Enabling automated driving with artificial intelligence and connectivity

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Redundancy is crucial throughout sensing, thinking and acting. AI and connectivity are enabler for automated driving.
AI goes embedded
SW redundancy

How AI can be fooled ...

Source: Youtube

Source: Youtube
SW redundancy

Coming video generation Multi-path approach

Stereo

SFM

Optical Flow

Structure from Motion

Images

Lane

Gradients

Lanes

SemSeg

Pixel-wise Segmentation

Classifier

Object classifier

Light
Deep learning goes embedded

Comparison of Standard VGG16 and BoschNet:

- **Number of operations**
  - GOPS/Image
  - VGG16 vs. BoschNet

- **Accuracy**
  - VGG16 vs. BoschNet

- **Energy consumption**
  - Com. GPU vs. Bosch video

**Coming video generation**
Bosch road signature

Reliable localization in all conditions

Performance

Good conditions

Cameras

Radar

Bad conditions

Cameras

Radar
Bosch road signature

Radar-only localization

- Precise (10 cm)
- Efficient (~10 kB/km)
- Weather-independent
### Computational Power

**High performance computing is one key enabler**

<table>
<thead>
<tr>
<th></th>
<th>Body Computer</th>
<th>ESP</th>
<th>Powertrain ECU</th>
<th>Head Unit</th>
<th>Privately Owned Automated Cars Highway</th>
<th>Robotaxi</th>
<th>Computer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Computing power</strong></td>
<td>0.5K DMIPS</td>
<td>1.5K DMIPS</td>
<td>5K DMIPS</td>
<td>20K DMIPS</td>
<td>~560K DMIPS</td>
<td>~2000K DMIPS</td>
<td>100K – 500K DMIPS</td>
</tr>
<tr>
<td><strong>AI computing power</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>~300 TOPS</td>
<td>~1300 TOPS</td>
<td>44 TOPS*</td>
</tr>
<tr>
<td><strong>Safety</strong></td>
<td>MID (ASIL B)</td>
<td>HIGH (ASIL D)</td>
<td>MID (ASIL B)</td>
<td>LOW/MID (QM/ASIL B)</td>
<td>HIGH (ASIL D)</td>
<td>HIGH (ASIL D)</td>
<td>LOW</td>
</tr>
<tr>
<td><strong>Memory (Flash)</strong></td>
<td>6 MB</td>
<td>4 MB</td>
<td>16 MB</td>
<td>64 GB</td>
<td>64 MB – 8 GB</td>
<td>Up to 128 GB</td>
<td>256 – 512 GB</td>
</tr>
</tbody>
</table>

DMIPS = Dhry stones million instructions per second

TOPS = Tera operations per second (8 bit)

ASIL = Automotive Safety Integrity Level
Automated driving (L3-L5)

Integrated safety (ISO26262)
- System malfunctions

Safety of the intended functionality* (SOTIF)
- Misinterpretations of environment and foreseen misuse

Safe driving
- Driving rules and behavior

Increased safety with assisting functions
- ESP®
- ABS
- Automatic emergency braking
- Traction control system
- Electrical steering systems
- Active pedestrian protection
- Airbag control unit
- Lane departure warning
- Evasive steering support

Bosch drives safety on system level for decades

Bosch is member or founder of committees

Fundamentals of safety

Highway pilot

Robotaxi

* SOTIF not finalized yet. Release ongoing.
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Thank you