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Driverless Cars – Autonomous Cars

Ravindranath Bhaskar Kulkarni
M.E.S Defense Department India
Email:ravi_sun_usa@yahoo.com

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Abstract:

The field of autonomous automation is of interest to researchers, and much has been accomplished in this area, of which this paper presents a detailed chronology. This paper can help one understand various trends in autonomous vehicle technology for the past, present, and future. We see a drastic change in autonomous vehicle technology since 1920s, when the first radio controlled vehicles were designed. In subsequent decades, we see fairly autonomous electric cars powered by embedded circuits in the roads. By 1960s autonomous cars having similar electronic guide systems came into picture. In 1980 we saw vision guided autonomous vehicles, which was a major milestone in technology and till date we use similar or modified forms of vision and radio guided technologies. Various semi-autonomous features introduced in modern cars such as lane keeping, automatic braking and adaptive cruise control are based on such systems. Extensive network guided systems in conjunction with vision guided features is the future of autonomous vehicles. It is predicted that most companies will launch fully autonomous vehicles in next decade. The future of autonomous vehicles is an ambitious era of safe and comfortable transportation. Driverless cars – also known as self-driving cars or self-driven cars and autonomous vehicles – have recently become a heated topic in the US. In the wake of Google's launch of a test project featuring its own self-driving pods, debate has gone viral on the internet. There's fear of privacy being violated, hackers taking over control of the car, and loss of personal freedom behind the wheels. On the other side, there's been much enthusiasm for the technology solving huge problems coming from car crashes and worsening traffic congestion and gridlock. E-vehicles is the new buss or this era. These vehicles have electric batteries as driving force with zero pollution and nil fossil fuel. The carbon emission and harmful gases will be controlled. However here are more challenges in these E-vehicles.

Keywords —Autonomous, fossil fuel, Driverless cars, E Vehicles, Autopilot

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I. INTRODUCTION

Modern age is the age of technology and innovation. Technology is always at stake. The returns on investments are serving long time specially on vehicles. Rapid advances in technology have made it possible for humans to make their work easier and faster in many ways. Scientists and technologists with the help of technocrats, are always busy in working to innovate and improve new technology products to facilitate and make human life easier not only to save time and effort but also to ensure safety. Technology is making human beings more and more lazy. Driverless car is one out of many such innovations intended to help human beings in their daily life. Work on car automation started as early as in 1920s. Few companies which still in the manufacturing field of cars are Jaguar, Rolls Rice, Dodge, etc. More encouraging results in this development were seen in 1950s, which encouraged the scientists to keep working and first truly automatic cars were seen in 1980s ("History of autonomous car,"). However, according to Marks (2012), meaningful developments in driverless cars were exhibited by US Defense Advance Research Project Agency (ARPA) by organizing competitions of such cars in desserts in 2004 and 2005 and in urban area in 2007. Many research organizations are involved in the development of driverless cars, however, Google is far ahead of others in its research on this particular technology (Mui, 2015).

Consumers all around the whole world are enthusiastic about the advent of autonomous cars for private and public. An autonomous car can operate without human control and does not require any human intervention. Campbell et al. stated that modern autonomous vehicles can sense their local environment, classify different kinds of objects that they detect, can interpret sensory information to identify appropriate navigation paths whilst obeying transportation rules. Considerable advancements have been made in giving an appropriate response to unanticipated circumstances where either a backlash can occur in the vehicular systems or some medium in the external environment may not behave as predicted by internal prototypes. To carry out successful autonomous navigation in such situations, combining a variety of technologies from different disciplines that span computer science, mechanical engineering, electronics engineering, electrical engineering, and control engineering, etc.is significant (Deshpande, 2014). Now one more aspect is robotics and drone technology, new fields are making a land mark change. The timeline of autonomous cars begins in 1926 with world's first radio controlled car- 'Linriccan Wonder'. Significant advances in autonomous car technology has been made after the advent of the vision guided Mercedes-Benz robotic Van in 1980, since when the main focus has been on vision guided systems using LIDAR, radar, GPS and computer vision. This developed into the autonomous technologies present in modern cars like adaptive cruise control, lane parking, steer assist etc. And, in the future, we will be part of a future where fully autonomous cars will be a reality, based on official forecasts by various automobile companies. Transportation accidents is one of the major causes of death in the world. By, next decade this world could prevent 5 million human fatalities and 50 million serious injuries by introduction of newer and innovative methodologies and investments in road safety, from regional to international levels. The Commission for Global Road Safety believes that it is very crucial to stop this avoidable and horrendous rise in road injuries, and initiate year on year reductions (Campbell, 2010).

If a paramount and efficacious action is not taken, transportation injuries are set to rise to 2.4 million per year, becoming the fifth leading cause of death in the world. So, number of traffic collisions will drastically decrease due to an autonomous system's increased reliability and faster reaction time compared to humans. This would also reduce traffic congestion, and thus increase roadway capacity since autonomous vehicles would lead to a reduced need of safety gaps and better traffic flow management. Parking scarcity will become a historic phenomenon with the advent of autonomous cars, as cars could drop off passengers, and park at any suitable space, and then return back to the pickup point of the passengers. Thus, there would be a reduction in parking space. Need of physical road signage will decrease as autonomous cars will receive necessary information via network. There would be a reduction in the need of traffic police. Thus, autonomous cars can reduce government spending on things like traffic police. The need for vehicle insurance will also decrease, along with a decrease in the incidents of car theft. Efficient car sharing and goods transport systems (as in case of taxis and trucks respectively) can be implemented, with total elimination of redundant passengers. Not everyone is suitable or good drivers so, autonomous cars provide a relief from driving and navigation chores. Also, commute time will decrease, as autonomous vehicles can travel at higher speeds with minimum chances of error. The car's occupants will appreciate the smoother ride experience as compared to non-autonomous cars. Autonomous cars provide excellent benefits, but, some challenges do exist. Although the notion has been rejected, but, it is believed that an advent of autonomous cars would lead to a decrease of driving-related jobs. Also, situations like inability of drivers to regain control of their cars due to inexperience of drivers, etc. is an important challenge. Lots of people love driving, and it would be difficult for them to forfeit control of their cars. Autonomous cars also pose challenges interacting with human-driven vehicles on the same route. Another challenge to autonomous cars is that who is to be held liable for damage- the car manufacturing company, or the car's occupants/owner, or the government. Thus, implementation of a legal framework and establishment of government regulations for autonomous vehicles is a major problem. Software reliability is also a major issue. Also, there is a risk of a car's computer or communication system being potentially compromised. There is a risk of an increase in terrorist and criminal activities, for instance, cars could potentially be loaded with explosives by terrorist organizations and miscreants. They could also be used as getaway vehicles and various other criminal activities. Thus, autonomous cars have both pros and cons.

II. HISTORICAL ANTECEDENTS

Historical events helped shape modern semi-autonomous vehicles. The first step towards autonomous cars are the radio controlled car, called Linriccan Wonder. It was demonstrated by Houdina Radio Control in New York City. It was basically a 1926 Chandler that had transmitting antennae on its rear compartment and was operated by another car that sent out radio impulses while following it. These signals were caught by the transmitting antennae. The antennae sent the signals to circuit- breakers which operated small electric motors that directed the car's movements. It was one of the most primitive forms of autonomous vehicles. The United States' Bureau of Public Roads considered the construction of an experimental electronically controlled highway, in which, four states- Ohio, Massachusetts, New York and California - bade for the construction. Then governor, DiSalle pressed for such experiments for the future of automation. In the 1980s, a vision-guided driverless Mercedes-Benz robotic van, which was designed by Ernst Dickmanns and his team at the Bundeswehr University Munich, Germany, achieved a speed of 63 km/h on streets without traffic. Various national and international projects were launched with the progress in the field of autonomous vehicle technology. The ability of unmanned ground vehicles to navigate miles of difficult off-road terrain, avoiding obstacles such as rocks and trees was demonstrated by Demo III (2001). Real-Time Control System, which is a hierarchical control system was provided by the National Institute for Standards and Technology. Along with individual vehicles' control (e.g. throttle, steering, and brake), groups of vehicles had their movements automatically coordinated in response to high level goals (Bellutta, 2000; Shoemaker, 1998; Hong, 2002).

III. CONTEMPORARY PROGRES

The modern automobile companies keep coming up with newer autonomous features in their recent models. Technological advancements seen every day in areas like information technology, communication, data analysis and storage etc. is not exclusive to these areas alone.

IV. DRIVERLESS CARS

Driverless cars are standard passenger cars with additional capabilities of replacing the driver by an intelligent autonomous system to run the car. In such cars, GPS receivers and mapping technology are installed to navigate paths and destinations. Radar system is used to detect obstacles that the driverless car may encounter. A laser ranging system scans the outside environment in three dimensions. The car also comes with a video camera to identify various objects like signs, lights, humans, and other cars. The system of the car uses all the information to decide the behavior of the car in a particular situation (Waldrop, 2015). Thus, driverless cars are capable of performing all the functions of a human driver through automatic processing units.

Driverless cars – also known as self-driving cars and autonomous vehicles – have recently become a heated topic in the US. In the wake of Google's launch of a test project featuring its own self-driving pods, debate has gone viral on the internet. There's fear of privacy being violated, hackers taking over control of the car, and loss of personal freedom behind the wheel. On the other side, there's been much enthusiasm for the technology solving huge problems coming from car crashes and worsening traffic congestion and gridlock.

The polarized debate calls up two images – computerized artificial intelligence system HAL 9000 becoming an antagonist murderously attempting to take control of the spaceship in "2001: A Space Odyssey;" and there's KITT, a black Pontiac Firebird Trans Am that safely transports do-good action hero Michael Knight in "Knight Rider."

A new white paper on the subject, "Hands off the Steering Wheel– The state of autonomous vehicle government policies, testing projects – and when these vehicles will likely make it to roads," explores these polarizing issues and what to expect in coming years.

Since Google's announcement in May of this year, there's been a wave of debate and analysis over this ground-breaking technology and when it's likely to show up in large numbers on our roads. Beyond Google, Nissan and other car and truck makers are making bold statements about it, and studies have been released this summer, sharing perspectives from consumers and transportation and technology experts. Highlights of this white paper include details on states that have adopted autonomous vehicle testing programs and policies, along with where it stands in the US government and other nations; and the role Google has played in self-driving cars being tested in states, and the company potentially entering the automotive business with its own car. General Motors has played a key role in the history of autonomous vehicles dating back to its

The white paper was written by Jon LeSage, editor and publisher of Green Auto Market, and media consultant at LeSage Consulting. The consulting practice creates content, marketing communications, and market intelligence in clean transportation, advanced and autonomous vehicles, and urban mobility. Green Auto Market delves into these issues on a weekly basis.

"Hands off the Steering Wheel" digs deep into the subject matter that readers are very passionate and opinionated about – and need to stay current and well informed on where it all stands. While the characters of HAL 9000 and KITT come from science fiction, the topic of self-driving, autonomous vehicles have lately been stirring more passionate comments on social media, blogs, and editorial think pieces than anything else seen for years in the automotive and transportation space.

V. CURRENT USE

Despite the rapid developments and technological advances in the accuracy and reliability of driverless cars, they are still not in common use and have not been presented for public transport yet. All the carmakers have been in a race, busy in testing their prototypes for quick delivery into the markets. Google has been ahead of all in this race. By 2013, Google car completed around 200,000 miles of accident free driverless test drives (Poczter & Jankovic, 2013). According to Mui (2015), more than 20 Google driverless cars have completed test drives of more than 1.7 million miles out of which around one million miles to test drives were in driverless mode. To speed up entry in to the market, Google is driving its autonomous cars around 10,000 miles per week in real environments, without controlled environments. Google is also doing simulated driving of its driverless cars for around 3 million miles a day. It is expected that Google's driverless cars will soon be into the market for public use.

VI. BENEFITS OF DRIVELESS CARS

Driverless cars bring many advantages to human beings over the traditional cars. Google aimed at changing the car technology to bring about driverless cars into the market in order to reduce number of road accidents, save people's time, as well as carbon emissions. According to Poczter and Jankovic (2013), 10.8 million accidents per year happen only in USA. These accidents not only cause more than 36000 deaths but also around $300 billion costs annually. One major benefit of driverless cars is that they are programmable and they don't possess unpredictable behavior like humans do. The high customizability of the program of the car, these can be easily adjusted to follow local traffic laws, and obstacles that it encounters. For example, Google's car is programmed to follow traffic rules and signs and responds to signs and obstacles faster than humans can do to help avoid accidents and thus save lives. The inches forward feature of Google Car is very efficient to indicate to other vehicles about its intentions at crossings and intersections (Poczter & Jankovic, 2013). These features make driverless car safer than traditional cars. Google cars estimate to be able to not only save 30,000 lives but also $2.7 billion of cost and more than 2 million injuries. Poczter and Jankovic (2013) cites Bureau of Transportation 2009 statistics that Google car can reduce the average commuting time of Americans from fifty-two to only five minutes daily. The suggested approach is that being intelligent, autonomous cars can drive close to each other with less errors and hence can efficiently utilize road space on freeways. In addition, to saving on commuting time, driverless cars can avoid congestion thus saving 4.8 billion hours and 1.9 billion gallons of fuel annually (US Energy Information Administration, 2012) as cited by (Poczter & Jankovic, 2013). Driverless cars make carpooling an easy and realistic option due to its technological capabilities. These cars are also capable of self-parking and retrieving thus saving time in these activities. The intelligent map techniques and more interaction with centralized systems can also help not only to detect or forecast congestion routes but also to select and use shortest routes between destinations thus reducing fuel consumption even more. All the car-sharing and optimized route selection is estimated to cut the gas consumption by 80 percent. This will not only reduce the number of self-owned cars on the road but will also help save energy to meet more demands in future thus adding to the economy of the country (Burns et al., 2013) as cited by (Poczter & Jankovic, 2013).

VII. SECURITY ASPECTS

It is important to discuss the security concerns of driverless cars. Being technologically advanced and intelligent, driverless cars are secure and offer safe rides as compared to traditional cars and makers are working on safety measures to make it even more safe. Urmson (2015) explains that Google's driverless cars encountered 11 minor accidents without any injury during their 1.7 million miles drives. However, an encouraging fact is that all these accidents were rear-end crashes and side-swipes due to the fault of human drivers driving traditional cars. Google is working on to avoid incidents even due to the others' faults. Driverless cars often faced accidents due to other people not paying attention to driving or breaking the traffic rules on signals and crossings. Google is working on the learn from experiences and working on typical driving behaviours in order to incorporate safety measures into its driverless cars.

VIII. ETHICAL, LEGAL AND SOCIAL IMPLICATIONS

The innovation of driverless cars especially the Google's car brings several social and ethical implications. There are certain legal and ethical implications, which need to be taken in account when it comes to driverless cars (Goodall, 2012). Driverless cars are programmed to prioritize the safety of the occupants and in case of some accident scenario it may harm a pedestrian or a human driver in order to save the occupants. This is against the ethical standards and is an issue to be taken care of. Another ethical consideration is that in case of harm due to driverless car, who will be accused; the car owner, the car itself or the manufacturer? Poczter & Jankovic (2013) point out a very important ethical and social issue regarding the development and use of driverless cars in transport system. The use of such cars will not only reduce the revenues of gasoline businesses but it will also reduce jobs and increase unemployment among the existing transport system. This is a very serious social and ethical issue of consideration.

IX. PROSPECTIVE PREDICTIONS

Any technology enthusiast is curious about the future of cars and how will cars become more reliable, and faster. The governmental organizations are very optimistic about autonomous cars, of course they also have lots of challenges to face with the advent of autonomous cars. Autonomous cars provide advantages like high reliability, high speed, lesser governmental spending on traffic police, reduced need of vehicle insurance, reduction of redundant passengers, etc. with challenges like implementation of a legal framework for autonomous cars, and possible criminal and terrorist misuse among some. Tesl plans 90% autonomous cars for public which is expected to have an 'autopilot' feature which would make the '90% autonomous' travel possible. Google plans to release its 'Self driving cars' for public.

X.FUTURE USE

The speed of development in driverless cars seems to change the future of transportation dramatically. As discussed at various points, these cars seem to occupy a greater value in transport sector in future and will be used to revolutionize the very roots of transport system.

E-Vehicles will bring new challenges on road. Especially when there is traffic jam on highways. The batteries will get discharged due to use of air- conditioner. Then to transport the battery to the stagnated E-vehicle will require drones. Humans beings will not be able to collect batteries from vendors or kiosk. Subsequently tradesmen to replace the battery will not be possible on traffic jam areas. Thus the E-vehicle drivers have to be able handed & self-reliant and techno savvy. Drones needs to designed to carry spanners, batteries. Further drones should be available on shortest message may be by message or email or mobile call from E-Vehicle drivers.

Similar technology needs to concentrate on new material for batteries. A make shift from lead batteries to lithium to next generation batteries is a must. More research in battery manufacturing technology is required.

XI. CONCLUSION

Driverless cars are no doubt the hottest innovation of the technological age. The many advantages in terms of economy, safety, time saving, and security make it the innovation to be further enhanced and brought into the transport system as soon as possible so that society can benefit from it. However, the legal, social, and ethical considerations again make it very challenging task. Therefore, it is concluded that the car-makers work out each and every bit of possible enhancement in the development of these cars while keeping all the ethical and social considerations to make full benefit of this technology. Overall, the advantages of these cars are more than its disadvantages or limitations. Hence, these cars must be launched to save time, money, and lives of people as well as huge amounts of energy to add to the economy. These cars can bring prosperity into the major part of any country where they are deployed. However, steps must be taken to consider the issues of the community that will have to suffer its consequences.

This paper discusses basic chronology leading to the development of autonomous cars. Autonomous vehicles developed from the basic robotic cars to much efficient and practical vision guided vehicles. The development of Mercedes- Benz vision guided autonomous van by Ernst Dickmanns and his team gave a paradigm shift to the approach followed in autonomous cars. Also, contemporary developments in autonomous cars reflect the vivid future autonomous cars behold. Official future predictions about autonomous cars point out that most automobile companies will launch cars with semi and fully autonomous features by 2020. Most cars are expected to be fully autonomous by 2035, according to official predictions as cited earlier. This paper reviewed the historical antecedents, contemporary advancements and developments, and predictable future of semi and fully autonomous cars for public use.

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