**Autonomous vehicles and IoT advancements**

**Course title:** Project about the internet of things

**Course number:** 236333

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**State of IoT - 2021**

In the recent times, Iot has been taking an ongoing increasing role in our life. This rapid advance in technologies has presented new opportunities, ones not so long ago would have been classified as science fiction. Those opportunities include the ability to establish a well-constructed and reliable connection between the physical world and the virtual space, through which we can act upon data gathering, deep analysis, and real time feedback allowing us to respond in a calculated manner upon real life scenarios.

As can be seen in the graph provided below, taken from an IoT analytics research, the state of IoT today, and the direction upon the field is headed just shows there is not going to be any slow down in the development of these technologies, and more great innovations await.

A picture containing graphical user interface

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State of IoT 2021: Number of connected IoT devices growing 9% to 12.3 billion globally, cellular IoT now surpassing 2 billion.

**Intro to Autonomous vehicles**

A self-driving car, also known as an autonomous vehicle (AV or auto), driverless car, or robotic car (robo-car), is a vehicle that can sense its environment and moving safely with little or no human input. The future of this technology may have self-driving cars combine a variety of sensors to perceive their surroundings, such as radar, lidar, sonar, GPS, odometry and inertial measurement units. Advanced control systems interpret sensory information to identify appropriate navigation paths, as well as obstacles and relevant signage.

Possible implementations of the technology include personal self-driving vehicles, shared Robotaxis, and connected vehicle platoons (a method for driving a group of vehicles together, meant to increase the capacity of roads via an automated highway system). Several projects to develop a fully self-driving commercial car are in various stages of development, but there are no self-driving cars available for everyday consumers.

Autonomy in vehicles is often categorized in six levels, according to a system developed by the Society of Automotive Engineers (SAE). The SAE levels can be roughly understood as:

* Level 0 - no automation.
* Level 1 - hands on/shared control.
* Level 2 - hands off.
* Level 3 - eyes off.
* Level 4 - mind off.
* Level 5 - steering wheel optional.

As we can see there are different levels of autonomy, when we think about autonomous car, we probably think about level 5 autonomy.

At the current state, we are at a stage which can be roughly translated to vehicles autonomy of level 3.

**Technology In Autonomous Vehicles**

LiDAR:

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Pic url= https://www.smallworldsocial.com/how-autonomous-cars-map-the-environment/

LiDAR stands for “Light Detection and Ranging” and describes a sensor technology that can create a map of the environment around it.

Generally, LiDAR sensors send out infrared light, and measure the time it takes for the light to bounce off an object and back to the sensor, creating a three-dimensional map. However, there are two different types of LiDAR:

* Time of Flight LiDAR (TOF)
* frequency-modulated continuous-wave (FMCW) LiDAR

while they both perform the same functionality, each one has its advantages and disadvantages:

The TOF type is the most common form of LiDAR on vehicles that map their surroundings by measuring pulses or photons of light that it sends out and bounce back. The other form of LiDAR, FMCW, sends out a continuous stream of light rather than pulses of light, to map its surroundings. This form of LiDAR has a limited field of view, so vehicles with multiple LiDAR sensors are typically using these, while TOF typically has a 360-degree range, allowing for a single device to do the job. Usually, lidar is working in correlation with cameras.

Camera:

In some cases, vehicles will use only cameras to provide data to the entire autonomous driving system, relying on the visual data from the cameras and processing and analyzing it. For Instance, one car manufacturer that uses this technique is Tesla.

Radar:

Radar is working in the same principal as LiDAR but is using radio waves instead of light and is less accurate. However, radar is better in difficult conditions such as fog and in long distances. As LiDAR Radar need to use cameras as well. Cameras are using Radars as complementary sensors to be able to provide accurate data when cameras are having difficulties, this is done to sense the surroundings in harsh visibility conditions.

Diagram

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( Bosch, together with Dutch map and traffic information provider, TomTom, claims to be the first to use radar signals as a localisation layer for high-resolution maps for automated driving. Until now, video data has been used for this purpose.)

**Which one is better?**

The answer to this question will vary with its connection to the related conditions, depending on these, each sensor has its own unique advantages and disadvantages, some of the conditions that come into play are:

* Accuracy - Lidar and cameras give a better and more accurate representation compared to a Radar. However this accuracy is severely reduced when the visibility conditions get harsher, while the latter does not suffer as much from this affect.
* Distance – On the contrary to the previous point, here the Lidar comes out with the upper hand, it can reach much further objects then the the camera and the Lidar.
* Computing power – Lidar and Radar require higher processing power (especially Lidar, providing better accuracy), since both require the reconstruction of all the received signal into 3d mapping of the surrounding. This fact also makes these option more prune to bugs and mistakes.
* Cost – despite the ongoing reduce in Lidar cost in recent years, it remains the more expansive option compared to cameras for example.
* Ease of recognizing data - It’s important to mention as well that the only one out of the three that can provide 2d object information is the camera, while the Lidar and Radar are not compatible to distinguish such details in this dimension. Such ability can provide the crucial ability to recognize signs and written text.

**Autonomous cars and IOT:**

The European automotive industry, representing 6.1% of total EU employment and 7% of EU GDP, is facing a digital revolution in the 21st century in the form of the connected and autonomous vehicle. For reference provided below a short manufacturers involved in the making of autonomous cars components.

Table

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With the integration of Internet of Things (IoT) components into vehicles, they become part of a network. Vehicles can communicate with each other, with the surrounding infrastructure and with other drivers.

Gradually the technologies of IoT for connected and autonomous vehicles (combined with the evolution of AI, communication networks) Present:

* First, assisted driving, e.g.: steering, acceleration and brake support.
* Then conditional automation - the system has longitudinal and lateral control in a specific use case.
* Followed by high automation - the system can cope with all situations automatically in a defined use case.
* Finally full automation - the system is able to drive the vehicle in all conditions; no driver is required.

Diagram, timeline

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The current and future evolution of these connected and autonomous vehicles will have a significant impact on mobility in Europe, as well as on its industry and economy. The benefit of this digital automotive evolution will be mainly safer, more accessible as well as sustainable transport.

First, connected and autonomous vehicles are expected to have a positive impact on road safety. About 90% of the 40,000 yearly road fatalities in the EU are caused by human error. Automotive technologies enabled by connected and autonomous vehicles that can improve safety include:

* eCall (emergency calls): automatically dials the European emergency number 112 in case of a road accident and transmits the vehicle’s location to emergency services.
* Connected and autonomous driving technologies will significantly improve traffic flows, reduce the incidence of critical situations, optimize the handling of corresponding scenarios, relieve the pressure on drivers and the environment and support jobs and growth.
* Electronic Stability Control: allows for stabilization of the vehicle and prevention of skidding. This is estimated to reduce the number of fatalities by 15-20%.
* Other driver assistance systems (enabled by IoT, depicted below) aid safety of the driver as well as his surroundings.

Diagram

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* Artificial situational awareness: for a connected and autonomous vehicle, artificial situational awareness can allow for safer traffic decisions. This is, for example, enabled by mental models to predict future states of the driving environment, and is further supported by improved connectivity of the vehicle

Secondly, connected and autonomous vehicles will make mobility more accessible for elderly people and those with disabilities. This goes especially for people living in areas with dispersed demand for public transport, such as suburbs and rural areas.

Finally, such vehicles can also have a positive impact on sustainability in multiple ways, in the form of reduced emissions and energy savings:

* Decrease of congestion: as congestion leads to a waste of fuels, connected and autonomous vehicles can reduce congestion via improved coordination through their networks - Smoother driving: higher levels of automation and driving efficiency will result in an increase in fuel efficiency.
* Pooled-ride services: the rise of connected and autonomous vehicle technology also allows for the growth of the business of pooled-ride services through services as Uber Pool and Lyft Shared (besides the traditional carpooling), which make use of centralized coordination of fleets to group together travelers moving to and from neighboring locations.

**Risks of Autonomous vehicles:**

When we think about autonomous cars, we can think about many risks that might occur, lets discuss few of them:

1. Failure of sensors: as we already discussed autonomous cars are using different sensors to sense and get a good mapping of the surrounding environment. As a result of this dependency on different sensers every failure of a sensor can be lethal.
2. Technological difficulty: autonomous cars are using complex system that is suppose to "think" and be able to make decisions as a response to unpredicted events occurs in the environment, such system can develop behind our comprehension, so we can’t possibly count and consider every single scenario, which can cause unpredictable behavior that can turn out lethal.
3. Cyber threats: Besides unintentional threats like sudden malfunctions in the AI systems, there are intentional attacks that aim to specifically harm the safety-critical functions of the AI systems. Examples include painting the road to misguide the navigation system or putting stickers on stop signs to prevent it from being recognized. Such alterations can lead the AI systems to wrongly classify objects which as a result could make the self-driving car behave in a dangerous manner.

Light Detection and Ranging (LiDAR), is the camera and laser-pulse range measurement system that form the “eyes of the self-driving vehicle, feeding information about the driving scene and environment into a CNN computer model that makes decisions such as speed adjustment and steering corrections”. Unfortunately, the CNN can be easily hacked by “adding small, pixel-level changes to the input images which can’t be seen by the naked eye”. Unfortunately, this vulnerability can allow bad actors to hack self-driving cars.

The On-Board Diagnostics (OBD) is one of the most vulnerable parts of self-driving cars; malware codes can be inserted into the Electronic Control Unit (ECU) via the OBD. The inserted malware can tune and reprogram the ECU. An infected ECU may be unable to communicate with other Onboard Unit (OBU) components like LiDAR, Camera, and Radar which would compromise the safety of the self-driving cars.

**Conclusion:**

In this seminar we gave an overview about autonomous vehicles, starting with a definition of what precisely is an autonomous car? we spoke about the current state do the of autonomy level cars nowadays have. Following this, We mentioned the values and advantages autonomous vehicles hold, then we spoke about the risks and concerns this vehicles have in order to give a full view about this subject.

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