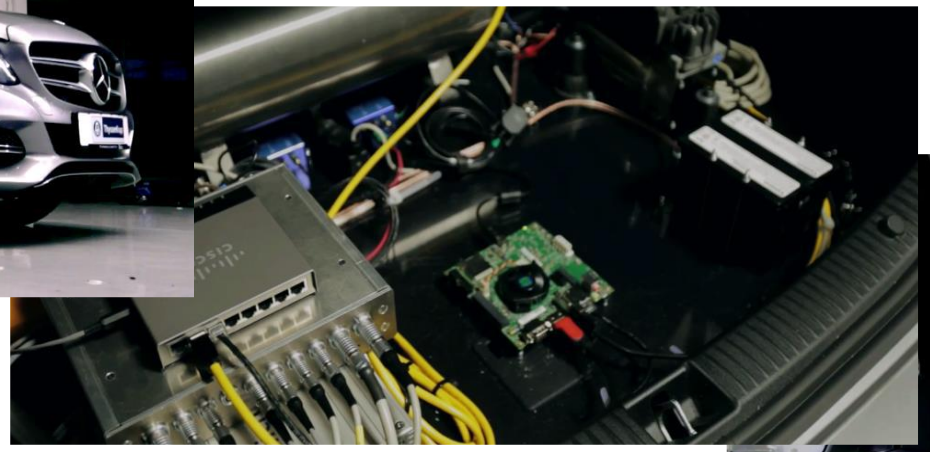
arpad.takacs@adasworks.com



Vision

AdasWorks revolutionizes the automotive industry by building artificial intelligence software for automated driving.

Foundation

Founded in July, 2015
AdasWorks is a spin-off of Kishonti Ltd.

Professional experience

High-performance embedded programming
Computer Vision
Mapping and navigation
Robotics
Automotive engineering

Memberships and partners

Khronos Workgroup
Embedded Vision Alliance
Professional partners

Solution overview

AdasWorks

1. Artificial Intelligence
   - Neural Networks
   - Unsupervised learning
   - Reinforcement learning
2. Multipe camera support
3. Integrated hardware agnostic
4. Scalable and future proof
5. Quick testing and validation cycle (GPU-based)

“The future of technology, and medicine in general, is not in blood and guts, but in bits and bytes.”

Dr. Richard Satava,
University of Washington

ADAS – Advanced Driver Assistance Systems
  Goal: increasing driving safety and enhancing driving experience
Automation – Adaptation – Enhancement

Cameron Gulbransen Kids Transportation Safety Act

Public Law 110–189
110th Congress

An Act

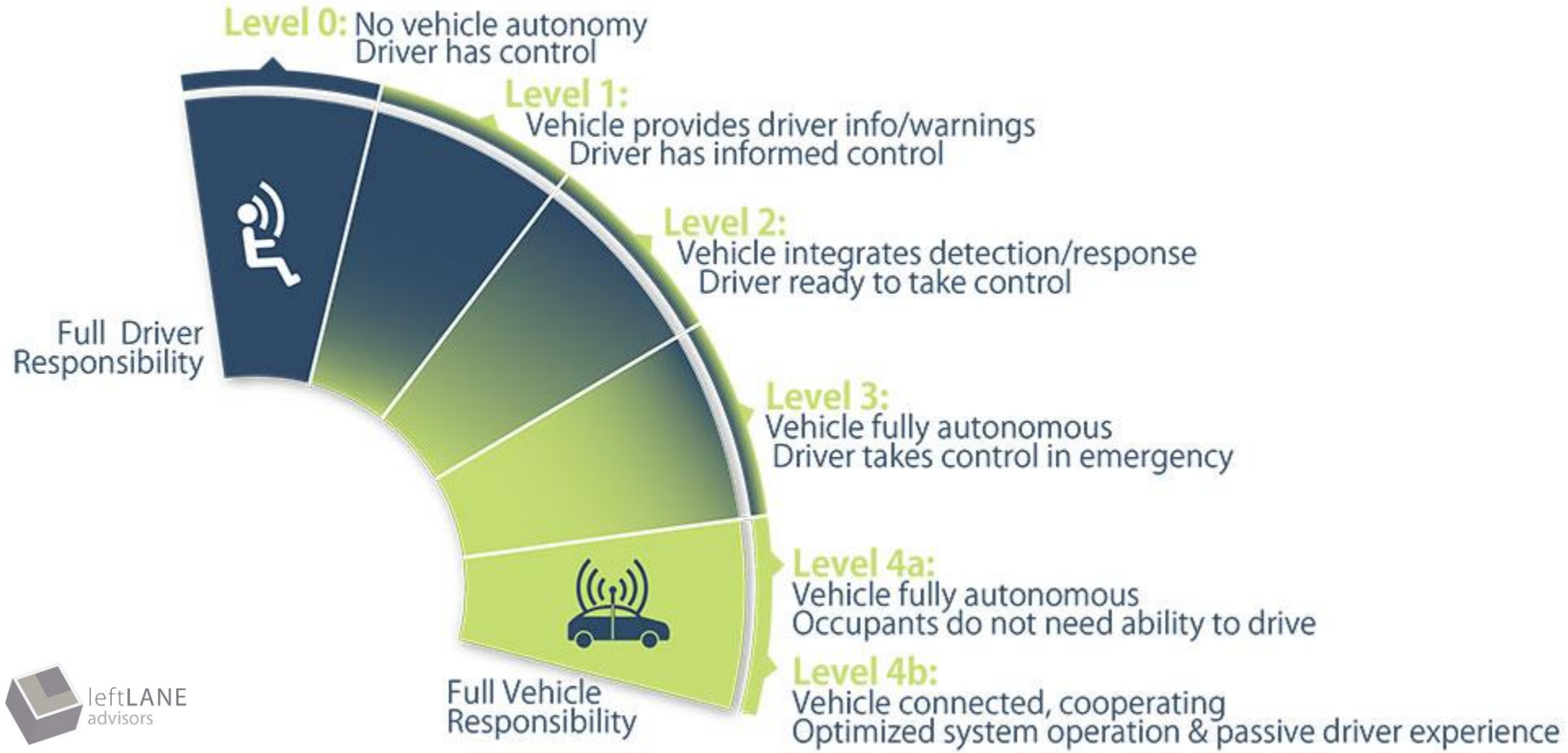
To direct the Secretary of Transportation to issue regulations to reduce the incidence of child injury and death occurring inside or outside of light motor vehicles, and for other purposes.

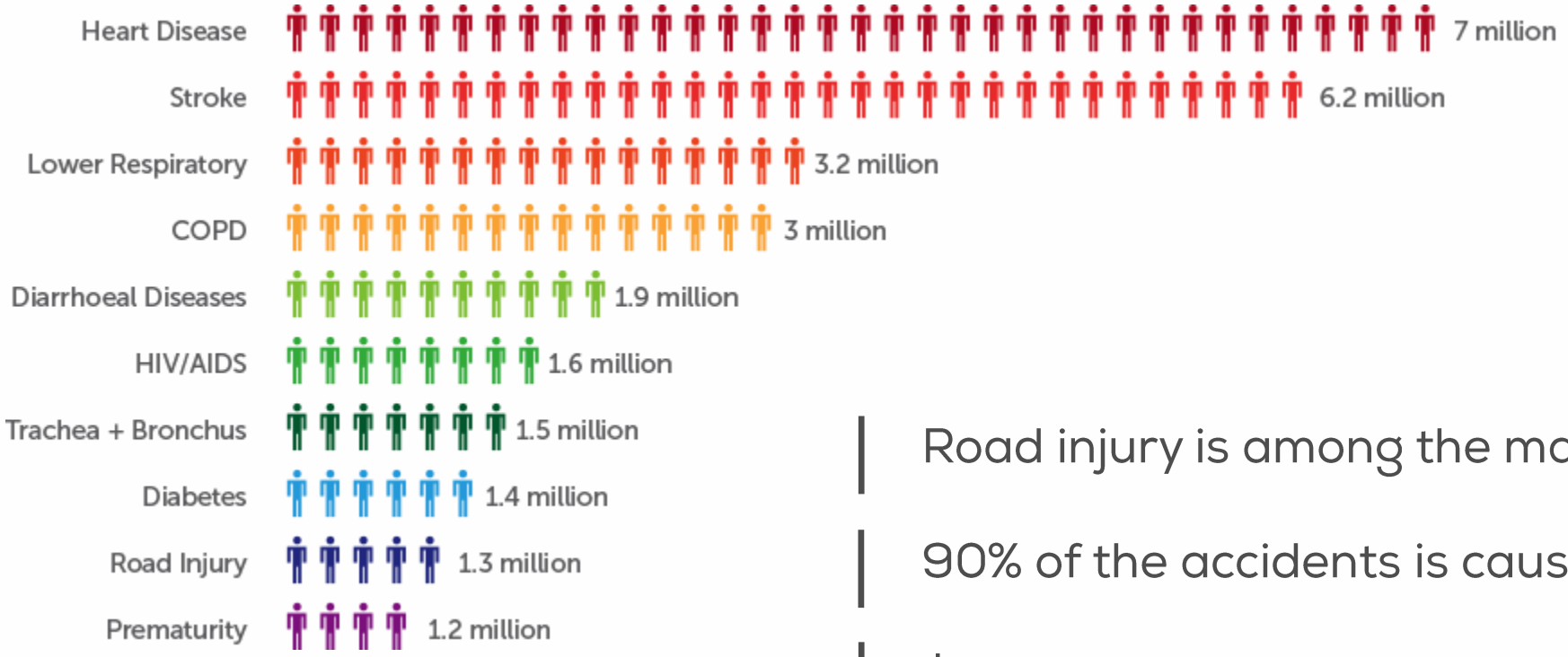
Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE.

This Act may be cited as the "Cameron Gulbransen Kids Transportation Safety Act of 2007" or the "K.T. Safety Act of 2007".

Levels of autonomous driving according to NHSTA





- Road injury is among the major causes of death
- 90% of the accidents is caused by human failure
- $ 871 Billion economic damage in the US annually

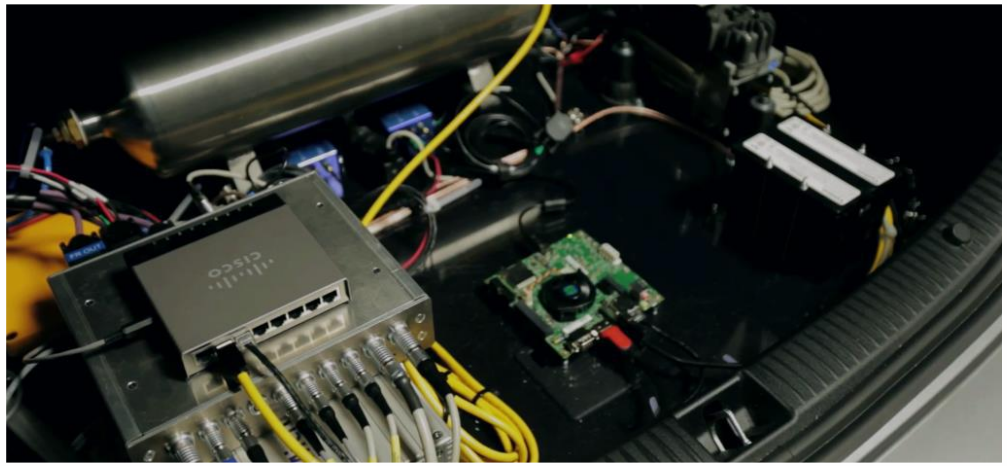
Smart devices of the future

The first automated car driven by a single application processor
Nvidia Tegra K1: $ 50
The cost of Google Car's sensors reaches $ 100k

A new system is needed, where the components are cheap and can be obtained
anytime, anywhere
Shared technology is the key!

99% of the information is obtained from the cameras

Today's cars are equipped with 50-100 different microprocessors
There is a lack of integration
The future: 5-10 chips altogether

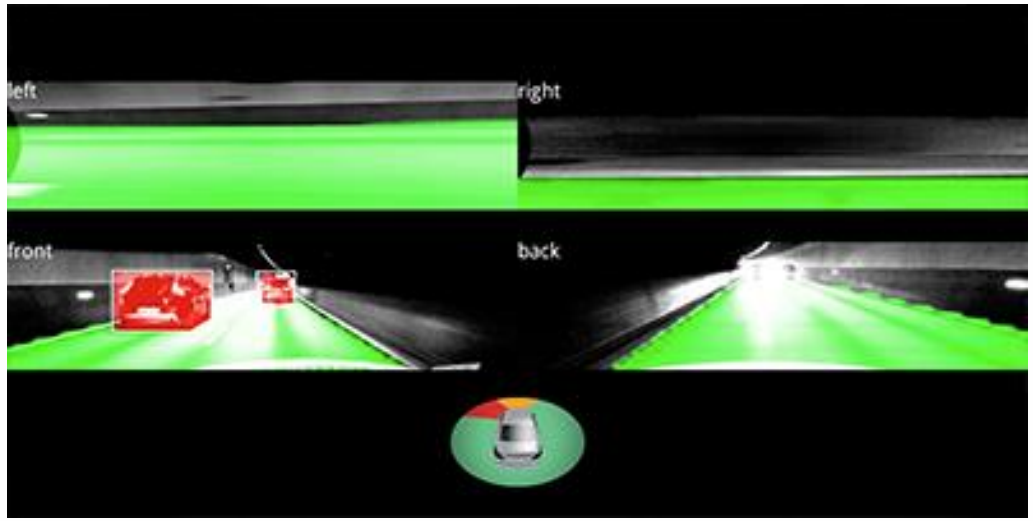


Drivers are making decisions based on visual information

We will have to share the roads with non-autonomous cars and their drivers
Behavior prediction

Before that: integration and cooperative driving…

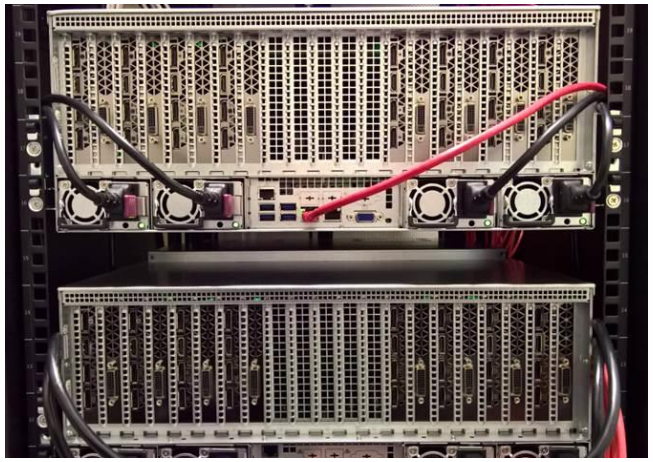
vs



Deep neural network algorithms for embedded processing are used

Massively parallel GPUs can be used to train faster
(50 times faster than CPU training)

Alternative technologies (FPGA, ASIC)



Low performace on many cores
Computation tasks are homogeneous
- Matrix multiplication
- Convolution

Massive Parallel Programming

Cost Over Time

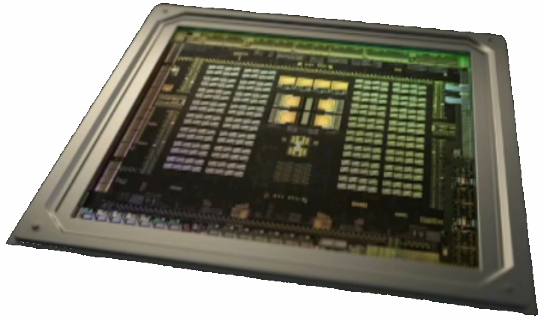
NVIDIA GeForce TITAN X

NVIDIA cuBLAS, cuDNN, cuFFT libraries optimized for the device
High level ML framework support

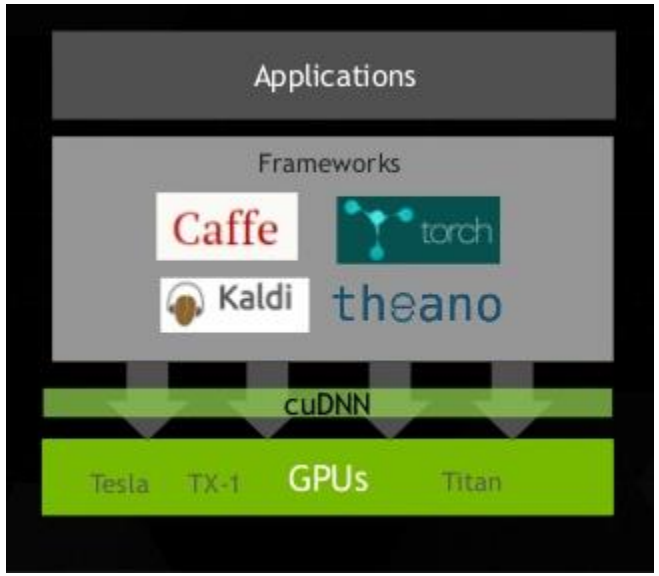
3072 cores
12 GB memory
1000 MHz base clock
Maxwell-architecture

NVIDIA GeForce TEGRA X1

Used in Drive PX
Low power, automotive application support
Drive PX2: autonomous car development



256 cores
1000 MHz base clock
Maxwell-architecture



cuDNN
Deep Neural Network library
Standard routines implemented and accelerated
Highly supported by DNN frameworks

cuBLAS
BLAS library for CUDA
Fully connected networks

cuFFT
Accelerated FFT library for CUDA
General image processing

Generic libraries

Covering 70-80% of the use cases
Supported and continously developed kernels
Extendable

Custom kernels

Special datasets
Extreme use cases
Workload

GPUs in CV	Per pixel operation Image filtering Optical flow: per pixel, per feature Detection: HOG, LBP, VJ
Development	SLAM Hybrid solutions Parameter setting, parameter learning 3D bounding box detection with SFM
Prototyping	Production and development

Neural networks

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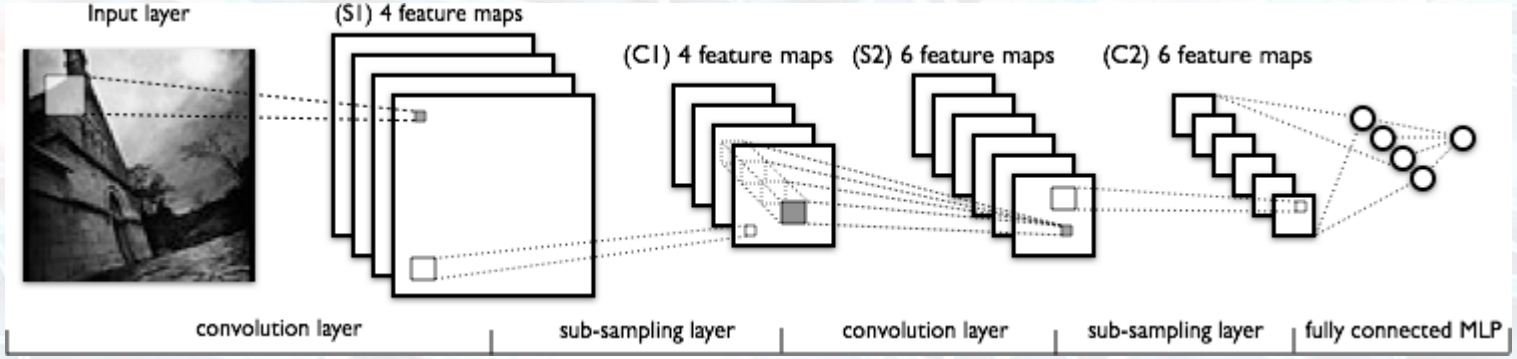
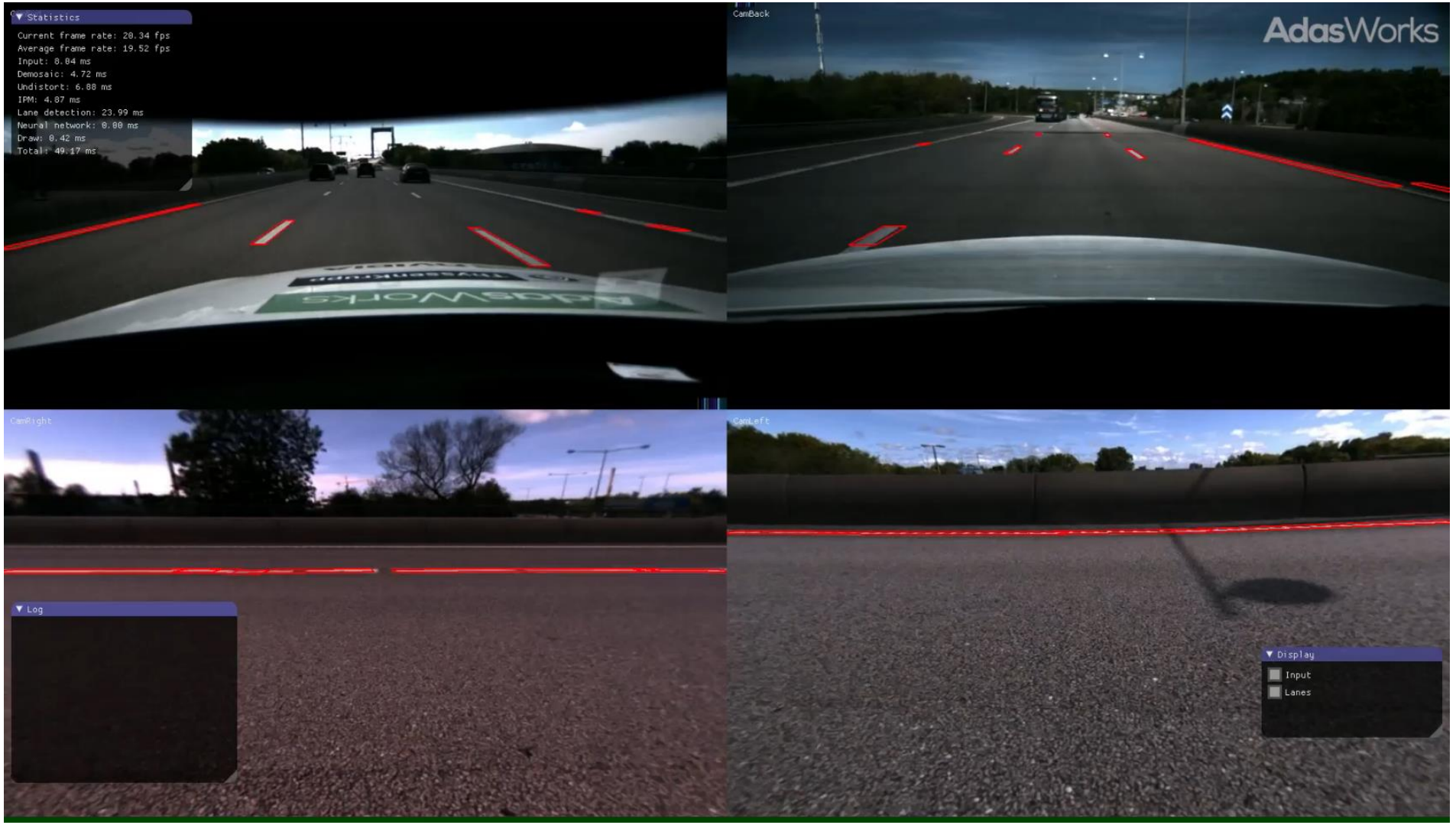
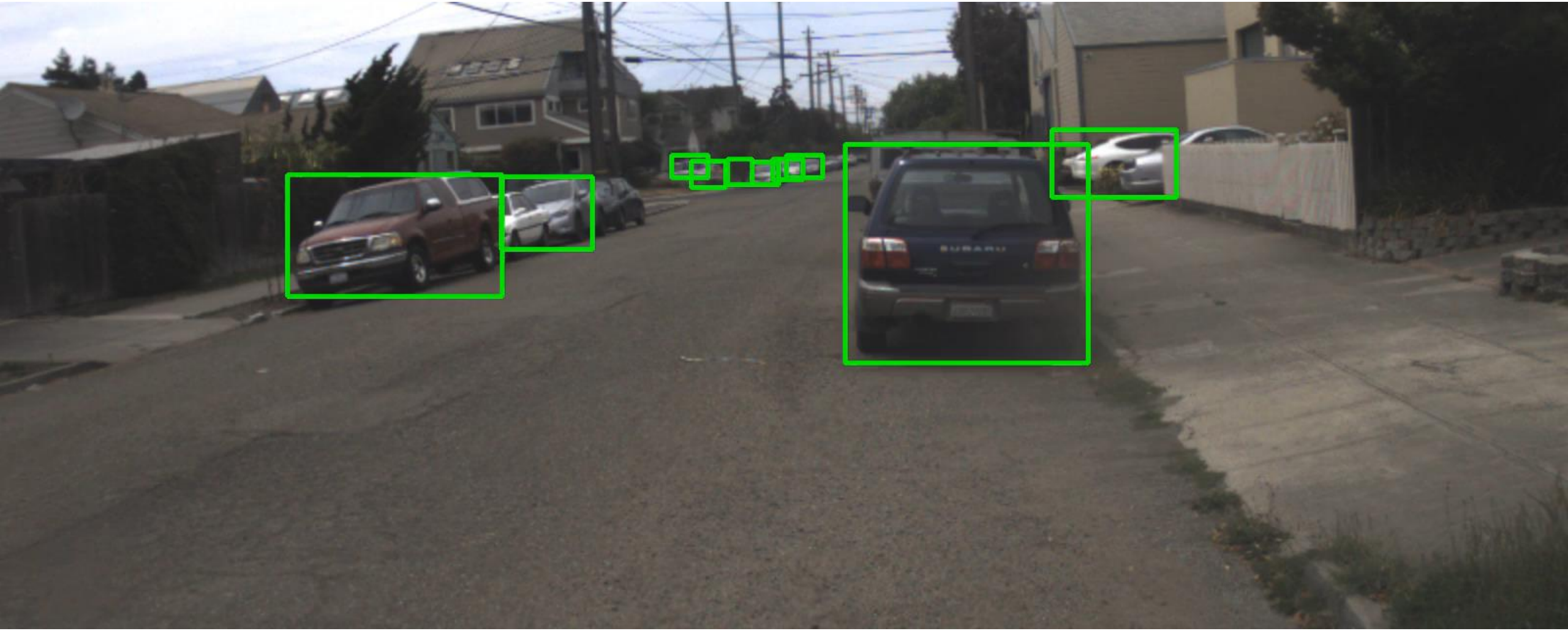
More robust than traditional computer vision algorithms
- For partially occluded objects
- For estimation of the behavior of objects

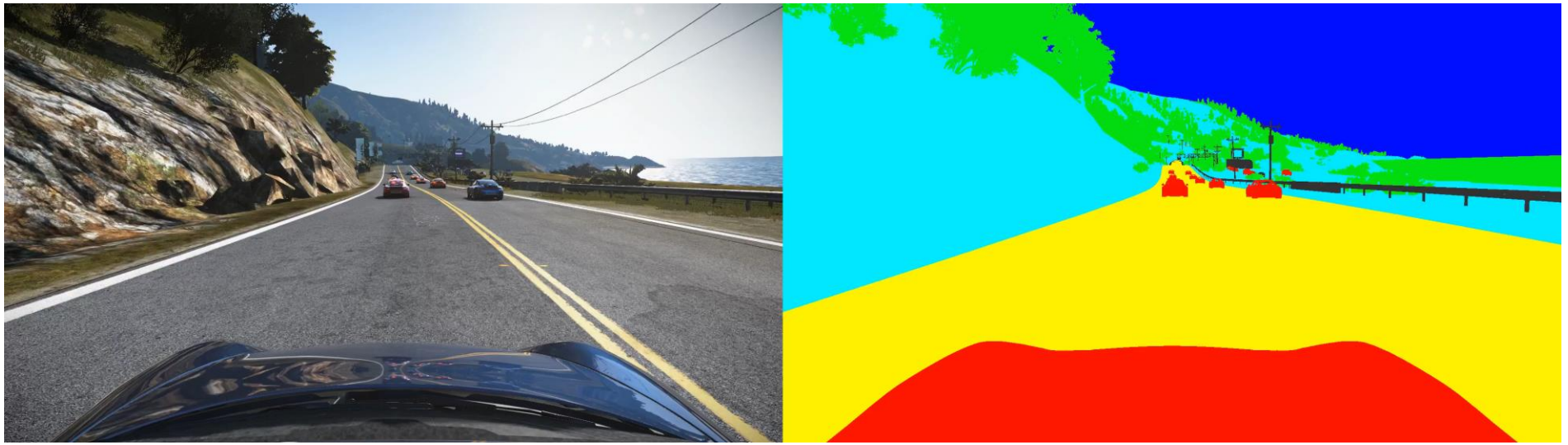
The same type of algorithm is used for detection and classification
- Needs lower processing power for complex tasks
- Classification of multiple objects in same runtime

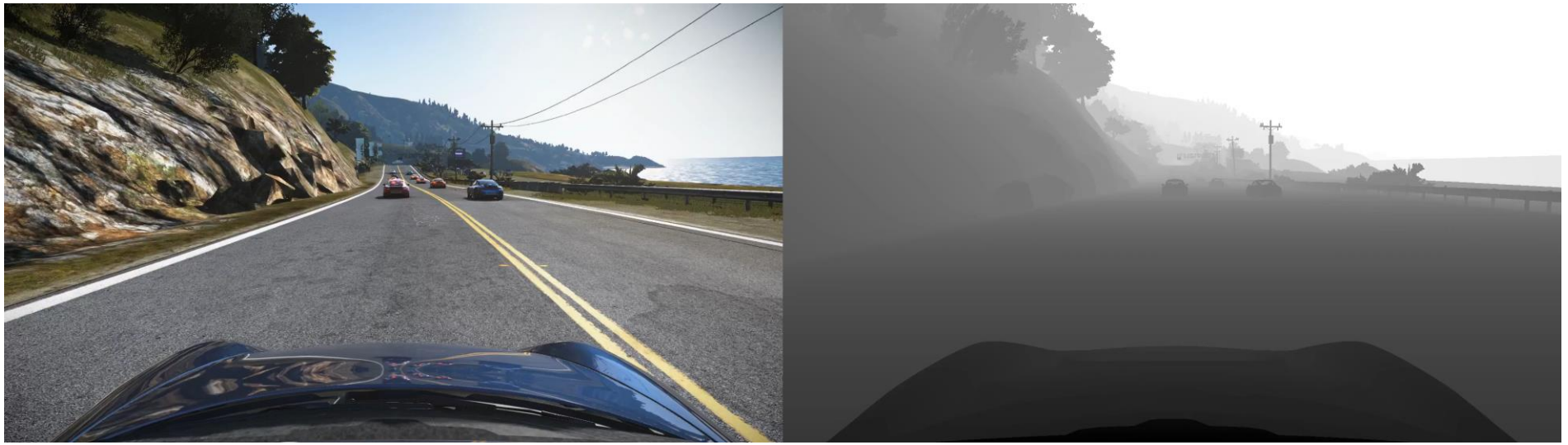
Convolutional Neural Networks



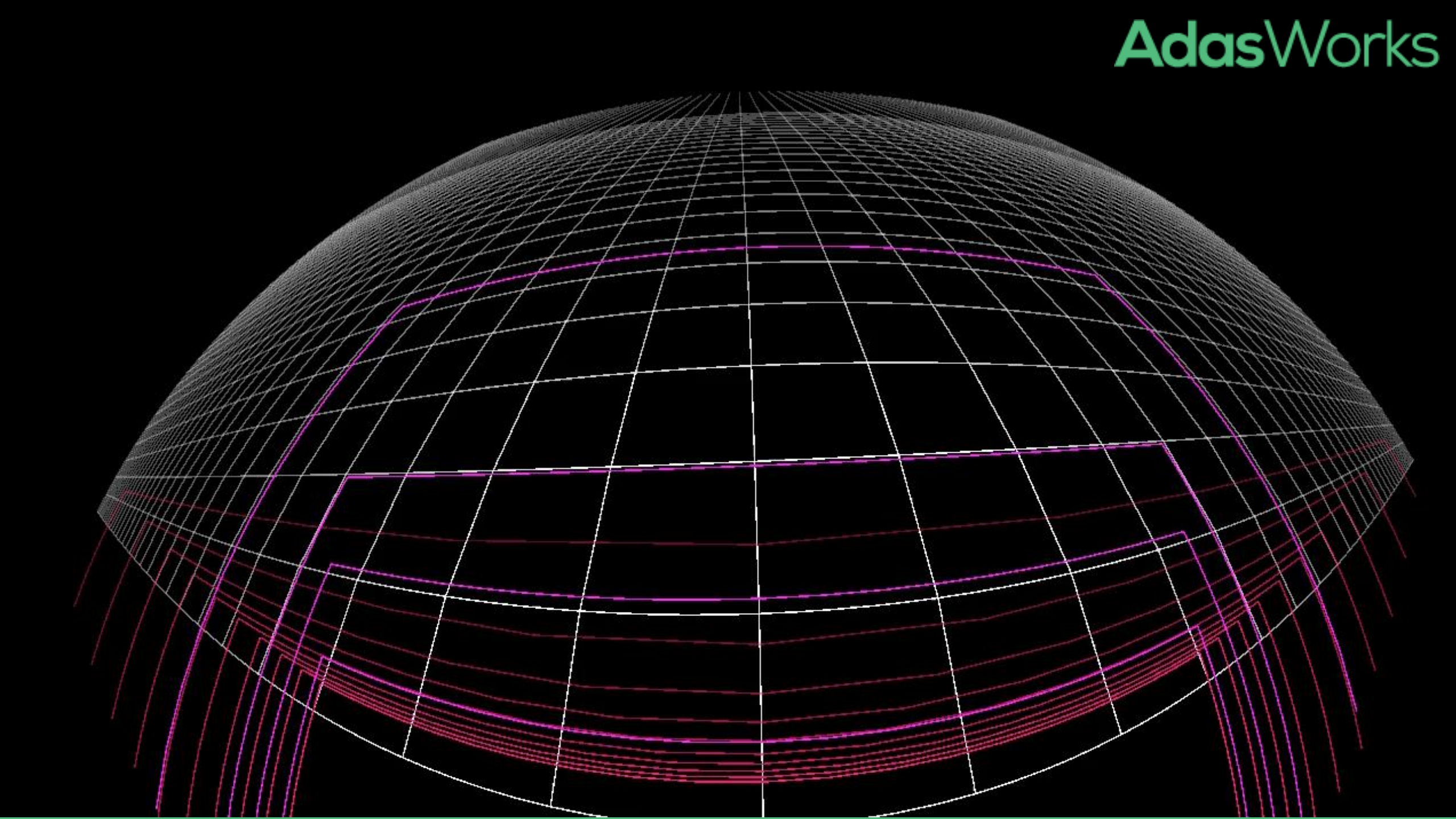

Statistics
Current frame rate: 20.34 fps
Average frame rate: 19.52 fps
Input: 8.04 ms
Demosaic: 4.72 ms
Undistort: 6.88 ms
IPM: 4.87 ms
Lane detection: 23.99 ms
Neural network: 0.00 ms
Draw: 0.42 ms
Total: 49.17 ms
CamBack
AdasWorks
CamRight
Log
CamLeft
Display
Input
Lanes








VISEGRÁDI
CENTER
AdasWorks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360° Intelligent Surround View System

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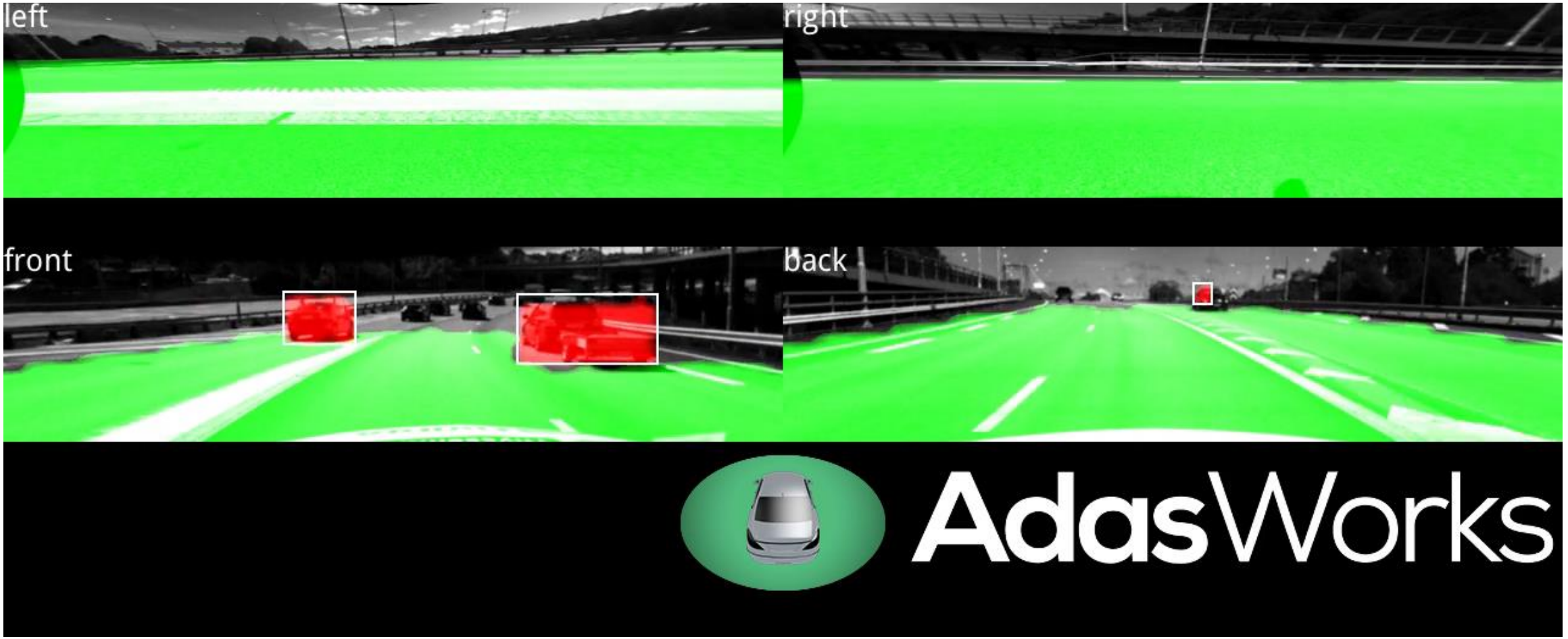

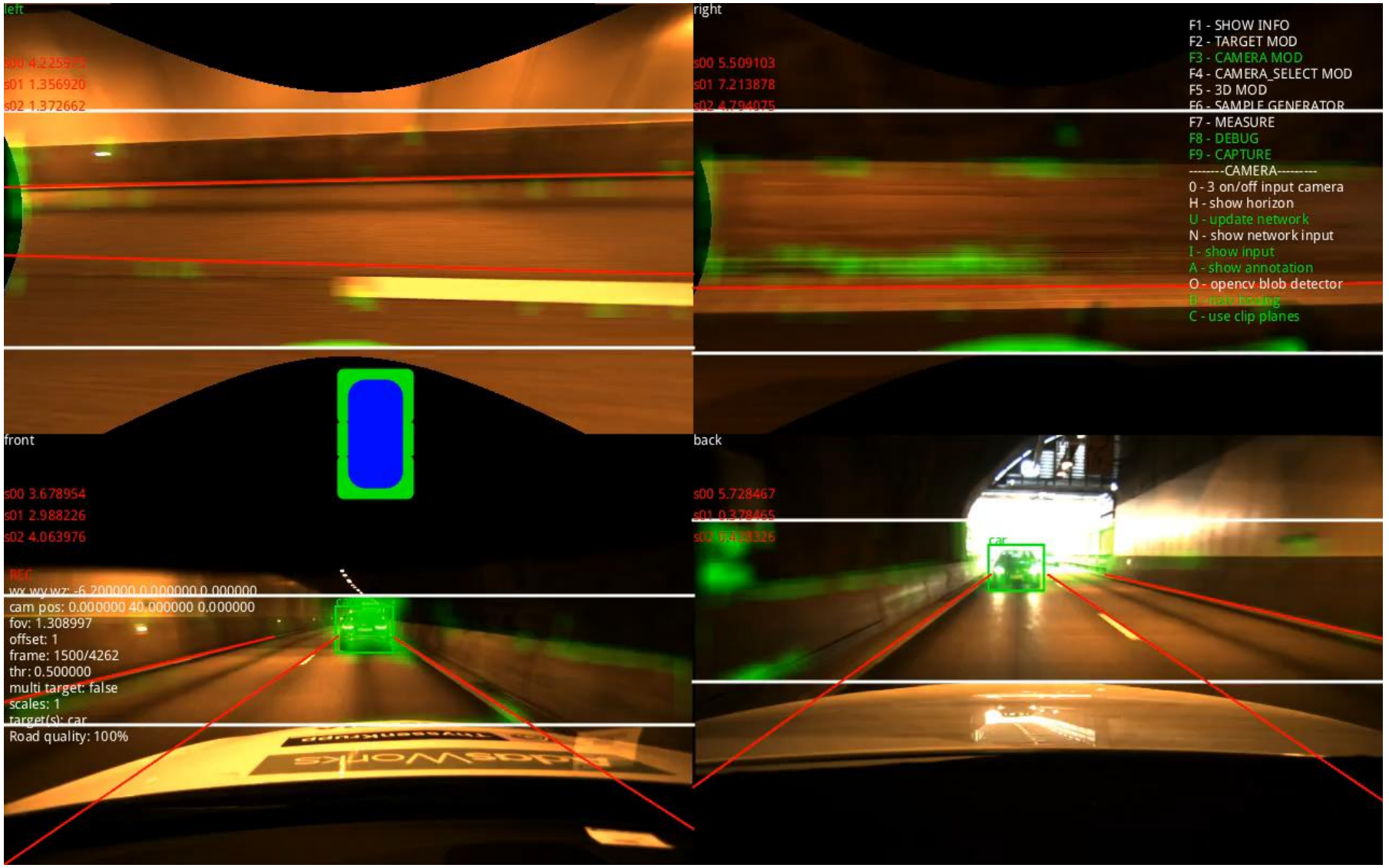
left
s00 4.225975
s01 1.356920
s02 1.372662
right
s00 5.509103
s01 7.213878
s02 4.794075
F1 - SHOW INFO
F2 - TARGET MOD
F3 - CAMERA MOD
F4 - CAMERA_SELECT MOD
F5 - 3D MOD
F6 - SAMPLE GENERATOR
F7 - MEASURE
F8 - DEBUG
F9 - CAPTURE
--------CAMERA---------
0 - 3 on/off input camera
H - show horizon
U - update network
N - show network input
I - show input
A - show annotation
O - opencv blob detector
B - make bagging
C - use clip planes
front
s00 3.678954
s01 2.988226
s02 4.063976
REC
wx wy wz: -6.200000 0.000000 0.000000
cam pos: 0.000000 40.000000 0.000000
fov: 1.308997
offset: 1
frame: 1500/4262
thr: 0.500000
multi target: false
scales: 1
target(s): car
Road quality: 100%
back
s00 5.728467
s01 0.378465
s02 0.428326
car


Drive Me
SELF-DRIVING CARS FOR
SUSTAINABLE MOBILITY
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VOLVO
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Automated data collection for high detailed maps

here

Reliability	Incorrect reconstruction of the environment Incorrect decision making and reaction
Creativity	Unknown/unlearned situations Value of human life
Security and safety	Legal frameworks Home-made software

“Volvo will accept full liability whenever one of its cars is in autonomous mode.”

Håkan Samuelsson
CEO - Volvo Cars

When will the self-driving cars take over the traditional driving?

What are the main factors?

Will human driving become a luxury?

Who will make the decisions?

Contact

Szépvölgyi út 39. 1037 Budapest

www.adasworks.com

jobs@adasworks.com  *@adasworks* info@adasworks.com