

Road Mapping Innovation based on Autonomous

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Vehicle sensors



History of LiDAR



Principle of LiDAR

Detection Capabilities

	Lidar	Radar	Video
Sensing Dimensions	3D	1D	2D
			×
Field of View			~
Object Detection – Shape / Orientation		×	~
Object Detection – Static / Lateral Motion		×	~
Resolution with Range		×	×
Range Accuracy			~
Rain, Snow, Smog, Dust, Sand Storm			×
Fog			×
Ambient Light – Pitch Darkness / Bright Sunlight			×
Read Sign / Color		×	<i>~</i>
Intensity / Reflectivity			~

Credits @ Quanergy 2022

LiDAR is required to fill the gaps in camera and radar-based perception and to enable the automotive industry to implement higher levels of autonomous driving.

Lidar in Automotive for Safety

Today	ADAS Basic	L2+	L2++/L3	AV Subs
Camera	0-2	1-3	-	-
Radar	0-1	3-5	-	-
Lidar	0	0-1	-	-
Future Migration	ADAS Basic	L2+	L2++/L3	AV Subs
Camera	1-2	2-7	8-12	12
Radar	0-1	5	5-6	8
LīDAR	0-1	1	1	3-4
Night Vision	0	0	0-1	1
System Cost (w/DMS, compute, software)	~\$200	~\$1,000	~\$1,600	~\$5,000
Driver of Future Migration (ex. costs)	ADAS Basic	12÷	12 ; ; /13	AV Subs
Camera	Regulation	FoV	Surround View	Surround View
Radar	-	Surround View	Surround View	Surround View
Lidar	Night/Weather	Robustness	Robustness	Surround View
Night Vision	-	-	Redundancy	Redundancy
		1	Credits	(a) City Research 2020

Higher levels of automation require:

- redundancy and overlap between sensors are required
- LiDAR becomes a necessity

Automotive LiDAR Applications

X Collision Avoidance X Highway pilot X Traffic Jam Pilot X Lane keeping and Lane change X Valet Parking X Parking Monitoring Mapping & SLAM X X . . . X Smart Cities

X Autonomous driving

LiDAR in Automotive Ride Comfort

3

3

3

4

3.5

3.5

3.5

4.5

4

4

4

4.5

MPC with SE -original

4.5

4.5

5

5

- 5

1.5

1

 $\mathbf{2}$

2.5

time [s]

3

3.5

	Predictive Suspensions
Goal	More ride comfort thanks to preview for active suspension
Approach	XenoTrack measures road profile & generates suspension control signal
Result	Up to 70% more body stabilityBest quality road profile measurement

0.5

0

Measurement Principle

What is it:

Measurement of the height profile of the road before it hits the wheels, to allow a (semi-)active suspension keeping the car straight and stable.

Characteristics:

- Real-time output of road profile in front of each of the 4 wheels (540Hz)
- Works on any road type
- High accuracy
- High resolution
- Automatic roll & pitch calculation
- Configurable feedforward delay

Road damage

3D view reveals:

- X Longitudinal and traversal cracks
- X Potholes and repaired asphalt
- **X Gutter** next to curbstone

Road mapping – Future

Cost

Today Sensors mounted on everyday vehicle Measurements frequency months Data collected by dedicated teams

Yesterday Sensors mounted on special vehicle Dedicated personnel Data collected by dedicated teams

MFV / Visual Inspection

Dedicated Vehicle

In the next 5 years Sensors mounted on utilities vehicles Measurements frequency weeks

by Utility

Services

In the next 10 years Sensors mounted on everyone's car Real time mapping Infrastructure collecting the data

V2

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View of the Road Before and After the Winter

XENOMATIX

- XenoTrack will see the bottom of the puddle since the light reflection at the bottom is more intense than the one at the surface.
- Road profile can still be seen, and driver can be alerted in case of aquaplaning risk.

Stereovision cameras can see water but don't understand the depth / amount / risk

Wet Road Measurements

XenoTack v2.1 RC1 XP OFFLINE.

– 0 ×

Measurements in Snow

Conclusion

Safety	Maintenance planning	Comfort	Self-driving cars
- ADAS functions such as lane keeping relay on clear road markings	- Objective numbers reveal where and when to best spend road maintenance budget	- Delicate transport (<u>e.g.</u> non-urgent ambulance service) needs road quality for route selection	- Self-driving vehicles need road profile info for safe & comfortable navigation:
- Worldwide yearly cost of bad roads is estimated to be: ??? (accidents, damaged vehicles, back injury,)	- Road digitization documents evolution of road condition for road exploitation under consignment	- <u>SatNav</u> feature: From A to B in most comfortable way	 Pothole avoidance Speed reduction at bumps Curbstone detection Platform localization for shuttles & buses
- Human, visual, on-site road inspection is slow and dangerous	- Acceptance of road (re)construction	- Government aiming to increase of standard of living	

True solid state lidar