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IoT IN AUTOMOTIVE INDUSTRY: CONNECTING CARS

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1. Introduction.

In the world we live today there is an increasing demand for smart and connected devices. These devices enable us to complete tasks, enhance experiences and perform processes in a smoothie way. Such tendency will continue in growth, therefore by 2020, the 90% of brand new manufactured cars will feature a built-in connectivity, growing from less than 10% today¹.

When extrapolating the concept of IoT to the automotive industry, we can summarize it into three main branches². On one side, we have the connectivity between vehicles, which is related to connectivity from one vehicle to two or more vehicles (vehicle-to-vehicle). On the second side we have the connectivity between vehicles with external infrastructure (vehicle-to-infrastructure). And on the third side we have the connectivity with external hardware or external devices (vehicle-to-devices). Taking this concept, a connected car according to Delgrossi³, is a vehicle which contains a platform that enables the exchange of information between the car and its surroundings, using local wireless networks, internet or sensors.

2. Theory framework

Connected vehicles interact with their environment. That means, they “communicate” and are capable of data transmission. At the same time they share computational efforts between other vehicles, between external infrastructure and other devices.

![Figure 1. Categories of connectivity based on IoT in vehicles](source)

V2V - Vehicle to vehicle. Cars interacting with other cars
V2I - Vehicle to infrastructure. Cars interacting with roads or external objects
V2X - Vehicle to device. Wireless communication to any device

Source: Own elaboration from Delgrossi (2013).

¹ According to Machina Research (2013).
For the purpose of our case of study, we take into consideration the v2i category, considering the car and its interactions with external physical objects such as roads, pedestrians, obstacles, in order to achieve a better and safer experience of driving. Nowadays in the market, we can pick up few options that are being developed by major car industries that embrace the idea of an autopilot car, capable of driving while the driver rests comfortably on the seat. That is the case for Volvo, which is researching and developing the concept of Autonomous Driving. At the moment, the only system which permitted to drive safely on roads is the semi-autonomous driving. The first reason is because this technology is in continually research. And the second, perhaps the most relevant reason, is due to the fact that the legal framework for the implementation of this way of driving is not prepared and approved yet, with the exception of testing in certain places.

Our proposal is the development of a technology, that will produce reliable and safe sensors capable of enhance the experience of driving, maximizing the security and reducing risks of accidents. The proposal constitutes a serious and interesting endeavor, because it will revolutionize the way of driving forever, opening up new forms of smart transportation. As Volvo says, it “[…] has the power to change the world as we know it forever”.

In order to describe the steps for the development of our proposal, we have delineated the steps that are integral part of the process for autonomous driving in our connected car.

a. **Location information**: Using GPS technology, the car will determine where in the world is currently located.

b. **Surrounding information**: Using the built-in sensor that we propose, the car will sense and detect all the physical objects around. With an algorithmic software, it will process movements of objects (if there is any) to establish a differentiation process that can lead to the recognition of objects (if the objects that moves is a cat, a pedestrian, a ball or another vehicle, for example).

c. **Processing information**: With the information provided by sensors and once the result of the algorithmic software is given, the driving software will know what to do next. Or even, it will predict the next movement of the object.

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4 Taken from http://www.volvocars.com/intl/about/our-innovation-brands/intellisafe/intellisafe-autopilot/this-is-autopilot

5 http://www.volvocars.com/intl/about/our-innovation-brands/intellisafe/intellisafe-autopilot/this-is-autopilot/autonomous-drive-in-detail
d. **Driving information:** As the driving software receives the input from the processing information, the output will be the driving path. It will define speed and direction of the car. Such output, is what we denominate Autonomous driving, the most important part of our connected car using IoT technology.

3. **Exemplification of the nanoscale sensor**

The connected cars can be best described as a platform that enables the exchange of information between the car and its surroundings, either through local wireless networks or via the internet. The exchanged information is acquired by sensors placed on the car. These sensors are able to detect **physical, external objects** like pedestrians, cyclists, vehicles and more. The sensors are designed to drive safely around these interferences.

The car processes both map and sensors' information to determine where it is in the world. These cars know what street they're on and which lane they're in. the sensors help detect objects all around us. The software classifies objects based on their size, shape and movement pattern. It detects a cyclist and a pedestrian for example. After that, the software predicts what all the objects around us might do next, it predicts that the cyclist will ride by and the pedestrian will cross the street. Then, the software chooses a safe speed and trajectory for the car. These cars can nudge away from the cyclist and then slow down to yield to the pedestrian.

For example, sensors that implied on Volvo vehicle that is currently being developed:  

![Figure 2. Sensors exemplification](http://www.volvocars.com/intl/about/our-innovation-brands/intellisafe/intellisafe-autopilot/this-is-autopilot/the-tech)

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6 [http://www.volvocars.com/intl/about/our-innovation-brands/intellisafe/intellisafe-autopilot/this-is-autopilot/the-tech](http://www.volvocars.com/intl/about/our-innovation-brands/intellisafe/intellisafe-autopilot/this-is-autopilot/the-tech)
4. Implementation

A connected car capable of performing an autonomous driving will change the concept of transportation and will take the technology to a next level. Researchers have been working and developing sensors capable of doing smart recognitions of the surrounding environment. However, the results so far are not definitive, and it urges a legislation that will ease the procedures and protocols pertaining to this matter. The legislation is the key for a successful implementation of the entire proposal. Sensors that would be developed will contain such technology that will enhance the technology of Nanosensors plus the technology of algorithmic software. Both combined, will represent a secure and safe process that will surpass the establish security requirements and safety protocols.
5. Conclusions and recommendations.

There are some benefits compressed into some driving characteristics\textsuperscript{7}, which will be taken into account with our proposal and that can be achieved with the following recommendations:

- **Mobility management**: This will be improved the coordination system of the autonomous driving software, will allow drivers to reach destination in a faster way, avoiding traffic jams for example, with the help of traffic assistance and parking lot or garage information systems.

- **Vehicle management**: The connected car will make all the vehicle processes even easier for the driver. Vehicle service reminders, condition information, remote operation, expiration date of insurances. All the data can be translated, with the help of an application, to a personal computer and can be checked from a comfort couch.

- **Entertainment**: Connected car will have all the applications related to entertainment, when the autonomous driving software is working on the road. The path can be displayed and connected into mobile devices. Making the driving, even possible from a mobile phone screen.

- **Safety**: The idea of implementing sensors being capable of enabling an autonomous driving, should be secure and should provide a sense of safeness. Applications can avoid crashes or minimize damage when it cannot be avoided.

- **Well-being**: Comfort and ergonomic driving. For example a fatigue detection system that will disclose an alarm, when there is a determined number of hours of continual manual driving. Built-in calls for medical assistance.

- **Home integration**: A connected car will present a better way to be connected with home, making car an extension of the house. For example, turning off alarms when approaching home, turning on or turning off lights of home, adjusting thermostat and so forth.

Not to mention that a connected car in the way we are proposing this model, will have a **beneficial impact on energy efficiency**, since autonomous driving can drive down fuel consumption due to the fact that is almost a “perfect” driving, shorting distance and choosing the optimal way to destination. Moreover, the more connected cars we would have, the more optimal traffic conditions we are going to have on roads. Advanced traffic control systems would make possible the reduction of traffic jams and subsequently, fuel consumption.

\textsuperscript{7} Strategy\& (2014). In the fast lane: The bright future of connected cars.
6. References

1. Machina Research Forecast Website. Available at: https://machinaresearch.com/forecasts/


4. Taken from http://www.volvocars.com/intl/about/our-innovation-brands/intellisafe/intellisafe-autopilot/this-is-autopilot


