Virtual Assistants and Self-Driving Cars:
To what extent is Artificial Intelligence needed in Next-Generation Autonomous Vehicles?

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About the ERAdiate project (Univ. of Žilina, SK)

- **ERA Chair pilot project funded under FP7 Pilot (2014-2019)**
  - Part of H2020 pillar "Spreading Excellence and Widening Participation" expected to close the research and innovation gap in the EU

- **Realisation of full potential of the Univ. of Žilina and its region in the field of Intelligent Transport Systems (ITS)**

- **ERAdiate impacts beyond Research and Innovation**
  - Internationalisation,
  - Fostering Inter- Trans- disciplinarity
  - Institutional and structural changes
 - Regional impact by involving public and private actors in ITS initiatives and projects

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Role of AI in Autonomous Driving

- **Use of AI in "self-driving" tasks (i.e. described in SAE standard J3016) out of scope in this talk**

- **Focus on AI role in Human-Autonomous Vehicle (HAV) interaction: Virtual Assistants and the car as a *Social Robot***

- **Past, present and future of virtual assistants and AI-based intelligent agents for IoT applications**

Virtual Assistants in Desktop Environments

▶ **Quite popular in the Nineties:** animated characters/avatars such as *Clippy the Paperclip*

▶ **Supporting user learning, efficiency and productive with a specific software product**

▶ **Two main behaviours**

　▶ Proactive Help

　▶ User Query (typically based on text input)

▶ **Controversies on added value of virtual assistants, designed as "virtual butlers"**

> Hi! I am Clippy, your office assistant. Would you like some assistance today?
>
> Yes   No
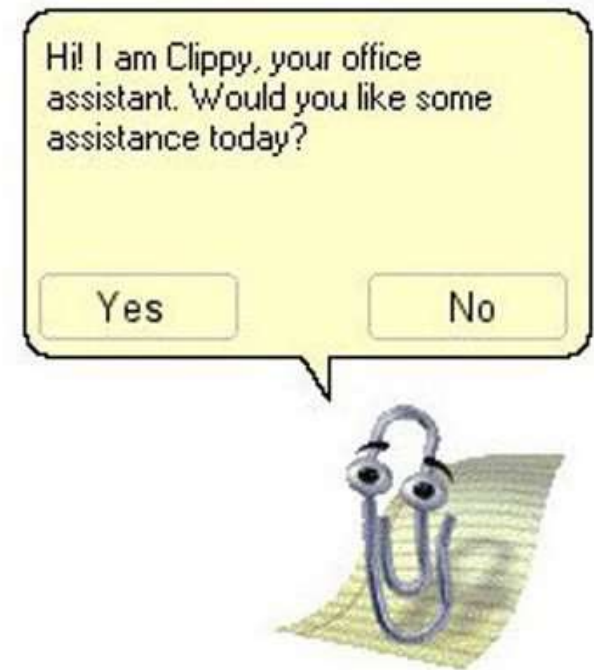
Virtual Assistants in Mobile Contexts

▶ **Virtual assistants again in fashion** thanks to technological advances such as the shift from touch to speech interfaces and AI breakthroughs

▶ **Intelligent Agents that are part of the Operating System:** Apple Siri, MS Cortana, Google Assistant, Amazon Alexa

▶ **Two main behaviours (as desktop assistants)**
  - ▶ Proactive Help
  - ▶ User Query (text or speech input)

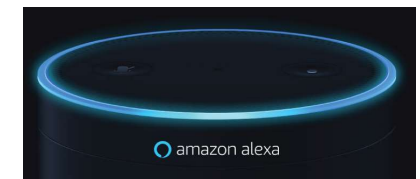▶ **Perceived usefulness and social acceptance far from optimal:** more about curiosity than utility
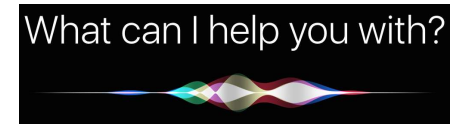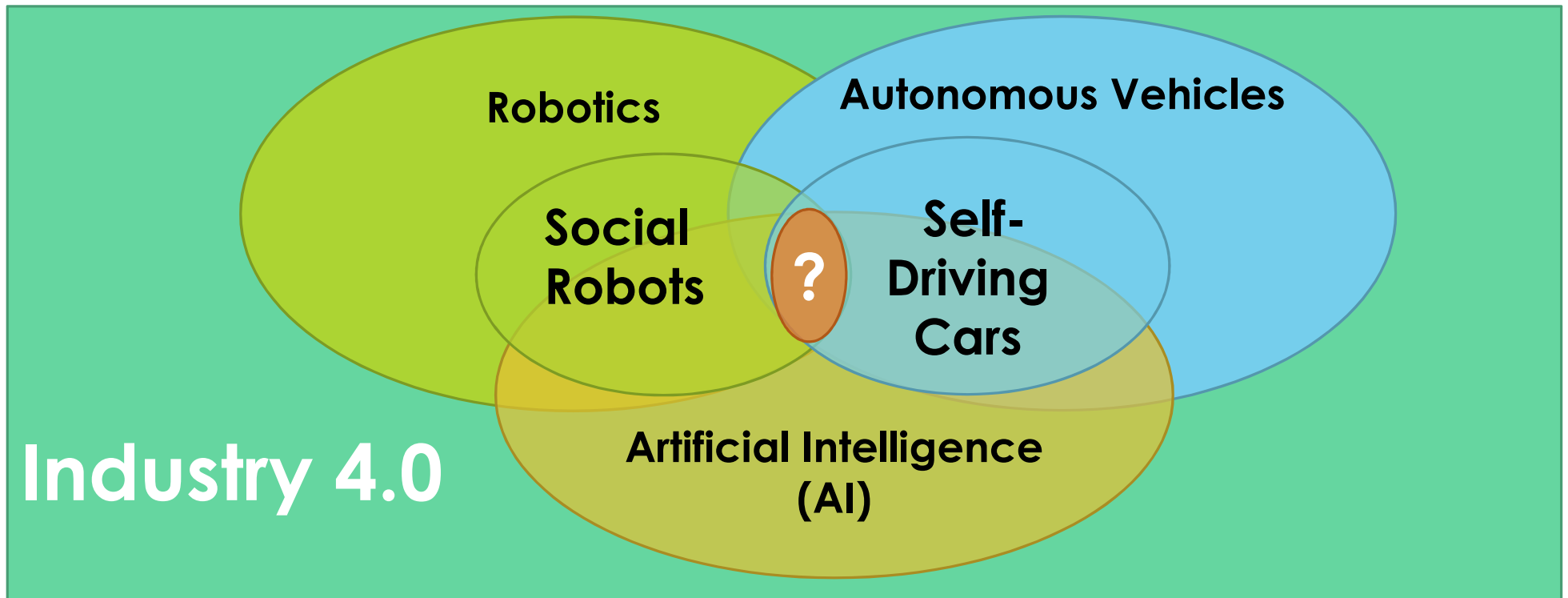
Siri

Google Assistant

Cortana

Alexa

Virtual Assistants and the Internet of Things

▶ **Virtual assistants designed for mobile contexts** and ubiquitous interaction are part of "smart devices" and the Internet of Things (IoT)

▶ **Increasingly sophisticated:** meant to process and connect contextual input with large sets of data in real-time

▶ **Automotive Sector** among the first areas impacted. High expectations and uncertainty

Context of Analysis

Industry 4.0

Robotics
Autonomous Vehicles
Social Robots
Self-Driving Cars
?
Artificial Intelligence (AI)

Virtual Assistants as a type of (Disembodied) Robot

▶ **Defining a Robot is a Challenging Task**

▶ **Characterise robots by features (Robolaw Project)**

  ▶ *Use/Task:* two large categories – industrial and service robots

  ▶ *The environment where the robot operate:* physical, virtual

  ▶ *Nature:* embodied or disembodied (virtual agent, bot)

  ▶ *Human-Robot Interaction:* interface, communication form

  ▶ *Autonomy: tele-operated, semi-autonomous, fully autonomous*

Virtual Assistants as Social Robots

- Social Robots are a special type of service robots with advanced capabilities in interacting and communicating with humans
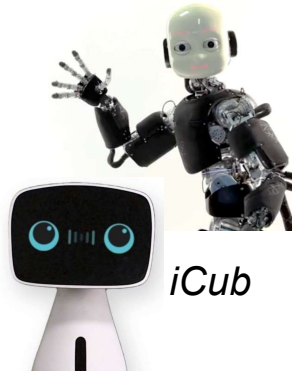
Paro *Genibo*

Asimo *Nao* *iCub*

Aido

Two main categories

- Robot companions (embodied)
- Intelligent agents, virtual assistants (disembodied)

Alexa *Cortana* *Google Assistant* *In-Car Virtual Assistants*

Siri

The Place for AI in Autonomous Driving:
Learning from Robotics

▶ **Supporting or Replacing the Human?** (e.g. under which circumstances, how)

▶ **Scope of action:** aiming at "Operational autonomy" (linked to e.g. safety functions only) or full autonomy (i.e. the "sentient" car)?

▶ **Dealing with sensitive personal data:** ethical, legal and security issues.

AI in "safety-related" Autonomous Driving Functionalities is based on Standards

▶ **Five levels (SAE Int. Standard)**

  ▶ **Level 1-2:** Assisted Driving

  ▶ **Level 3**: Semi-Automated (current state of the art)

  ▶ **Level 5:** fully autonomous (in respect to driving functionalities)

▶ **Why not adopting the same approach for the general use of AI in autonomous driving** (including role of virtual assistants)?

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	Monitoring of Driving Environment	Fallback Performance of Dynamic Driving Task	System Capability (Driving Modes)
Human driver monitors the driving environment						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
Automated driving system ("system") monitors the driving environment						
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
4	High Automation	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a request to intervene	System	System	**System**	Some driving modes
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a human driver	System	System	System	**All driving modes**

The Self-Driving car as a Social Robot:
various approaches and products

▶ **Unlike safety-related functionalities, scope of virtual assistants in autonomous driving is completely unregulated and based on proprietary systems, different views and approaches**

▶ **Two broad categories of "social" features/functionalities**

  ▶ **In-Car Virtual Assistants:** integration of existing virtual assistants (e.g. Siri, Cortana, Alexa, Google Assistant) or implementation of ad-hoc ones

  ▶ **Communication Devices** (e.g. displays) for informing, possibly in language-independent way, people outside the car (e.g. pedestrians)

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Communication Displays

▶ **Roof-mounted communication display** through which the self-driving car communicates its intentions/plans to people outside the car (typically pedestrians)

▶ **Language-independent:** communication via emoticons

▶ **Supporting safety-related objectives** and other purposes, such as **"shared mobility"** (e.g. also driveless robo-taxis, being developed by Uber)

In-Car Virtual Assistants

"Car Makers choose virtual assistants" (BBC News, 6/1/2017)

- ▶ Safety-related functionalities
- ▶ Customised infotainment
- ▶ Personal Health and Well-Being
- ▶ Gateway to IoT (e.g. home control)

Gateway to IoT (e.g. home control)

▶ Virtual Assistant not only as human-car interface, but as access point to "everything"
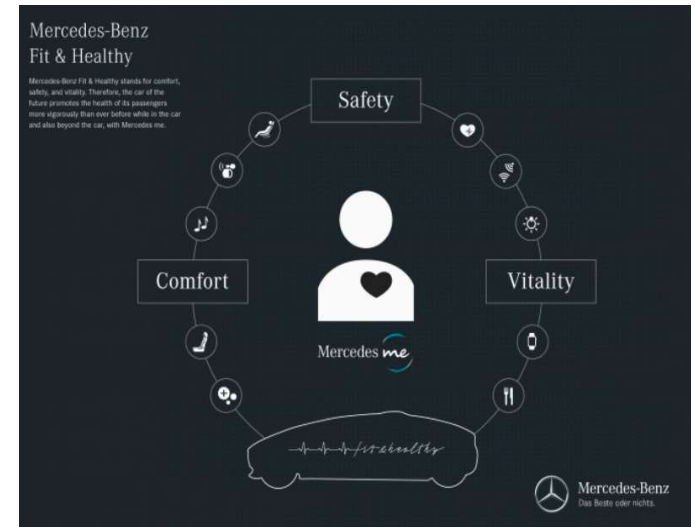
Customised Infotainment

▶ "IoT Connected Cars and Virtual Assistants make life simpler"

(Vision of Nuance, IT company specialized in voice/natural language processing)

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Personal Health and Well-being

▶ Virtual Assistants as "Personal Coach": recommendations and in-car services supporting health and well-being

Recent Strategic Developments

Automotive Companies	Virtual Assistant
Mercedes-Benz, Daimler, Hyundai	Google Assistant
BMW, Nissan	Microsoft Cortana
Ford	Amazon Alexa
General Motors	IBM Watson
Toyota	Yui
Honda	HANA (Honda Automated Network Assistant)
Most car manufacturers (including the ones above)	SIRI (via Apple CarPlay app)

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Highlights on AI and Self-Driving Cars

- **NVIDIA and the AI Co-Pilot (CES 2017)**

Highlights on AI and Self-Driving Cars

- **Nissan featuring Microsoft Cortana (CES 2017)**

Highlights on AI and Self-Driving Cars

- **Mercedes-Benz Fit and Healthy Research Car (CES 2017)**

Highlights on AI and Self-Driving Cars

- **Honda's NeuV featuring HANA (CES 2017)**

Highlights on AI and Self-Driving Cars

- **Toyota's Concept-I featuring Yui (CES 2017)**

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Highlights on AI and Self-Driving Cars


- **Volkswagen's Sedric (Geneva Motor Show 2017)**

Social Robots, AI and Self-Driving Cars

▶ **Car manufacturers and ICT companies established strategic partnerships** and are investing massively into "connected and autonomous driving", seeing the car as gateway to the IoT

▶ **Too early to judge possible impact, but a few considerations**

  ▶ No common approach on the role of AI, apart on its use in safety-related functionalities (in line with international standards)

  ▶ Commercial solutions more conservative than what they may appear

  ▶ Solutions optimized for car ownership and "brand loyalty". Shared mobility and interoperability supported, but unclear how personal data would be handled

Social Robots, AI and Self-Driving Cars

▶ **Self-Driving Cars turn into Social Robots**, thanks to an algorithmic AI "brain", a big data "memory", a "voice" (virtual Assistants) and "gestures" (communication displays)

▶ **Virtual Assistants will "know" the user better than he/she does**

  ▶ Role of virtual butler (as "Clippy") still predominant

  ▶ "Sentient" and self-aware cars still far away

▶ **Towards Hyper-Connectivity:** virtual assistants as the "glue" binding humans with diverse and separate technologies, with a *"human touch"*

AI & Industry 4.0
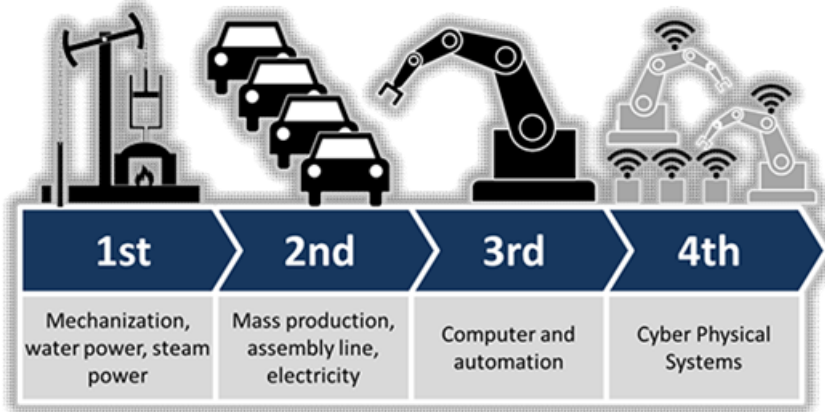
- ▶ Not only about "smarter factories"…
- ▶ Interconnection and interdependency of human beings, objects & systems
- ▶ Role of Humans and Autonomous Technologies in near-future society

The Way Ahead : Social Robots in Human Societies

"It is essential that the big ethical principles which will come to govern robotics develop in perfect harmony with Europe's humanist values"
(2016 Study on European Civil Law Rules in Robotics, commissioned by the European Parliament)

"Reflect on what kind of society we want to build and live in. This includes the robots we build and use, and tells us about the model of our society"
("Situating the Human in Social Robots. In Vincent et al. (Eds.). Social Robots from a Human Perspective, Springer 2015")

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Your Role as IEEE Members and ITST Experts

- **Contribute to IEEE mission:** "*IEEE is the world's largest professional association dedicated to advancing technological innovation and excellence for the <mark>benefit of humanity</mark>*".

- **Major Impact of AI-based Applications on Global Societies**
  - Deep concerns raised, among others, by Bill Gates, Elon Musk and Stephen Hawking

- **Adequate Solutions Require:**
  - Input from all relevant disciplines (technical and non-technical)
  - Joint development by all relevant actors (role of standardization)
  - Well-defined legal framework (principles globally agreed)

Some Recent Developments

- **ITU "AI for Good" Global Summit (Geneva, 7-9 June 2017)**
  - Technical standardization and Policy Guidance for AI

- **"Partnership on AI" by Google, Facebook, Amazon, IBM and Microsoft:** AI solutions for the benefit of people and society
  - Apple and Elon Musk's OpenAI initiative not taking part

- **IEEE Global Initiative for Ethical Considerations in AI and Autonomous Systems**, launched in April 2016
  - Six Working Groups (P7001, P7002, P7003, P7004, P7005, P7006)
  - WG P7006 on "Personal Data Artificial Intelligence Agent"

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Thank You for Your Attention!

Time for Questions

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