LÍNGUA INGLESA

TECNOLÓGICAS

TEXTO: CHEHRI, A.; MOUFTAH, H. T. Autonomous vehicles in the sustainable cities, the beginning of a green adventure. **Sustainable cities and Society**, v. 51, 2019.

Questão 1:

De acordo com o texto (CHEHRI; MOUFTAH, 2019), é correto dizer que o conceito de cidade inteligente:

a) Inclui iniciativas sensíveis à informação, portanto, não afetadas por mudanças econômicas rápidas e sistêmicas.
b) Refere-se ao processo de tornar as cidades mais eficientes, menos barulhentas e mais sustentáveis.
c) Prevê melhorar a qualidade de serviços oferecidos pelo governo em detrimento do bem-estar do cidadão.
d) Será definido quando se conhecer a complexidade do planejamento, organização das cidades.

Questão 2:

Um dos benefícios de veículos autônomos e conectados (CAVs) em cidades sustentáveis é que eles podem diminuir

a) a emissão de gás carbônico e o tempo de viagens.
b) o número de veículos e de estacionamento disponíveis.
c) o número de acidentes de carros e o número de viagens.
d) a emissão de gases diversos e acidentes em viagens.

Questão 3:

Leia as seguintes afirmações:

(I) Na área de transporte inteligente, o monitoramento automático das ruas inclui dois módulos independentes.
(II) O monitoramento automático de ruas inclui detectar e localizar obstáculos presentes na trajetória do CAV.
(III) O controle de navegação e a centralização na pista estão disponíveis para veículos autônomos e conectados.
(IV) Em veículos autônomos, detectar e monitorar pistas inclui um estágio de 'percepção' e 'ação'.

Assinale a alternativa que apresenta somente afirmações corretas:

a) I, II e III.
b) II e III
c) III e IV.
d) I, II e IV.

Questão 4:

Sobre a tecnologia dos veículos autônomos, é correto dizer que:

a) a inteligência artificial é necessária para que os veículos autônomos criem um mapa 3D para ensinar o piloto sobre o ambiente.
b) a interface com o usuário deve ser mínima para que o motorista não precise tomar decisões ao longo do trajeto.
c) a tecnologia 5G pode complementar a conectividade entre veículo e infraestrutura, mas não entre um veículo e outro veículo.
d) a detecção e alcance da luz (LIDAR) serve para detectar, classificar e monitorar objetos nas proximidades do veículo.

Questão 5:

De acordo com os autores, a inovação em mobilidade é necessária considerando o crescimento da população. Discorra sobre a relação entre mobilidade e cidades e explique, de acordo com o texto-base, o que é necessário para se garantir a acessibilidade integral às áreas urbanas.

Questão 6:

O uso de multisensores é necessário para se diminuir os riscos em veículos autônomos e conectados. Discorra sobre como as câmeras são incorporadas a um sistema de visão de forma a superar os limites impostos pelo seu uso isolado, de acordo com o texto.

Questão 7:

Explique sobre **DOIS** dos dilemas sociais apresentados no texto-base.

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Autonomous vehicles in the sustainable cities, the beginning of a green adventure

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ABSTRACT

Every revolution promises a spirit of optimism and significant changes. Connected and automated vehicles (CAVs) are coming to our roadways. CAVs have a crucial role to play in the future of transportation. These emerging technologies will provide a safe travel mode by eliminating the human driving error. The CAVs are never distracted or tired. In the last five years, autonomous driving has gone from "may be possible" to "inevitable". Beyond safer and more enjoyable routes for passengers, the autonomous car also represents a significant step forward in terms of sustainable development. However, many questions remaining under investigations, when will autonomous cars be available? What should be improved first, vehicles or infrastructures? What are the requirements that must be satisfied by Intelligent Transportation Systems (ITS) in smart and sustainable cities? How will these modern technologies impact our transportation systems and the social world? What and how the leading technologies can be used in autonomous cars? What type of sensors and embedded devices to be used? In this paper, we address those issues and to try to provide some suggestions for these technologies that are currently emerging.

1. Introduction

Incorporating elements like technologies, environmental sustainability, and accessibility, smart cities are increasingly becoming part of the common vernacular.

The term and phenomena of smart cities are relatively new. Historically, the use of the word 'smart' was first applied within the literature of new urbanism in urban growth and development in America in the 1990s. Castelnovo (2016) argues that smart city initiatives are highly information intensive and often use citizen-generated information.

Due to the complexity of how cities are planned, regulated, organized, and funded, there is no established definition for the "smart city" and "sustainable city". However, they could represent a real urban transformation in the face of rapid and systemic economic change (De Jong, Joss, Schraven, Zhan, & Weijnen, 2015; Pangbourne, Stead, Mladenović, & Milakis, 2019; United Nations, 2015).

Nevertheless, the concept can be described as a process that will make cities more efficient, livable, less noisy, and environmentally friendly. This will improve both the quality of government services and citizen welfare (Duarte & Ratti, 2018; Gopalakrishnan, Chitturi, & Prentkovskis, 2015; Mccarthy, 2017; Parkin, Clark, Clayton, Ricci, & Parkhurst, 2018).

Mobility has been a central theme in cities since the beginning of urbanization and has been an essential driver of growth and progress (Alam, Gattami, Johansson, & Tomlin, 2011; Igliński & Babiak, 2017).

Connected and automated vehicle (CAV) has become the focal point of current transportation studies for a while. Equipped with sensors and connecting devices, CAVs can detect the infrastructures, the pedestrians, the surrounding vehicles automatically, and calculate the most efficient self-driving plan (Alam, Mårtensson, & Johansson, 2015; Calvert et al., 2018; Gawron, Keoleian, De Kleine, Wallington, & Kim, 2018; Ge & Orosz, 2014; Liang & Peng., 1999; Plessen, Bernardini, Esen, & Bemporad, 2016; Stone, Santoni de Sio, & Vermaas, 2019; Turri, Carvalho, Tseng, Johansson, & Borrelli, 2013).

The expectations of this technology are high, and it is not to be denied that automated driving will influence our road traffic in the future (Chong, 2016). But there are still many challenges to be overcome before these great opportunities can be realized. In addition to vehicle sensors, networking with the road infrastructure can also contribute to a secure implementation, especially in the higher-ranking transport network (ICTC, 2017).

Though the CAVs are still in their early stages, their track record is imposing. This paper is the results of the combination of the most recent

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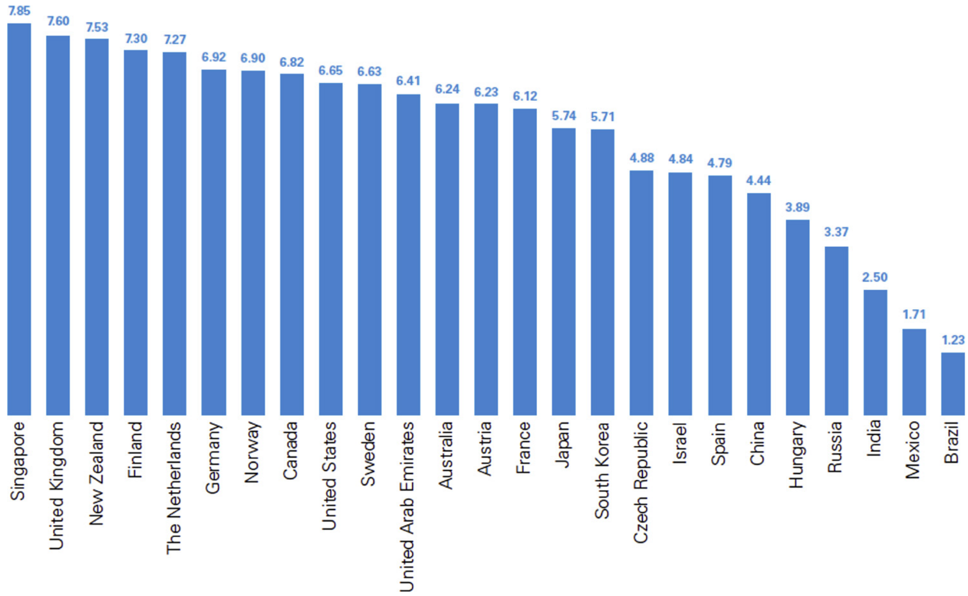

Fig. 1. AVRI aggregate scores by country source (KPMG International, 2019).

advances in CAVs, covering topics like automation, car visions systems, and artificial intelligence. This survey is complemented with a thorough literature review of the latest and relevant studies.

The remainder of this paper is structured as follows. Section 2 gives an overview of the ITS and CAVs. In Section 3, we provide some questions and answers for the beyond traffic smart and sustainable cities challenge. The key technologies toward self-driving vehicles are given in Section 4. Section 5 deals with the social acceptability of this technology and with some philosophical questions. Section 6 provides some conclusion and directions for future work.

2. ITS and CAVs: state of the art

Autonomous vehicles have garnered a lot of attention in the last few years, although industries are still testing AVs. Recent research on AV modeling and impact predictions have become more and more mature. With tech pioneers like Google (Waymo, 2018), Testa (Autopilot Tesla, 2018) and Uber (Self-Driving Cars Uber, 2018), as well as American multinational automaker (Ford (Ford Autonomous 20121, 2018Ford Autonomous 20121, 2018) and General Motors (Cruise Automation, 2018)), it is not surprising that the most significant progress in autonomous technology has come from the United States. However, more and more, international players like in Europe and Japan have begun to make substantial advances in this area.

In the United States, most important initiatives have been launched to address the problem of mobility. In August 1997, an essential demonstration of the "Automated Highway System Consortium (NAHSC)" is being held in San Diego, where various autonomous vehicles can be compared. On this occasion, a specific infrastructure had been prepared by inserting magnetic pins for guidance in individual sections of motorway (Bishop, 1997).

In 1986, the PROMETHEUS, an ITS research program, was launched by the European Automotive Industry. This program involved several Europeans governments and several university research centers and more than thirteen car manufacturers. It intended to work out concepts and draw up possible solutions aimed at improving all areas of European road traffic, i.e., making driving in Europe safer, efficient, economical, comfortable, and more environmentally acceptable (Williams, 1988).

When the ITS program became active throughout the world, Japan was one of the most ambitious participants. In Japan, where the mobility problem is much larger, a few prototype vehicles have been developed for different projects. As in the USA, the Advanced Cruise-Assist Highway System Research Association (AHSRA) was founded in 1996 to involve a large number of automotive manufacturers, research centers, and public–private partnership (Tokuyam, 1997). However, by 1997, it had renamed itself the Advanced Cruise-Assist Highway Systems Research Association and changed its emphasis too much nearer term systems for driver warning and control assistance (Hosaka & Mizutani, 2000; Suetomi et al., 1999).

The ITS is now beginning a new stage, which can be characterized by maturity in its approaches and by adopting new sophisticated technologies.

Several smart and autonomous vehicle models are currently tested on the road. The design of these prototypes results both from the critical analysis of the results coming directly from the underlying research and from the contribution of other disciplines, among which computing, wireless communications, automatic, signal processing, robotics, artificial intelligence, to name just a few (Evestedt, Ward, Folkesson, & Axehill, 2016; Fassbender, Heinrich, & Wuensche, 2016; Frasch et al., 2013; Funke & Gerdes, 2016; Funke et al., 2012; Funke, Brown, Erlien, & Gerdes, 2017; Galceran, Cunningham, Eustice, & Olson, 2015; Goldbeck, Hürtgen, Ernst, & Kelch, 2000; González, Pérez, Milanés, & Nashashibi, 2016; Guanetti, Kim, & Borrelli, 2018).

According to the 2016 Autonomous Vehicles Readiness Index (AVRI), the following nine countries were deemed to be at the forefront of this technology: Germany, United States, United Kingdom, Sweden, Japan, France, Italy, and South Korea. Meanwhile, in 2019 the AVRI adds new countries (Finland, Hungary, Czech Republic, Norway, and Israel) for a total of 25; the list of these countries are shown in Fig. 1.

3. The smart vehicles for smart cities

Cities are becoming the epicenter for mobility innovation – and for good reason. Mobility is the lifeblood of any city. It enables the movement of people, goods, and thus ideas, social interactions, and resources. Mobility is what makes a city livable and an attractive place to live.

This increased population growth in cities means that by 2050, congestion and thus commute times could increase threefold, costs of transportation could increase fourfold, and emissions could rise to five times the current levels – if timely steps are not taken to address them. The availability of space-efficient and affordable modes of transport for inhabitants is fundamental to ensure the full accessibility to urban areas.

3.1. Why the autonomous vehicle is the center of attention?

As discussed in the previous section, the main goals of autonomous vehicles are to improve road quality, safety, efficiency, and comfort (Forbes, 2014).

It is argued that autonomous vehicle aims to increase road safety, reduce traffic congestion, gas emissions, and fuel consumption. These data are not yet all encrypted because they are difficult to estimate; however, some of them are available. Thus, the use of new transport technology such as (1) Adaptive Cruise Control (ACC), which partly manages the acceleration and braking of the vehicle, (2) eco-navigation and (3) inter-vehicle communication could reduce fuel consumption by 2–4% (2647 billion barrels of oil) and cut greenhouse gases by 279 million metric tons each year for the next ten years in only the United States.

When the autopilot is activated, the driver is replaced by a computer system to improve specific dimensions of driving such as safety, traffic fluidity, ecology, and economy. Some simulations studies have shown that driving safety can be increased when the degree of automation is high. Indeed, inter-vehicle safety distances are more respected compared to manual driving (Jamson, Merat, Carsten, & Lai, 2013). Similar results were found for the use of ACC only, compared to manual driving (Stanton & Young, 2005).

Recent studies show that autonomous technologies have the ability to cut urban travel time by a third and reduce greenhouse emissions by two thirds. That includes almost 30% fewer vehicles in already crowded cities. In fact, studies have shown that autonomous technologies can reduce urban travel time by 30 percent, bring down emissions by 66 percent. The growing need for parking spaces would also reduce significantly by more than 40% and lower the number of required parking spots by 44%. Autonomous technology has the potential to reduce traffic accidents by nearly 90 percent (87%) and is thus of significant value to cities (Fig. 2). On the other side, the Electric vehicles (EVs) fight climate change by powering transportation with electricity, not fossil fuels. Driving an EV can cut fossil fuel emissions in half, or get rid of them entirely when renewable energy sources are used.

Chan summarized the positive contribution of the autonomous vehicles and their impact on different levels, namely: user, infrastructure, and sustainable cities and society (Chan, 2017) Table 1.

3.2. What should be improved first, vehicles or infrastructures?

A modernization of highways and roads will undoubtedly accompany vehicular automation. The French Institute of science and technology for transport, development, and networks (IFSTTAR) has launched the 5th Generation Road program. This program aims to design full-scale demonstrators, which integrate the numerous innovations (Sohm et al., 2012). This new type of road aims to:

- The 5th generation Route proposes to develop a new generation of infrastructure designed, constructed, and maintained in a “system” approach that meets current synergistic technologies adapted to different contexts.
- Establish communication and exchange of data between the infrastructure, the vehicle, and the city's traffic and road network management office.
- Create recyclable materials that can self-diagnose and self-repair.
- Ensure optimum surface condition permanently despite climatic variations, etc.

New technologies will be incorporated into these roads to complement vehicle driving aids systems (Stanton & Salmon, 2009). These roads will be somewhat intelligent and can give indications to CAVs such as the speed to adopt, the turning radius or the braking power to achieve. According to the authors, the use of these smart roads will be mandatory and not optional.

For example, Safe-D UTC proposed and evaluated of a narrow automated vehicle-exclusive reversible lane on an existing smart freeway (Fig. 3). The main objective of their research is to assess the safety impact of an innovative infrastructure solution for safe and efficient integration of Automated Vehicle (AV) as an emerging technology into an existing transportation system (Safe-D UTC, 2019).

3.3. Sensors for autonomous driving

All the sensors used in “indoor” mobile robotics does not apply in the same way to equip an ITS system which, let us not forget, is intended to face the outside world in very different and challenging conditions. Therefore, the tactile sensors and acoustic sensors are inappropriate to be used for applications involving high-speed vehicles (Bertozzi, Broggi, & Fascioli, 2000). This is because of the proximity required by the tactile sensors and the sensitivity to air movement for the acoustic sensors.

Autonomous vehicles that operate in the city and the urban environments must contend with several challenging perceptual problems. These include the detection and avoidance of static obstacles; the detection and tracking of roads; and the detection and prediction of other moving objects (Darms, Rybski, Baker, & Urmson, 2009).

The sensors based on the vision, such as a camera, have been used for ITS application. A video image processor (VIP) system typically consists of one or more cameras, a microprocessor-based computer for digitizing and analyzing the images, and software for interpreting those collected images and converting them into traffic flow data (Federal Highway Administration Research & Technology, 2019).

Unfortunately, by the environmental conditions, the vision sensors and camera are more sensitive to fog, rain, snow, pollution, lack or excess of light, and so on.

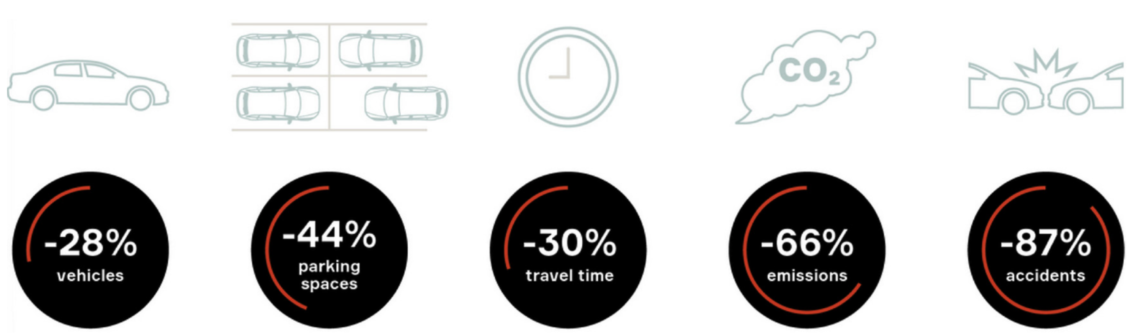

Fig. 2. The benefit of autonomous vehicle in sustainable cities.
Source: Picture taken from APTIV (2019), world economic forum and BCG.

Table 1
Contribution of the autonomous vehicles.

Citizen (user)	Road infrastructure	Sustainable cities and society
• Fewer collisions on the road by eliminating or minimizing human errors. • More comfortable and less stressful journeys. • Greater freedom of mobility for the disabled, tired, drunk, inattentive, very old, or children. • An alternative mode of transportation and perhaps more efficient. • Ownership of the vehicle less necessary or unnecessary for individuals. • Automated handling of maneuvers achievable in the event of vehicle or user failure.	• Reduce traffic congestion by reducing incidents and improving flow management. • More efficient real-time navigation. • More accessible, reliable, and flexible shared routes for transit and mobility services. • More efficient infrastructure through better vehicle control. • More affordable mobility services and less subsidized transit operations by public services. • Improved economic returns and business models for private investors. • Resource savings for infrastructure, including parking and road construction.	• Improve care and services dedicated to people with reduced mobility. • Encourage the transition from personal ownership to carpooling services. • Reduce the driver shortage for some countries and regions. • Reduce insurance and related property costs. • Reduce the accident rate and reduce societal losses. • Make vehicles and infrastructure more environmentally friendly. • Provide transport services that are increasingly capable of improving safety, reliability, security, and productivity.

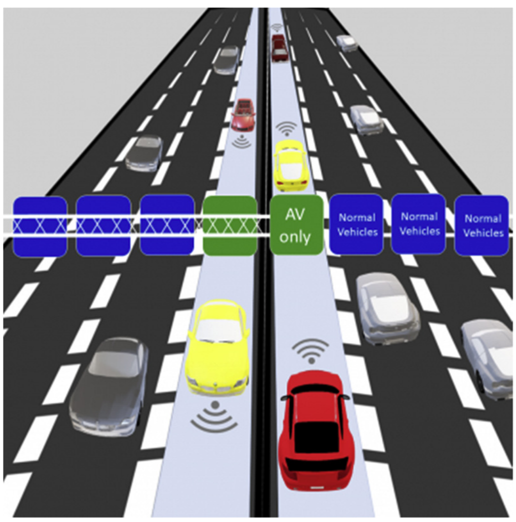

Fig. 3. Vehicle-exclusive reversible lane on an existing smart freeway (Safe-D UTC, 2019).

3.4. Vision systems for connected and automated vehicles

A large amount of information to be acquired, processed. It then becomes inevitable to equip the vehicle with a considerable number of sensors responsible for receiving and measuring with a given precision each type of information. Sensors of various types are used to limit the risks due to intrinsic measurement errors at each sensor.

The road and the environment sensing is currently mainly achieved using vision systems (cameras), laser telemetry systems, and radars. Each of these sensors has intrinsic characteristics limiting its performance, hence the idea of combining these sources of information. Cameras, for example, provide relevant information on the scene but are extremely sensitive to changes in brightness and contrast, their detection ability is mostly affected in adverse weather conditions (i.e., fog, rain, snow, etc.), the sudden transition between bright and dark region (i.e., the entrance or the exit of a road tunnel). To overcome these deficiencies, vision systems from cameras are often associated with a laser telemetry system advantageous even in adverse weather conditions.

Moreover, the sensors embedded today in the autonomous vehicle are "intelligent" because they do not only provide a data measurement but are accompanied by an integrated software brick capable of performing a first phase of processing this information.

Some sensors allow, for example, to determine the distance between the vehicle and an obstacle but also the nature of the obstacle detected (pedestrian, cyclist, car, truck, etc.) (Gibson, Mills, & Klein, 2007).

The vision systems, in turn, use one or more cameras (multi-view cameras) to deliver information or to perform recognition of elements of the scene (signs, etc.). However, as the speed of the vehicle increases, the detection of the components must be done quickly.

Currently, this detection can be performed in real time according to the software requirements, but this is only true for particular well-defined objects (cars, pedestrians, trees, etc.) and considering variable detection rates of a situation at the same time. If the recognition rate will undoubtedly increase in the years to come, the challenge still lies in the detection of small-size elements that can appear suddenly on the road (for example an animal running across the street, etc.).

3.5. Real-time road lanes detection and tracking

Automatic tracking of the road is probably one of the approaches that have generated the most work in recent decades. Its implementation is based on two complementary modules ensuring the following tasks:

- The detection of the lines separating the different lanes of the roadway.
- The detection and location of obstacles possibly found on the current trajectory of the vehicle.

Indeed, the detection and location of obstacles is an integral part of the task of automatic tracking of the road (Plessen, Bernardini, Esen, & Bemporad, 2016). As a result, these two research themes in the field of intelligent transport have forged a common destiny. In what follows, we discuss in more detail the detection of markings on the ground and the detection of obstacles.

In automated vehicles, the lanes detection and tracking are divided into two stages, of the "perception" and "action". Some examples of the strategies that can be adopted to solve the problem of lateral control are presented in (Taylor, Ko¢secká, Blasi, & Malik, 1999).

Be that as it may, the position of the markings on the road being useful to other subsystems of comparable devices, the location of these is in any case generally executed. Currently, the CAVs are at stage two, which means that some driver assistance systems can be automated, such as cruise control and lane-centering (Fig. 4).

Fig. 4. The fully autonomous future is still a number of years away (Nick, 2018).

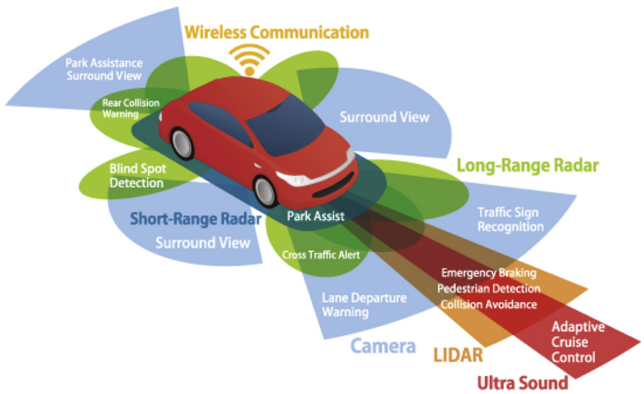

Fig. 5. The technologies behind autonomous vehicles (Landmark Dividend LLC, 2019).

4. The technologies behind autonomous vehicles

Self-driving vehicles employ a wide range of technologies like cameras, radar, and radio antennas to navigate safely on our roads. In modern autonomous vehicles, these technologies are used in conjunction with one another, as each one provides a layer of autonomy that helps make the entire system more robust and reliable (Fig. 5).

Utilizing a variety of technological advancements, including artificial intelligence (AI), Fifth generation cellular network technology (5G) and more, autonomous vehicles are undoubtedly one of the most anticipated innovations of our time.

4.1. Artificial intelligence (AI)

Autonomous vehicles learn from their environments by effectively creating 3D maps of their surroundings. These maps allow CAVs to gain a full picture of their whereabouts in real-time (Crowe, 2016). Prise 3D images are captured using a combination of radar and LIDAR. The latter of which pulls lights from a laser to measure ranges and distances. Once the photos are captured and filtered, it is up to the computer system to accurately interpret the meaning behind them and compute the value of the information it has gathered — this where artificial intelligence (AI) comes in.

For a long time, man has long dreamed of autonomous "thinking" machines that are free of human interference (Tsugawa, Yatabe, Hirose, & Matsumoto, 1979). The arrival of the first computers dramatically accentuated this interest and made it possible to concretize the project around a new scientific discipline in the late 1950s, the AI.

Deep learning is a further development of the application of neural networks known since the 1950s and refers to learning processes with multi-layered neural networks. These computational methods are roughly based on how the brain works by simulating its architecture – consisting of simulated neurons and their connections, amplified or attenuated by the "experiences" of the network.

With deep learning, the neural networks are now extremely good at capturing and identifying image content. These advances are significant for automated driving. In the future, vehicles will not only have to recognize traffic signs without errors but also pedestrians, cyclists, or trees.

4.2. Human machine cooperation

While AI is central to the machine's ability to decipher the meaning behind information received, a well-functioning human–machine interface is critical to ensuring that the system works according to the needs of the human in the vehicle (Debernard, Chauvin, Pokam, & Langlois, 2016).

The relationship between man and machine has changed massively in the last 20 years. The recent technological advances in automated cars made this possible only by making the interface between people and vehicles usable and desirable. In the future, this interaction will become essential. That's why it makes sense for us to divide the collaboration between man and machine into different types, and in terms of design, appropriate requirements, processes, and defined methods.

- *Transfer and command:* The user (i.e., driver) transmits some specific tasks and subroutines to the car. No further human support is needed. This type of collaboration was applied first to the factory robots and in certain functions in the vehicle, such as a congestion assistant.
- *Monitoring:* The objective here is to examine and analyze fully automated work and decision-making processes, such as autopilot. The driver plays only the monitoring roles. However, the vehicle must communicate relevant information and ask the drivers to react in case of problems or danger.

Design defines the relationship between supervision and actual intervention in an emergency, whereby it should, in principle, support the individual in his ability to act. Because in the course of automation, we will exercise specific skills so rarely that we may not be able to master it sufficiently in the case required.

High-performing human–machine cooperation must include transparency regarding the decision-making process of the car, based on information that is commonly used by the driver (Dikmen & Burns, 2016).

4.3. Fifth generation cellular network technology (5G)

The 5G, with its ultra-fast throughput, low latency, and increased reliability, will also allow vehicles to benefit from real-time data to enrich fully autonomous driving experiences (Huawei White Paper, 2017). The 5G promises a data rate 100 times higher than the current 4G: up to 10 gigabits per second and also, significantly faster reaction times (Fig. 6).

5G can replace, or at least complement, alternative connectivity technologies. For example, 5.9 GHz is dedicated short-range communication (DSRC) in the process of being mandated for V2V technology in the United States. If the traditional advanced driver assistance systems (ADAS) sensing technologies or DSRC failed for vehicle-to-vehicle (V2V) communications or vehicle-to-infrastructure (V2I) communications, the 5G could take over. The cellular option is known as cellular vehicle-to-everything (C-V2X). It uses existing 4G mobile standards like Long-Term Evolution (LTE) for both V2I and V2V. Specifically, in the early stage, before vehicles are fully autonomous, 5G will also support the following use cases, which requires more reliable technology (European Telecommunications Standards Institute, 2012; Lioris, Pedarsani, Tascikaraoglu, & Varaiya, 2017; Society of Automotive Engineers, 2017).

4.4. Light detection and ranging (LIDAR)

The technique of LIDAR relies on remote measurement based on the analysis of the properties of a beam of light (e.g., laser) sent back to its transmitter (Wolcott & Eustice, 2014). The operation of LIDAR is similar to that radar, the difference being the spectral range of electromagnetic waves.

While LIDAR technology was initially used for urban planning and archeology, for CAVs to successfully function and avoid accidents, LIDAR and other embedded sensor are required. The perception module is responsible for detecting, classifying, and tracking different objects present in the environment around the vehicle (Fig. 7).

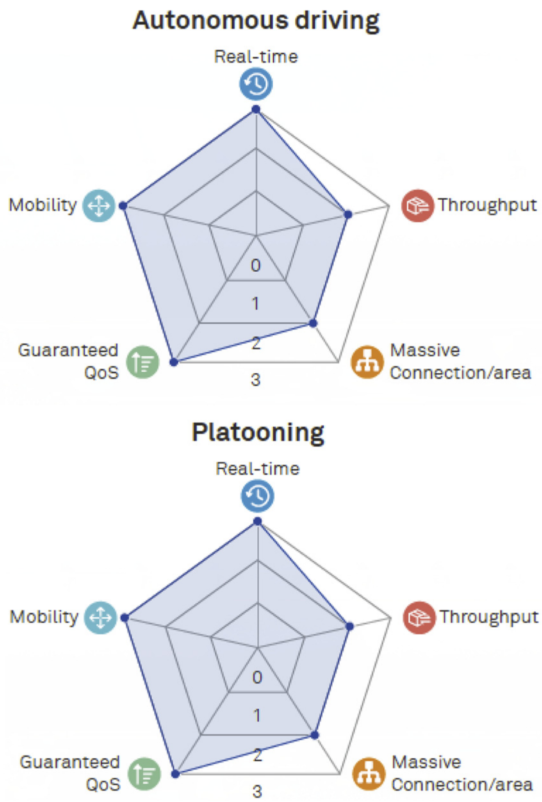

Fig. 6. The most 5G relevant use case in CAVs (Huawei White Paper, 2017).

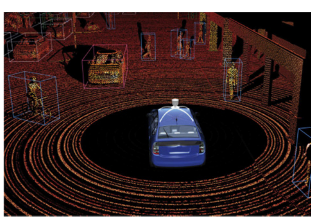

Fig. 7. 360-map of the vehicle surroundings. The roof-mounted LIDAR sensor is used to generate a high-resolution map of the vehicle surroundings.
Source: Courtesy of Google.

5. The social dilemma of autonomous vehicles

The autonomous vehicle is among the most promising technological solutions to reduce road accidents. However, it remains to prove that automated driving is safer and more effective than human conduct in everyday use.

Indeed, for large-scale commercialization, it is essential that future buyers have confidence in these vehicles to entrust their lives to them (Lee & See, 2004). We must, therefore, improve the image of autonomous driving. This is not easy since the rare accidents, including these vehicles, are put forward by the press.

While waiting for these vehicles to be accessible to the general public, there remain several years of research in the human sciences, and more particularly in the field of human–machine interactions, to continue to examine and understand the attitudes and behaviors of drivers concerning fully automated driving (Bonnefon, Shariff, & Rahwan, 2016). The questions that can be asked relate to how these drivers receive this technology, what opinions they have regarding its use, and what their behavior is in this new vehicle. Do drivers accept this new mode of transportation? What do they think? Are they ready to use it? In what conditions?

Finally, another obstacle to the development of autonomous cars, which is not negligible, is that most drivers enjoy driving, and they still want to drive their vehicles.

6. Conclusion and discussion

In recent decades, transport systems have been given great importance to improve safety conditions, optimize the operation of road networks, reduce energy consumption, and preserve the environment. At a time when environmental considerations require the hunt for fuel-intensive vehicles, the arrival of autonomous cars sounds like good news with a more sober consumption and lower CO_2 emissions.

In this paper, we have presented a new way of analyzing and summarizing the benefits of autonomous vehicles and their impact on different levels: user, infrastructure, and sustainable cities and society. Also, we aim to gain a deeper understanding of various technologies behind autonomous vehicles. This paper reviews the structure and ubiquity of moral dilemmas and social acceptability of autonomous vehicles.

Beyond safer and more enjoyable routes for passengers, the autonomous car also represents a significant step forward in terms of sustainable development. Despite an increase in the number of users and therefore, kilometers traveled, autonomous vehicles will be more environmentally compatible, energy-friendly (cleaner cars, smoother traffic, car-sharing solutions). All these innovations will significantly reduce the ecological impact of the transport sector.

The autonomous driving task as a whole becomes hugely complex and must gradually be considered to the same degree of criticality as that applied in the aeronautical field. Each element of the system necessary for the implementation of a delegation of the conduct (navigation, perception, generation of the trajectories and control) comprises its own level of complexity, related as well to the material part (sensors, actuators, system of acceleration and braking) than to the software part (algorithms for data analysis, control system, perception, decision, etc.).

Several research efforts, from both industry and academia, have been opened to solve these problems. The various tasks in question are listed below:

- *Architecture design and implementation of an autonomous vehicle:* The significant difficulty is to understand the driving architecture of the autonomous vehicle in its entirety. Indeed, the many interactions between these levels must be controlled because they are likely to generate edge effects often challenging to predict during the design phases.
- *Core technologies used in self driving cars:* A coherent vision for an autonomous vehicle, cameras, and radar sensors are the "eyes" of the car. The only question is how these sensors collect the data will become not only useful but will make "thinking" cars. For vehicles to become smart and deals with a complicated traffic situation, machine learning or artificial intelligence is the key. Just like a human, deep learning computers do not interpret an image pixel by pixel, but holistically. Therefore, artificial intelligence and deep learning will be the disciplines of the future.
- *Autonomous cars: social, legal and economic implications:* The question is how technological advances will be able to improve road safety while limiting the new risks of this new technology. All the technological developments that this evolution imposes will have a direct impact on the society where the vehicles have, in a certain way, structured our way of life. These autonomous vehicles call into question the paradigm of individual mobility in various aspects: economic, social, legal, etc. The models on which these vehicles will be based will probably differ from those currently known. As interest in autonomous car technology grows, the social and economic implications of this technology will affect various stakeholders, including its commercialization. For this reason, interdisciplinary work is necessary to apprehend the autonomous car as a whole and

to prepare its future presence in everyday life.

However, beyond technical issues, other aspects need to be carefully considered, such as the legal aspects of liability in case of fault or incorrect behavior of the system, as well as the influence of automatic driving on human passengers. Therefore, a long period of extensive testing must precede the provision of these autonomous vehicles on the market.

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LÍNGUA INGLESA

TECNOLÓGICAS

GABARITO

TEXTO: CHEHRI, A.; MOUFTAH, H. T. Autonomous vehicles in the sustainable cities, the beginning of a green adventure. **Sustainable cities and Society**, v. 51, 2019.

Questão 1:

Enunciado:
De acordo com o texto (CHEHRI; MOUFTAH, 2019), é correto dizer que o conceito de cidade inteligente

Gabarito:
Refere-se ao processo de tornar as cidades mais eficientes, menos barulhentas e mais sustentáveis.
Justificativa: A alternativa está correta. A resposta pode ser encontrada no seguinte excerto: *Nevertheless, the concept can be described as a process that will make cities more efficient, livable, less noisy, and environmentally friendly*.

Distratores:

1) Inclui iniciativas sensíveis à informação, portanto, não afetadas por mudanças econômicas rápidas e sistêmicas.
Justificativa: A alternativa está incorreta. A inadequação pode ser identificada no seguinte excerto: *Smart city initiatives are highly information intensive and often use citizen-generated information. They could represent a real urban transformation in the face of rapid and systemic economic change.*

2) Prevê melhorar a qualidade de serviços oferecidos pelo governo em detrimento do bem-estar do cidadão.
Justificativa: A alternativa está incorreta. A inadequação pode ser identificada no seguinte excerto: *This will improve both the quality of government services and citizen welfare.*

3) Será definido quando se conhecer a complexidade do planejamento, organização das cidades.

Justificativa: A alternativa está incorreta. A inadequação pode ser identificada no seguinte excerto: *Due to the complexity of how cities are planned, regulated, organized, and funded, there is no established definition for the "smart city" and "sustainable city".*

Questão 2:

Enunciado:
Um dos benefícios de veículos autônomos e conectados (CAVs) em cidades sustentáveis é que eles podem diminuir

Gabarito:
a emissão de gás carbônico e o tempo de viagens.
Justificativa: A alternativa está correta. A figura 2 apresenta uma redução de 30% de tempo de viagens e de 66% de emissão de CO_2.

Distratores:

1) o número de acidentes de carros e o número de viagens.
Justificativa: A alternativa está incorreta. Não se trata do número de viagens e sim do tempo de viagens.

2) o número de veículos e de estacionamento disponíveis.
Justificativa: A alternativa está incorreta. O textos não informa que vai diminuir a disponibilidade.

3) a emissão de gases diversos e acidentes em viagens.
Justificativa: A alternativa está incorreta. O gráfico apresenta emissão de gás carbônico e de acidentes de trânsito, não incluindo outros gases e outros acidentes.

Questão 3:

Enunciado:
Leia as seguintes afirmações:

(I) Na área de transporte inteligente, o monitoramento automático das ruas inclui dois módulos independentes.
(II) O monitoramento automático de ruas inclui detectar e localizar obstáculos presentes na trajetória do CAV.
(III) O controle de navegação e a centralização na pista estão disponíveis para veículos autônomos e conectados.
(IV) Em veículos autônomos, detectar e monitorar pistas inclui um estágio de 'percepção' e 'ação'.

Assinale a alternativa que apresenta somente afirmações corretas:

Gabarito:
III e IV
Justificativa: A asserção (III) está correta, o que pode ser verificado no seguinte trecho: *Currently, the CAVs are at stage two, which means that some driver assistance systems can be automated, such as cruise control and lane-centering.* A asserção (IV) também está correta, o que pode ser verificado no seguinte trecho: *In automated vehicles, the lanes detection and tracking are divided into two stages, of the "perception" and "action".*

Distratores:
1) I, II e III.
Justificativa: A asserção (I) está incorreta, a inadequação pode ser verificada no seguinte trecho: *Its[Automatic tracking of the Road] implementation is based on two complementary modules [...].*Da mesma forma, a asserção (II) está incorreta, pois não se resume ao obstáculos presentes somente na trajetória do veículo. A inadequação pode ser verificada no seguinte trecho: [...] *the detection and location of obstacles is an integral part of the task of automatic tracking of the road[...].*

2) II e III
Justificativa: A asserção (II) está incorreta, pois não se resume ao obstáculos presentes somente na trajetória do veículo. A inadequação pode ser verificada no seguinte trecho: [...] *the detection and location of obstacles is an integral part of the task of automatic tracking of the road[...].*

3) I, II e IV
Justificativa: A asserção (I) está incorreta, a inadequação pode ser verificada no seguinte trecho: *Its[Automatic tracking of the Road] implementation is based on two complementary modules [...].*

Questão 4:

Enunciado:
Sobre a tecnologia dos veículos autônomos, é correto dizer que:

Gabarito:
a detecção e alcance da luz (LIDAR) serve para detectar, classificar e monitorar objetos nas proximidades do veículo.
Justificativa:
A resposta está correta, a adequação pode ser constatada no trecho: *The perception module is responsible for detecting, classifying, and tracking different objects present in the environment around the vehicle*

Distratores:

1) a inteligência artificial é necessária para que os veículos autônomos criem um mapa 3D para ensinar o piloto sobre o ambiente.

Justificativa: A alternativa está incorreta, pois o texto não fala sobre a inteligência artificial ensinar o piloto sobre o ambiente, o que pode ser verificado em: *Autonomous vehicles learn from their environments by effectively creating 3D maps of their surroundings. These maps allow CAVs to gain a full picture of their whereabouts in real-time*

2) a interface com o usuário deve ser mínima para que o motorista não precise tomar decisões ao longo do trajeto.

Justificativa: A alternativa está incorreta, a inadequação pode ser verificada em: *High-performing human–machine cooperation must include transparency regarding the decision-making process of the car, based on information that is commonly used by the driver*

3) a tecnologia 5G pode complementar a conectividade entre veículo e infraestrutura, mas não entre um veículo e outro veículo.

Justificativa: A alternativa está incorreta, a inadequação pode ser verificada em: *5G can replace, or at least complement, alternative connectivity technologies. For example, 5.9 GHz is dedicated short-range communication (DSRC) in the process of being mandated for V2V technology in the United States. If the traditional advanced driver assistance systems (ADAS) sensing technologies or DSRC failed for vehicle-to-vehicle (V2V) communications or vehicle-to-infrastructure (V2I) communications, the 5G could take over.*

Questão 5:

<u>Enunciado</u>:

De acordo com os autores, a inovação em mobilidade é necessária considerando o crescimento da população. Discorra sobre a relação entre mobilidade e cidades e explique, de acordo com o texto-base, o que é necessário para se garantir a acessibilidade integral às áreas urbanas.

<u>Resposta esperada</u>:

O candidato encontrará as informações solicitadas na questão nos dois primeiros parágrafos da seção 3. O primeiro parágrafo elucida a relação entre as cidades e a mobilidade e o segundo parágrafo apresenta as razões que devem ser consideradas para que o acesso às áreas urbanas esteja disponível.

Cities are becoming the epicenter for mobility innovation – and for good reason. Mobility is the lifeblood of any city. It enables the movement of people, goods, and thus ideas, social interactions, and resources. Mobility is what makes a city livable and an attractive place to live.

This increased population growth in cities means that by 2050, congestion and thus commute times could increase threefold, costs of transportation could increase fourfold, and emissions could rise to Five times the current levels – if timely steps are not taken to address them. The availability of space-efficient and affordable modes of transport for inhabitants is fundamental to ensure the full accessibility to urban areas.

Questão 6:

Enunciado:
O uso de multisensores é necessário para se diminuir os riscos em veículos autônomos e conectados. Discorra sobre como as câmeras são incorporadas a um sistema de visão de forma a superar os limites impostos pelo seu uso isolado, de acordo com o texto.

Resposta esperada:
A resposta está na seção 3.4 Especialmente no parágrafo 2 que explica por que as câmeras precisam estar integradas em um sistema de visão e no parágrafo 4, em que os autores explicam como os sistemas de visão usam múltiplas câmeras para superar os limites impostos no uso isolado de uma câmera.
The road and the environment sensing is currently mainly achieved using vision systems (cameras), laser telemetry systems, and radars. Each of these sensors has intrinsic characteristics limiting its performance, hence the idea of combining these sources of information. Cameras, for example, provide relevant information on the scene but are extremely sensitive to changes in brightness and contrast, their detection ability is mostly affected in adverse weather conditions (i.e., fog, rain, snow, etc.), the sudden transition between bright and dark region (i.e., the entrance or the exit of a road tunnel). To overcome these deficiencies, vision systems from cameras are often associated with a laser telemetry system advantageous even in adverse weather conditions.
The vision systems, in turn, use one or more cameras (multi-view cameras) to deliver information or to perform recognition of elements of the scene (signs, etc.). However, as the speed of the vehicle increases, the detection of the components must be done quickly.

Questão 7:

Enunciado:
Explique sobre **DOIS** dos dilemas sociais apresentados no texto-base.

Resposta esperada:
A resposta está na seção 5 do artigo. O candidato deverá explicar quais questões sociais estão em jogo no uso de veículos autônomos e conectados, como: a imagem da direção autônoma, as atitudes e comportamentos na interação entre máquina e o ser humana na direção autônoma e o fato de que muitos motoristas gostam de dirigir seus veículos.