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Autonomous Vehicles: The Revolutionary Drive

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Abstract: This paper presents a review of the utopian world of Autonomous Car Industry. It explores autonomous vehicles, discusses the technology used such as LIDAR, RADAR, cameras, sensors, actuators, GPS etc. and also analyzes the impact of autonomous cars on the economy as well as on the environment, with their benefits and shortcomings and provides a viewpoint, of their current status globally and prospects in INDIA. This paper brings into our knowledge the different consolidations and mergers in between the automobile and tech companies along with their heavy payouts, also confers about the various autonomous features like Adaptive Cruise Control (ACC), Auto Parking, Lane Detection, Forward Collision Avoidance, Vehicle to Vehicle (V2V) Communication and many more that are now become a standard in the high end and luxury vehicles. This paper provides the helpful support to the researchers and the tech companies in taking the future steps towards the adoption of Autonomous Car which can be a driving force for our industry.

Keywords

NHTSA	***National Highway Traffic Safety Administration***
V2V	***Vehicle To Vehicle***
ACC	***Adaptive Cruise Control***
LIDAR	***Light Detection And Ranging***
RADAR	***Radio Detection And Ranging***
GPS	***Global Positioning System***
IMU	***Inertial Measurement Unit***
HMI	***Human Machine Interface***
DOT	***United States Department of Transportation***
IIHS	***Insurance Institute For Highway Safety***
OEM	***Original Equipment Manufacturer***
NTSB	***National Transportation Safety Board***
LDW	***Lane Departure Warning***
IOT	***Internet of Things***
V2I	***Vehicle to Infrastructure***
DSRC	***Dedicated Short Range Communication***

I. INTRODUCTION

Once the realm of the science fiction, Autonomous Car is now on the edge of becoming the reality because of the technological developments. Although the fully developed self-driving car is still a big picture, but the cars with basic autonomous capabilities are presently available in the market. Engineers are putting their entire repertoire to bring this big picture of the autonomous car into viable experience till 2020.

The autonomous car is the car with its own brain. Earlier the competition among the automakers, was regarding the engine performance and fuel efficiency which has now been shifted towards the development of the software, that operates the self-driving car. Cameras and sensors are cars eyes, they see what's around the vehicle, the software is the brain, which will analyze all information inside and around the cars circumference area and makes even control of the steering and wheels.

National highway traffic safety administration (NHTSA) has classified the development of self- driving car in 5 levels.

1) *Level 0:* This is the car with no autonomous features.
2) *Level 1:* These are the cars in which single automotive function is performed, that is specific control is needed (hands on the steering wheels and the pedals are controlled with feet). This includes automated parallel parking, cruise control, and lane guidance. Users are fully involved in controlling functions.
3) *Level 2:* In these cars, two or more automated functions are performed at one time, like lane centering along with adaptive

cruise control or lane keeping with automotive braking. User is needed to be available during driving, and in some cases, they can get themselves disengaged with their hands off the steering and foot off the pedal all at the same time.

4) *Level 3:* In the car of this level the users can relinquish themselves from all safety critical functions but under some conditions. In some, it would be fully autonomous but in other, it won't. Like on the highway or in some enclose campus it can be fully automated and needs no control, but the same function is not followed on the street driving. Major difference between the level2 and the level3 car is that in the level 3 car users will have ample amount of time to take control. But that doesn't mean that they are free from the emancipation of the car.
5) *Level 4:* Level 4 cars are the fully automated cars. There is no need of the users in this car. This is still the fantasy. But many automakers and software giants have promised to convert this nightmare into practical experience approximately till 2020. Many online transportation network companies like UBER are eagerly waiting for this. At level 4, cars will be fully automated, but will not work in certain weather conditions and they have given the level 5 cars the position of the fully automated car which doesn't differ its function in any conditions with Level 0 to Level 3 being the same as of NHTSA. TESLA has developed the car with the autopilot features, which is characterized in the Level 2 car.[12][25]

II. TECHNOLOGICAL DEVELOPMENT AND EQUIPMENTS

A. GPS

In designing an automated self-driving car, navigation and guidance play a vital role. It's the basic block which guides where you are and what the itinerary is to be followed to reach the destination. It solves the problem of how the vehicle is doing versus the goal. If the original route that has to be followed has interrupted and diverted, then the path must be re-computed in quick real time to avoid going to the wrong path. This requires more complex computation with respect to designing a straight path from 1 to 2.

The cardinal subsystem used for this purpose is GPS (global positioning system), which assess the at hand position based on complex analysis of signal received from at least four of the constellation of over 60-low orbit satellites. It provides about 1-meter location accuracy which is a good start.

Though GPS system is the indispensable function of the self-driving car, but it's not sufficient. The GPS system is occluded by the radio interference, canyons, tunnels and many other factors. To overcome these hurdles, GPS is supplemented with the inertial guidance which requires no external signal of any type. The IMU (Inertial Measurement Unit) consists of a platform fixed to a vehicle, and this platform has three gyroscopes and three accelerometers, one pair oriented each of the orthogonal X, Y and Z axis. These provide the data on the linear and rotational motion of the platform, which is then used to calculate the motion and position of the vehicle regardless of speed or any sort of signal obstruction. IMU can't determine the initial location, but only the motion. This present location is determined by GPS only.[21]

B. LIDAR

To analyze and interpret the 360° surroundings in order to avoid collisions is the important feature of the autonomous car. LIDAR stands for light detection and ranging. It provides the accurate 3D information of the surrounding environment and that too in quick succession.

This information helps us to determine the object identification, motion vector determination, collision predicts avoidance strategies. The LIDAR systems detect the object by firing out a Laser beam and waiting for its reflection to come back. The reflected wave helps to determine the distance between the car and the other objects. The Velodyne 64-beam laser Google's car uses this system which is unambiguous up to 100 feet, and take about 1.3 million readings per second with 360° rotation. Since LIDAR are costly that's why ELON MUSK, founder of TESLA refutes the use of LIDAR.[14]

C. RADAR

To track the speed of other cars, parking and lane changing, LIDAR system doesn't perform meticulously. Therefore, RADARs are used in front and back bumpers and sides of the vehicle. There are two types of radar system.

1) *Short-range Radar:* These analyze feels around the car's immediate surroundings, especially at low speeds. This system is already used in the blind spot detection.
2) *Long-range Radar:* These are used at high speed and over relatively long distances. The incorporation of the long-range radar with the algorithm based processing of images from stereovision cameras gives the autonomous car the capability of knowing, with a high degree of accuracy, about the changing location profile of the object around its circumference range. Considering the movement of the nearby cars, Google's car use a radar to regulate the throttle and brakes in order to avoid the collision.[14]

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D. Sensors

Human beings analyze their activities themselves like at what speed they have to walk and about various other needs, similarly it is the prime requirement of the car also to monitor themselves like whether it is not traveling over the speed limit or if something is wrong with the car. Though various sensors including pressure sensors, light sensors, and acceleration sensors are already in use. But there's some advancement is needed in the active safety and human-machine interface.

E. Human Machine Interface

The HMI (Human Machine Interface) is the too complex system used in the autonomous car as this will be more sophisticated from one we use today. Apart from infotainment/entertainment it also needs to notify the occupants, whether the car needs the manual control and thus, this will avoid any hazardous accidents.

F. Domain Controller / Brain

Various signals from the RADAR, LIDAR, HMI, etc. needs to be process at a single point which serves as the brain of the whole system. This system receives the input from all assembled equipments, processes and takes the necessary action. Once the decision is made, then the various Mechatronic units like steering wheel, throttle, brakes, suspension, etc. are informed which physically control the Drivetrain components.

III. FEATURES

A. Autonomous Features In Vogue

Almost all automakers have made a move to self-driving features. The United States Department of Transportation (DOT) has passed some guidelines, including some basic safety autonomous features that should be adopted by all high-end luxury vehicles. Some of these autonomous features are depicted as follows:

1) *Forward Collision Avoidance System:* In 2003, Honda first introduced this feature of prognosticating collisions and autonomously applied the brakes to avoid any accident, on its car Inspire and later on Acura. Forward and rear cameras, radar, LIDAR, detect and anticipate any possibility of a car crash, providing a warning to the driver and prevent its occurrence. In march 2016, NHTSA (National Highway Traffic Safety Administration) and IIHS (Insurance Institute For Highway Safety) has proclaimed this feature to be included in all cars by 2020. This technology of predicting collision and taking the suitable action autonomously helps in decreasing the odds of crashes and due to its safety evaluations, behavior, most high-end and luxury vehicles incorporate this feature to be mandatory.[79]
2) *Self – Parking System:* In this growing span of urbanization and population when we have limited parking spaces, squashing your car amidst the cars in a parking lot is a big task. To overcome this task, now cars has come to market with Self Assist Parking feature by which, clicking on a button can self-parked your car to a safe and free space without leaving any dent or scratch to the car. The first vehicle to parallel park autonomously was a research prototype made in France by the INRIA (Institut National de Recherche en Informatique et an Automatique) setting the foundation for self- parking vehicles. Volkswagen, in 1992, used this technology in its IRVW (Integrated Research Volkswagen) future concept car by using an array of sensors to guide vehicles to self-park. This feature reduces the hustle among the drivers to get space in the parking lot, just at a click of a button and also saves money by increasing the fuel efficiency and most importantly the time of the commuters.[14]
3) *Adaptive Cruise Control (ACC):* Distracted Drivers sometimes be found in lacking to take the cruise control to avoid accidents. This feature allows the vehicle to speed up or slow down corresponding to the distance from the following car in order to maintain the desired and safe gap by using either radar or laser sensor system. It includes the behavior of autonomously applying brakes or slows down in the case of traffic congestion and accelerating again when the road is clear. Adjusting the speed of the vehicle corresponding to the speed of the following vehicle and overtaking the throttle of the car is its main job. BMW was one of the first automobile concerns that introduced a vehicle with fully adaptive cruise control in its 5, 6 and 7 series since 2007. This combination of traditional cruise control with laser sensors and radar system helps in abating the plausibility and severity of rear-end collisions, and arises as a basic safety feature coming in most of the luxury vehicles in this automated world.[4][18][14]
4) *Lane Departure Warning System:* This feature adds one more feather to the cap of the autonomous world. Using different video sensors, laser sensors, radar sensors and cameras, it detects the lane marking on the roadway and ring alarm, if any kind of deviation occurs from the lane so that the driver can take the appropriate step in accordance. US company 'Iteris' first introduced this Lane Departure Warning System in Europe for Mercedes 'Actros' commercial trucks. Lane Departure Warning

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(LDW) system just warns in case of lane deviation and then it is up to the driver to take relevant action or not, while with Lane Keeping Assist, we can have one more shield of protection. This system can automatically take action if the driver was not responding to the warning and controls the power steering to keep the vehicle in its lane and reduces the plausibility of the accident. In 1992, Mitsubishi motors has started offering this feature on Mitsubishi Debonair.[77]

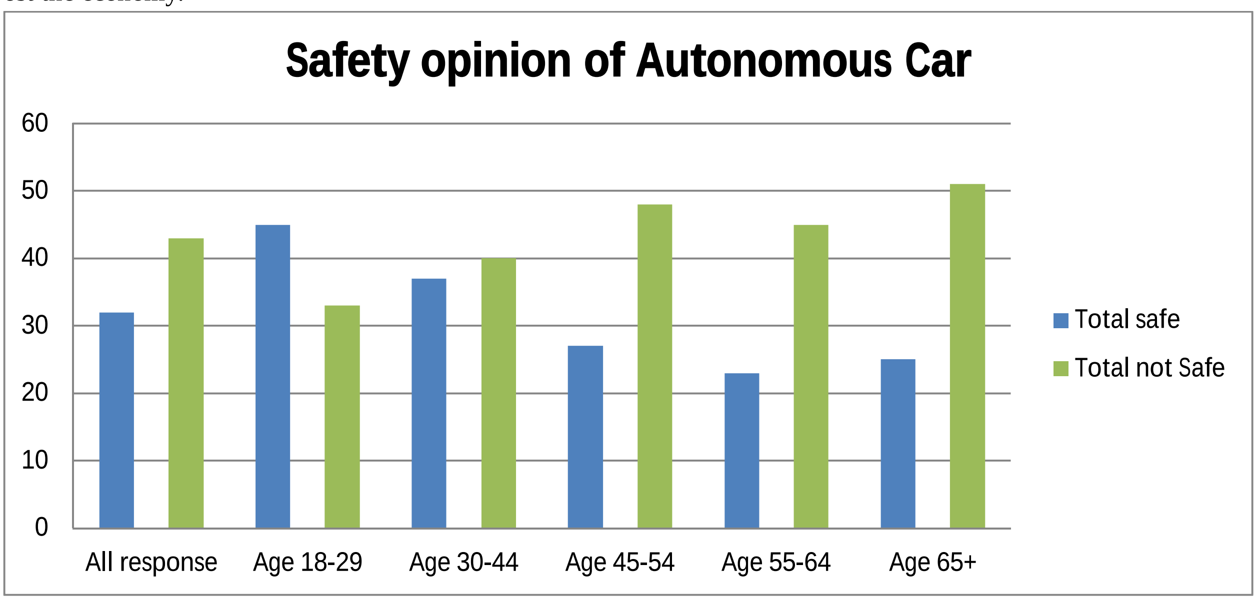
5) *Vehicle to Vehicle (V2V) Communication:* This feature is the ultimate outcome of IOT (Internet of Things). Cars on the roadways can talk to each other, exchanging their data of speeds and distances over an ad-hoc mesh network, leading in improving traffic management and ease congestion. Vehicles can also communicate with the roadside barriers, buildings, traffic signals, and boards, called as Vehicle to Infrastructure (V2I) communication. V2V technologies use Dedicated Short Range Communication (DSRC) which is a kind of mesh network supporting every ture and retransmit signals to the vehicles in the vicinity. NHTSA also published a notice regarding this feature to be mandatory in almost all vehicles that will help in alerting the drivers and potentially decrease the collisions.

IV. ECONOMIC IMPACTS OF AUTONOMOUS DRIVING

Heading towards the automated technology, now we can picture the world where we read the newspaper, check out emails, prepare a report, take the breakfast etc. while commuting in a driverless car. That means that there is no need to skip breakfast, newspaper, in the hurry of getting into the office. Many software companies like Google, Apple, Intel also compete with the traditional automakers into the advent of self-driving cars. The multiplying invention of self-driving cars has a direct impact on the market economy and the industries. Demands shifts, now the industries drift themselves to adopt this industrial revolution, providing a boom to our economy.

A. Economic Benefits Of Self Driving Technology

In 2012, there were 30,800 car fatalities in U.S. and 22,910 including drivers and passengers were dead. We can suppress this high rate of road crashes and increase the human productivity using self-driving car technology. Loss of human lives is directly proportional to the decrease in the economy and the figures are more staggering in the U.S., where car crashes alone can sum up to $900 billion annually, hence U.S. adopts this automated technology more aggressively to acutely control the traffic fatalities and hence boost the economy.



U.S. ex-president Barack Obama, also applauded the self-driving car technology and made sure that government will help in nurturing this vision, and wrote: “In the seven-and-a-half years of my presidency, self-driving cars have gone from sci-fi fantasy to an emerging reality with the potential to transform the way we live”. The United States Department of Transportation (DOT) also disclosed the guidelines for automated vehicles, including the checklist that must be fulfilled by the different manufacturing companies. A fleet of autonomous vehicles reduces the traffic gridlock and ease the traffic congestion results in boosting up the fuel efficiency and saves the economy.[11][19][20][25]

B. Obstructions To Economy

This distracting invention is not proving to be good for many industries. An era will come when people will rely more and more on automated vehicles for their commutation, resulting in wrecking of many automobile industries, as private ownership of vehicles will come down to less than 5%. A fleet of autonomous vehicles leading to no demand for drivers will ultimately lead to the drop in employment where 20 of our regular cars can be replaced by one autonomous car. According to Bureau of Labor Statistics, there were about 1.6 million truck drivers in America whose income constitutes to approximately 0.3% of the U.S. GDP and with this innovation, an era will come when these truck drivers will have to search for other jobs, suppressing the economy.

In accordance with an estimation by IBIS world's 413,046 people were hired in the taxi service in the U.S. alone. All these people will get into stuck since now the invention of self-driving technology gave rise to demand mobility increasing the unemployment rates. Insurance companies are also struggling to maintain its importance in this race of automated vehicles causing potential bankruptcies. Now the question arose that What is the use of car insurance when there is no car crash? Due to no human intervention and eradication of car crashes in autonomous vehicles, the insurance sector loses a huge chunk of its business in which $220 billion supports 277,000 jobs.[11][19][20][25]

V. ENVIRONMENTAL IMPACT OF AUTONOMOUS CARS

Autonomous vehicles have the potential to transform our transportation system. But the convoluted question that comes in front of adoption of autonomous vehicles (AVs) is the effect of this on the environment, that whether this adoption will have the incremental or detrimental effect. According to the environmental research community, it is too early to determine the exact solution of this completely perplex question. Better concatenation of engineering, social science, and planning disciplines is needed in order to achieve the optimum result.[8][72]

"Try to leave the earth a better place than when you arrived" Sidney Sheldon

A. Incremental Affects Of Autonomous Vehicle Adoption On Environment

1) *Gridlock Diminution:* According to the research conducted by the National Renewable Energy laboratory and the University of Maryland, automation could deliver around 15% in fuel savings by maintaining the optimal speed and smooth driving. Vehicle to vehicle communication features eradicate the problem of random start and stop action done by the maladroit human driver. Thus, due to smoother traffic flow, less time and resources are spent in idle cars stuck in traffic congestion, which ultimately reduces the emission of greenhouse gases.
2) *Platooning:* The close interconnection of vehicles following each other can result in a reduction of the aerodynamic drag. This interconnectivity pattern formation is called platooning. There are various positive results of this formation which has incremental environmental impacts, including
   a) Mitigation in congestion
   b) Increase roadway capacity
   c) Reduce the need to increase road capacity

Drag reduction is one of the biggest benefits offered by platooning. A 2013 study by North American Council for freight efficiency found that trucks can reduce fuel consumption by 10% when driven this way.[54]

3) *Meet-Head-On Avoidance:* One of the leading causes of the congestion is the vehicle crashes. Thus, in order to improve the crash safety rating, vehicles are made larger. Though this method proves beneficial regarding the safety of the driver, but it has the detrimental effect on the overall efficiency of the vehicle. The autonomous vehicle can reduce crashes through technology and adoption of this technology will ultimately be beneficial for reducing the size of the vehicle without putting out the safety issue of the user, and this vehicle will become more fuel efficient.
4) *Sudden Impacts:* Acceleration and deceleration in non-periodic basis will lead to the emission of greenhouse gases. With the inbuilt features of the vehicle to vehicle (v2v) communication and vehicle to infrastructure communication, autonomous vehicles will be able to accelerate and decelerate on the periodic basis, which will reduce the emission of greenhouse gases and also avoid the wastage of energy, leading to increasing fuel efficiency.
5) *Ride-Sharing:* On demand mobility and ride sharing services can have a positive impact on the environment. As this service leads to the reduction in car ownership, which will directly reduce the burden of a large number of vehicles on the road leading to reduction in emission of greenhouse gases.

" I think the environmental problem will be the number one item on the agenda of the 21st century. This is the problem that cannot be postponed." Mikhail Gorbachev

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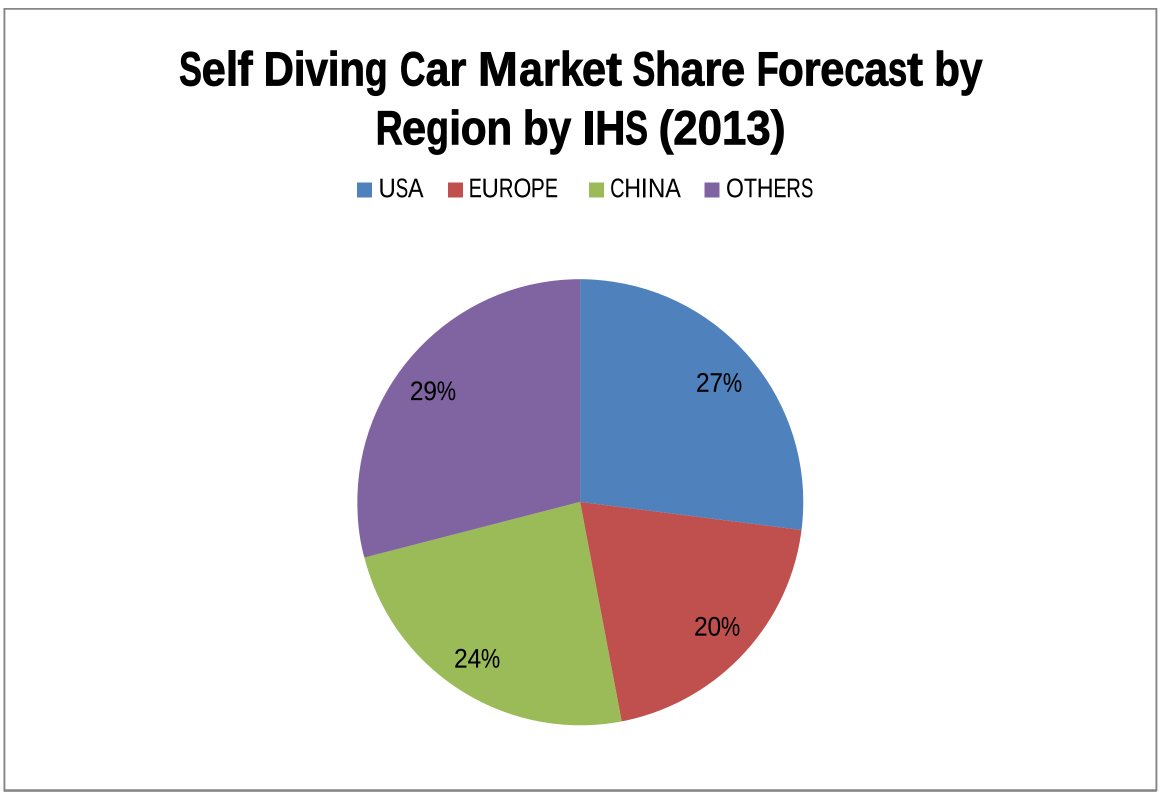
B. Decremental Effects Of Autonomous Vehicle Adoption On Environment

1) *Free Hand Driving, Increases The Need Of Luxury Features:* Incongruous to the current paradigm, which involves the complete involvement of the driver throughout the duration of the trip, a user of the autonomous vehicle is free to perform other activities. This freedom of travelers will begin to demand more features like TVs and other adventurous stuff in the vehicle. Users will begin to demand more comfort and convenience in order to create the home like environment in the vehicle itself. This will lead to the increase in weight of the vehicle which will correspondingly decrease the vehicle efficiency, leading to more greenhouse gas emission which will affect the environment.
2) *Increased Travel Demands:* Demographic groups like the elderly, underage and the physically impaired who were earlier, almost detach from the driving, will now utilize the technology to travel freely. Although the social aspects of this part are venerated, but the environmental impact is detrimental. An increase in the vehicle mile travel will increase the greenhouse gas emission, that will affect the environment. Further additional vehicle mile travel may occur due to unoccupied travel miles, where the vehicle will move without a passenger. It has been estimated that due to the higher parking cost, the users will ask the car to travel like the free dwellers in the outskirts which will increase the vehicle mile travel. There is one plausible scenario where in the long journey, passengers will boycott the use of planes and trains and will use the autonomous vehicles in search of the luxury overnight sleeping compartments, which will increase the vehicle mile travel leading to increasing in greenhouse gas emission.
3) *Increased Highway Speed:* Aerodynamic drag will increase with the increase in the speed of the car on the highway. This results in increased fuel consumption and reduces efficiency.

VI. CURRENT STATUS OF AUTONOMOUS DRIVING GLOBALLY

Different traditional automakers BMW, Audi, General Motors, Volkswagen, Ford, Nissan, Tesla, etc. have merged with new tech companies like google, apple, Intel, Mobileye, Microsoft, etc. in search of winning the race against the production of first fully automated car on the road.



Cars with some autonomous features are already in the market, but the fully automated world, that has the potential of reducing 1.3 million road deaths globally per year is still yet to come. More than 33 corporations are currently working and soup up the competition on raising the level of the autonomous vehicles.

1) In march 2016, one of the first automaker company General Motors has made an announcement of acquiring the Cruise Automation startup and invested 500$ million in Lyft in building its first fully autonomous cars.
2) In summer 2016, Uber purchased the San Francisco based autonomous truck startup Otto with a payout of $680 million and started building their prototypes alongwith their reliability check.
3) Delphi, a GM derivative, and Mobileye, an Israel tech company both emerged as the premier auto part suppliers for self-driving cars to consolidate with BMW and Intel to overcome challenges and bring autonomy on roads by 2021.
4) Next we came with Ford, that also aspires to hit the road with the largest fleet of driverless cars by 2021, bulked up its staff in Silicon Valley to increase the production. It has also procured a stake in Velodyne, the leading manufacturer of Lidar sensors in self-driving cars.
5) Paul Willox, the chairman of Nissan Europe also made an announcement of introducing Nissan Leaf Electric Cars on the London Streets.
6) At the end of 2016, press agency reports that Baidu, a Chinese tech firm and BMW end up their partnership of manufacturing self-driving cars after giving reasons for having different ideas and developmental pace. Baidu had been using BMW 3series for on-road testing in China. Baidu, also partnered with NVIDIA, invested a huge amount of $150 million in Velodyne, is now open for partnership after split up with BMW.
7) Google being a tech company can serve the technology to the automakers. Waymo, the Google's self-driving car project talked to Honda Motor Co. to provide its autonomous technology in this Japanese automaker car and signed a partnership with it. Waymo has also engaged in a partnership with Fiat, Chrysler and built hundreds of hybrid Chrysler minivans with the google's techniques and features.
8) In late December 2016, Volvo announced of becoming the first car maker to provide the facility of Skype conference call in its cars by dealing with Microsoft, the software icon. The upcoming Volvo 90 series will include this feature of conference call providing assistance to business commuters. Also, Volvo cars have struck a deal with Autoliv, a Swedish-American company providing automotive safety features, and set up a joint venture named Zenuity to develop software comprising autonomous safety and driver assistance features.
9) Audi, the premium automaker has partnered for decades with the most famous interactive computer graphics manufacturer Nvidia , providing the award-winning infotainment system in almost all cars that Audi ships. NVIDIA CEO Jen-Hsun Huang has proclaimed the new partnership of NVIDIA with Audi at CES (Consumer Electronics Show) 2017 to produce the level 4 fully autonomous cars by 2020 providing the full autonomy with no human intervention.
10) Last but not the least, the perennial favorite tech company Apple's CEO Tim Cook revealed that it is also turning its attention towards the auto market and start working on building the autonomous icars under the project named as Project 'Titan'. According to the Walls Street Journals Paper, Apple shifted the launch date of its electric cars from 2019 to 2021.

Many more tie-ups and consolidations are going on daily with different agreements and payouts, but the goal is the same - Desideratum for autonomous vehicles.[2][24][26][27][28]

VII. PROSPECTS OF AUTONOMOUS CAR IN INDIA

India is a developing nation, and with the huge investment made in the technology field, India has transformed itself into Digital India. India with the billions of population is the huge and challenging market for the autonomous cars.

Indian market acceptance to the autonomous cars will provide the fast pace to the technological development. There are various benefits to this acceptance which includes increased safety, reduction in pollution (which is the huge threat at this moment), reduction of driver stress, fuel efficiency and possibilities of increased road safety. Mahindra having an eagle eye begun its mission of innovation for autonomous cars through 'rising prize' a US1$ m incentive for the solution of the driverless car in India.

Being the emerging nation, India has the bunch of challenges in acceptance of the autonomous car. These challenges include increased costs, reduced employment, social equity and security and privacy concerns. Before making our approach towards acceptance of autonomous cars, there is the huge hurdle of the vehicle infrastructure which comprises of surrounding around the car that needs special attention like animal sharing the roads, other vehicles not obeying the traffic signals, avoiding pit holes and huge traffic congestion.

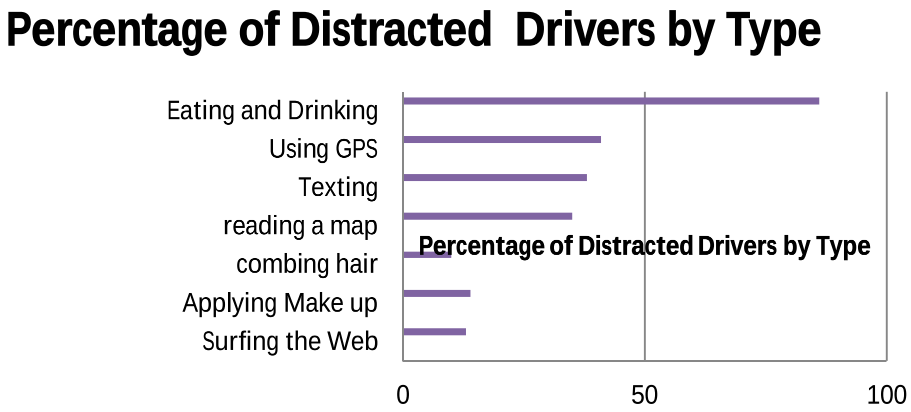
Acceptance of autonomous cars requires amendments in the traffic rules as it needs special legislation and permission. The slow moving legislation of India is another impediment to the acceptance of autonomous cars. But the recent involvements between the government and industry and the government focus on the technological development is the positive sign for the autonomous car developments.

Despite all the stumbling block, 57% of the global consumers trust the driverless cars and this percentage is increasing in developing nations like India. Because of the fearing driving experience witness, there is a lot of willingness among the people to use the automated vehicles. And as the development and technology will groom, many barriers will get eradicated, more people will become familiar with the technology and the trust will build, which will ultimately lead to the high acceptance rate and the market of autonomous cars will eventually flourish.[23][25][86]

VIII. ADVANTAGES OF SELF DRIVING CARS

A. Limited Car Crashes

Autonomous cars come as an elixir for road accidents. For those who want to ride self-driving cars onto the road, they can have a major key point. Since over 90% of the car accidents involves human error and the fact that these cars don't do the rash driving, don't drink, don't get distracted, don't feel dizzy over the steering wheel, result in a significant decrease in car accidents. Self-driving cars cannot fully vanish car accidents, but they can very well reduce the possibility of it, and according to a survey by checking 90% of the car crashes we can save 30,000 to 40,000 lives per year in the US alone and also $190 billion each year in healthcare costs.[11][19][24][27]



B. Lower Fuel Consumption

Traditional cars are responsible for about 27% of the carbon emissions. Rash driving on the green and sudden brakes on the red result in degrading the fuel efficiency. Rushing and braking waste fuel. In autonomous cars, due to their reliable V2V (Vehicle to Vehicle) and V2I (Vehicle to Infrastructure) connectivity they can easily synchronize with others vehicles and road infrastructure. With their features like cruise control, auto parking, lane detection, etc. traffic flow gets smoothen with lesser fuel consumption and results in the reduction of energy by 4% to 25%. This also results in saving approximately $500 billion per year with the eco-friendly air to breathe.[8]

C. Ease Traffic Congestion

Here the question arises that how can driverless cars contribute to less traffic gridlock? The answer is: High V2V and V2I communication in driverless cars help in communicating with other vehicles in its vicinity. These cars, using its advanced Global Positioning Systems (GPS) know the next step of the cars in its proximity which results in avoiding any sudden intersections and smoothen the traffic flow. It can drive very close to other vehicles leading to better road usage and ease congestion. And with this lesser congestion, travel time can also be decreased, which further increase the human productivity.

D. Increase In Human Productivity

With the revolution of driverless technology, autonomous vehicles overtook the driving and freed up the time of the commuters which can be resorted to different additional jobs. According to the U.S. Census, an average worker devotes 25 minutes to drive to work and with the inclusion of autonomous technology this time can be utilized in providing more to our economy, more they can serve as employees, even now they have more time to learn a new skill or course. This revolution also opened up a variety of jobs in manufacturing and production department and provides so many avenues, to groom as humans, increasing the human efficiency and productivity.

E. Maneuverability For Disabled

It is a very exciting prospect for the future that many blind and aging people with any disability can be a part of this rough and tough road life. Steve Mahan is blind and tested the google's self-driving car successfully. This era of self-driving technology is coming as a promising way to free up the mobility impaired users. It makes easier for children, elderly people, disabled, who are dependent on others for their portability and up brings a new opportunity for mobility approaching.

F. Military Merger

After the aerial defense, now it's the turn of ground combat to go unmanned. Last year, The U.S. Army Tank Research and Development has shown off its autonomous vehicles at the Detroit show. Due to its various advantageous features like collision avoidance, obstacle detection, lane changing, etc., we can use the Autonomous vehicles as robots that can be destructive and can also be used as support companions to the army on the battlefield. It is a merger between the autonomous vehicles and the army. Both are beneficial to one another in the way that this military application boosts up the development procedure of autonomous technology and helps in making the drones and spy planes for ground.

IX. SHORTCOMINGS

With the profound advantages and Socioeconomic benefits of autonomous cars, we know that driverless cars don't hit and run, don't drink and drive, they don't talk on phones while driving, they don't bed down on the steering wheel. But inspite of all this, we encounter some scenarios which came forward as the major challenges in the adoption of this technology.[13][86][96][97]

A. Driverless Cars Are Vulnerable To Hackers And Software Glitches

Driverless cars are highly prone to be hacked and plagiarized, for terrorist attacks, warn by a security expert of Institution of Engineers & Technology (IET). Driverless Cars due to their Internet connectivity and other infotainment features, can be easily hacked and create a chaos on the roads. An increase in the complexity of the cars will increase the equal possibility of hacking and the attackers can get more ways to get into the car functionalities. In July 2015, researchers Charlie Miller and Chris Valasek demonstrated and exploited a security issue by taking the control of the key vehicle systems in Jeep Cherokee using a laptop. They were able to alter the air conditioning, turn on the windshield wipers, acquired control over the transmission - transporting the jeep to a standstill. This incident is a red flag for the future cyber attacks, a threat to take seriously. The National Highway Traffic Safety Administration (NHTSA) also released some cybersecurity guidelines to make the vehicles more secure and threat free. It was suggested that by having a good Vehicle to Vehicle (V2V) communication can degrade the possibility of car crashes, but in the arena of hackers and terrorists, good V2V communication can be hazardous and widespread the necrosis of the passengers.

Vehicle Infotainment manufacturer Harman has already found ways to establish the car connectivity with the cybersecurity. It relies on using firewalls for separating car system with different autonomous infotainment features, using the secure boot and data encryption.

B. Bad Weather Conditions - A Dilemma

If you want to cherish the rains and snowfall, then driverless cars may ruin your trip.

Driving in rain intervene the human visibility and same is the case with the lasers and cameras of the driverless cars. LIDAR (light and radar) sensors can't identify roads, obstacles in falling rain or snow. Since they are covered in snow, they detect a large puddle to be a blacktop. In order to resolve and minimize this adverse effect of inclement weather, researchers from Ford and University Of Michigan made a breakthrough and came with another method that navigates perfectly in the bad weather conditions. They created high-resolution 3D maps which can't even detect the roads, but also that what's above the road. These maps grasp things such as road markings, landmarks, signs, geography, and topography. This way, when snow muddles the vision, and the car can't see the lane markings, then, it can use these things such as landmarks, signs, topography or whatever it detected above the road to locate itself on the map. Then, it will follow the maps to successfully resume its route.

C. Ethics On Road

Suppose a scenario where you and your wife are traveling in a car and there is a group of four men just came across in the direct path of your car. Then in such situation, your car will take a turn away from the passengers where you risk yourself and your wife lives but saving those four men. There will be an important ethical aspect for the development of driverless cars. They are programmed to save more lives and harm none or fewer.

This ethical and moral issue creates a hindrance for the customers to invest in buying a car that may lead to the loss of their own family since it is ethically preferable to put the lives of self-driving car passengers at risk in order to save other lives.

D. Liability And Reliability Of Autonomous Cars

Who is responsible for the car crash? This is the most common and frequently asked question nowadays that in the case of any car crash who is going to be responsible, the car owner or the manufacturer company.

GOOGLE'S CAR CRASH: According to the Washington Post of Feb'2016, Google's self-driving car takes some blame for the crash for the first time. Google's car was trying to make a right-hand turn on red, driven to the right on the El Camino Real path halted by sandbags on the Castro Street. Google's car tried to make the way around the sandbags by breaking the line of vehicles on the left and in lieu, it got struck with the metal piece of the bus.

TESLA CRASH: National Transportation Safety Board (NTSB) unclosed an investigation into a lethal accident occurred on 7th May 2016, in Williston, Florida involving Tesla Motors Inc. Sedan Model S, driving by Joshua Brown with a feature called Autopilot enabled. With the autopilot mode ON, the car's sensors failed to differentiate in between 18 wheeler truck and a trailer under a bright spring sky and collided with the truck massively.

These all car crashes questioned upon the automated features of the self-driving cars and highlighted the liability issue, resolving the fault in a car accident.[13]

E. Affordability And Accesesibility

"Will you ever be able to afford a self driving car?" is still a big question.

The cost of implementing this autonomous, self-driving technology can be a way out of reach for a large mass of people. Automobile sector companies now work upon to bring the best technology to the market, but at a reasonable price so that it can be easily afford and access by any family. Driverless cars have the potential to decrease the accidental issues, providing the safety features and for every person, safety is preferred over the price. Thus self-driving cars can be easily adopted if they are easily accessed and affordable. With the inclusion of different autonomous features in the car, the cost will increase drastically. Hence this is the challenging issue for the car makers to provide better technology at reasonable rates. IHS (Information Handling Services) Automotive has made a prophecy that the price for the autonomous technology will add between $7,000 and $10,000 to a car's sticker price in 2025, and will decline to around $5,000 in 2030 and about $3,000 in 2035. By 2035, the penetration rate of Level 4 autonomous cars is quite enough to make it completely autonomous without human occupant's control.

F. Leads To Unemployment

Adoption of this new technology will lead to a high rate of unemployment for the taxi drivers, drivers of delivery vans, trucks etc. Their livelihood got a stuck due to this autonomous technology. This Artificial Intelligence mechanism may also provide a lot of jobs, but then these jobs are not for the low skilled labors who just know that how to drive the car.

For a 45-year old person, who never attended the school before and just know how to drive for his livelihood, the growing rate of acceptance of self-driving technology can be a crunch.

X. CONCLUSION

In conclusion, upon amalgamating the benefits and potential issues of self driving cars, it is quite interesting to see that whether our society will adopt the autonomous driving or not, whether driverless cars will be rolling on the roads or not? Automobiles are hundred times costlier than the mobile phones, and in this era, where we have a majority of middle class families, it is very difficult or we can say unaffordable to buy any vehicle just for its advanced features, safety equipments and ecofriendly behavior. Relying upon the optimistic predictons and benefits of autonomous driving, many automobile companies along with the tech companies are investing in the automation, but these large benefits and advance features will add up a significant amount of cost in the car's price. We can't neglect the fact that these autonomous vehicles can self drive only in the limited weather conditions, their new costs, additional risks for the users who are not familiar with the self driven technology. This innovation also brings the cost effective alternative of the car sharing which reduces the private ownership of the cars and thus the total driving and increases the urban space. With the profound benefits which sometimes double counted and the relevant issues, autonomous driving emerged as the technology that ease our livelihoods, but with a huge amount to payout for this. Despite of the pile of complications with the expansion of autonomous driving, nobody can argue with the irrevocable fact that, no money can commensurate with the human life. Autonomous vehicles with different automatic features, easing the commuters, result in a huge drop in road accidents, and this is the sole reason that demands a hike in its advancement.

During 2020's and may be 2030's autonomous vehicles are the highly expensive novelties that is unaffordable for most of the class, but with the passage of time and innovations of technology, autonomous driving will itself find its way by 2040's or 2050's when there will be a large fleet of driverless cars rolling on the road.

The benefits and issues of the self driving cars may generate a debate over it, but with the net benefits, Autonomous vehicles restrain the human intervention and increases the productivity. Referring to the above, it can be said that Autonomous Driving is not the need, it just provides relaxation in the growing rat race.

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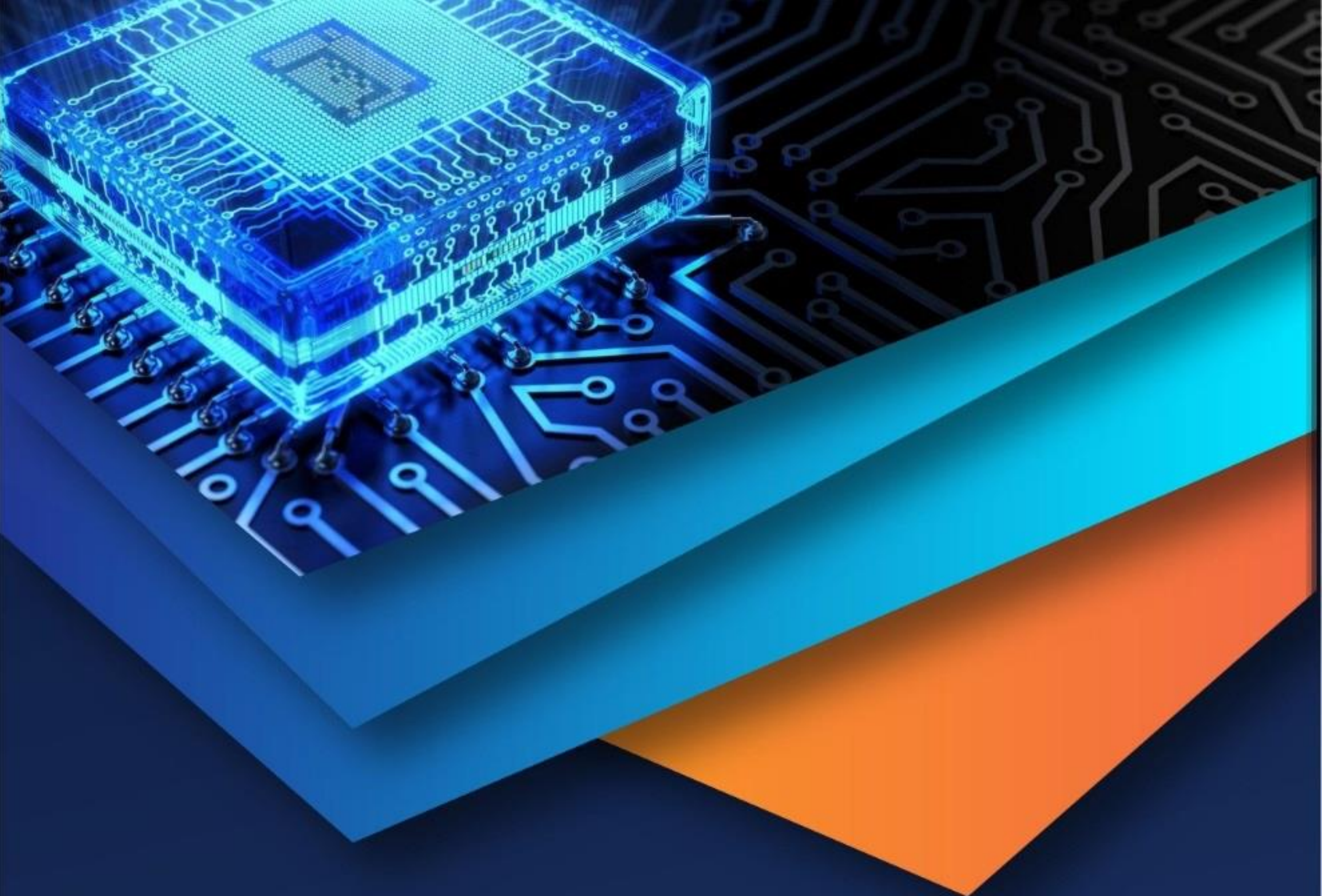

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