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ARTIFICIAL INTELLIGENCE AND AUTONOMOUS VEHICLES: CONTEMPORARY ISSUES AND CHALLENGES

AUTHORED BY - ASHISH KUMAR VERMA

Abstract:

There have been rapid advancements in the field of Artificial Intelligences. From humanoid robots like Sophia to concept vehicles everything has became reality which once existed only in myths and fantasies. Apart from playing assistive roles in our life now technology is ready to take on driver's seat. Technology and artificial intelligence has become inseparable part of our life. Road accidents are one of the major causes of death across the world. Apart from this vehicular pollution, lack of parking facilities in megacities etc are some of the concerns whose solutions Autonomous vehicles brings with them. The present paper seeks viability of these vehicles from legal point of view. Efforts are also made to point out various areas which will help in efficient rolling of these vehicles.

Keywords : Artificial Intelligence , Autonomous Vehicles , Self Driven Vehicles .

I. INTRODUCTION

Development from fire to the wheel can be taken as the best example of the phrase 'Necessity is the mother of invention'. Man has invented and discovered many objects and phenomena to make his life easier and more comfortable. Before the development of transportation, humans traveled on foot and then they started using pet animals for conveyance. The first industrial revolution was the catalyst for the development of modern transportation systems.[1]Bicycles, trains, automobiles, trucks, airplanes, and trams were among the many new forms of transportation invented in the 17th and 18th centuries. There has been rapid advancement in the field of Artificial Intelligence in recent times,

[1] "How did Transportation Change during the Industrial Revolution?"*UKEssays* (November 2018) *available at* https://www.ukessays.com/essays/history/how-did-transportation-change-during-the-industrial-revolution.php?vref=1 (last visited on (Last visited on May 15 2022).).

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and field of Transportation is also one of the sectors which is heavily influence by its growth. Development of Autonomous Vehicles have attracted every ones attention towards them.

The fourth industrial revolution can revolutionize not only our perceptions of what is possible but also how society works. In some ways, it will represent the culmination of both the second and third industrial revolutions, which gave us mechanized transportation and the internet in its current form. Keeping this in mind, transportation is the industry that has the most potential for breakthroughs and transformations. A strong legal framework is required for any technology to reach its full potential because it serves the dual functions of setting the boundaries for future research as well as directing research in such a way that it acts as a force multiplier without suffocating future research. Mobility, like medicine, has the shortcoming that if the underlying technology is not well thought out; it can result in multifaceted loss of resources both material as well as human. While if we closely monitor the transport industry, we may conclude that on one hand, it has made our lives very easy but it is imperative to remember that road accident is one of the leading causes of deaths and loss of limbs and livelihoods in the world. And this problem can be addressed by the use of technology in the right manner.

The majority of large cities around the world confront transportation, traffic, and logistics difficulties. This is due to the rapidly increasing human population as well as the expanding number of automobiles on the road.[2]The technology could be extremely helpful in designing and managing a sustainable transportation system. Artificially intelligent systems can detect patterns in large datasets and simulate complex methods to enhance decision-making efficiency and resource allocation.[3]The deployment and adoption of highly autonomous vehicles and improved traffic management systems will be the most significant changes in the industry.

II. Artificial Intelligence: Meaning and Definition

Artificial can be said to be something that is non-natural i.e., something created by humans and not by nature. Intelligence simply refers to the ability to understand think and learn. Simply it can be

[2]Lakshmi Shankar Iyer, "AI enabled applications towards intelligent transportation"*Transportation Engineering* 2 (September 2021) *available at*https://doi.org/10.1016/j.treng.2021.100083 (last visited on (Last visited on May 17 2022).).
[3]Takeyoshi Imai, "Concepts of Automobiles, Autonomous Driving, Driving, and Drivers" 5 *Kenshu* 822 (2016).

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said artificial intelligence is the study of how to make computers do the things which humans can do the better. Artificial Intelligence (AI) is a branch of Computer Science, which mainly deals with the automation of intelligent behavior. This behavior we may take from all spheres be off —the human, animal world, and vegetation. This concept was considered for the first time by famous English Mathematician Alan Turing in his seminar paper "Computing Machinery and Intelligence"[4], authored in 1950. Artificial intelligence is also defined as the ability of a machine to perform the cognitive functions of a human at ease. The phrase Artificial intelligence was initially coined by John McCarthy, a computer scientist at Dartmouth Conference in 1956 and thus he is also considered the Father of Artificial intelligence.[5] Due to the availability of massive volumes of data created by numerous devices, as well as efficient hardware, software, and network infrastructure, this six-decade-old notion has recently acquired traction. The introduction of Artificial intelligence has enabled process automation, resulting in innovative business solutions.

Defining Intelligence

Defining intelligence is a very difficult task. As everyone has his or her own parameters to define it based on his or her own experiences and views. According to the *encyclopedia of artificial intelligence*[6] *'Intelligence is the ability to reason and to profit by experience. An individual's level of intelligence is determined by a complex interaction between their heredity and environment.'*
If we go by the dictionary meaning intelligence refers to *'the exercise of understanding: intellectual power: acquired knowledge: quickness of intellect.'*[7]

We need to consider intelligence in a much broader sense, particularly if we are to investigate intelligence in machines

Types of Artificial Intelligence

Artificial Intelligence can be distinguished into two types based on the functions and abilities it

[4] A.M. Turing, "Computing Machinery and Intelligence" 236, *Mind A Quaterly Review of Psychology and Philosophy* 433 (October 1950).
[5]Yanyan Dong, JieHou, *at. al.*,"Research on How Human Intelligence, Consciousness, and Cognitive Computing Affect the Development of Artificial Intelligence" 1680845*HindawiComplexity*10 (2020) *available at* https://doi.org/10.1155/2020/1680845(last visited on(Last visited on May 17 2022).)
[6] Juan Ramón RabuñalDopico, Encyclopedia of Artificial Intelligence, 2008
[7] Colin McIntosh,Cambridge Advanced Learner's Dictionary,2013

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provides. The first is weak Artificial Intelligence, also referred to as narrow Artificial Intelligence, which is designed to perform a specific task, such as facial recognition, Internet Siri search or self-driving car. Many current systems that claim to use "Artificial Intelligence" is most likely weak Artificial Intelligence that focuses on a narrowly defined specific function. Many researcher's long-term goal is to develop strong Artificial Intelligence, or Artificial General Intelligence (AGI), which is the speculative intelligence of a machine that can understand or learn any intellectual task that a human can, thus assisting humans in solving the problem at hand. While narrow Artificial Intelligence may outperform humans in tasks such as chess or problem solving, its impact is still limited. Artificial General Intelligence, on the other hand, has the potential to outperform humans in nearly every cognitive task. Strong AI is a different view of Artificial Intelligence in which it can be programmed to act like a human mind, to be intelligent in whatever task it is given, and even to have perception, beliefs, and other cognitive abilities normally only attributed to humans.

III. Artificial Intelligence in present times

"[AI] is going to change the world more than anything in the history of mankind. More than electricity."—[8]**Dr. Kai-Fu Lee**

From myths and fables to realistic Humanoid robots like SOPHIA by Hanson Robotics who can express feelings and communicate like a human, the journey of the development of Artificial intelligence has been remarkable. We have to keep doing innovations in artificial intelligence. The day is not far when humans will have artificially intelligent companions beyond toys like AIBO or Furby. Someday, Artificial Intelligence and humankind might coexist in a fashion where it will be very difficult to differentiate between humans and humanoids. Artificial Intelligence is profoundly changing society in ways we could never have predicted. From unlocking our smart phones to our day-to-day activities, online shopping, intelligent car dashboards, autonomous robots, and so on, technology is holding fast to us in every aspect of our lives. Though the concept of Artificial Intelligence was first discussed in the early 1950s, laying the groundwork for many computer learning and complex decision-making processes, it is only now that this field of technology is gaining traction. It is indisputable that the technology sector has seen a wide range of changes over

[8]The Future of AI: How Artificial Intelligence Will Change the World available at: https://builtin.com/artificial-intelligence/artificial-intelligence-future/ (last visited on June 2 2022)

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the years.

IV. Autonomous Vehicles

Autonomous vehicles which are sometimes also referred driverless vehicles are vehicles that use a variety of sensors, cameras, radar, and robotics technologies to travel between destinations without human interference. Various companies across the world like BMW, Ford, Apple, Google, Waymo, etc. are trying to develop Autonomous vehicles for more safe and efficient driving experiences. According to Gartner Glossary [9] *"An autonomous vehicle is one that can drive itself from a starting point to a predetermined destination in "autopilot" mode using various in-vehicle technologies and sensors, including adaptive cruise control, active steering (steer by wire), anti-lock braking systems (brake by wire), GPS navigation technology, lasers, and radar."*

A glance at the communications of many car manufacturers, suppliers, and technology companies shows that they usually refer to 'automated driving', and only rarely to 'autonomous driving'. The former term is the umbrella term that includes several phases of automation beginning with driver assistance systems. The latter describes the final stage of automation, the situation in which a system takes over all steering, accelerating, and braking maneuvers. In this phase, a person is out of the loop and the car is able to act totally alone at all times and in all traffic situations. Vehicles that have reached this stage can be described as autonomous, driverless, or self-driving. In short, the term automation is used to express the self-acting aspect of a machine. Autonomy goes beyond that and means the self-governing ability of an entire system. John McCarthy who is also one of the founding fathers of artificial intelligence - described something very similar to the modern-day autonomous vehicle in his essay 'Computer-Controlled Cars'. He referred to an automatic chauffeur as being capable of navigating on public roads through *television camera inputs that use the same visual input available to the human driver.* [10]He stated that users will be able to enter a destination using a keyboard, which would then prompt the car to immediately drive them to the desired location.

[9] https://www.gartner.com/en/information-technology/glossary/autonomous-vehicles
[10]The history of self-driving car *available at* https://www.digitaltrends.com/cars/history-of-self-driving-cars-milestones/#dt-heading-the-driverless-dream-begins (last visited on June 12, 2022).

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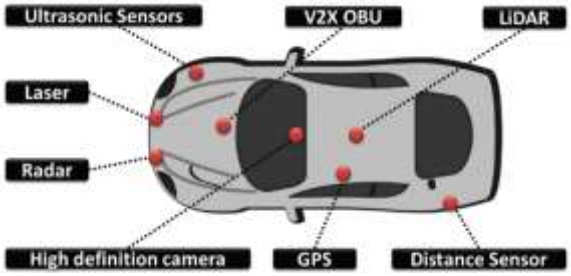
V. Various components used in Autonomous Vehicles



"Source: Andreas Herrman, Walter Brenner ,et.al., *Autonomous Driving: How the Driverless Revolution Will Change the World."*

Cameras

Cameras are like the eyes of Autonomous Vehicles. Camera Systems makes use of CMOS image sensors with a high-definition ability of 1 to 2 megapixels. Mono and stereo cameras in combination with radar systems provide a very precise evaluation of speed and distance as well as the outlines of obstacles and moving objects. Cameras provide visuals to the Electronic Processing Unit in a similar fashion our eyes provide them to the brain for Autonomous Vehicles to function efficiently good image processing unit is very important**.** Today's automobiles rear and 360° video systems usually have a centralized processing system which means that a central control unit processes the raw data of four to six cameras. Since the processing is done in software, the processor also faces tough requirements.

Radars

Radar sensors are used for both short-range 11(24 GHz) and long-range (77 GHz). They are located in the front and back of the vehicle and are used basically to monitor the traffic. Objects measuring from a few centimeters to measuring to Kilometers can be measured. Advanced Driver Assistance System uses several radar sensors which play a crucial role in the functioning of Autonomous Vehicles. In this technology, radio waves are used to detect and locate objects.

[11] David Coffin, Sarah Oliver, Building Vehicle Autonomy: Sensors, Semiconductors, Software and U.S. Competitiveness, Office of Industries,2020.

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Lidar:

This is similar to radar technology. Lidar refers to Light Detection and Ranging. In this technology, object detection is done by use of light. As compared to radar it is newer and requires a highly sensitive receiver. Creates an accurate 3D map of a vehicle's surroundings and also Operates well in low light It is used primarily to measure distances of stationary as well as moving objects, system here employs special procedures to provide three-dimensional images of the detected objects.

There are two general trends in the automotive market for the future: infrared LIDAR systems that works with the aid of a Micro-Electro-Mechanical System (MEMS), use a rotating laser, or a solid-state LIDAR.

Positives of Lidar technology

- Very accurate picture of surrounding and can be created in 3 Dimension.
- It also works effectively in low-light scenarios.
- Results obtained are very consistent.
- Results obtained are very quick and laser beams take less than a nanosecond to travel.
- Data can be collected from a variety of locations like mountains, dense forests, etc.
- This is less expensive as compared to other techniques

Visual Technology

Some versions of Tesla's Autopilot and Intel's Mobil eye use the highly reliable visual, camera-based approach to self-driving, as opposed to laser-radar (LIDAR) technology.

- Can work in environments where Lidar can't for example in bad weather conditions
- is much cheaper than LIDAR
- Less obtrusive to vehicle design.

But to make it work, visual technology demands massive computing power, to crunch all the visual data.

Aerial on back of the car for determining vehicles location

An aerial on the back of the car receives information about the exact location of the car, with the help of Geo Positioning Satellites. The vehicles's GPS inertial navigation unit works with the sensors to help the car localize itself. But GPS estimates may be off by several meters due to signal disturbances

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and other interferences from the atmosphere. To minimize the degree of uncertainty, the GPS data is compared with sensor map data previously collected from the same location. As the vehicle moves, the vehicle's internal map is updated with new positional information displayed by the sensors.

Ultrasonic sensors

An ultrasonic sensor placed on one of the rear wheels helps in tracking the movements of the vehicles and also alerts the vehicle about the obstacles in the rear. These ultrasonic sensors are already in use in some technologically advanced vehicles. Vehicles that offer automatic 'Reverse Park Assist' technology utilize such sensors which help them to navigate the vehicle into tight reverse parking areas. Ideally, these sensors get activated when the vehicle is engaged in the reverse gear.

Algorithms to interpret road signs

Different software is programmed to correctly interpret common road behavior and signs. For example, if a cyclist shows any signs that he intends to move the driverless car interprets it correctly and slows down to allow him to move. [12] Predetermined shape and motion descriptors are programmed into the system which helps the car in making decisions. For instance, if the car detects a two-wheel object and determines the speed of the object as ten miles per hour rather than fifty miles per hour, the car instantly interprets that this vehicle is a bicycle and not a motorbike and it runs accordingly. Several such programs are needed in the car's central processing unit which works together to help the car make safe and intelligent decisions on busy roads**.**

SIFT

SIFT (scale-invariant feature transform) algorithms detect objects and interpret images. For example, for a triangular sign, the three points of the sign are entered as features. A car can then easily identify the sign using those points.

[12]Supra note 8

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Adaboost for data classification

This algorithm13 collects data and classifies it to boost the learning process and performance of vehicles. It groups different low-performing classifiers to get a single high-performing classifier for better decision-making.

Text on boost for object detection

These are the algorithms used for data collection and classification so that it can be used effectively in increasing the learning process and performance of the vehicle. It groups different low-performing classifiers to get a single high-performing classifier for better decision-making.

Histogram of oriented gradients (HOG)

These are the algorithms used for the analysis of the movement of objects.

Machine learning methods

Autonomous vehicles make use of various hardware and software's to collect and analyze information collected through various sensors[14]. In order to have better object detection and visualization vehicles need to have greater precision with regard to data processing abilities are concerned. With the increase in automation level technicalities and complexities also increases. [15]To make real-time driving decisions, Autonomous vehicles rely on algorithms developed using a subset of Artificial Intelligence known as machine learning. Machine learning is concerned with developing computer algorithms that can automatically generate simulation solutions for new data without the need for a programmer to provide the solution.

Different types of machine learning algorithms are being used for various purposes in autonomous vehicles. Data processing becomes more efficient by employing suitable machine learning algorithms. Machine learning algorithms help Autonomous Vehicles in collecting and interpreting

[13]WenyangWang ,The improved AdaBoost algorithms for imbalanced data classification,Information Sciences ,Volume 563, 2021

[14] How Machine Learning in Automotive Makes Self-Driving Cars a Reality Available at https://mindy-support.com/news-post/how-machine-learning-in-automotive-makes-self-driving-cars-a- last visited on May 22, 2022)

[15] Supra note 10.

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data that it is collecting from various sensors and cameras placed in various locations in cars. Sometimes machine learning also helps in performing various functions even in a better manner and with greater efficiency than natural persons.

VI. Levels of Automation

The Society of Automotive Engineers (SAE) has defined 6 levels of driving automation ranging from 0 which is fully manual to 5 which is fully autonomous. These levels have been adopted by the U.S. Department of Transportation. [16]Researchers say that by 2025 there will be approximately 8 million autonomous or semi-autonomous vehicles on the road. Before running on roads, these cars will have to pass rigorous testing phase. Different car manufacturers apply different approaches to the development of Autonomous vehicles. Traditional car manufacturers use the traditional evolutionary concept which starts from no automation to furthering upwards but if we see the approach of Tech giants like Tesla , Wayno etc., they have been trying to develop Autonomous vehicles since from start.

VII. International Laws relating to Autonomous Vehicles

The rapid growth of the Autonomous Vehicles (AVs) industry has inspired legislators and regulators around the world to create policy frameworks and regulations to allow for the safe testing and development of the technology. Over the last two decades, the autonomous vehicle industry has progressed a lot and has moved from science fiction to a very plausible reality in present times. The credit for developing this industry at a very rapid phase certainly goes to significant advances in the field of science and technology, especially in the field of Artificial Intelligence. In order to make the journey of Autonomous vehicles smoother digital and legal infrastructure around the world need to be strengthened and major countries around the world have taken initiatives in this direction.

[16]JörgenFrohm, Johan Stahr" Levels of Automation in Manufacturing", international journal of ergonomics and human factors ,vol 30 .2008

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Geneva and Vienna convention

The Geneva Convention[17] and Vienna Convention[18] are international agreements that list the basic rules for road traffic, drivers, and vehicles. The Geneva Convention states that driver is any person who guides the vehicles that may automobile or driver by any animal. He should be able to change its direction and should be able to control them in physical manner. Similarly Vienna Convention also states that every moving vehicle or combination of vehicles shall have a driver[19] and that every driver shall possess the necessary physical and mental ability and be in a fit physical and mental condition to drive[20]. These laws have been central to the discussion on allowing Autonomous vehicles on public roads due to their definitions of 'driver.' The Vienna Convention, however, also states that: "*Vehicle systems that influence the way vehicles are driven and are not in conformity with the aforementioned conditions of construction, fitting and utilization, shall be deemed to be in conformity … when such systems can be overridden or switched off by the driver"*[21] This paragraph opens up the meaning of 'driver' to an interpretation that may allow a high level of automated driving as long as a driver can override or switch off the automated system. The Geneva and Vienna Conventions place a high value on the concept of the driver. The concept of a driver serves as a starting point for establishing rules to ensure safe road traffic interaction depending on the situation.

United Nations regulations of Automated Lane Keeping Systems(ALKS)

The Regulation's objective is to provide consistent requirements for vehicle certification in relation to Automated Lane Keeping Systems. Without additional driver input, ALKS regulates the vehicle's lateral and longitudinal movement over lengthy periods of time. ALKS is a vehicle control system in which the activated system is in primary control. The resolution defines[22]Automated Lane-Keeping System (ALKS) for low-speed application is a system that is activated by the driver and which keeps the vehicle within its lane for a traveling speed of 60 km/h or less by controlling the lateral and longitudinal movements of the vehicle for extended periods without the need for further driver input. Within this Regulation, ALKS is also referred to as *'the system'*.

[17] The Geneva Convention on road traffic of 1994.
[18] the Vienna Convention on road traffic 1968.
[19] Supra note 5 , Article 8(1)
[20]id,. Art. 8(3)
[21]id ,. Art. 8(5)
[22] United Nations Economic and Social Council, Uniform provisions concerning the approval of vehicles with regard to Automated Lane Keeping Systems, article 2.1

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General standards for system safety and failsafe reaction are also included in this regulation. When the ALKS is turned on, it will take over some functions from the driver, i.e., it will handle all scenarios, even failures, and it will not jeopardize the safety of the vehicle's occupants or other road users. However, the driver always has the option to overrule the system at any time. ALKS can be activated in specific circumstances on roadways that restrict pedestrians and bicycles and are designed with a physical barrier that separates traffic traveling in opposing directions and prevents vehicles from crossing across the vehicle's path. This Regulation sets a maximum operational speed of sixty km/h for passenger automobiles.

The European Union

With present technology, the European Union has a comprehensive set of rules that regulate traffic. However, in European Union law, there is no legal definition of 'driver' or 'driving.' Nonetheless, the term "drivers" is mentioned in the Third Driving License Directive.[23] Despite significant efforts in this area, in European Union also there appears lack a regulatory framework for automated driving. The European Commission's study *On the Road to Automated Mobility: an EU Strategy for Future Mobility*[24] is crucial in this regard. The Commission offers a systematic European Union approach to connected and automated mobility, outlining a clear, forward-thinking, and ambitious European agenda. One of the objectives of the agenda is to ensure that the European Union's legal and policy frameworks are ready to support the deployment of safe, connected, and automated mobility.

VIII. Indian Laws relating to Autonomous Vehicles

For Autonomous vehicles to run on roads it is necessary they should be included in the legal framework of the country. Provisions should be included in the regulatory framework providing and surrounding motor vehicles in India. There is currently no special legislation in India to control Autonomous or self-driving vehicles.

[23] European Union, "Directive 2006/126/EC of the European Parliament and the Council of 20 December 2006 on Driving Licenses"*Official Journal of the European Union*, 403–418 (2006).

[24]European Union, "On the road to Automated Mobility: An EU strategy for mobility of the future" 283 (European Commission, Brussels, May 17, 2018) *available at*http://ec. europa.eu/transparency/regdoc/rep/1/2018/EN/COM-2018-283-F1-EN-MAIN-P ART-1.PDF. (last visited on June 18, 2022).

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Motor vehicles act 1988 ("MV ACT")

The Motor Vehicles Act of 1988 lays down the minimum age for driving a vehicle, as well as the liability and registration of the vehicle. Section 2(9) [25] defines the term driver as the person who controls the steering of the vehicle. It also provides that no motor vehicle may be driven without a valid driving license.[26] Similarly section 2(10) defines a Driving license which is issued by competent authority to person above the age of eighteen years. Section 2(28)[27] and section 2(30)[28] defines a motor vehicle and motor vehicle owner. It says that vehicle should be registered in the name of owner but in case of Autonomous vehicles one major issue which surfaces is that who will be considered owner that is manufacturer of the supplier if software which operates and controls the vehicles. The Act makes it the responsibility of the vehicle's owner to ensure that the aforementioned provisions are followed. The question is whether such responsibilities of the vehicle owner would still exist in the age of self-driving cars. Appropriate amendments in the Act to allow for a special type of license for autonomous vehicles or none at all. Also, the present age bar seems to be redundant in the case of the operation of autonomous vehicles as Artificial Intelligence would operate the vehicle.

Consumer protection act, 2019

The Consumer Protection Act, 2019[29] governs damages resulting from negligence, manufacturing defects, design defects, failure to warn, misrepresentation, unfair trade practices, and breach of warranty. In the event that Autonomous vehicle is involved in an accident, the issue of liability may lead to legal complications. Manufacturers will be held to a higher standard of accountability than

[25] The Motor Vehicles Act, 1988(Act No. 59 of 1988), s. 2(9).
[26]Id., s. 3(1). no motor vehicle may be driven without a valid driving license
[27] Id., s. 2(28) "a 'motor vehicle' or 'vehicle' which means any mechanically propelled vehicle adapted for use upon roads whether the power of propulsion is transmitted thereto from an external or internal source and includes a chassis to which a body has not been attached and a trailer but does not include a vehicle running upon fixed rails or a vehicle of a special type adapted for use only in a factory or in any other enclosed premises or a vehicle having less than four wheels fitted with engine capacity of notexceeding1 [twenty-five cubic centimeters]"
[28] Id., s. 2(30). [28] *'owner' means a person in whose name a motor vehicle stands registered, and where such person is a minor, the guardian of such minor, and in relation to a motor vehicle which is the subject of a hire-purchase, agreement, or an agreement of lease or an agreement of hypothecation, the person in possession of the vehicle under that agreement;*

[29]The Consumer Protection Act, 2019 (Act No. 35 of 2019).

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they are currently held to. In addition, the CPA establishes the right to consumer education.[30]The consumer will need to be properly educated on how self-driving vehicles work and how to remain calm and in control in the event of an emergency. Because driverless technology eliminates the possibility of human mistakes, accountability for a flaw in goods or a deficiency in services would fall on either the manufacturer or the technology supplier, depending on the situation. Given that customer concerns regarding liability could be a stumbling block to the acceptability of self-driving cars, a solution must be found.

The Consumer Protection Act, 2019, under section 2(34) defines product liability So, if we regard Artificial Intelligence to be a product, the manufacturer is fully responsible for whatever harm it causes. However, another concern is whether Artificial Intelligence is a service or a product, because it is essentially a large piece of programming code, and programming code loaded in a system is often seen as a service rather than a product. Rather than product responsibility, these situations are typically considered a breach of warranty.[31]Furthermore, it is possible that the owner or driver of a fully autonomous vehicle caused the accident, in which case the manufacturer, software developer, or both will be held liable for any damages caused by the autonomous car. As a result, regulations must be made to assign liability and specify the scope of contributory negligence in order to eliminate ambiguity and assign responsibility to the appropriate party which is an arduous task.

Information technology act, 2000

One of the most important Acts which will play a crucial role in the protection of owners' rights is the information technology act 2000. As Autonomous vehicles require and process a huge amount of data. Protection of these data can be provided under this act, as currently, India doesn't have specific legislation relating to data protection. Privacy and data protection would primarily come under the Information Technology Act, 2000[32]('IT Act') and Information Technology (Reasonable

[30]Id., s. 18. *"(1) The Central Authority shall— (a) protect, promote and enforce the rights of consumers as a class, and prevent violation of consumers rights under this Act; (b) prevent unfair trade practices and ensure that no person engages himself in unfair trade practices; (c) ensure that no false or misleading advertisement is made of any goods or services which contravenes the provisions of this Act or the rules or regulations made thereunder; (d) ensure that no person takes part in the publication of any advertisement which is false or misleading.*

[31] *Hallinan v. Fraternal Order of Police of Chi.* Lodge No. 7, 570 F.3d 811, 820 (7th Cir.2009).

[32]The Information Technology Act, 2000 (Act No. 21 of 2000).

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security practices and procedures and sensitive personal data or information) Rules, 2011 ('IT Rules') which provides for the protection of Sensitive Data and Personal Information ("SDPI"). Section 2(k)[33]defines computer resource. Section 66 of the IT Act classifies hacking as the situation where someone who, with the intent to cause wrongful loss or damage, or knowledge of the same – "*destroys, deletes, or alters any information in a computer resource, or diminishes its value, or affects it injuriously*."[34]The scope of such regulations will be needed to be expanded to account for circumstances in which a hacker can take entire control of a vehicle by hacking into a computer or a central processor that controls autonomous cars and traffic coordination. In addition, laws will need to include measures for the security and appropriate use of passenger data, as well as the growing threat of hackers, cyber espionage, and conflict.

Geospatial Policy 2021

Since Autonomous Vehicles require to process huge amount of data hence Geospatial policy can play vital role in these vehicles as now data and can freely shared and licensed even to foreign companies.

IX. Challenges relating to Autonomous Vehicles

In present times the automotive industry is going through a paradigm shift. Vehicles were made by humans to make transport of people and goods easier and convenient[35], in over the past years purpose has remained the same but vehicles have become more intelligent comfortable, and secure. All this is possible because of various technological innovations. If we talk about Autonomous Vehicle, they are on the verge of becoming reality from people's imagination. Automated vehicles have become a hot topic in present times. Challenges relating to Autonomous Vehicles can be technological or Non technological challenges like ethical challenges. In case of any accident vehicles driver is generally expected to take control of vehicles but in fully autonomous vehicles only vehicles is there to handle

[33] Id., s2(K) "*computer resource‖ means a computer, computer system, computer network, data, computer database or software."*

[34]) Id., s. 66."*Computer related offences.–If any person, dishonestly or fraudulently, does any act referred to in section 43, he shall be punishable with imprisonment for a term which may extend to three years or with fine which may extend to five lakh rupees or with both."*

[35] Transportation Research Board, National Automated Highway System Research Program: a review, TRB Special Report 253, National Academy Press, Washington DC, 1998.

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such situations which make people a little awary of these vehicles.

Similarly if we see a driver learns a lot from his past experiences which he utilizes while driver which can come handy in case of autonomous vehicles similarly ethical issues like whom to save in case of vehicles like if accident occurs whom the vehicle is expected to save that is to save owner who has invested money or poor frailing pedestrian[36] , all these can be potent challenges for developers which time will witness how they get sorted out.

X. Challenges of Autonomous Vehicles in India

***Won't allow driverless cars in India*[37]**

In India, autonomous vehicles will face a number of problems, including the following:

Infrastructure

Road infrastructure is still evolving and far from equivalent to those seen in the Western world. Because the quality of roads and network service in the country is still inconsistent and autonomous vehicles require high-speed connectivity, which is limited to urban areas.

Economics

In the west, ride-hailing and ride-sharing applications are the key drivers of autonomous car adoption. In some areas, hiring a driver is prohibitively expensive. In India, on the other hand, hiring a driver is still inexpensive. For acceptance in high-growth economies like India, the cost of automobiles incorporating these technologies must be competitive.

Connectivity and network

Autonomous vehicles will only be successful if they are part of a network of autonomous vehicles and an advanced eco-system that works together to drive. Even advanced countries are at least 5 years away from commercializing driverless vehicles in some shape or another, despite numerous

[36] A.H Herrmann , W.B Brenner , R.S. Stadler , Autonomous Driving: How the Driverless Revolution Will Change the World Pageno.. 97, Emerald Publishing Limited, 1st ed. 2018.

[37] "Won't allow driverless cars in India: Gadkari*" The economic times ,* Sep 24, 2019 avialable at <https://economictimes.indiatimes.com/industry/auto/auto-news/wont-allow-driverless-cars-in-india-gadkari/articleshow/71282488.cms?from=md>(last visited on July 7, 2022)

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testing.

Data related problems

Autonomous vehicles run on the concept of connected technology[38]. This implies that a huge amount of data will be processed and produced by these vehicles. It is imperative on the part of the Government to provide a robust data protection mechanism so that user's data can be protected and preserved effectively. In India, the focus on autonomous vehicles will be on supporting the driver in order to make roads safer, rather than on replacing them. It is expected that, autonomous vehicles will be available in India by 2025, at least at Level 3, which corresponds to partial automation. When it comes to driverless vehicles, safety is a huge worry. As the number of electronic components in autonomous vehicles has grown, so has the surface of attack.

XI. Way forward

The World Automobile industry is moving towards automation. Many cars today have assisted driving technology and it won't be long before we see a fleet of cars that don't have anyone in the driver's seat. Almost every company in the world is trying to progress in this direction by assimilating the best available technologies. The ultimate aim is to achieve automation of Level 5[39]. Some of the points which can help in the effective rolling of this technology are as follows –

- Regulatory frameworks around the world today revolve around the notion of the driver. Since Autonomous Vehicles possibly will not have any physical driver in the driver's seat hence it becomes crucial that appropriate legislation should be made or existing ones should be amended. The phase at which technology is changing at the same phase law also need to be changed else they can prove to be major hurdle.
- Since Autonomous Vehicles are heavily dependent on the use of Artificial Intelligence and if Artificial Intelligent entities are taking such important decisions which could have a direct effect t on our lives, then regulation of A.I. becomes more important through appropriate legislation at the

[38] The Four Problems With Economic Data In India available at https://www.bloombergquint.com/opinion/the-four-problems-with-economic-data-in-india (last visited on July 10, 2022).
[39] Philip Koopman & Michael Wagner, "Challenges in Autonomous Vehicle Testing and Validation" Carnegie Mellon University 2016.

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state and global level. At present only European Union proposed and attempted to reregulate it through specially dedicated Act in 2021.

- Since Autonomous vehicles Internet of Things (IoT) effort should be made to provide reliable digital infrastructure as connectivity is one of the major issues even today.
- Apart from connectivity data issue is also an area of concern. As a huge amount of data will be generated by these vehicles protection and sharing of it also raises many issues, hence efforts should be made at the national and international level by means of suitable legislation so that data can be shared without adequate safety and security.
- Efforts should be initiated to incorporate machine-readable signs and symbols.
- Public Perception plays a very important role in the success of any innovation and technology hence adequate steps and programmers should be floored so that people are not hesitant about adopting these vehicles as for year's people are accustomed to seeing the driver in the driver's seat and it can be quite surprising if he disappears all of sudden.
- Different countries have different traffic rules and sign and to code them into a machine learning software is not practically feasible for companies which can prove too costly hence efforts should be made to frame uniform rules.

Conclusion

Life nowadays is heavily dependent on technology which has become a very vital part of our lives as it makes our life easier and more comfortable. The automobile industry is one of the sectors which has felt the impact of growing technologies and Artificial Intelligence in recent time times. The emergence of concept vehicles is one of the fine examples of this. **Hendrith**[40] **Vanlon Smith quote** *"Cars are evolving to match the new paradigm. Soon, things like steering wheels, pedals, and rear-view mirrors will seem ancient. More practically, we will all be better able to optimize our time and attention to focus on more important tasks, family, work, and self-care."* This shows the significant progress made in this direction. Autonomous Vehicles as the name suggests refers to vehicles that can drive themselves without any human intervention. They are also sometimes referred to as driverless, self-driving, or robotic vehicles. The desire for autonomous automobiles is not new,

[40] Andreas Herman Walter Brenner , et al., Autonomous Driving : How the Driverless Revolution Will Change the World, Emerald Publishing Limited , UK,2018 page 230.

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despite the fact that the traditional automobile provides individuals with control and power over a vehicle, as well as the feelings of freedom, mobility, pride, and joy.[41] For decades, Autonomous Vehicles have been discussed in great detail, firstly as science fiction and then followed by many scientific articles. The ability of automated vehicles to handle a varied variety of traffic circumstances is critical for their ongoing development. It seems very coherent that suitable momentum for the development of autonomous vehicles has already been set and the world is gearing in this direction at a very adaptive phase.

[41] J. Rosenzweig, M. Bartl," A Review and Analysis of Literature on Autonomous Driving, in: The Making of Innovation " E-Journal, 157, 2015: