

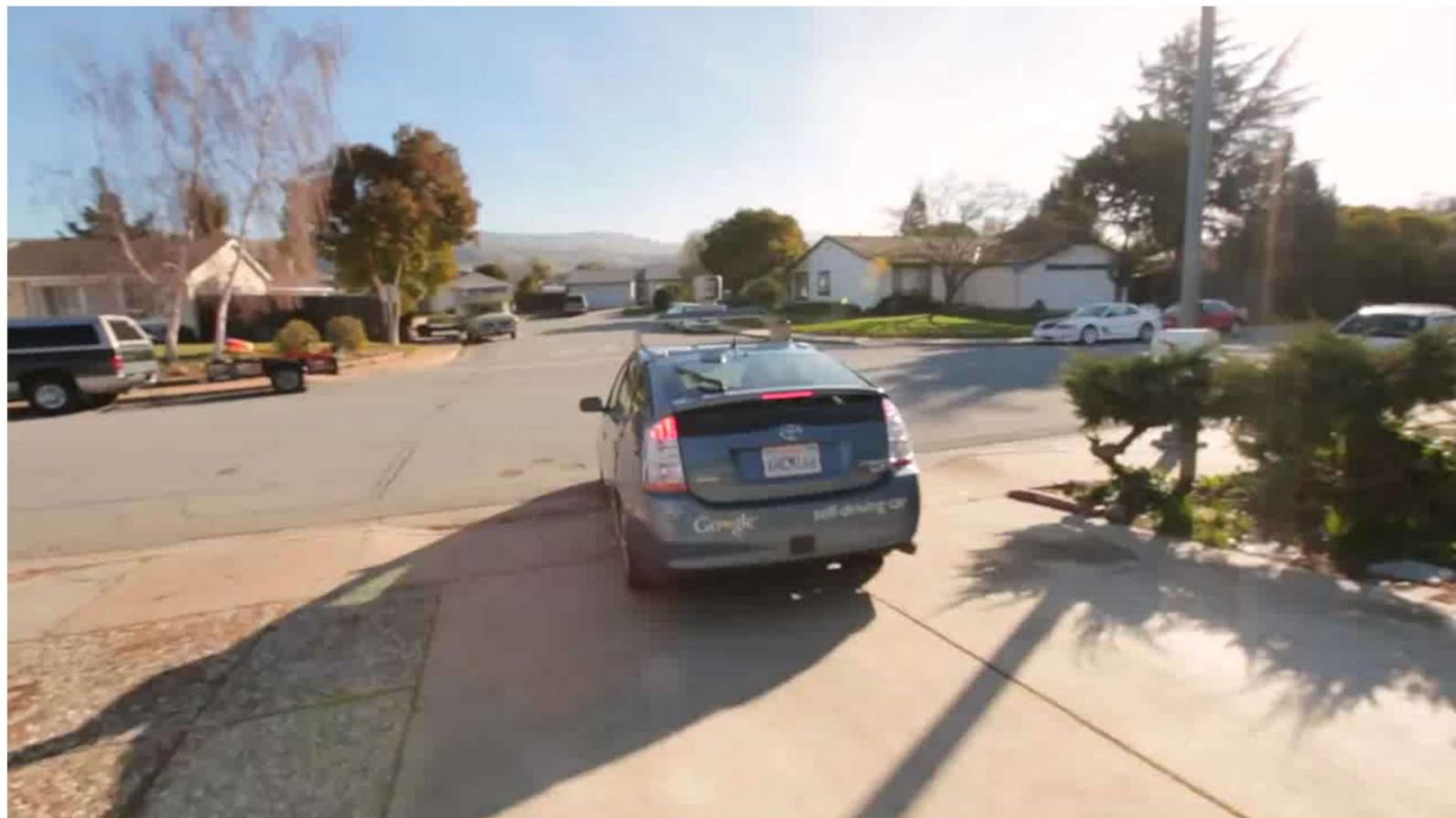
Autonomous Driving: the missing piece

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VisLab - Ambarella

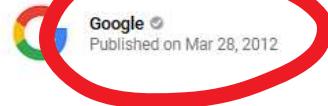
Parma, Nov 20, 2020



Self-Driving Car Test: Steve Mahan

9,169,501 views

1K 51K 5.3K SHARE SAVE ...



SUBSCRIBE 7.3M



Official Blog

Insights from Googlers into our products, technology, and the Google culture

What we're driving at

October 9, 2010

Larry and Sergey founded Google because they wanted to help solve really big problems using technology. And one of the big problems we're working on today is car safety and efficiency. Our goal is to help prevent traffic accidents, free up people's time and reduce carbon emissions by fundamentally changing car use.

So we have developed technology for cars that can drive themselves. One automated car, manned by trained operators, just drove from our Mountain View campus to our Santa Monica office and on to Hollywood Boulevard. They've driven down Lombard

October 28, 2010





Outline

1. Brief speaker introduction
2. General overview about AD
3. Technical implementation; open issues

WARNING:
This presentation is biased!

VisLab



Group started in mid '90s at the Univ of Parma, Italy

Spin-off launched in 2009

ARGO (1998)



June 1-6, 1998



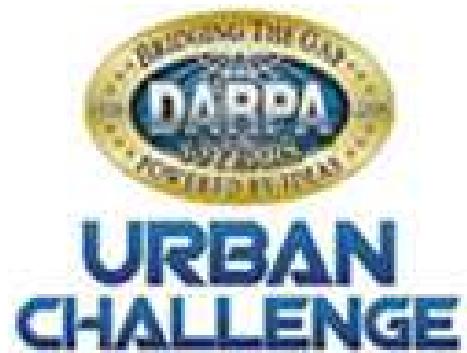
Distance: 1860 km
Time: 6 days
Max speed in AD: 123 km/h
Percentage of AD: 94%



TerraMax (2005)



DARPA Challenges (2004-07)

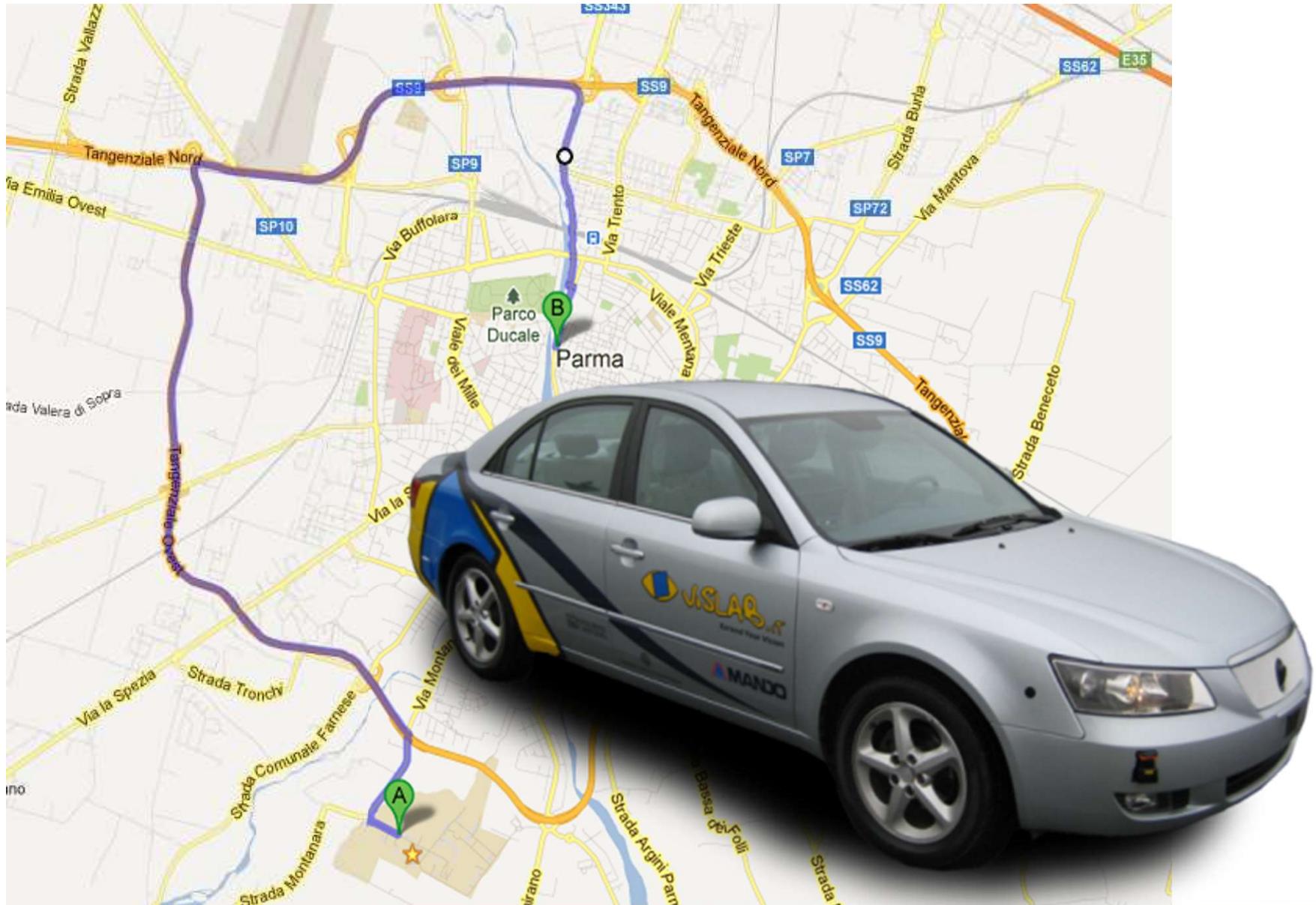


VIAC (2010)





PROUD test (2013)

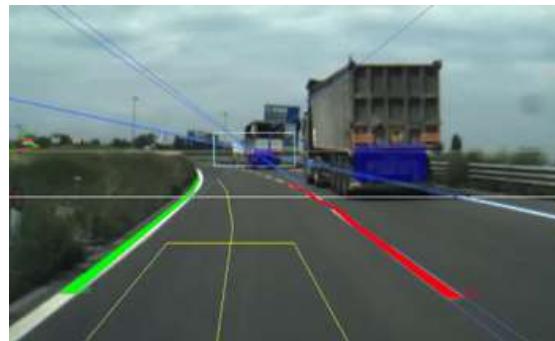




Downtown Parma, Italy – July 12, 2013

VisLab + Ambarella

- In July 2015 VisLab joined Ambarella
 - Ambarella, a chip company, world renown for high quality ultra HD video acquisition and processing
 - VisLab, a computer vision startup with long history in ADAS and autonomous driving



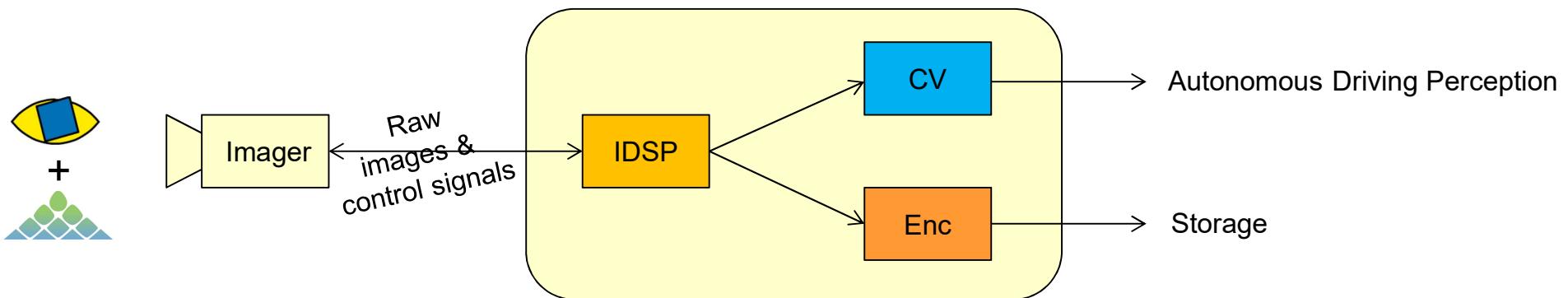
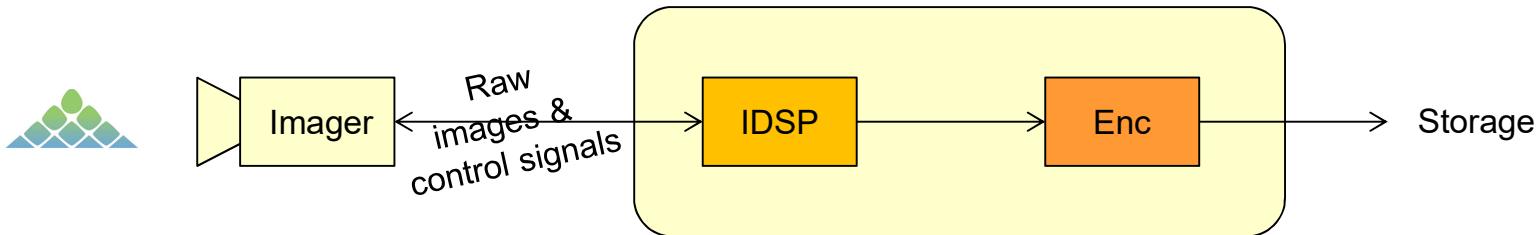
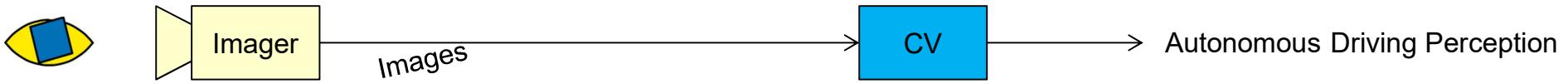
VisLab + Ambarella



Ultra HD 4Kp60

Ambarella™

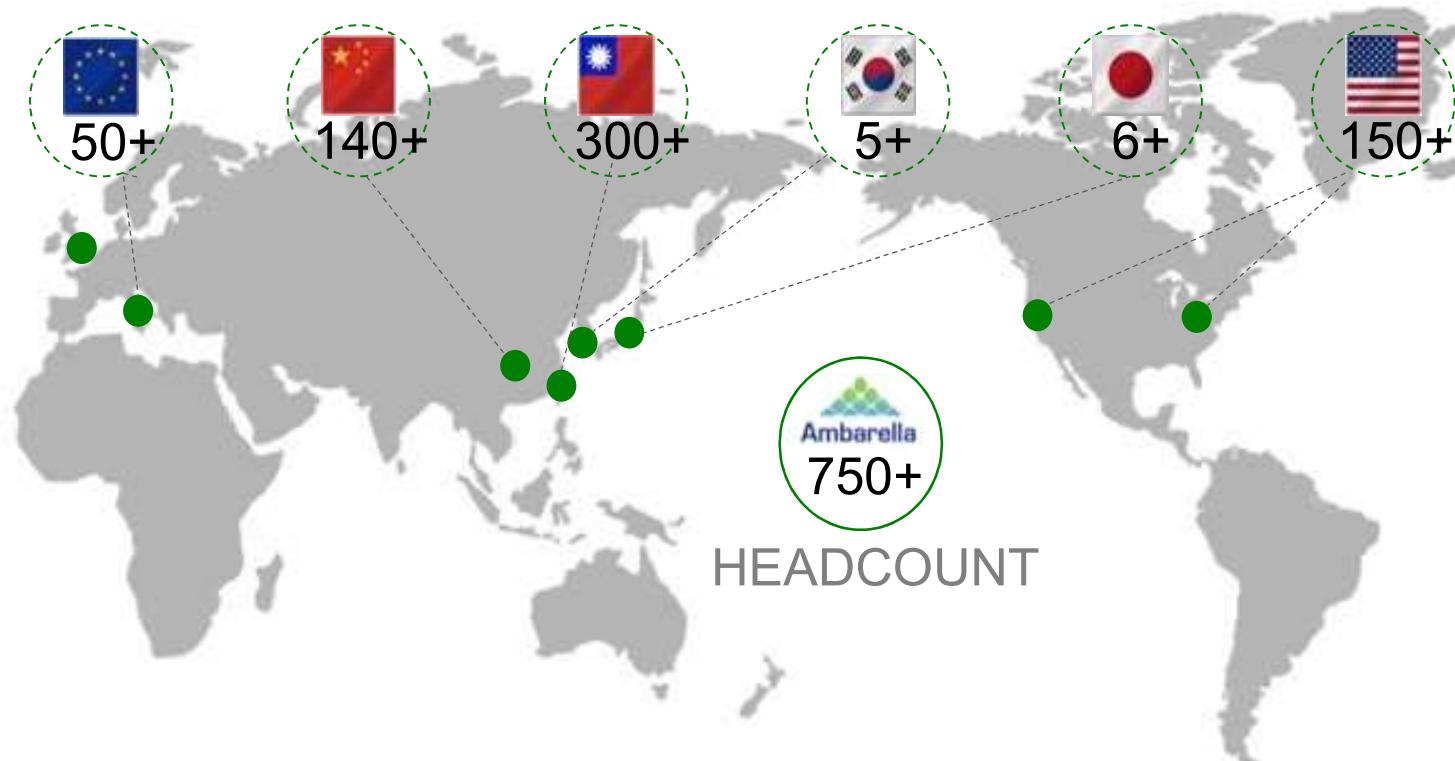
Joining the know how



Ambarella, nowadays

- Ambarella is now a chip maker focused on **computer vision**
 - Mastering the entire stack, from image acquisition to image coding, to image understanding
- Second generation of CV chips
 - Processing multiple 4k images; with stereo and CNN; 30fps; 2-4W power
- Active in Automotive applications:
 - DVR, AVM, E-Mirror, DMS, ADAS, L2-3, L4-5
- Demoing chip capabilities on our autonomous vehicles

Ambarella, Inc.



- 2004: Ambarella founded
- 2012: Initial Public Offering – NASDAQ : AMBA
- 2015: VisLab acquired
- 2018: Over 200 million HD video cameras enabled

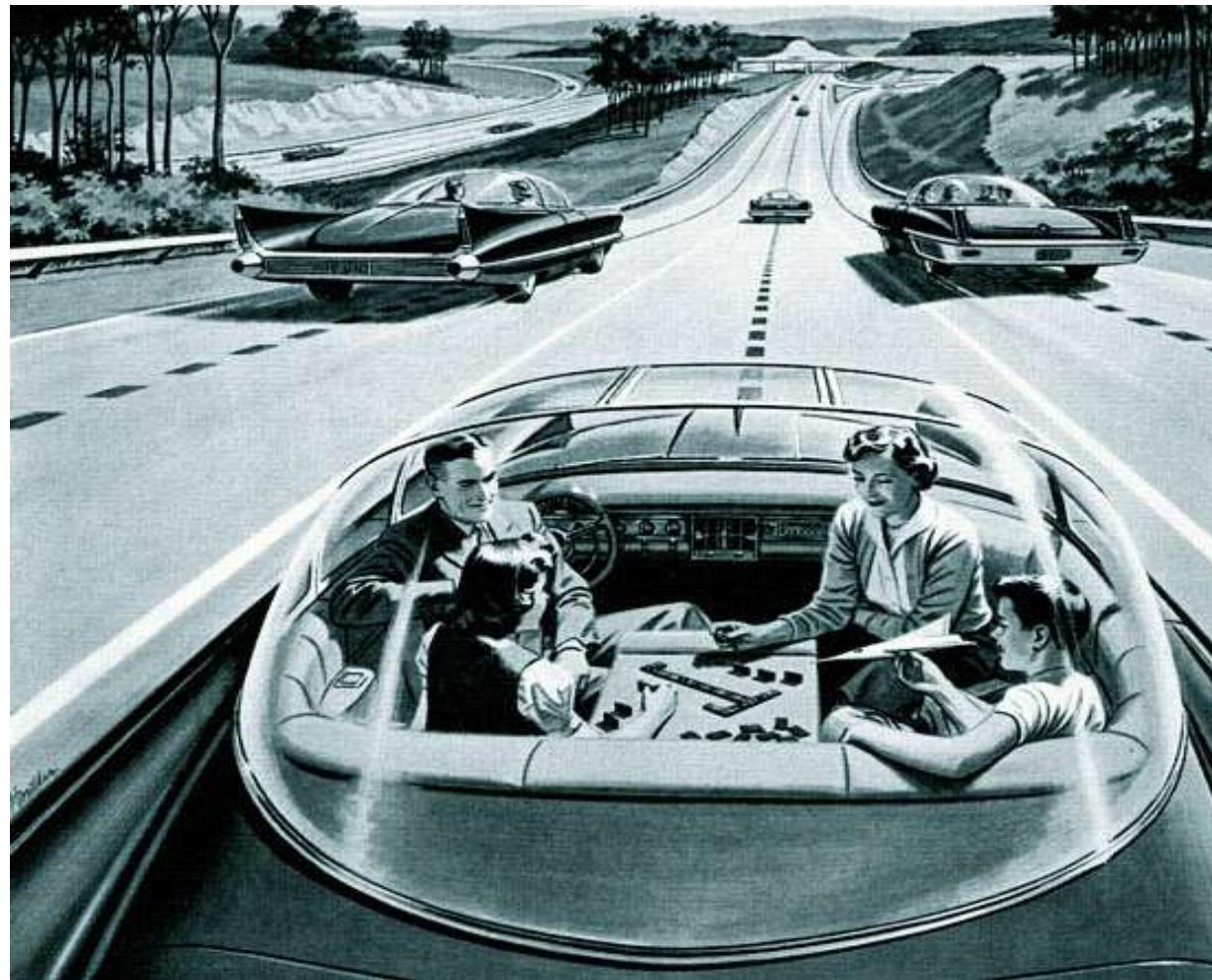
Autonomous Driving: the missing piece

World Milestones

- 2005-7
 - DARPA Challenges set the interest for Autonomous Robots
- 2010
 - First announcement of large IT company working on AD
- 2013
 - First car maker announces delivery of autonomy by 2020

What does AD mean?

- When was the idea conceived?



What does AD mean?

- When was the idea conceived?
 - The implementation is extremely articulated



Ohio State U.

- Covering different disciplines
- Never before in human history

Autonomous Driving

- Why is AD hot?



93% of road accidents due to human error

Advantages

- Why is AD hot?
- Driving is dangerous!
- Other advantages:
 - improving travel speed,
 - increasing comfort,
 - optimizing power consumption,...
 - **First real implementation of AI on a physical system**

AD Levels

SAE AUTOMATION LEVELS

SAE AUTOMATION LEVELS					
Full Automation					
0	1	2	3	4	5
No Automation	Driver Assistance	Partial Automation	Conditional Automation	High Automation	Full Automation
Zero autonomy; the driver performs all driving tasks.	Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.	Vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times.	Driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice.	The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.	The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.

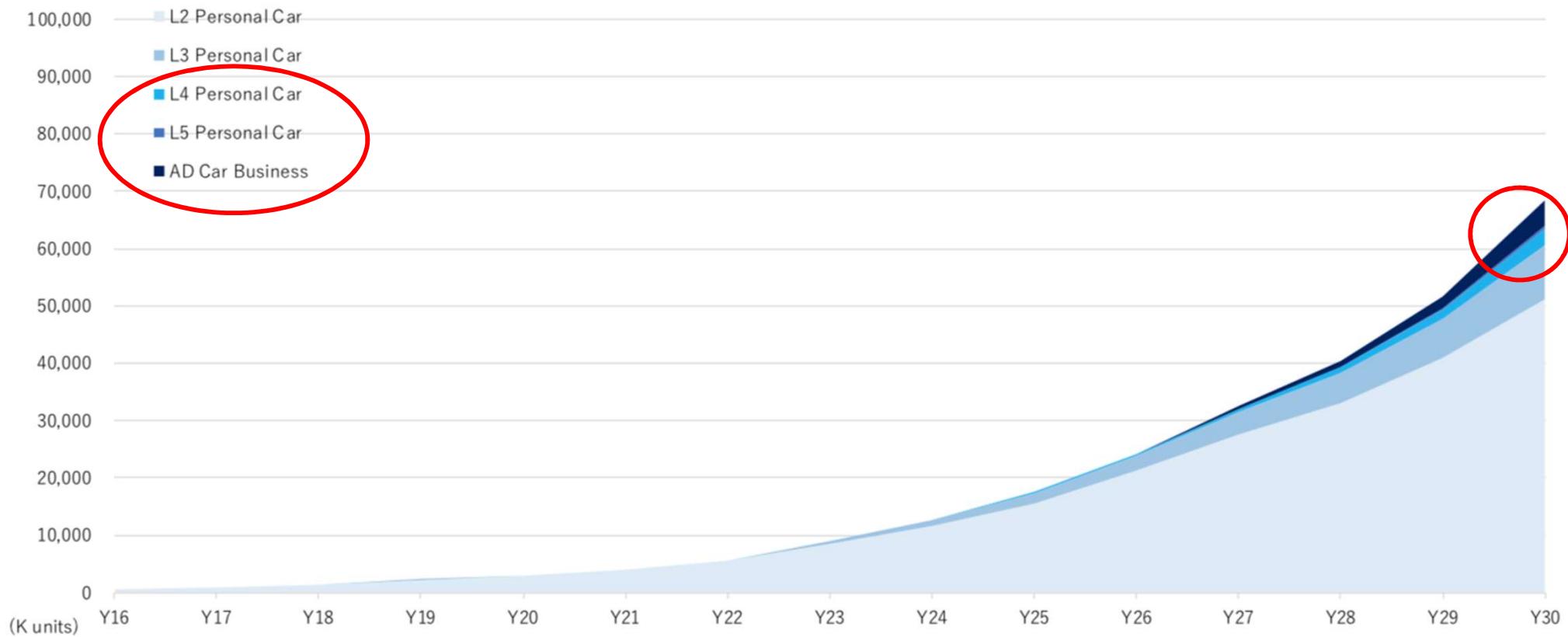
Will L4 and L5
disrupt the business?

Personal cars vs aTaxis

Impact

- How will this technology impact on our lives?
 - Auto industry:
 - Less cars? Less OEMs? New vehicle fleets providers?
 - Insurance industry
 - Delivery industry / logistics
 - Air industry
 - Urban design
 - Personal (Will you own a garage? Living downtown)

Market opportunities





AD Technology

Technology

- **Smart Vehicles** or **Smart Infrastructure?**
 - Do we need special arrangements, like 5G?
 - Do we rely on static data, like maps?
 - Is crowdsourcing an option for safety critical systems?
 - How much testing do we need?
- AD implementation:
 - 3 levels of an intelligent vehicle:
sensing, planning, acting

The Intelligent Vehicle

- Perception (understand the surroundings) ...eyes
- Decision (select the maneuver) ...brain
- Actuation (act on vehicle control) ...hands & feet

Perception

- Scene understanding is based on:
 - **Physical perception**
all around, measure distances and speeds,
recognize road players,...
 - **Behavioral perception**
non-verbal communication, special signs, contextual
analysis,... Based on expectations.

Adapt to local driving cultures or enforce rules?

Perception sensors

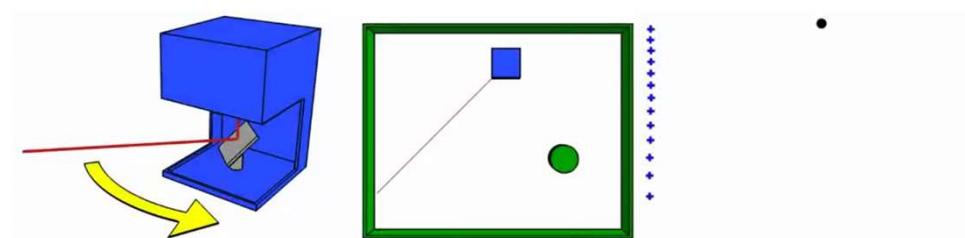
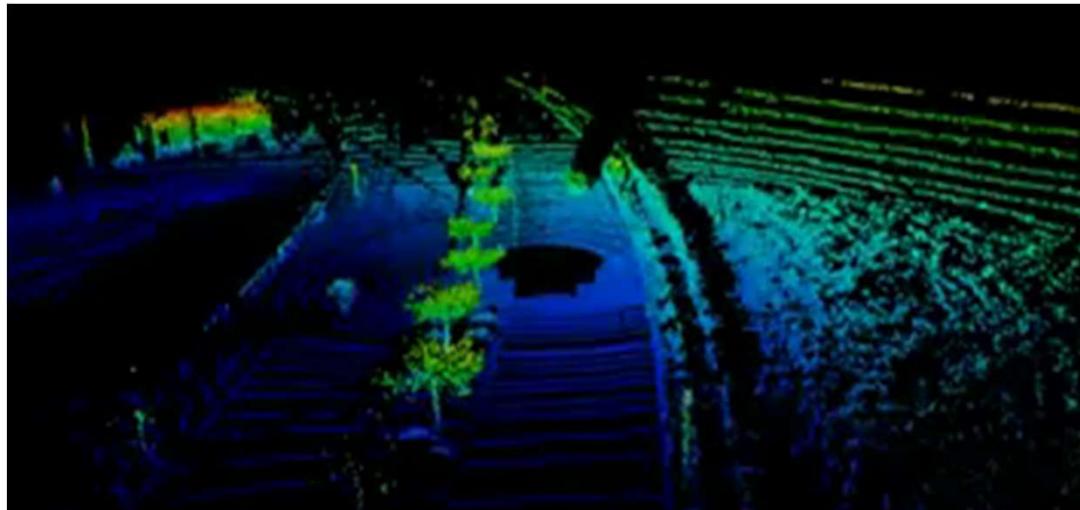
- Sensors:
 - Radar:* does not suffer from bad weather
 - Sonar:* low cost, very effective for short range
 - Laser (LiDAR): very precise, day and night
 - Vision: very dense information content

Vision is considered a 'passive' technology

*Already used in series production

Sensing technology

- Lidar seems the most widely used technology



Taken from www.youtube.com/watch?v=VgoWVFaYbiA

Sensing technology

- Why many prototypes now use lidar?



Sensing technology

- Why many prototypes now use lidar?
 - quick solution to perception (expensive prototypes)
to allow focusing on decision making
 - Cameras historically suffered from some flaws,
although considered potentially very capable

Now gaining a renewed interest

4k Image Resolution



4k, cropped (3840 x 1280)



Image Quality – Sun



Image Quality – Night

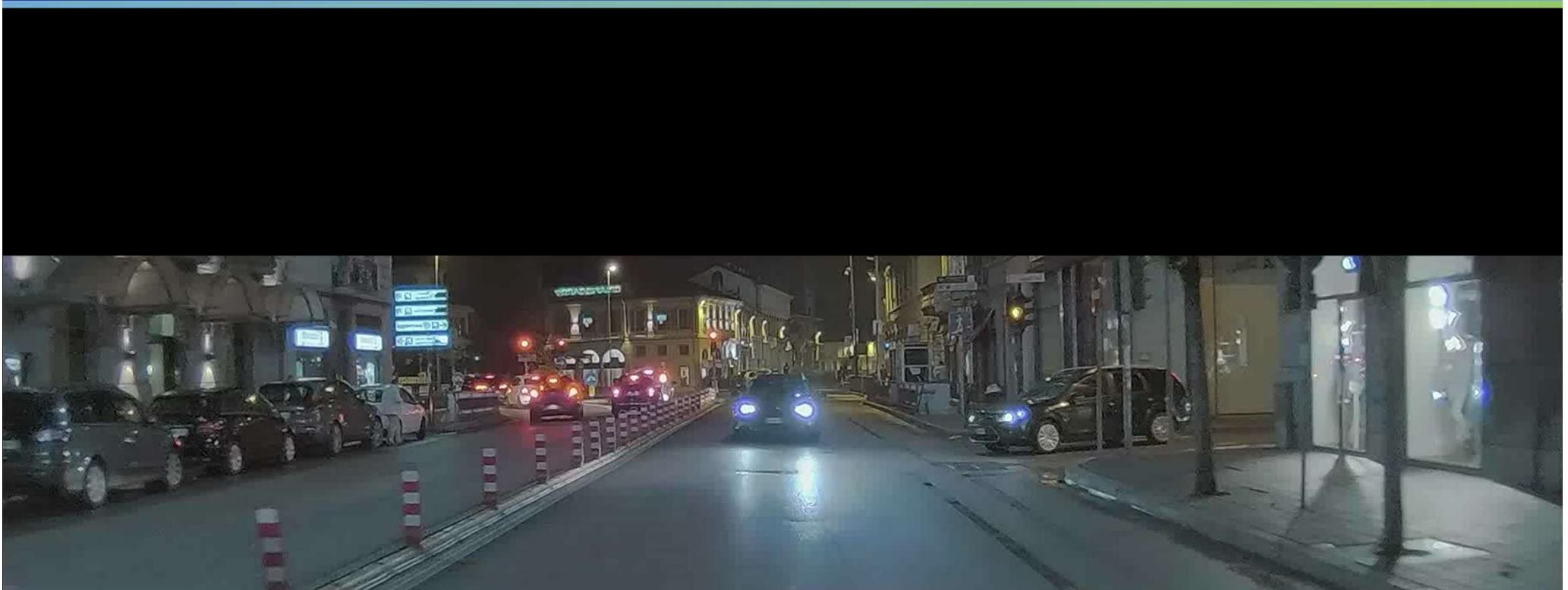
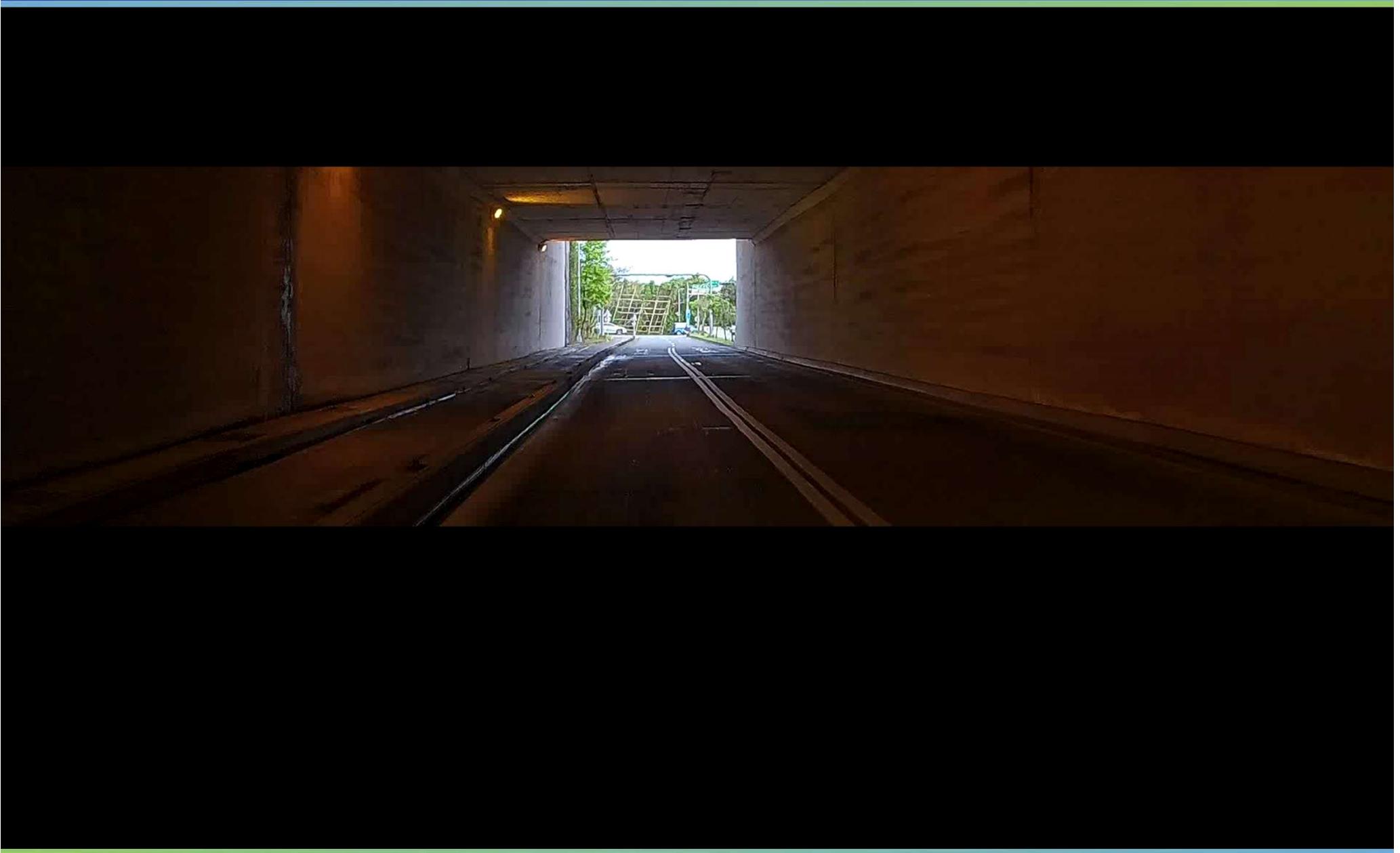


Image Quality – Tunnel

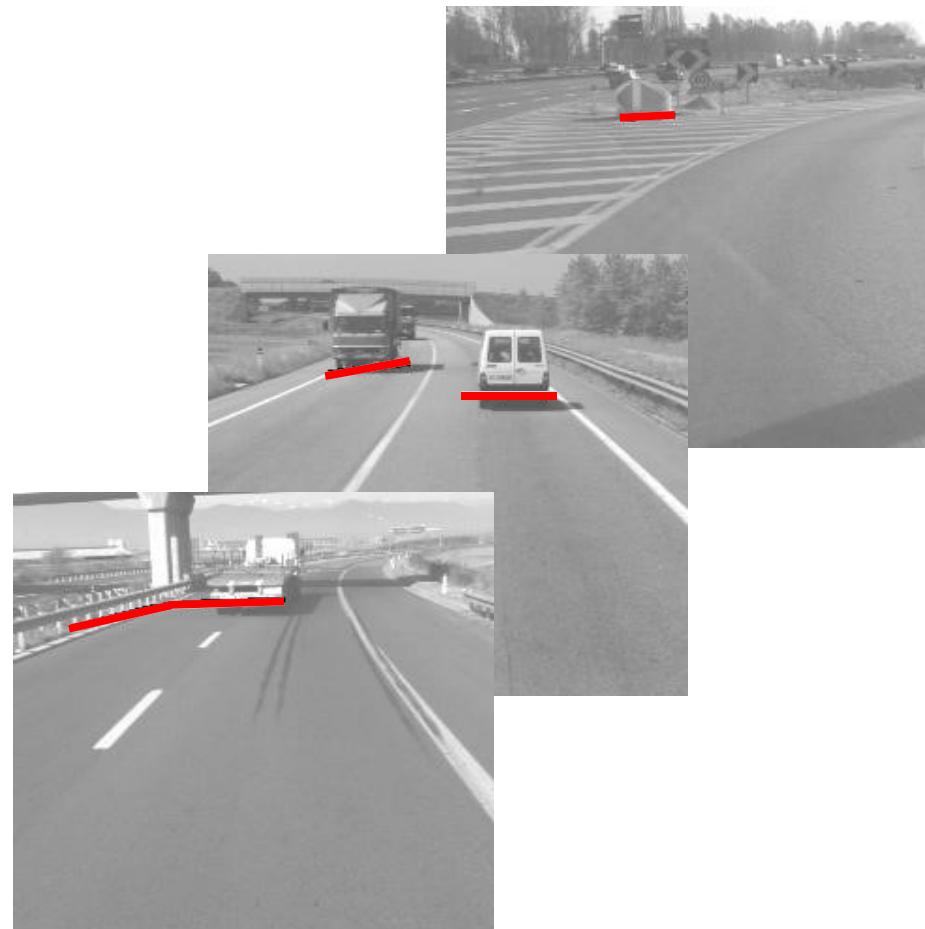
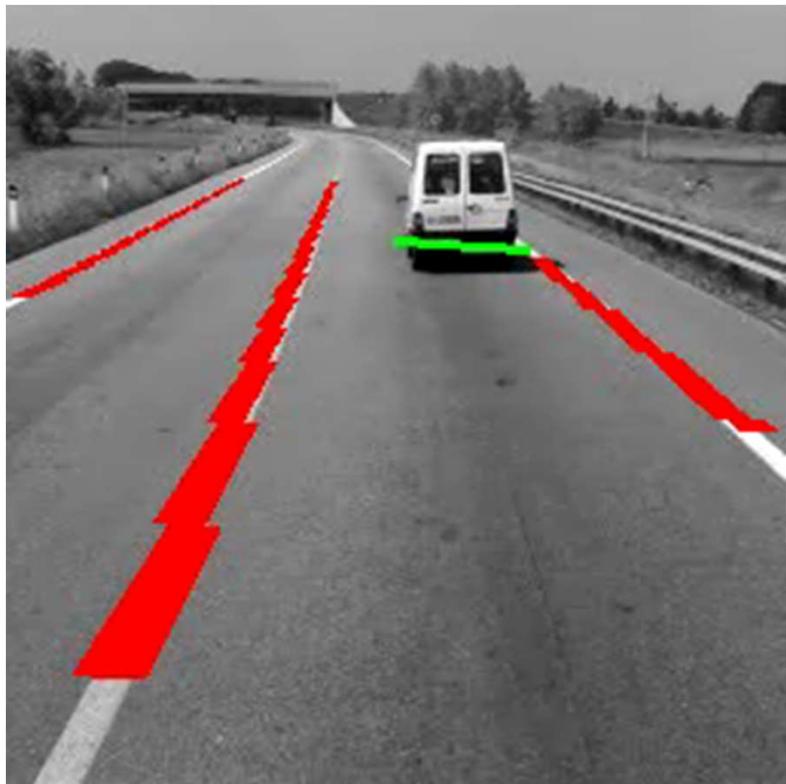


Stereovision

- Vision brings additional advantages when using **two** cameras at the same time



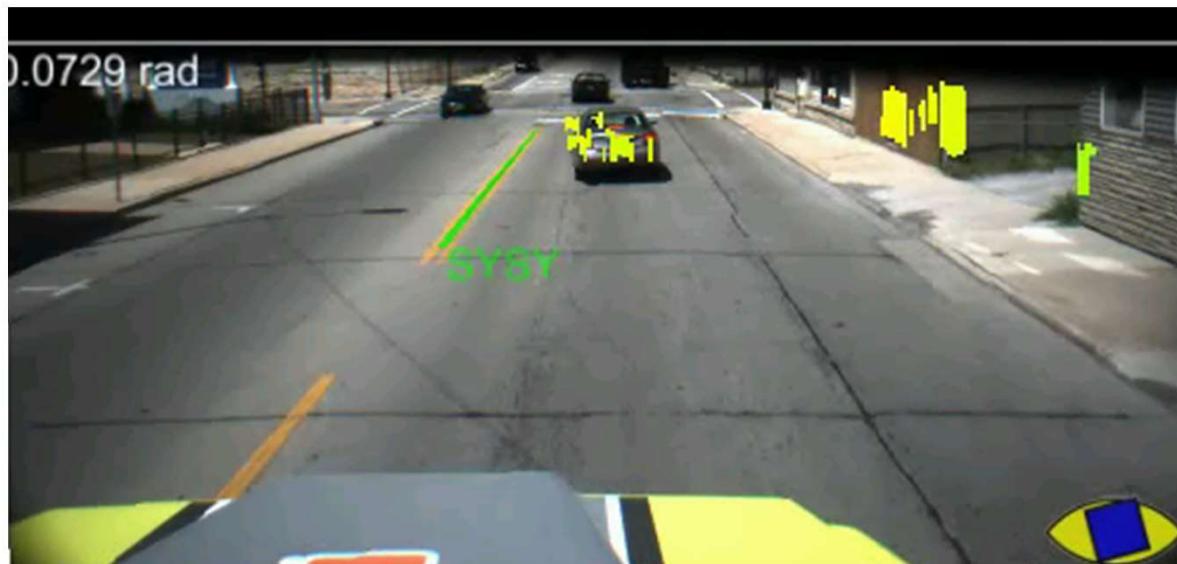
Pioneering automotive stereo technology – 1998



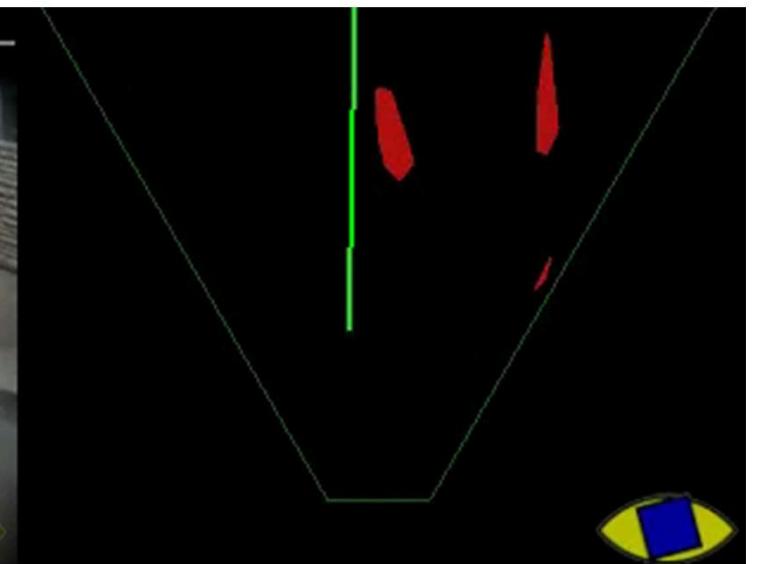
Deployment as main sensing technology – 2005/7



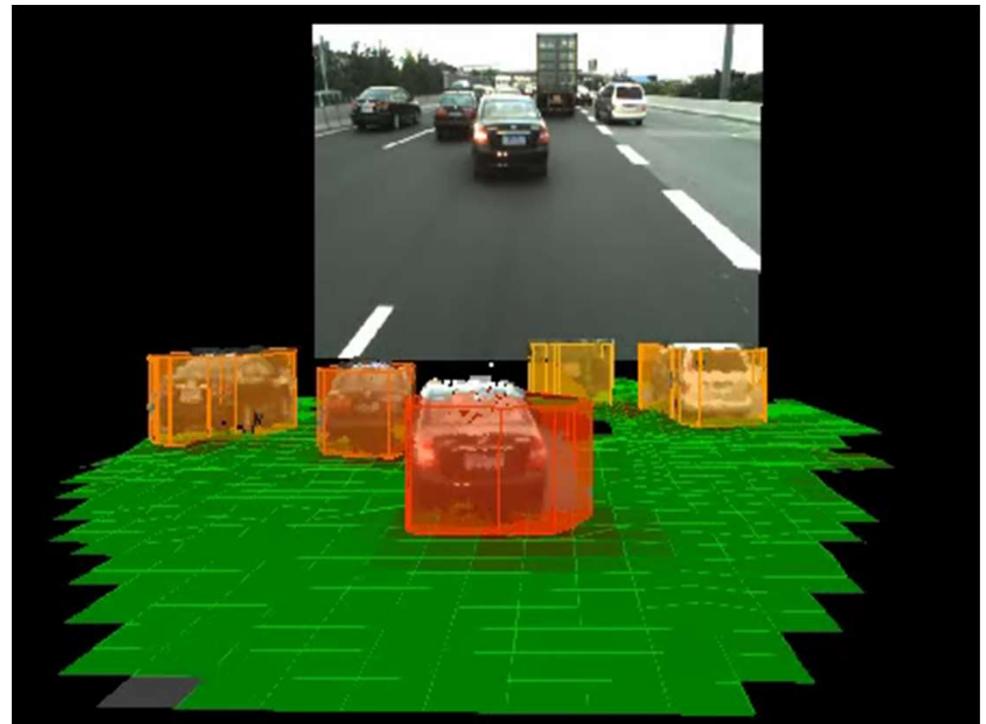
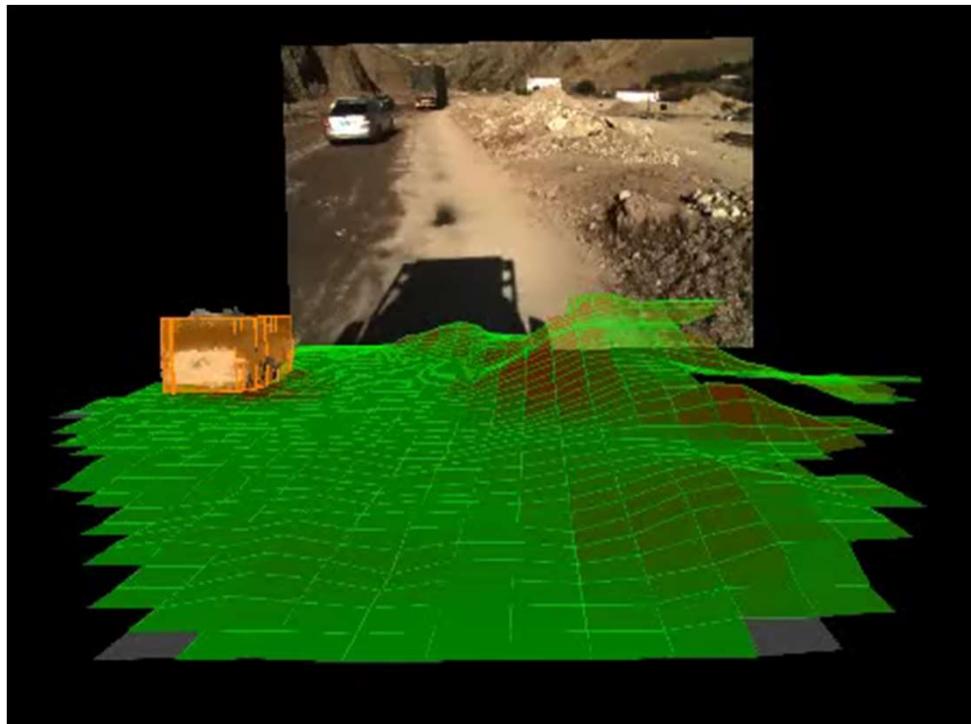
DARPA Grand Challenge, 2005



DARPA Urban Challenge, 2007

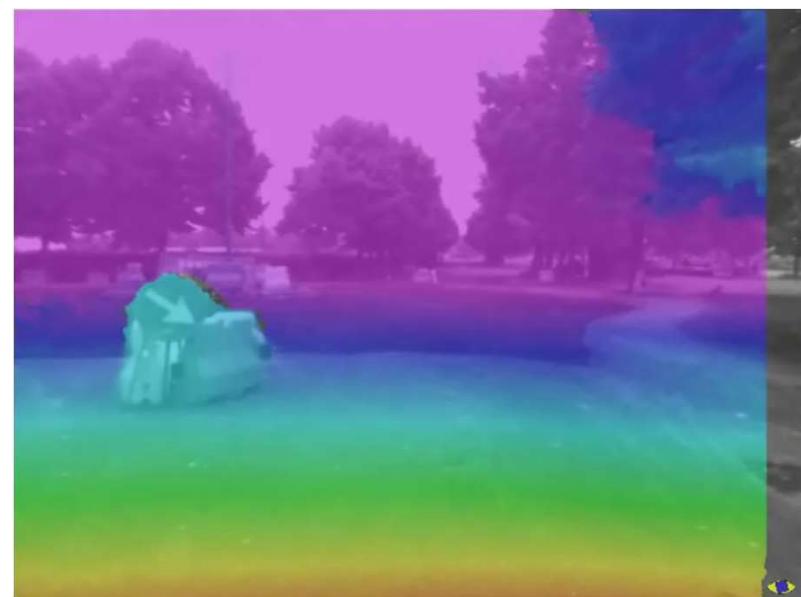


Endurance test – 2010

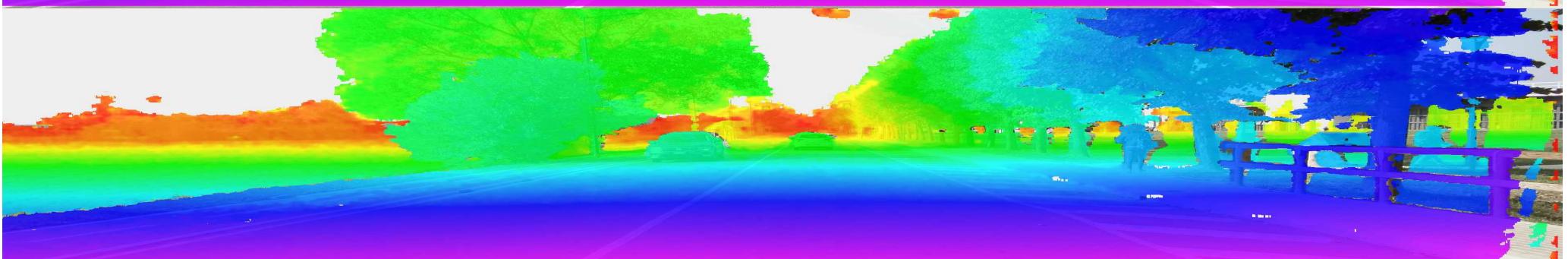
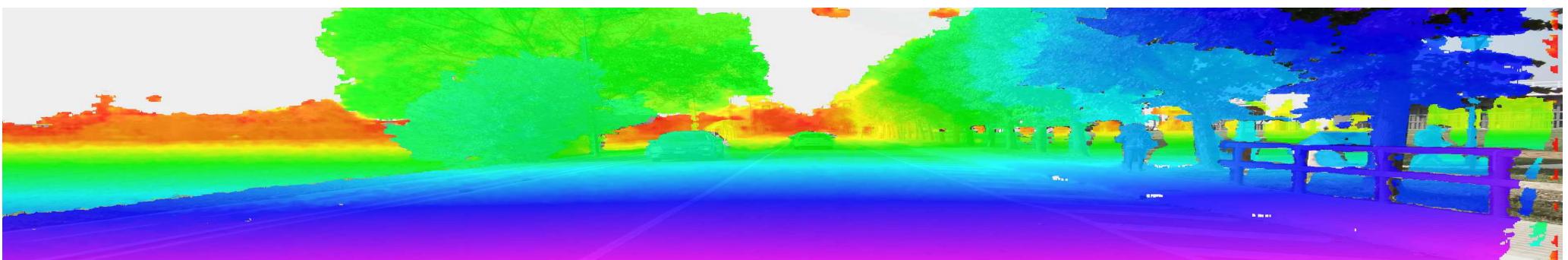


VIAC: VisLab Intercontinental Autonomous Challenge, 2010 – viac.vislab.it

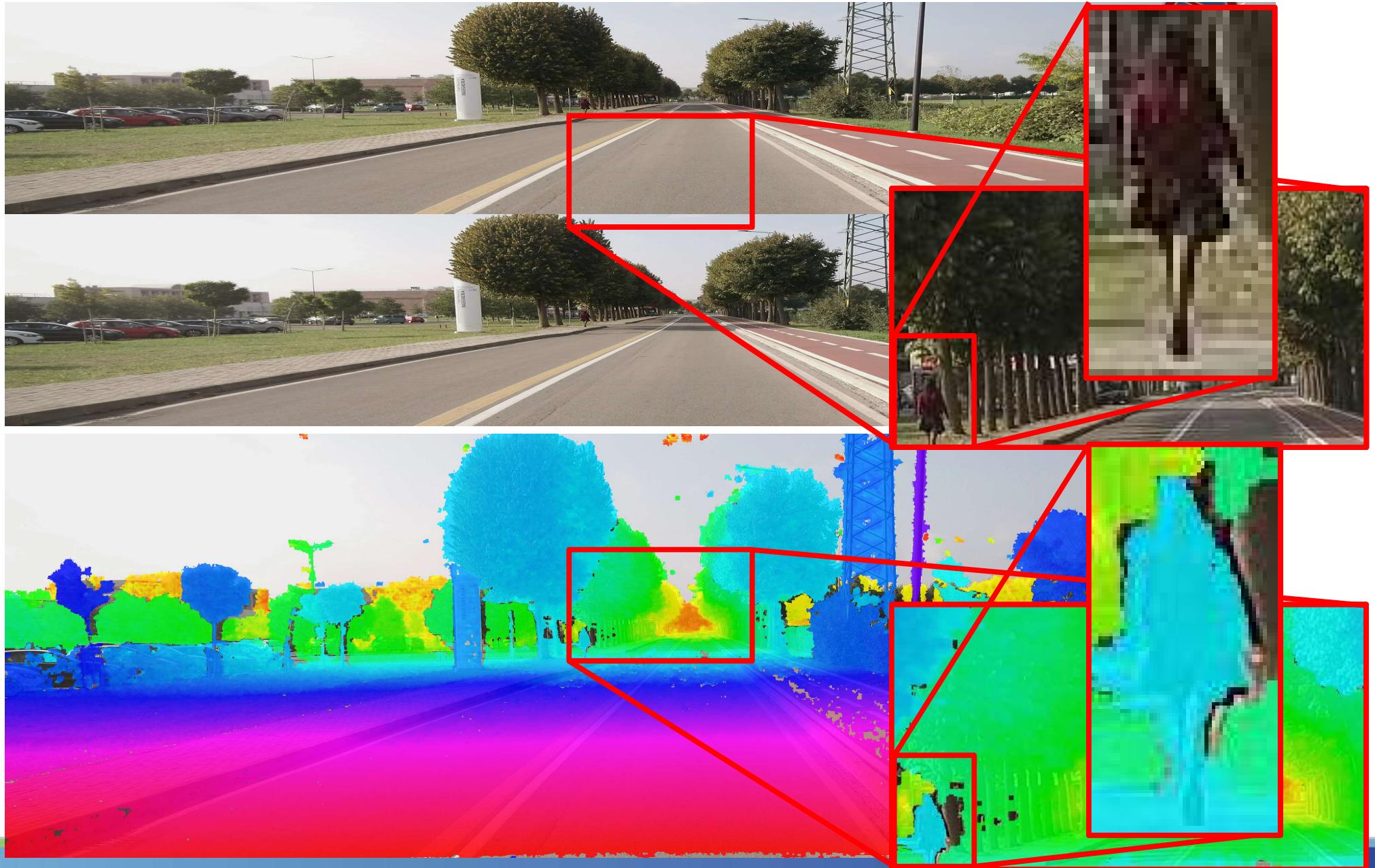
First embedded product – 2013



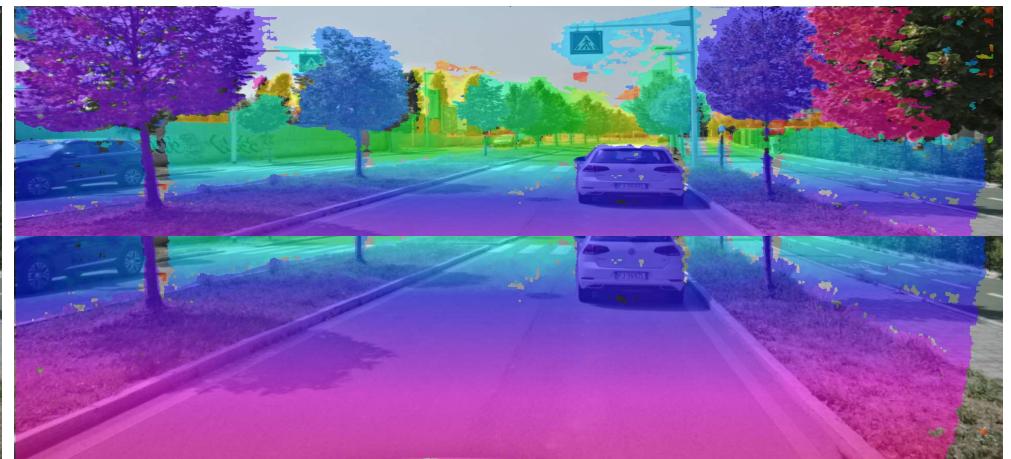
Stereovision



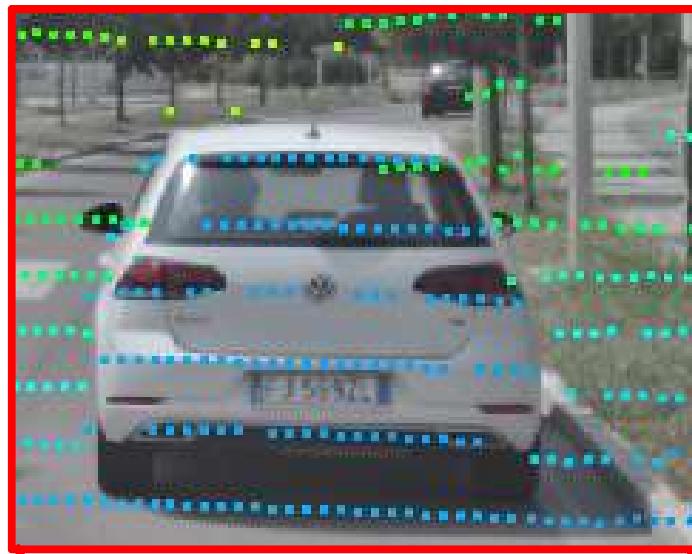
4k Stereo Vision



Stereo vs Lidar



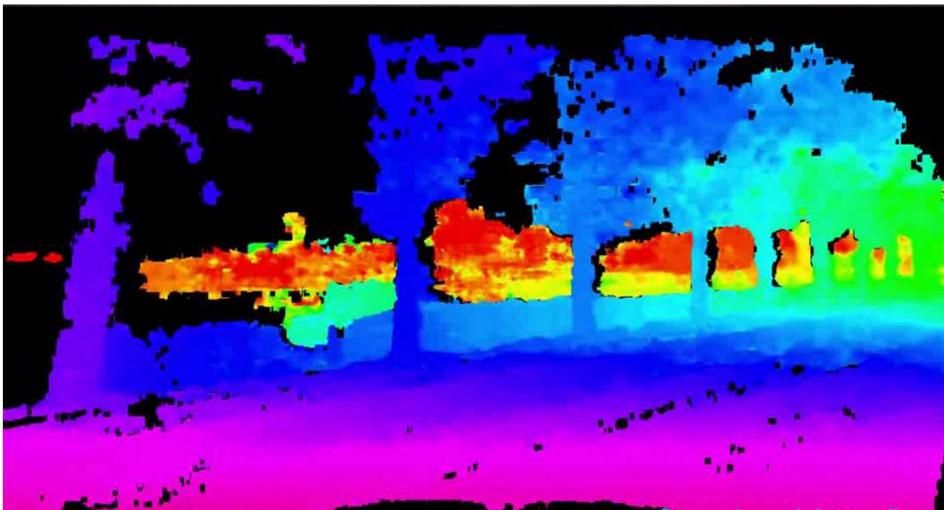
Stereo vs Lidar



Stereo vs Lidar



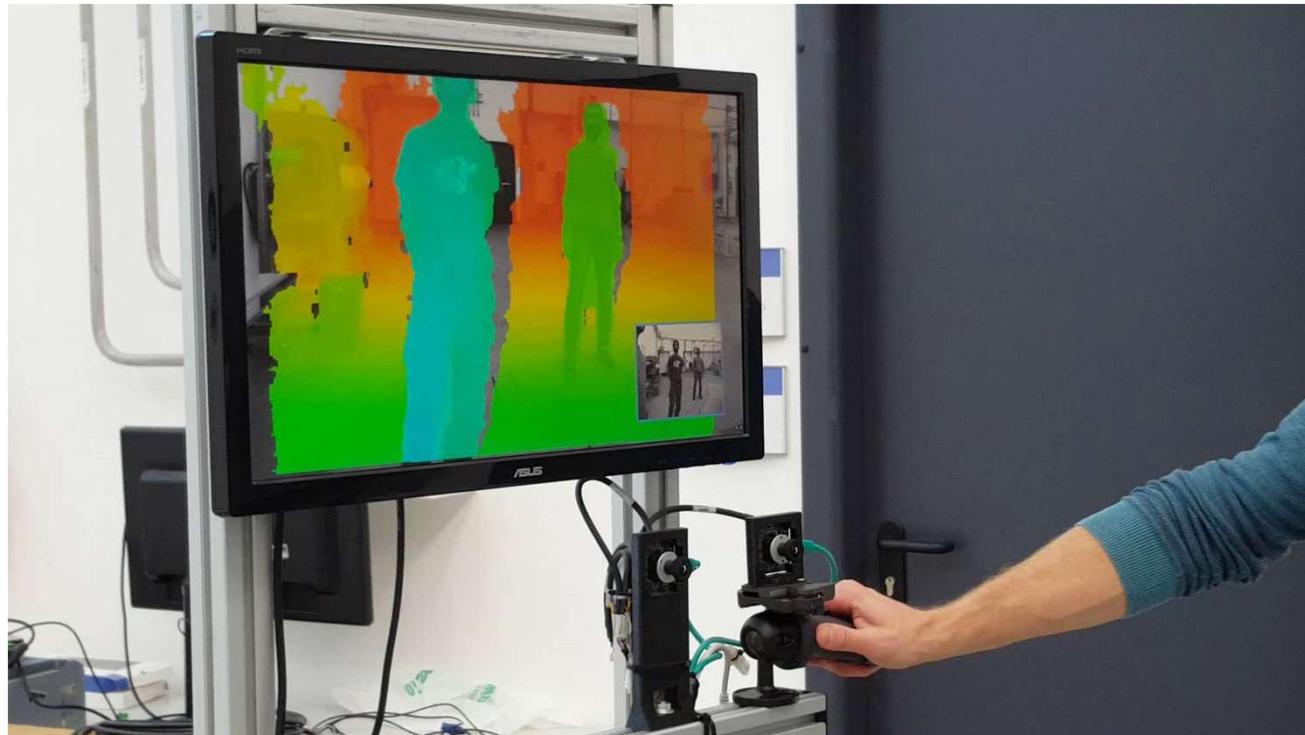
Low light performance



Watch on YouTube: <https://youtu.be/QZM-5dIZSJk>

Stereo Calibration

- In the past calibration has been one of the major showstoppers for stereo vision, especially on vehicles
- A stereo camera is a measurement instrument and calibration needs to be maintained... **for years!**



EVA – Embedded Vehicle Autonomy



Current push on Vision

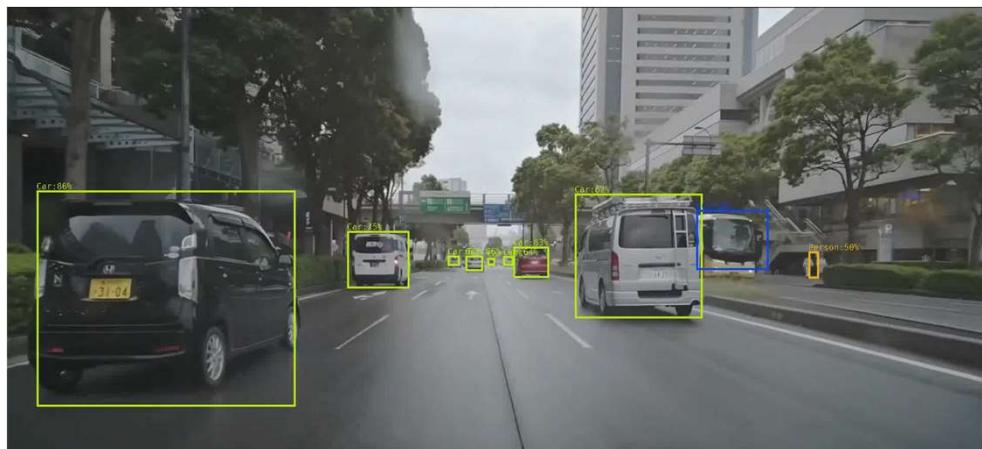
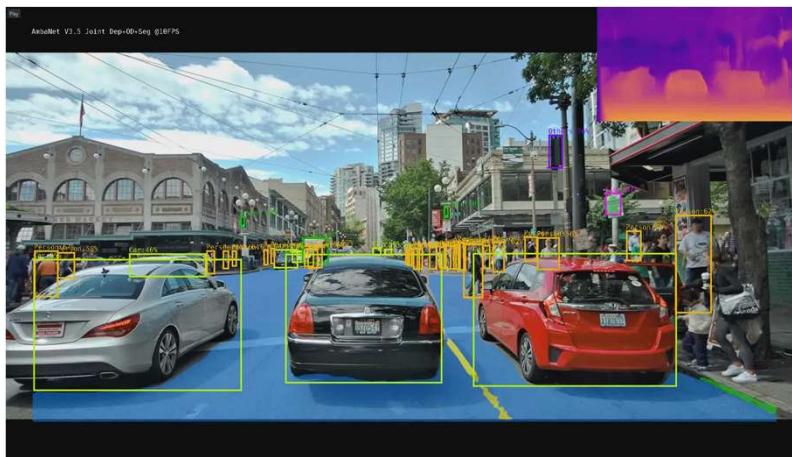
- Computer Vision is **hot!**
 - Availability of high performance computing systems
 - Capabilities of Deep Learning techniques



Taken from www.youtube.com/watch?v=rB1BmBOkKTw

Monocular processing

- Ultra high resolution + excellent image quality
→ top level monocular processing



The missing piece

- **Image quality**

top level image quality thanks to best-in-class IDSP with tight connection with imager

- **Processing speed**

Real time processing speed (30fps) thanks to careful choice of hw integration of selected building blocks

- **Power budget**

Ultra low power consumption thanks to years of experience in chips for battery-powered wearable devices

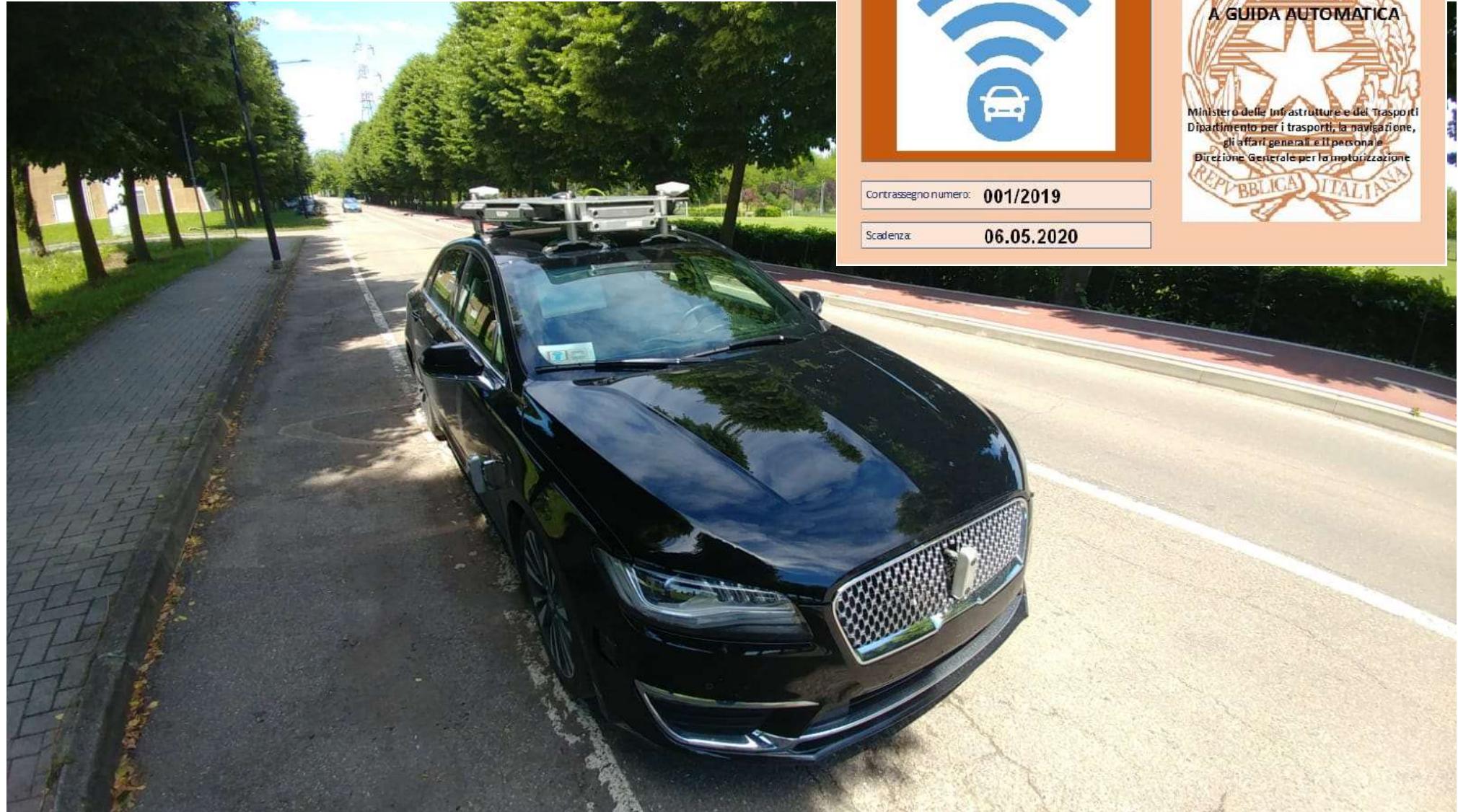
Low power budget allows to overcome dissipation issues, allowing previously critical installation setups

VisLab in Parma, Italy

- On Parma university Campus
 - Doubling office space
- About 50 engineers (90+% PhDs)
- Working closely with Santa Clara (US), Shanghai (China), Taipei (TW)
- Fleet of cars (Italian Ministry authorization, licence for California and Nevada)

35 open positions!

On-road testing



Driver training with ANAS



Conclusion

**DRIVING
FORBIDDEN!**