Market Trends in Automotive Perception: From Insect-Like to Human-Like Intelligence

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The goal in automotive is to reach autonomy. Critical questions: when, where and how?

“The fly has the CPU of a toaster nonetheless it can do quite a lot”

Bruno Maisonnier
Anotherbrain CEO

~25k pixels

~0TOPS
Processing power per $ is (was) doubling every 18 months

Advancements in digital electronics are strongly linked to Moore's law: microprocessor prices, memory capacity, sensor performance ...

Digital electronics has contributed to world economic growth in the late 20th and early 21st centuries.

Moore's law describes a driving force of technological and social change, productivity, and economic growth.
# SEMICONDUCTOR PLAYERS INTO THE SCALING ROADMAP

## The end of Moore’s Law economics?

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<tr>
<th>Altis</th>
<th>DB Hitek</th>
<th>Freescale</th>
<th>Fujitsu</th>
<th>Global Foundries</th>
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The end of Moore’s Law economics?

<table>
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<th>Years</th>
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<th>2014</th>
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“Moore’s Law” supported the growth of markets and technology in the semiconductor space for 50 years.

It is now challenged from the technology standpoint but also the economics.

This presentation is looking into some similar “law” that could be seen in the “More than Moore” paradigm, i.e. image sensors and cameras.

Automotive is the first “sensing” market for image sensors, where cameras are used in combination with computing chips for automotive ADAS, but also in some robotic vehicle applications for autonomous driving (AD).
There are two distinct paths toward autonomous vehicles.

- **Level 1**: ADAS vehicle
- **Level 2**: AD
- **Level 3**: Robotic vehicle

Where?

- Anywhere
- Limited distance
- Designated areas
- Designated places

How?

- Some players may want to change sides.
Robotic cars use a different set of technologies than conventional cars

2018
Automotive
ADAS Level 1-2-2+

23M cameras for 94 cars
mass market technology
standard production
1.3Mp 3.75um 1/3” RS

Application: Car
ownership
personal mobility

Main Players:

Mainly Camera
& Radar

High diversity of sensors

2018
Industrial
AD Robotic cars

30k cameras for 4k cars
industrial grade technology
add-on retrofit approach
5.2Mp 3.45um 2/3” GS

Application: Fleet
ownership
Mobility as a Service (Maas)

Main Players:

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Robotic vehicles are using chips in the 50W to 100W range.

ADAS computing is using chips in the 2W to 20W range.

Human brain: 1,000 Petaops / 20W

ADAS Level 3 will probably require similar performance to current robo-taxis.

Next battleground for the ADAS industry.
Due to Moore’s Law, players like Mobileye and Waymo were able to increase the processing power of their solutions by x2 every 24 months (at constant price).

From observation, the flux of camera data increases x2 only every 48 months.

The flux of data fed to the AD system doubles every 48 months*.

* The “More than Moore” law is twice slower than the Moore’s law.
From 10 years of market analysis, seems like a “More than Moore law”: 

Computing power requirement increases with the square of data 

Current AD system design will be heavily limited by the ability to increase processing power 

• Computing performance improvement will be in great demand (architecture, memory, GAAfet…) 

• Sensing performance improvement (resolution, dynamics, frame rate) will have slower pull 

• New sensing and computing approaches, improving “quality” vs. “quantity” of data is needed (Lidar, Thermal, SWIR,…)

AUTOMOTIVE MARKET TREND — ADAS TO AD
There are three innovation scenarios for the future of automotive sensing & computing.

- **More of the same computing**
  -今天的 (Today ADAS)
  -2018: SONY, BOSCH, Continental
  -2025: Level 2++
  -2032: Level 3-4-5
  -2039: Video based autonomy

- **New computing**
  -Quantum? Neuromorphic?
  -Tomorrow AD Robotic
  -Disruption?
  -Robotic autonomy using “better” data coming from new sensors

- **New sensors**
  -Addition of Lidar / Thermal / Swir...?
The goal is to reach autonomy. Question: when, where and how?

- There are currently 2 paths toward autonomy: ADAS automotive or AD robotic
- Both paths follow a newly defined “More than Moore Law”: computing power requirement increases with the square of the data being processed
- The consequence is that in today’s innovation scenario in automotive, we are mainly waiting for Moore’s Law to act to improve current ADAS application, using “same sensor” and “same computing” approach
- The other innovation scenario currently being used is looking into new technologies for better sensing, (lidar, thermal infrared, time gating, SWIR,...) knowing the computing power available. This approach is used by the AD robotic camp and could eventually bring L2++ to automotive sooner
- Disruption in this space would be the 3rd path to innovation: New technologies are emerging which could disrupt the roadmap, new sensing approaches combined with a new computing paradigm could accelerate history — neuromorphic, quantum technologies (else?) are highly needed
Thank you