« From human driving to automated driving »

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Why automation?

Automation is a global answer to four important societal issues:

- To improve Efficiency
- To improve sustainability
- To make driving available for all
- To improve road safety

**Automation is a global answer to four important societal issues**
Some definition: automation degrees
from Tom M. Gasser (BAST)

- **Driver Only:**
  - Human driver executes manual driving task
- **Driver Assistance:**
  - The driver permanently controls either longitudinal or lateral control. The other task can be automated to a certain extent by the assistance system.
- **Partial automation:**
  - The system takes over longitudinal and lateral control, the driver shall permanently monitor the system and shall be prepared to take over control at any time.
- **High automation:**
  - The system takes over longitudinal and lateral control; the driver must no longer permanently monitor the system. In case of a take-over request, the driver must take-over control with a certain time buffer.
- **Full automation: “hands-off, feet-off, brain-off”**
  - The system takes over longitudinal and lateral control completely and permanently. In case of a take-over request that is not carried out, the system will return to the minimal risk condition by itself.
Out of classification but very important ...

- Fully automated but without driver in the car
  - Possible now
  - In dedicated area
- Examples
  - Automated parking valet (eg « MIL » project in France)
  - Automated test on test tracks (Daimler)
- Open the way toward innovation
  - Allows to push the technology while minimizing the risks
  - Allows to push innovation while legal framework is changing
Human-machine interaction : the horse-rider metaphor

- Horse and rider form a whole.
- The rider gives orders to the horse but ... ... the horse refuses to execute dangerous orders (e.g. collision, dangerous jump)
- If the rider gives up (no reaction), the horse stops or ... go back home (“MRM” : minimum risk maneuver)
State of the art

From human driving to automated driving

- **1971**: ABS
- **1995**: ESC
- **2000**: LKA
- **2010**: LDW
- **2010**: ACC
- **2010**: PA
- **2020**: Stop & Go
- **COPilot System (HAVE-IT)**
- **2020**: Low Speed Automation
- **2020**: Other Fully automated systems

**Timeline**

- **1971**: Driver only
- **1995**: Driver assistance
- **2000**: Partial automation
- **2010**: High automation
- **2020**: Full automation

Date: 19/03/12
Some set ideas to sweep

- "Highway automation (HA) is a means to promote the automobile at the expense of other modes?"
  - No: HWA sets the optimal functioning of networks with a limited level of supply
- "Highway automation is technologically too complicated?"
  - Many technological building blocks already exist: the real challenge is their reliability at an acceptable cost
- "The automation poses insurmountable problems of responsibility?"
  - It has been solved for aircraft, train, subway (we all take highly automated aircraft and fully automated train (eg. Line 14 in Paris))
- "Trains roll on rails, aircraft flights in air corridors, not cars"
  - Cars have very low cost "rails": lane markings
  - Cars could have "air corridors": dedicated roads
Main obstacles

• Individual acceptability by the drivers (and passengers)
  – Are they ready to accept driving automation?
  – What degree of automation do they expect?
  – How do they use automation: in which context, under which conditions?

• Legal acceptability
  – What is the compliance with existing laws (Vienna Convention)?
  – What is the compliance with Highway Code?

• Feasibility
  – What is feasible today, in the near future, later?
    • We need a roadmap
Acceptability by the drivers

• **Values carried by the vehicle are evolving**
  – Vehicle no longer makes reference only to « power », « speed » but also…
  – … to values like : safety, efficiency, comfort, sustainability
• **In urban area vehicle becomes an extension of living space (home, office)**
  – Depending on the context (e.g. traffic jam), the possibility to delegate the driving task to a “copilot” becomes a growing customer aspiration
• **For specific driving tasks drivers seem ready to “give up” (passer la main)**
  – “Parking valet”
  – Maneuvers difficult to manage
  – Low Speed Automation
Legal acceptability (1/2) : Are we « Vienna Convention compliant » ?

- Vienna Convention remainder (art. 8.5)
  - Every driver shall at all times be able to control his vehicle …

Compliant

Almost compliant

Not compliant

Driver only

Driver assistance

Partial automation

High automation

Full automation

MRM: “minimum risk maneuver”

Vienna Convention should evolve
Legal acceptability (2/2) : Are we « Highway Code compliant » ?

• Automated systems can easily implement national highway code
  – Speed compliance (e.g. speed limit respectful)
  – Interaction compliance (e.g. distance headway)
  – Meteorological condition compliance (speed limit adaptation)
  – Maneuvers compliance (e.g. overtaking rules)
  – Etc.

• To be compliant with different European Highway Code
  – Vehicle could have National Highway Code profile
  – Localization could be used to determine the profile to select
How could Vienna Convention evolve?

- The horse-driver could be a the good paradigm
- Could we imagine a revised article 8?
  - “Every driver and its driving assistance shall at all times be able to control his vehicle …”
- What does it’s mean?
  - The confidence level assigned to the whole "driver-controller" system is as high as the trust level attributed to the driver only.
    - Implies a high level of reliability
    - Both drivers and system must be able to auto diagnose themselves.
      - Implies: driver and car monitoring
Feasability:
The challenge: low-cost, highly reliable

- I need to know
  - Where am I? Accurate localization
    - GNSS, lane marking detection
  - Where are my close neighbors and what are their intention?
    - Data fusion from different sensors
  - Where are my distant neighbors and what are their intention?
    - V2V, V2I communication with high level of QoS

- I need to control the trajectory
  - With accuracy: precision actuators
  - With reliability: redundant architecture, deterministic latency time (i.e. Flexray bus)
  - With a variable feedback to the driver: steer by wire
Feasability (2/2)
Test and validation : an open issue

• Reliability must be proven
  – System must be standardized
  – Test and validation must cover the whole complex system including the wide variety of use case and environmental (sometimes adverse) conditions
    • However testing an infinite number of test cases is impossible → need new testing methods

• System assessment
  – In “naturalistic” driving conditions (“field operational test”)
    • Usage, usability, utility, impact
Low Speed Automation: « story board »

- I drive my car normally
- I arrive on a dedicated LSA area
- I meet a congestion zone at low speed
- The vehicle ask if I want to activate the LSA? OK!
- The vehicle is traveling in LSA mode
- The flow velocity increases: LSA conditions no longer exist
- The vehicle is asking me to take control.
- If I react,
  - it’s OK,
  - otherwise the vehicle stops on the emergency lane
Thank you for your attention

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