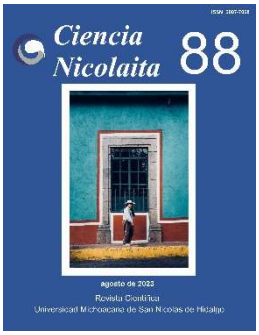

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Héctor Manuel Godínez-Cárdenas y Mauricio Pacheco-Capitaine*

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Correspondencia de autor: mauricio.pacheco@upaep.edu.mx

Artificial intelligence and advanced driver assistance systems absorption (ADAS) in Mexico

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Héctor Manuel Godínez-Cárdenas y Mauricio Pacheco-Capitaine*

Universidad Popular Autónoma del Estado de Puebla, Doctorado en Planeación Estratégica y Dirección de Tecnología, Puebla, México

Abstract

The driver assistance systems ADAS, are revolutionizing the way in which man and vehicle interact, while the car develops the work that the driver can lose by distraction. Also, the roads are an important point for the driver to have problems when driving, and the difficulties that these new technologies present with society, this seeks to provide security and not be perceived as obstacles when companies implement such technology in their vehicles. The objective of this work is to conduct a comprehensive literature review to determine the degree of absorption of both artificial intelligence and ADAS systems in motor vehicles in Mexico. This study shows how artificial intelligence assists man in his motor functions so that driving is a human-machine complement, strengthening the bond as an assistant.

Keywords: artificial intelligence, advanced driver-assistance systems, automobile, absorption, concept.

Autor de correspondencia: mauricio.pacheco@upaep.edu.mx; https://orcid.org/0000-0001-5330-7178

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Introduction

In the present research, the manner in which Artificial Intelligence (AI) has been implemented in passengers' cars is identified. Additionally, Advanced Driver Assistance Systems (ADAS) are defined, and the relationship between AI and ADAS systems is explained. Finally, it is intended to show an overview of the absorption that the developing countries, specifically Mexico, have regarding these technologies throughout last years. Humans could cause traffic accidents because of distraction, drowsiness, tiredness, speeding, fatigue, psychotropic substances abuse or for the fact of being bad drivers (Sinche-Cueva, 2020). During 2019, in Mexico, the number of accidents was 362, 586, causing 91, 713 people injured and 4, 125 deaths. From the accidents, 334, 925 were due to driving inattentive to the conditions of traffic, and 9, 447 because bad road conditions. The types of collisions registered were against vehicles, pedestrians, a fixed object or a motorcyclist. Additionally, Chihuahua with 28, 169 and Nuevo Leon with 76, 930 are the states with more accidents in the country, and Mexico City added 10, 673 more traffic accidents (INEGI, 2021). In order to face this problem, advanced driver assistance systems are developed, which help humans to maintain safe driving. One of the main objectives of ADAS is to ensure recognition of different hazards and, accordingly, to implement an early warning system or to intervene directly in the driving policy. These systems need to classify the road types and detection disturbances with high accuracy to provide those reactions (Tumen, Yildirim & Ergen, 2018). The processing of the information coming from both sensors and cameras, the decision-making in the given situations as well as the necessary steps to be taken will be accomplished by artificial intelligence implemented in automobiles with ADAS systems (Kiss, 2020). Urban roads or highways in a country, which are essential for comfortable transportation and whose function is to facilitate the efficient and safe transit of people and vehicles, have generally the road surfaces more well-kept than others, their strips tend to be better marked and regular. On the contrary, residential, city or rural driving environments are not well marked, these are usually not delineated and the asphalt is not in optimal condition (Tumen *et al*., 2018).

Literature review

Road conditions in Mexico

In order to reduce road traffic deaths and injuries, safety should be taken into consideration during the planning, design and operation of roads. The lack of specific infrastructure features that can ensure pedestrians, cyclists and motorcyclists a safe journey leaves them vulnerable to injury. Crash likelihood and severity could be affected by failings in infrastructure, which can be identified by mechanisms provided by road safety inspections and the star rating of roads (World Health Organization, 2018). According to the statistical yearbook of accidents in federal highways, within the most relevant statistics of the collisions registered in the road network monitored by the National Guard, a universe of analysis is contemplated, which is made up of 12, 056 accidents; an analyzed network, almost 50 thousand km in length. The database breaks down several causes associated with the same event; it acquires a multi-causal character. In 2019, there is a record of 15, 139 contributing circumstances to 11, 730 mishaps. It is worth mentioning that for 326 collisions, there is no information on the triggering agents. The collisions' cause results analysis showed that 11, 360 of them were related to the human factor, the road is identified in second place of importance with 1, 898, followed by the vehicle and natural agents with 1, 073 and 808 causes, respectively (Cuevas *et al*., 2020).

In the same statistical yearbook of accidents in federal highways, it is shown that the combination of driver, road and natural agent caused 489 accidents with a balance of 503 victims. Among the 1, 898 causes of collision due to the road, the main circumstances were that the road was wet, slippery, that there were objects on it, lack of signs, cattle raid, damage and other circumstances not mentioned (Cuevas *et al*., 2020). Additionally, the World Health Organization (2018) stated that improvements to the road infrastructure are important to improve road safety; however, Mexico has not yet implemented audits or

star ratings required for new road infrastructure. Although there are standards for the safety of pedestrians and cyclists, inspections of existing roads and investments to upgrade high risk locations are missing.

In Mexico, a serious problem is the pavements in poor condition, which force drivers to react in an unforeseen way to avoid damage to their vehicles, in general, these evasive maneuvers involve sudden movements with frequent invasion of other lanes or emergency braking that cause collisions rear (García de Quevedo *et al*., 2018).

Vehicle fleet in Mexico

Nowadays, there are some vehicle safety features that make a substantial contribution to reduce road traffic deaths and injuries or prevent crash occurrence, such as electronic stability control and advanced braking. Although the benefits of such technologies have been proven, not all new and in used vehicles are required to be equipped with these and other recognized vehicle safety standards (World Health Organization, 2018). During 2019, in Mexico, the total national number of registered motor vehicles was 50,594,282. This information includes the vehicle class (cars, trucks and passenger vans, trucks for cargo and motorcycles), as well as the type of service (official, public and private) (INEGI, 2021). In Mexico, the average age of the vehicle fleet is 16.3 years (Diario Oficial de la Federación, 2012), which represents an aging fleet of vehicles in which the possibility of failure in the machine is very feasible due to the fact that most of these vehicles use low and medium efficiency braking systems coupled with highly deteriorated suspension and steering systems. Additionally, the antilock braking systems (ABS), brake assistance system (BAS), traction control and airbags are not yet mandatory even on new cars (García de Quevedo *et al*., 2018).

According to the statistical yearbook of accidents in federal highways, among the 1, 073 causes of collision due to the vehicle in Mexico, it can be found that the main circumstances were because of vehicle´s poor mechanical or electrical conditions, tires, breaks, overweight & oversized vehicle, lights, steering, suspension, axles, badly secured load, transmission, and engine (Cuevas *et al*., 2020). Furthermore, the United Nation General Assembly has recommended the implementation of new car assessments as a means of improving vehicle safety. However, Mexico has not yet applied vehicle standards like frontal impact standard, electronic stability control, pedestrian protection or motorcycle anti-lock braking system on every new and in used car (World Health Organization, 2018).

The use of aging vehicles, lack of preventive maintenance as well as technological safety devices further complicate the balance of the urban system. The road system in Mexico experiences increasing chaos not only due to the operation of the system itself, but also due to different factors such as the weather, human error, insufficient complementary infrastructure, or poor-quality construction processes and materials (García de Quevedo *et al*., 2018).

Artificial intelligence and its basis

Along with technology new tools arise to take better advantage of the utilities of the same, is for this reason, that the study of artificial intelligence addresses issues of risk and ethical aspects, to assess various scenarios that are generated in human activities, raising from various perspectives in AI applications, since in many areas there is a lack of projects such as AI and it is necessary to combine with other activities to make good use of this tool, as it is the basis of many of the applications today (Rodríguez *et al*., 2020).

For this, it is necessary to conceptualize what artificial intelligence refers to, one of the first conceptualizations was held at Dartmouth in 1956, which proposed artificial intelligence, this proposal has served as a basis for generating new knowledge, in this proposal AI refers to every aspect of learning or any other characteristic of intelligence, which in principle can be described so accurately that can make a machine simulate it (McCarthy *et al*., 2006).

Also, AI can be oriented towards science and technology, defined as an activity to create intelligent machines, to determine the quality that allows them to function in their environment, and in an appropriate way, it has been accepted to help build other concepts (Nilsson, 2009).

Likewise, artificial intelligence is defined as aspects of computation created to interact with the world through perceptions and recognition capabilities, towards intelligent behaviors, to then take the necessary information available to make decisions, and these attributes are mainly human, AI provides the

Table 1
Elements and concepts of authors on artificial intelligence.

Authors	Concepts	Objectives	Applications
Boden, 2017	AI is a structured space with diverse capabilities for processing information.	Technological: the use of computers to do useful things. Scientific: Use of concepts and models to solve problems about humans and living things.	At home, cars (autonomous vehicles), offices, banks, hospitals, internet (internet of things), robots, satellites, animation, video games, navigation systems, web search engines, health, transportation, cell phones, virtual reality.
McCarthy *et al*., 2006	AI is every aspect of learning or any other characteristic of intelligence, which in principle can be described so precisely that it can make a machine simulate it.	The goal of the proposal was to bring together a select group of researchers to work on the foundations of AI.	
Stone *et al*., 2016; Zawacki *et al*., 2019	It is a multidisciplinary branch with areas such as mathematics, computer science, economics, logic, sociology, neurosciences, psychology, engineering, and statistics among many other areas, through people with access to machines.		
Nilsson, 2009	AI: It is an activity to create intelligent machines.	Determine the quality that allows it to function in its environment and in an appropriate manner.	
Benítez *et al*., 2014	AI: is an academic discipline that relates to the theory of computation.	Mimic human intellectual faculties convert them into artificial systems.	Systems identification and data processing.
Luckin *et al*., 2016	AI: are computer aspects created to interact with the world through perceptions and recognition capabilities, towards intelligent behaviors, and then take the necessary information available to make decisions, and these attributes are mainly human.	AI: provides the ability to respond and interact with people.	It provides continuous and intelligent support for various activities in education.

Source: Own elaboration.

ability to respond and interact with people, this tool provides continuous and intelligent support for various activities (Luckin *et al*., 2016). Table 1 focuses on the important aspects that researchers have proposed as a concept for artificial intelligence.

On the other hand, artificial intelligence is considered at its core, as a multidisciplinary branch that can take different areas such as mathematics, computer science, economics, logic, sociology, neurosciences, psychology, engineering, and statistics among many other areas, by means of people with access to machines (Stone *et al*., 2016; Zawacki *et al*., 2019).

Another definition of artificial intelligence refers to an academic discipline related to the theory of

computation, where the most common applications are systems identification and data processing, noting that the objective is to imitate human intellectual faculties to convert them into artificial systems, concerning human intelligence is posed as the processes of sensory perception and pattern recognition, with the use of various tools from different disciplines such as statistics, computer science, calculus, signal and data processing, neuroscience and robotics (Benítez *et al*., 2014).

The purpose of AI is for computers to accomplish the same kind of things that humans do with their minds, entering into issues such as perception, prediction, planning, and association to achieve their goals, as result, it seeks to process information from various activities to solve the tasks at hand such as houses, vehicles, offices, banks and in other activities. However, it is not only thinking about computers, but, what computers do, is what AI refers to, and can otherwise be considered virtual machines (Boden, 2017).

Applications in Artificial Intelligence

The need to identify how artificial intelligence works has allowed the creation of mixed methods that unify the configuration of the artificial with the human, creating a fusion of these human and technological factors, this change has been made possible by the use of digital media, facilitating the work and providing software such as APIs that can mimic human functions (Awad & Feinstein, 2020).

This ease of performing various operations threaten human tasks in jobs, so the task is related into how companies should combine jobs to perform by four distinctive activities that are mechanical, intuitive, empathetic, and analytical, this replacement mainly seeks to streamline tasks and less in replacing jobs, resulting in a replacement of artificial intelligence that will do the tasks with an edge of empathy and intuition (Huang & Rust, 2018).

Seen in this way, AI proposes to apply available tools, offering an overview of AI projects integrated into the development of each specific area, with this, the creation of technology in different processes must be assumed and this favors the understanding of the reality to which it is directed and put it into practice for regulatory compliance (Martínez, 2019).

Therefore, the construction of a conceptualization is far from a simple computer, the elements that help to compose the abstract that can become is the superintelligence and singularity, the first is referred to by Bostrom (2016) as the surplus intellect in cognitive performance used by humans in any area of interest, and the second refers to the superintelligence system capable of perfecting itself by itself or can create other systems with exponential growth, favoring supernature, which is the desire to be well, driven in the design of technologies currently used (Terrones, 2020).

AI systems as it has been raised go beyond technological behavior, it seeks to incorporate technical and philosophical concepts to approximate the human and artificial, other elements that help explain the AI is bioethics, transhumanism, transcending out of any scientific questioning based on technology, strengthening the era of technological uniqueness, to identify the ethical and philosophical technical elements minimizing the problems in their adaptation and incorporation (Villalba, 2016).

On the other hand, studies have allowed the creation of AI categories, which can be divided into four systems: systems that think rationally, systems that think like humans, another system that acts rationally, and finally, systems that act like humans, the purpose of these systems are focused on understanding, predicting the information to process it, and so on (Cairó, 2011).

However, the people involved in the AI aspects, are the ones who evaluate and qualify ethical implications in AI, being an important factor, so that the management of the programmers until reaching the end-user perceive these benefits, since they accept or reject the changes if not reliable and transparent. This is related to bioethical designs, since if an algorithm is assigned to supply the activities of humans, it must be valued by social functions, as a result, AI must be designed responsibly, transparent, incorruptible, predictive, and must be revisable (Bostrom & Yudkowsky, 2014).

Table 2
Studies and application elements in artificial intelligence.

Authors	Case	Study and elements
Awad & Feinstein, 2020	Hybrid identity	Artificial Intelligence, programmed identity "Intelligent Personal Assistants" (IPAs), combining humankind and AI.
Huang & Rust, 2018	Substitution of work	Theory of four bits of intelligence: mechanical, intuitive, empathic, and analytical.
Martínez, 2019	Regulatory framework	Data protection from design and defects.
Terrones, 2019	Supernature	AI is a precursor to superintelligence and singularity, coupled with supernature as the desire to be well, which drives wellness in the design of today's technologies.
Villalba, 2016	Bioethics and AI	Transhumanism, artificial intelligence, and the bioethics of technology.
Cairó, 2011	Categories of AI	Systems that think like humans. Systems that act like humans. Systems that think rationally. Systems that act rationally.
Bostrom & Yudkowsky, 2014	Bioethical characteristics of AI	Accountable, transparent, reviewable, predictable, incorruptible is necessary for technological development.
Rodríguez *et al*., 2020	Learning ML	Development of practical AI projects to foster Computational Thinking and Learning ML skills as a tool for teaching and supervised learning.
Bonami, 2020	Education and ethics	Exploring dimensions: evaluation, application, and challenges of research as an aid to education.
Castillo, 2015	Autonomous cars	Artificial intelligence helps autonomous cars reduce risks.
Pedro, 2019	Communication and public relations	Maintenance and improvement of AI in organizations and the public.
Huhtamo, 2020	Autonomous driving in cars	Autonomous cars through the application of artificial intelligence, and it is advance towards new elements in driving traffic devices and automated streets and highways.
Carabantes, 2013	Techniques and conditions for thinking machines	This means of using computers to replicate AI and how to adapt the technology to society to finance its adaptation so that people can assimilate the new way of life.
Décima, 2018	AI bridging the digital divide	AI-enabled digital divide for a new knowledge society through pattern recognition.
Hueso, 2019	Risks and impact on AI	AI algorithms bring learning closer to deep learning, machine learning, and neural networks, with principles of responsibility and caution.
Porcelli, 2020	Social and ethical aspects	Ethical guarantee in artificial intelligence towards the correct use of algorithms, to reflect security.

Source: Own elaboration.

With the digital era, new features emerge that allow understanding social structures, through the reorganization and structuring of human and non-human through digital technologies, one of the applications of technology is for the surveillance of macro-level data and facial recognition, in terms of ethical issues are obtained due to the contributions of technology, these problems present dilemmas of investment, qualification and reasoning for such systems may be present in the technology (Bonami, 2020). Table 2 shows the results of applications and key elements that help to define aspects of artificial intelligence, favoring the construction of the research.

On the other hand, the connection of the digital world and the advance in technology, allow AI to be a determining factor for the automotive industry to develop these capabilities, with this favors the driver to be a passenger, resulting in driving without the need of people, with this, a reduction of accidents due to human causes is proposed (Castillo, 2015).

The adaptation and understanding of AI have shown that there is a lack of knowledge on the part of people towards the clear conceptualization of what artificial intelligence represents, for the implementation to be successful in organizations, it is necessary to understand how it affects and works, so that the adoption is better. However, the perception of AI adoption by creative people in communication areas, projects a lower risk for this automation, since it is necessary to incorporate creativity and humanity to this technology (Pedro, 2019).

This kind of approach to AI makes it clear that there is still a lot to be done to achieve stability in automation, the result of which is the introduction of autonomous driving displacing the human being as a driver, replacing him from his manual action, and this has been a preamble on the new culture of driving on streets and highways, posing a new traffic device at various levels and its adoption of autonomous cars favored by AI (Huhtamo, 2020).

To make a technological adaptation in artificial intelligence, techniques, and conditions must be reviewed to favor the understanding of AI towards social part, the search for these objectives enters the possibility of using computers as support to replicate the artificial characteristics, and how, it will be adequate for people to assimilate the adoption and finance the development for social growth, resulting in a system of symbols as computational processes are used to transfer it into an intelligent behavior (Carabantes, 2013).

As mentioned, artificial intelligence brings together various activities to transform the characteristics in which we live. The digital divide is heading towards a new technological development accessible to people, this is favored by AI to create a new knowledge society, artificial intelligence techniques help pattern recognition automatically, managing to help various industries such as automotive. However, there are limits to artificial intelligence, while they will never replace human capacity, but humans can benefit from many of their contributions as assistants (Décima, 2018).

AI algorithms are approaching self-learning machine learning (ML), neural networks, and deep learning, for artificial intelligence, there are several risks that people take care of because it can get out of control, specialists, technicians, and computer scientists analyze this integration as it is a technology that benefits, but affects other aspects if neglected, for this can take into account principles of responsibility and caution (Hueso, 2019).

Humanity has been transformed through the scope of technology and digitalization, making a physical, human and biological fusion, artificial intelligence solutions are present in many of the activities that are performed, solving economic and social problems, for this reason, the legislations have been given the task of solving some ethical and social problems, in the case of autonomous cars some of the data are modified so that it can have indications of signs, streets or problems immersed in the road, and other data that are added are related to the vehicle as to the distance between vehicles and people, resulting in assistance to the driver, this takes importance in ethics as they must ensure the operation of artificial intelligence and that is focused on the human, to be accountable and that the algorithms are transparent (Porcelli, 2020).

Advanced Driver Assistance Systems (ADAS)

Advanced Driver Assistance Systems have been the driver of innovation towards the enhancement of traffic safety and efficiency in an environment where the number of road vehicles has been growing, these sys-

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tems are integrated functions of automobiles developed to assist the driving process. By replacing or complementing driver's behavior, ADAS seek to eliminate human errors, which may lead to accidents (Massow & Radusch, 2018). New technologies are being integrated into vehicles to provide drivers with timely warnings about their surroundings. There are ADAS systems that actively and automatically intervene when detectin an imminent crash, some examples of these technologies include: Lane Departure Warning, Lane Keeping Assistance, Blind Spot Detection, Forward Collision Warning, Autonomous Emergency Braking and Adaptive Cruise Control (Spicer *et al*., 2019). Taking advantage of the advancement in telecommunication services, sensing technologies, automation, and computer vision technologies (artificial intelligence), those systems have achieved positive results in traffic resource integration (Wang *et al*., 2020).

Beyond the aim to support drivers by providing warning to reduce risk exposure, ADAS could also take control automatically of tasks to relieve a driver from manual control of a vehicle. These functions can be achieved due to all instrumentation and intelligence on board the vehicle, or through a cooperative approach in which assistance is provided from roadways or other vehicles (Piao & McDonald, 2008). Intelligent vehicles are classified into six levels as following; no automation, driver assistance, partial automation, conditional automation, high automation and full automation. Interaction or collaboration of automated vehicles and human drivers is in its initial stage and will be in this phase for a long time (Wang *et al*., 2020).

The driving assistance systems were relatively less complex some years ago, however, nowadays these systems become more complicated due to the demand of having a more reliable and interactive platform for safer roads. In addition, new challenges and complexities are continuously increasing in development of ADAS, which have been massively introduced and implemented into new vehicle generations (Taie *et al*., 2016). Intersection Advanced Driver Assistance Systems (I-ADAS) are being introduced to warn or assist the driver to avoid collisions at intersections and not just rear-end and road departure accidents. Because of the different scenarios in which these kinds of accidents can vary, the design of I-ADAS should target the most frequent and harmful ones in order to maximize effectiveness by identifying the characteristics of intersection crashes (Kusano & Gabler, 2015).

The most popular field in the automotive industry is represented by advanced driver assistance systems and those technologies have become very important for modern vehicle safety and driving comfort. Moving Object Detection (MOD) is also an essential technique of various sensor-based platforms because they are more intuitive and cheaper than sensor techniques (Cho *et al*., 2019). When talking about ADAS systems, a non-intrusive approach for monitoring driver drowsiness based on driver physical and driving performance measures is also presented. Those measures could be detected due to driver biological, subjective report, driving performance, driver physical and driver measures (Daza *et al*., 2014).

ADAS have the potential to mitigate the impact of traffic accidents with vehicles being equipped with different systems. However, there is an unwillingness of the drivers to invest in new cars or such systems (Viktorová & Šucha, 2018). Despite stated benefits to drivers, there are still some things to learn about drivers´ interactions with these systems such as the way technologies affect driver behavior, or the drivers´ perception of the benefits (Pradhan *et al*., 2018). Those systems assist a human to drive a car in a dynamic environment, by understanding the current situation it's possible to carry out an action selection. Although a given alert could be false, the human can be confident that there is no undesirable event if no alert is given (Inagaki & Itoh, 2013).

For realizing a function of the vehicle to the driver, it is essential for ADAS to know the driver's requirements. Accordingly, these systems should accurately recognize the intentions of the driver, in real time. To gain quantitative knowledge of the extent to which active safety technology has contributed to prevent traffic accidents, a road traffic simulation system using a 'nanoscopic model' of driver behavior has been developed, designed for traffic safety assessment and estimation of the effects of ADAS on reducing the number of traffic accidents (Yuhara & Tajima, 2006).

The importance of ADAS is increasing and it is becoming more critical over time. These systems are based on Radar systems and / or Laser scanners to avoid road collision, and on cameras (automotive digital imaging sensors) or Laser scanners to park automatically (Taie *et al*., 2016). Nowadays, high-performance

sensor technology has enforced safety systems by improving the perception of the environment and thus taking the best assistant decision. In order to achieve this task, different sensor of a combination of them are used, the most relevant are: Cameras to capture images of the surroundings, Radars to measure range and velocity, LiDAR to create high-definition maps, Ultrasonic to measure the distance to the object ahead, and GPS/GNSS/IMU to determine the position of the vehicle in the space (Turcian & Dolga, 2021).

ADAS systems are integrated by radars and cameras with their corresponding computing to process all the information gather by the sensors, due to this computational power, the expense of integrating all data rises significantly. In 2020 the global market for radar, cameras, lidar and their computing was about 8.6 billion US dollars, and it's expected reach to 22.4 billion US dollars by 2025 (Boulay & Malaquin, 2020).

Artificial intelligence and Advanced Driver Assistance Systems

Nowadays vehicles use various devices to make the driver have comfortable driving, presenting assistance between vehicle and driver, one of the common systems is where the driver has assistance such as tactile devices making use of manual, visual, and cognitive mechanisms, so the interaction with this can contract consequences (Wickens, 2002).

However, this study is directed to analyze the ADAS systems, since it is one of the best systems that some companies have adopted to assist the driver, through electronic devices to support the driver in problems that may occur while driving, offering better support than In-Vehicle Information System, IVIS (Kutila, 2006). Artificial intelligence brings many challenges, in which, the role of companies has been determinant for safety systems combined with AI, has a great development, Ambarella is a company in Silicon Valley that is developing the technology for its products to match advanced driver assistance systems, through human vision and computer devices (Ambarella, 2020). Table 3 shows the companies or projects that have invested and collaborated in technology so that the driving of vehicles is favored by ADAS systems and these systems created by artificial intelligence as assistance to people when driving.

Table 3
Findings from companies successfully developing ADAS technology.

Authors	Companies and project	Systems	Applications
Ambarella 2020	Ambarella	Artificial intelligence incorporated into the system (Advanced Driver Assistance Systems, ADAS). Chip (SoC) offers high resolution video accuracy, image processing and neural network processing for data extraction.	Human and computer vision via electric mirrors, driver monitoring, disk recorders, autonomous driving and robotic applications.
Motional 2021	Motional	CVflow® processor for autonomous vehicles. LiDAR sensors for imaging and radar.	Enable safe operation in different road and highway conditions. Image processing and artificial vision, through the use of the vehicle's cameras and sensors.
Godoy *et al*. 2015	AUTOPIA Program (Center for Automatics and Robotics, CAR) of the Polytechnic University of Madrid	Differential GNSS receivers (GPS plus GLONASS), Controller Area Network bus readers, CAN extract vehicle information, LiDAR sensors, ZigBee sensors as an auxiliary network for information exchange.	They incorporated vehicle location and perception of the environment, artificial vision cameras, simulating urban environments, locating traffic lights, traffic circles, and traffic signs.

Table 3. Cont.

Authors	Companies and project	Systems	Applications
López 2014	Mercedes Benz	TEMPOMAT	It allows maintaining the distance with the vehicle in front. BAS PLUS system is an intelligent brake that detects if the driver is aware of the situation and if not, the vehicle will initiate braking.
	Ford	Active Vision	This function offers detection of unintentional lane change, especially when the lane dividing lines are not visible, as well as to return the vehicle to the lane, the system will direct the vehicle to the center, this help is presented with speed above 60 km/h. As well as sign recognition, displaying a speed warning. It also offers high beam assistance when it is very dark on the road.
	Volvo	Driver Alert Control (DAC). City Safety	This system assesses the level of fatigue or if the driver is distracted, utilizing a camera with sensors, which evaluate the road showing a signal. The driver can rest for a while. It offers detection of pedestrians or animals in the dark, making a warning with lights and sound if the driver does not react even if the driver continues to accelerate. Traffic assistant helps the driver when traffic is heavy and does not exceed 40 km/h, maintains the distance between vehicles, keeping at least one hand on the steering wheel.
	BMW	Connected Drive. Night Vision Mediante Dynamic Light Spot	Stop & Go, is a warning when the vehicle detects a distance between another car and maintains that distance, on highways or the road is clear, through the cruise function. Based on radar and braking. Approach detection when a car is coming fast from the rear of the vehicle when you maintain a speed above 70 km/h. In a critical situation, the vehicle tightens the seat belts, puts the seats in a vertical position, and makes a total closing of the windows. It uses infrared in the dark to detect people or animals.
	Google	“Driverless Car” through LIDAR system (Velodyne)	It uses a 3D map, with laser beams to monitor the vehicle's environment, using sensors installed in the front and rear of the car, in addition to GPS and IMU (Inertial Measurement Unit).

Source: Own elaboration.

On the other hand, Motional is a major player in the use of autonomous driving technology, using Ambarella's products as part of its development in automotive advancement, selecting CVflow® artificial intelligence processors for autonomous vehicles, these processors work in conjunction with Motional's LiDAR sensors to provide better imaging and radars, facilitating the driving of vehicles in various road scenarios (Motional Selects Ambarella's CVflow® Artificial Intelligence Vision Processors For Its Autonomous Vehicles, 2021).

ADAS systems have improved driver safety and experience, these systems are based on warning the driver of possible risks, obstacles, and lane changes, some of the most outstanding assistances are based on stability control, cruise control, anti-lock brakes, and assistance when parking the vehicle, in Spain a program called AUTOPIA was created focused on driver assistance through artificial intelligence in vehicles, dedicated to improving the architecture and operational control to simulate driving on highways and cities, with satisfactory results for the improvement of driving control (Godoy *et al*., 2015).

A great number of accidents are produced by man because of tiredness, distractions, or talking on the phone, carelessness is due when the driver's vision is diverted and fails to pay attention to the details that surround him while driving, in which, the reaction time is very fast. For this reason, it is necessary for countries that have not developed this technology to take action in the use of these systems for driving assistance through artificial intelligence systems, which will help them to reduce accidents (López, 2014).

Advanced Driver Assistance Systems are increasingly being used in the automotive sector lead by the capability of OEM to process the data generated by multiple sensors, and their automated driving features. Audi and Tesla, for instance, are being using radars and cameras. Audi and Aptiv developed a domain controller to handle the gathered data and Tesla did the same with the improvement of its Autopilot hardware. On the other hand, BMW and Volvo are expected to follow the implementation of LiDAR detection systems, and Globally OEM are working to get higher computational power to be able to process all information coming from ADAS systems, so that they could be able to clearly distinguish and classify objects, pedestrians, cyclists, vehicles and any other potential hazard on the road (Boulay & Malaquin, 2020).

The relationship between artificial intelligence and driving assistance systems is due to the operation of pre-designed programmed software for different scenarios or problems that arise when driving there are preloaded software such as Open CV, Phyton incorporating assistance tools in artificial vision for the detection of obstacles, the result of this alerts the driver by sound and visual alerts to keep him alert, in this way, advanced systems and artificial intelligence assistants, do their job when driving (Pico-Aponte, 2019).

Methodology

A systematic review of academic articles was conducted to build the literature review, searching the Ebscohost database and Google scholar, to better understand the use, applications, and concepts on the topics of Artificial Intelligence and Advanced Driver Assistance Systems (ADAS) obtaining new technological perspectives and implementations of companies that are developing these technologies, serving as a reference for companies that develop these innovations to make decisions on the difficulties presented by countries that are not developed.

Limitations

The limitations of the study are time and the fact that it only focused on two databases to retrieve data on artificial intelligence and ADAS systems, and that research on Advanced Driver Assistance Systems in Mexico is not yet implemented and there is very little information on these systems.

Conclusion

The present literature review proposes the use of artificial intelligence as a mean of development of ADAS systems, showing that safety is an important aspect in the development of new technologies, the starting point begins when the safety of people is violated by driving. These technologies have been developed because of the number of accidents caused by human distraction, where the lack of skill or distractions while driving has led to multiple accidents. Addi-

tionally, vehicle's poor mechanical and electrical conditions and road bad infrastructure trigger more frequent collisions. There are many countries in which these problems are very common, however, technology plays an important role in the development of driver assistance tools for the safety of passengers and people driving the vehicle.

The improvement in the road infrastructure is an indispensable step, making driving more reliable and safer, where the driver should not worry about the road. The reality is that the road infrastructure is composed of elements and obstacles that the driver does not perceive and for those facts, accidents may arise. This research contributes to be aware of the use of ADAS systems for safe driving, this involves acknowledging how vehicles interact with the driver. However, the vehicle fleet of old cars are the most affected by these problems by not having the necessary technology for the vehicle to respond in case the driver is not aware of the problems around.

Throughout this research, it has been mentioned that there are some vehicle safety features that make a substantial contribution to reduce road traffic deaths and injuries or prevent crash occurrence. Although the benefits of such technologies have been proven, not all new and used vehicles are required to be equipped with these and other recognized vehicle safety standards. In Mexico, for instance, not all people have this type of vehicle that can be considered high-end. The research findings relate to the companies with the type of technology used, and that other companies use in their vehicles.

The objective of this research was to carry out an exhaustive literature review to determine the degree of absorption of both artificial intelligence and ADAS systems in motor vehicles in Mexico, which allowed us to explore the elements and arguments that are being established in developed countries to serve as a sample in developing countries. To the best of our knowledge, there is no information regarding the degree of absorption of both Artificial Intelligence and ADAS systems in motor vehicles in Mexico, therefore, some data are based on the World Health Organization report.

Likewise, the implementation and development of these systems in Mexico have not yet been possible, because technology developers keep their research and development centers in other places, so there is no defined place where you can say that the technology is born or has been implemented, simply create these improvements and people consume the technology. For this reason, in less developed countries it is sometimes not possible for this technology to arrive or people cannot acquire vehicles with these features, for this reason, companies and especially car brands are responsible for the development of these driving assistance systems favored by artificial intelligence programs that make vehicles safe machines.

In this sense, countries with greater economic development have been favored by these types of technological developments, since they have within-reach vehicles that comply with these systems, allowing them to have safe driving. By means of this data, the research sets the course and provides an approach to a new technological panorama, allowing automobile users to make decisions and governments to take action and be aware of the challenges that new developments bring with them.

This paper promotes the investigation of the current degree of absorption of Artificial Intelligence and ADAS systems in Mexico, and thus be able to foster the importance of these technologies to have a safer driving.

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