VOL. 5 Nº2- 2023

IBARRA - ECUADOR

Facultad de Ingeniería en Ciencias Aplicadas
Innovation & Development in Engineering and Applied Science

IDEAS

Artificial Intelligence Challenges - Autonomous cars: A brief review

http://doi.org/10.53358/ideas.v5i2.912

[1]Bryan Narváez, [1]Michael Irua, [1]Zhara Monteros,[1]Ana Umaquinga, [1]Jaime Michilena, [2]Galo Hurtado

[1]Universidad Técnica del Norte
[2]Instituto Tecnológico Particular Sudamericano Cuenca

Fecha de envío, junio 12/2023 - Fecha de aceptación, septiembre 26/2023 - Fecha de publicación, septiembre 28/2023

Abstract: This documentary-descriptive research aims to explore the advancement of artificial intelligence (AI) in self-driving vehicles and its impact on the benefit of society. While it is undeniable that self-driving vehicles have practically become a technological reality in the field of computing, both at present and in the foreseeable future. However, several apparent problematic aspects need to be addressed in terms of legislation, as autonomous cars are set to become an integral part of everyday life. Therefore, this research examines through a literature review the significant advances and efforts devoted to software design in this area of study focused on the operation of autonomous vehicles in urban environments and their ability to circumvent city obstacles as well as challenges to unforeseen eventualities.

Key words: Self-driving cars, Challenges, Decision-making, Safety and reliability, Human-machine interaction

Resumen: Esta investigación documental-descriptiva pretende explorar el avance de la inteligencia artificial (IA) en los vehículos autoconducidos y su repercusión en beneficio de la sociedad. Si bien es innegable que los vehículos autoconducidos se han convertido prácticamente en una realidad tecnológica en el campo de la informática, tanto en la actualidad como en un futuro previsible. Sin embargo, es necesario abordar varios aspectos aparentemente problemáticos en términos de legislación, ya que los coches autónomos están llamados a convertirse en parte integrante de la vida cotidiana. Por ello, esta investigación examina mediante una revisión bibliográfica los importantes avances y esfuerzos dedicados al diseño de software en este ámbito de estudio centrado en el funcionamiento de los vehículos autónomos en entornos urbanos y su capacidad para sortear los obstáculos de la ciudad, así como los retos ante eventualidades imprevistas.

Palabras clave: Coches autoconducidos, Retos, Toma de decisiones, Seguridad y fiabilidad, Interacción persona-máquina.

Autor de correspondencia:
Ana Umaquinga, acumaquinga@utn.edu.ec

[1]Bryan Narváez, [1]Michael Irua, [1]Zhara Monteros, [1]Ana Umaquinga, [1]Jaime Michilena, [2]Galo Hurtado
[1]{bonarvaezt, mairuar, zjmonterosb, acumaquinga, jrmichilena}@utn.edu.ec, [2]gphurtado@sudamericano.edu.ec

Introduccion

Autonomous vehicles are being developed to find a solution to issues caused by human drivers. Seventy-five percent of road accidents are caused by human errors and casualties exceed a million per year. Because of traffic jams in highways there has been an increase in air pollution and greenhouse gases. On the other hand, putting self-driving vehicles on the roads would be a feasible solution. However, self-driving cars should prove that their driving operation-skills are far safer than the driving performed by human drivers [1].

As artificial intelligence (IA) continues to evolve, we seem to depend on it more each time affecting the functioning of society. For instance, in 2018 there was an automobile accident in Arizona caused by an autonomous car because of a system fault. Since there are no policy guidelines dealing with AI, legal and ethical issues raised leading experts to take action regarding the classification of artificial intelligence as a legal entity entitled to liability, in other words it is subject to rights and obligations under the Law [2].

Furthermore, the Society of Automotive Engineers (SAE) has established a classification system consisting of six levels of automation for self-driving cars, ranging from level 0, indicating no automation, to level 5, representing complete automation. Currently, the autonomous cars that have been introduced to society fall into the category of partial autonomy, as they still require driver supervision to take control in emergency situations.

The autonomous vehicle research area is aiming for full automation, which implies continuous advances in both software and hardware. Consequently, specific electronic devices, such as Camera Monitoring Systems (CMS), are being developed to replace traditional side-view mirrors. These CMSs, integrated in Advanced Driving Assistance Systems (ADAS), are based on video sensors and multipurpose cameras capable of detecting various elements, such as lanes, signs, other vehicles, cyclists, and pedestrians [3].

Initially conducting a comprehensive risk analysis is a difficult as well as challenging task due to the presence of software and/or hardware defects that can affect the driving of automobiles making them to a greater or lesser degree unacceptable or risky for society. However, nowadays, with the advancement of technology, several methods of software improvement are being developed in this area of interest. One such method involves the application of system detection algorithms aimed at identifying and rectifying software defects, ultimately leading to their improvement. In addition, the integration of fast decision-making algorithms capable of effectively managing dangerous driving situations is being studied [4]. These algorithms operate intelligently, without compromising performance, enabling autonomous vehicles to make real-time decisions in complex environments. The result is the creation of a "true consciousness," in which vehicles act in accordance with socially acceptable values and norms [5].

In the development of this research work, implemented materials and methods for bibliographical search will be explained, followed by results and discussion where ethical and legal issues are raised in the event of autonomous vehicles claims will be discussed. Lastly, the perfecting of hardware security systems and software systems advancements focused on robot-automation will be explained.

Research Methodology

The methodology employed in this article is based on a "Short Review" approach specifically designed to provide a first approach and a general introductory overview in the field of autonomous vehicles. The main objective is to offer an introductory and accessible approach for the academic, business, and scientific community entering this field. This methodology is optimally suited to effectively present key concepts, recent developments, and inherent challenges in autonomous vehicle technology. This approach is characterized by its simplicity and clarity, allowing readers to quickly and comprehensibly delve into a constantly evolving field of study.

The search equation was performed by Scopus database between January 3rd 2022 and January 16th 2022. First, articles selected with the greatest impact found in quartiles Q1 and Q2, then the search for magazine reviews and journal articles published in the last 10 years that included the following key words. In Fig 1, the process for selecting the articles that make up the study is described.

Search equation

(TITLE-ABS-KEY ("artificial intelligence") AND TITLE-ABS- KEY "autonomous cars")) AND (LIMIT- TO (PUBYEAR , 2022) OR LIMIT- TO (PUBYEAR , 2021) OR LIMIT- TO (PUBYEAR , 2020) OR LIMIT- TO (PUBYEAR , 2019) OR LIMIT- TO (PUBYEAR , 2018) OR LIMIT- TO (PUBYEAR , 2017) OR LIMIT- TO (PUBYEAR , 2016) OR LIMIT- TO (PUBYEAR , 2015) OR LIMIT- TO (PUBYEAR , 2014)) AND (LIMIT- TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re"))

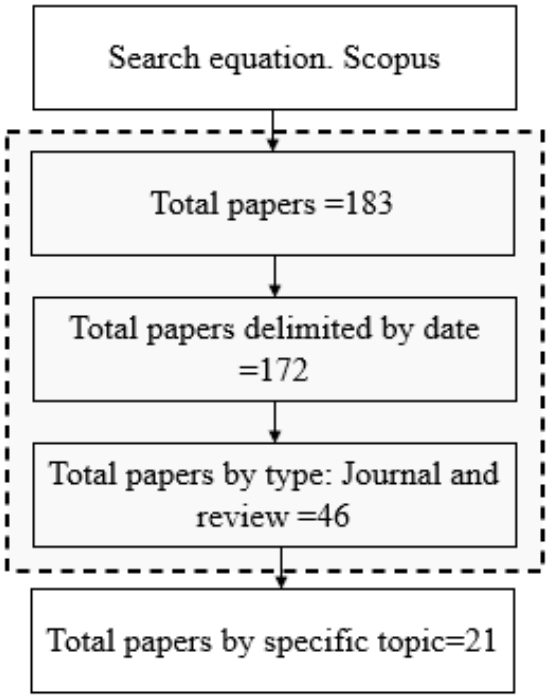

Fig. 1. Search Process

[1]Bryan Narváez, [1]Michael Irua, [1]Zhara Monteros, [1]Ana Umaquinga, [1]Jaime Michilena, [2]Galo Hurtado
[1]{bonarvaezt, mairuar, zjmonterosb, acumaquinga, jrmichilena}@utn.edu.ec, [2]gphurtado@sudamericano.edu.ec

Results and Discussion

Ethical-legal conflicts in the event of autonomous car claims

Artificial intelligence advancements are progressing rapidly and are being applied in various aspects of our daily lives, but they are also having societal implications. One significant concern that needs to be addressed is the issue of road accidents caused by autonomous vehicles. These incidents have prompted experts in the field to evaluate the accountability of AI, leading to discussions on whether AI should be recognized as a legal entity [6].

In most cases, it would be ideal that, in any situation there was a direct and total link between autonomous vehicles and artificial intelligence so AI may be considered a legal entity thus it could face independent liability in any claim raised.

The research of [7], describes that the current circulation of autonomous vehicles is minimal, even in very advanced cities, despite the lack of awareness of citizens regarding their presence on the streets. The author insists on the importance of acting with caution in the face of any unforeseen event or eventuality. From the legislative point of view, the author raises a crucial question that requires a thorough analysis: "Who would be liable in the event of a car accident?

On the other hand, the author [8] mentions that if an artificial intelligence -driven vehicle encounters an inevitable eventuality, software must be responsible for making the most accurate decision so as to mitigate the damage as dimly as possible considering that human beings exercise ample discretion and evidently the possibility that they come to a total agreement is dim in other words, regardless of the decision made by the software program, the "machine" would always be at fault.

Manufacturer companies of such vehicles have made a proposal stating that future autonomous vehicle owners sign a waiver in which they explain that, as direct manufacturers and vehicle assemblers of both material and IT systems, they will not be liable for the vehicle's complex software decision-making process upon the occurrence of any adversity.

A further point is that autonomous cars may cause far more serious damage despite not being driven by a driver. Although it is believed that with the aid of artificial intelligence mishaps could be prevented, but the truth is they are not free of liability regarding any malfunction, the author commented [9].

"What would happen to the pleasure of driving a conventional vehicle?", the author raised the question [10]. Conventional vehicles that really need to have a driver will always be around, despite the latest competent advancements in technology nowadays, since autonomous vehicles are not liked or accepted by just everyone. As some would prefer a semi-autonomous vehicle in which they feel satisfied experiencing manual driving. It is important to mention the rapid modernization in automated processes, the emergence of assisted vehicles with remarkable features, which offer greater safety, lower environmental impact, and greater reliability in long-distance travel. However, it is important to recognize that the presence of human drivers is still necessary despite these previously listed advances.

According to the author [11] who states that self-driving cars will have become true reality between five and ten years so one of the crucial objectives of this technology is to avoid individual's interference in self-driving operations of such vehicles since, thanks to the

innovative software they possess, there is a certain decision-making freedom that the surrounding environment provides. Although some vehicles are already circulating in the streets running operation tests in everyday life, it is true that they have avoided accidents because of specific technical failures, are not exempt of fatal accidents.

The author [12] tells us that certain traffic regulations do not include in the slightest way the mention of technology, since it is a proven fact that in most countries, regulation states that vehicles must be exclusively driven by a person who has and keeps in control of the vehicle in case of any possible occurrence.

Evidently, there has not been an adaptation by laws and regulations around the world, however, it would be beneficial that in a few years the update of suitable traffic regulations is considered.

Consequently, with respect to artificial intelligence in situations where more than one vehicle is included or a simple "accident" happens, it won't always be avoidable, either by a person or by the car's automation system so the accident can simply just happen, although it is worth noting that the author emphasizes [13] that "even then, autonomous cars are and will be superior to those driven by the common individual".

After having said that, there are far more questions such as at what moment is a self-driving vehicle able to differentiate between which life is more important to save either the passenger's or outsiders? The author [14] explains that the automobile is able to sacrifice itself for anyone. However, taking into account the contrasting affectations that may occur, there is no way of knowing what may happen to the people it decided to save at first, therefore a safe conclusion to state is that regardless the decision the car makes, it must be based on prioritizing passengers lives.

Hardware Systems— Perfectioning Safety

In view of recent surveys which refer to a high percentage of road accidents and an increase in irresponsibility when driving vehicles by their owners, he mentions that [1]: "Highway accidents happen so frequently that are now considered part of our daily life. However, the fact that the number of fatal accidents around the world should not be overlooked".

For this purpose, a mechanism able to prevent such mishaps should be developed. Modern automobiles are equipped with Camera Monitoring Systems (CMS) such as a back-up camera or a side view mirror replacement. "It is expected that these systems work in the most optimum way to achieve greater safety levels" –Automotive Safety Integral Level (ASIL)"[3], At present, with a safety purpose in mind, automation mechanisms should be implemented as an effective solution for the issue in question, as mentioned in [1] "Safety systems are unsafe until features are thoroughly tested and proven to be in line with reference quality standards such as ISO 26262."

In [15] describe in the future, cars are expected to be driven by an autopilot and auxiliary sensors to control the car based on directional changes, signaling and emergency situations, resulting in more reliable autonomous vehicles. However, the effectiveness of these sensors in detecting nearby objects to avoid collisions is still unclear. Therefore, real-time object detection is crucial to improve the safety and efficiency of autonomous cars.

However, not everything is so straightforward, as [9] highlights the evolution of proximity

algorithms that increase driver comfort and improve safety, as well as SAE level 2 automation to enable lateral control, also poses challenges. Object detection in frame-by-frame video transmission can be particularly challenging, as even a millisecond delay could result in a collision.

The use of Open CV determining the form analysis to find the size of the object of interest and object-detection. At the same time, nothing has worked one hundred percent since, recently promising vehicles displayed a number of errors; [9] High-profile accidents such as the Tesla -S Model fatality, it is clear that more work is required to improve user safety and acceptance.

Autonomous vehicles have great capacity and adequation for improved operationality as well as location tools, being the latter the most crucial for real-time location as stated by [15]" Real-time video-object-detection plays a decisive role in autonomous vehicles and other applications that help improve the vehicle's efficiency" since without GPS assistance, there would be not concept of time-space in line with real-time location. Therefore, renown brand names like Tesla Motors showed an interest for and applied a PCM to the Tesla collision to demonstrate how reliable automatic-pilot scope became a contributing factor" [9] All it takes is the adaptation and GPS improvement along with auto-pilot automation so that auto-pilot does not identify the algorithm as a glitch when driving takes place

As years go by, the future moves forward due to the advent of new automotive industries and the joining of mechanics with automation. Autonomous cars have been created along with a variety of benefits and ultimate safety systems as driving takes place, implementing algorithms systems as in the case of [15];" As a consequence, uses object-detection algorithms to perform operations like highway lane, pedestrian, traffic sign-detection and decision-making processes. "Object-detection technology may also be used in surveillance video and image-processing" Therefore, we may have an enhanced driving experience with autonomous vehicles, road trips will become faster and safer not to mention that these models make reference to sensor adaptation in each vehicle model, focusing on every carefully programed detail so that all sensor types work harmoniously taking control of the vehicle according to steering, brake, management and emergency systems [15].

Software systems advances focused on robot automation.

The first method described deals with robotic systems able to analyze and make decisions with an immediate response system. For the development of such system a feature that must be considered is "reasonable behavior" found in intelligent robots. Therefore, in order to achieve such behavior, the use of an approach called "hybrid paradigm" was recommended [15].

Until now, there are 3 classic paradigms known—hierarchical, reactive and hybrid. Their pre-determined functions sense or receive information, then with the same acquired information do the planning process and finally determine how to act or perform these actions [16].

Hierarchical paradigm approach was one of the first ones developed performing commands from "higher to lower" or "up-down" information structure as decision-making processes take place. First, the robotic system senses information, then planning begins, finally the robot takes action. This approach develops high-level decisions, notwithstanding it had some issues since the decision-making process took long to get answers by the robotic system thus the reactive paradigm surfaced. This approach performs actions based

on sensory signals excluding the planning phase, that is to say a "perception-action" is performed apt for low-level decision-making. However, this paradigm is unsuitable for the making of global decisions.

Hence, to achieve an immediate response in decision-making, a combination of low-level reactive methods and algorithms was applied creating a new approach called hybrid-paradigm which combines performance of the first two approaches. To clarify, in the first step the planning phase is performed then, actions are carried out in line with the reactive paradigm.

That is the reason why hybrid system is the most appropriate to manage control systems, but there is an issue. The search for logic to not only find reliable responses, but also to realize certain solutions.

The author [17] defines the following steps to detect software malfunction:

1. Define the scope of the analysis by identifying interactions, unexpected actions, and software failures.

2. Decompose the software and create a functional model based on inputs, outputs, and associated conditions.

3. Identify and evaluate functional failure modes, categorizing them into different types.

4. Analyze the interaction of functional failure modes with external software interfaces.

5. Incorporate the detected failures into a comprehensive analysis to determine risk levels.

6. Provide suggestions for improving the software to optimize its performance.

Line-following robots can be used in some industrial logistics applications such as heavy material transport and the agricultural sector. Due to environmental instability, several techniques for the operation of line-following robots have been developed using intelligent control mechanisms. In such practice, the author [18] implement Convolutional neuronal networks (CNN) on autonomous vehicles, as well as a Proportional Integral Derivative algorithm (PID) used by most applications requiring movement.

In order to implement these techniques, the following parts are required: Raspberry Pi camera module is a compact and lightweight camera that organizes image processing in "jpg" format. HC-SR04 ultrasonic sensor that uses a sonar to determine the distance from itself to a high -precision non-contact range-detection object. Raspberry Pi is a low-cost single board computer the size of a credit card and a four-64 bit-Core processor a1,2 GHz, 1 GB RAM, Wi-fi and Bluetooth 4.1. Engine controller L298N used to drive the pair of CC engines.

Once assembled, tests run was performed. The author [18] designed a CNN controller based on PID, meaning a neuronal network controller that analyzes 2D data like PID based images and video, regulating speed according to motor measurements.

A line was drawn on the floor and according to robot movements captured images a ±4 error margin was delivered. Explanation: A zero error-value means the robot is accurately

positioned in the center of the image while a positive error value means the robot deviated to the left. Negative error-value means the robot deviated to the right. An advantage of this particular design is that once the error margin has been extracted, PID controller is modified so the right or left motor speed is regulated thus error margin equals zero.

There are many algorithm systems designed with the purpose of perfecting software so that robot-automation can be a reality in the future. A few processes for algorithm development have been explained aiming to select which process would be most adequate to implement on autonomous vehicles. According to the author's opinion, software failure-detection process seems like a feasible solution to make strides in self-driving vehicles since the author [17], mentions that the failure-detection emanates from both software and hardware in other words, algorithm failure is examined along with its spreading to the entire system, therefore by correcting those failures the first time, the spreading will not happen a second time.

We could even implement the Rapid Response Algorithm method developed by the author [19], to prevent road accidents helping the autonomous vehicle make decisions in a short time obtaining almost an immediate response. The Mobil Robot method is particularly focused on other types of machines, for this reason it is not feasible for autonomous cars driven on highways.

Below is the trend of interest in the main items addressed in this study, see Fig 2, which identifies the interest in this area of research.

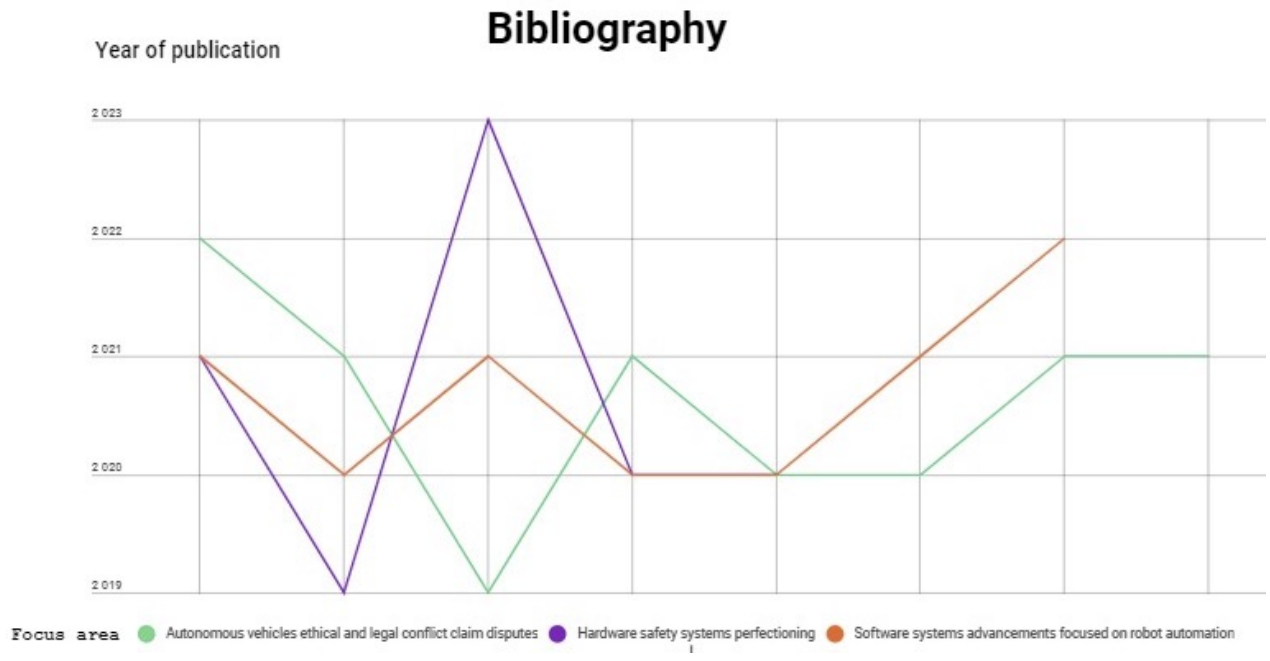

Fig 2. Trend analysis of interest in the study's themes

Finally, a summary is presented by author in the 3 topics addressed in the research in order to provide a summary of the previously presented detailed in Table 1.

Table 1. Journal articles by area of interest.

Focus areas	Bibliography
Autonomous vehicles ethical and legal conflict claim disputes	[10] [7] [11] [12] [9] [8] [6] [14] [13]
Hardware safety systems perfectioning	3] [15] [5] [9]
Software systems advancements focused on robot automation	18][16][15][20][17][19][21]

Conclusions

In conclusion, it is evident that society is not adequately prepared to deal with incidents related to vehicle automation. Consequently, each country should carefully consider establishing new laws and regulations governing autonomous vehicle traffic to ensure the safety of all humans and the environment. In addition, manufacturers and automotive companies involved in autonomous driving technology have taken precautions to distance themselves from potential drawbacks that may arise with the introduction of autonomous AI cars on the roads. However, determining the most appropriate regulations may require a significant amount of time and deliberation.

It is undeniable that Artificial Intelligence has begun to take control of activities in any area of life, transforming the world into a place with new realities and in certain areas more comfortable to live in. This influence of AI is especially noticeable in the field of vehicles, where innovation is constantly evolving.

Today, most vehicles seek to be environmentally friendly, versatile and, with the right advances, it is highly likely that autopilots will be installed by default, offering new challenges in the areas of technology and ethics, as well as a new driving experience and greater comfort for passengers. In this context, safety sensors emerge as the fundamental accessory to prevent accidents and ensure safety on the roads.

Advances in autonomous driving and electric vehicles represent significant steps towards a more sustainable and efficient future in terms of mobility. As progress continues in this direction, the safety of drivers and passengers will remain a crucial priority, and accident detection systems will play an essential role in preventing collisions and protecting human lives. The synergy between technological innovation and road safety represents an important milestone in the automotive industry's evolution toward a smarter and safer future.

The objective of this research work was to reveal software advancements with respect to different algorithms focused on robot-automation. With results delivered, the author focused on autonomous vehicles algorithms that would help improve software systems. In brief, algorithms supporting the improvement of software systems in autonomous vehicles totally programed to detect failures so that an immediate, accurate decision-making processes takes place.

References

1. Rajabli N, Flammini F, Nardone R, Vittorini V (2020) Software Verification and Validation of Safe Autonomous Cars: A Systematic Literature Review. IEEE Access. doi: 10.1109/ACCESS.2020.3048047

2. Ziemianin K (2021) Civil legal personality of artificial intelligence. Future or utopia? Internet Policy Rev 10:1–22. doi: 10.14763/2021.2.1544

3. Blankenbach K, Vogelmann M, Schmitz N (2021) Advanced optical methods for safe image reproduction on automotive displays. J Soc Inf Disp. doi: 10.1002/JSID.1079

4. Ostheimer J, Chowdhury S, Iqbal S (2021) An alliance of humans and machines for machine learning: Hybrid intelligent systems and their design principles. Technol Soc 66. doi: 10.1016/J.TECHSOC.2021.101647

5. Balistreri M (2019) Macchine senza guidatore: Considerazioni morali. Mondo Digit 18

6. Vicari RM (2021) Influências das Tecnologias da Inteligência Artificial no ensino. Estud Avancados 35:73–84. doi: 10.1590/S0103-4014.2021.35101.006

7. Cugurullo F, Acheampong RA, Gueriau M, Dusparic I (2021) The transition to autonomous cars, the redesign of cities and the future of urban sustainability. Urban Geogr 42:833–859. doi: 10.1080/02723638.2020.1746096

8. Utesch F, Brandies A, Pekezou Fouopi P, Schießl C (2020) Towards behaviour based testing to understand the black box of autonomous cars. Eur Transp Res Rev 12. doi: 10.1186/S12544-020-00438-2

9. Revell KMA, Richardson J, Langdon P, Bradley M, Politis I, Thompson S, Skrypchuck L, O'Donoghue J, Mouzakitis A, Stanton NA (2020) Breaking the cycle of frustration: Applying Neisser's Perceptual Cycle Model to drivers of semi-autonomous vehicles. Appl Ergon 85. doi: 10.1016/J.APERGO.2019.103037

10. Cascetta E, Cartenì A, Di Francesco L (2022) Do autonomous vehicles drive like humans? A Turing approach and an application to SAE automation Level 2 cars. Transp Res Part C Emerg Technol 134:103499. doi: 10.1016/J.TRC.2021.103499

11. Khan DA, Naaz S, Siddiqui F (2019) Design and realization of autonomous cars using deep Q learning. J Adv Res Dyn Control Syst 11:1808–1813. doi: 10.5013/ijssst.a.20.01.26

12. Ouarnoughi H, Grislin-Le Strugeon E, Niar S (2021) Simulating multi-agent- based computation offloading for autonomous cars. Cluster Comput. doi: 10.1007/s10586-021-03440-y

13. Ziemianin K (2021) Civil legal personality of artificial intelligence. Future or utopia? Internet Policy Rev 10:1–22. doi: 10.14763/2021.2.1544

14. Yun JHJ, Won DK, Jeong ES, Park KB, Yang JH, Park JY (2016) The relationship between technology, business model, and market in autonomous car and intelligent robot industries. Technol Forecast Soc Change 103:142– 155. doi: 10.1016/j.techfore.2015.11.016

15. Chelliah BJ, Chauhan V, Mishra S, Sharma V (2019) Advancement of driverless cars and heavy vehicles using artificial intelligence (Object detection). Int J Eng Adv Technol 9:6183–6186. doi: 10.35940/ijeat.A1676.109119

16. Gervasi R, Mastrogiacomo L, Franceschini F (2020) A conceptual framework to evaluate human-robot collaboration. Int J Adv Manuf Technol 108:841–865. doi: 10.1007/S00170-020-05363-1/FIGURES/11

17. Thieme CA, Mosleh A, Utne IB, Hegde J (2020) Incorporating software failure in risk analysis—Part 2: Risk modeling process and case study. Reliab Eng Syst Saf 198. doi: 10.1016/J.RESS.2020.106804

18. Farkh R, Quasim MT, Jaloud K Al, Alhuwaimel S, Siddiqui ST (2021) Computer Vision-Control-Based CNN-PID for Mobile Robot. Comput Mater Contin 68:1065–1079. doi: 10.32604/CMC.2021.016600

19. Varlamov O (2021) "Brains" for Robots: Application of the Mivar Expert Systems for Implementation of Autonomous Intelligent Robots. Big Data Res 25. doi: 10.1016/J.BDR.2021.100241

20. Schonhut-Stasik J, Huber D, Baranec C, Law NM, Morton T, - al, Riddle RL, Tokovinin A, Varlamov OO, Aladin D V, Adamova LE, Chuvikov DA, Saraev D V (2020) Creation of autonomous groups of combine harvesters and tractors for agriculture based on the Mivar decision-making systems "ROBO!RAZUM." IOP Conf Ser Mater Sci Eng 819:012002. doi: 10.1088/1757-899X/819/1/012002

21. The Future Of The Transport Industry - IoT, Big Data, AI And Autonomous Vehicles

UTN
IBARRA - ECUADOR

FICA