Transition to Autonomous Vehicles: Feasibility and Implication in The Near Future

Manik Sejwal, Research scholar, Bharati Vidyapeeth's College of Engineering (maniksejwal@gmail.com), Abha Tripathi, Research scholar, Bharati Vidyapeeth's College of Engineering (tripathi.abha1998@gmail.com), Devarshi Mukhhopadhyay, Research scholar, Bharati Vidyapeeth's College of Engineering (debom97@gmail.com), Rachna Jain, Assistant Professor, Bharati Vidyapeeth's College of Engineering (rachna.jain@bharatividyapeeth.edu)

Abstract – In the light of increasing vehicles leading to more accidents, congestion and pollution, this paper talks about the need of autonomous vehicles on the basis of recent studies and technological improvements. It also deals with the challenges to fully autonomous vehicles and the technologies that could accelerate the transition to them. In this paper we have described the usage of assisted driving in order to remove the day to day challenges the driver has to face while driving and also to remove the challenges autonomous vehicles are likely to face. It was observed that autonomous vehicles have the potential to far surpass the human driver in most of the scenarios.

Keywords: Assisted driving, autonomous vehicles, road safety, self-driving cars, traffic congestion

I. INTRODUCTION

Autonomous vehicles (AVs) were the subject of science fiction movies. With the advent of information technology from the late 20th century, more and resources are being allocated to delve into research and make this a reality. Currently the roads are filled with manually driven vehicles and humans do not have a very good track record at following road safety rules and regulations. Replacing these vehicles with automated ones can increase the safety and reduce pollution significantly.

We humans are inherently bad drivers and majority of the car crashes are due to driver error. The cause for driver errors are varied and range from the fact that the driver panics and tend to make the wrong decisions under pressure [1]. People also get distracted easily, learn slowly and often drive using guesswork. Each person has a different driving style which differs significantly on the basis of age, experience,route familiarity, urgency, sex, intoxication, etc. All this creates a lot of confusion which results in cars moving at varying speeds. This increases the destination time and fuel consumption as well as reduces safety. Proposed autonomous vehicles significantly reduce the above constraints.

Section II describes the related work of other researchers. A comparison of current technology with the required has been shown in section III. In section IV, the Challenges to fully autonomous vehicles are discussed. A method to overcome such problems has been provided under the section V (Assisted Driving) and its limitations are discussed in section VI.

II. RELATED WORK

In this section we will review some studies and implementation of various technologies like Intelligent Cruise Control, Advisory Acceleration and Cooperative Adaptive Cruise Control. Pamela I Labuhn, et al in 1993 [2] patented Adaptive Cruise Control which is an optional cruise control system vehicles that automatically adjusts the vehicle speed in order to maintain a safe gap from vehicles ahead. It uses radar, laser sensors or a stereotype camera setup which helps in applying brakes when detects that the car is approaching another vehicle ahead thus contributing in transition to complete automation.

Bart van Arem, et al in 2006 [3] discussed the impact of Cooperative Adaptive Cruise Control which is an extended version of ACC to overcome the problem of string stability. CACC addresses this problem, and may improve stability by reducing the delay of the response to the preceding vehicle. In human drivers this delay generally depends on reaction time and actions such as moving the foot from throttle to brake pedal.

Fazal Urrahman Syed, et al in 2010 [4] patented an Advisory Acceleration Control which uses an adaptive algorithm that arbitrates competing requirements for good fuel economy, avoidance of

intrusiveness and vehicle drivability. It thoroughly depends on the driver's acceptance or rejection of the advisory information which further can be used to adapt subsequent advisory information to the driving style.

III. A COMPARISON BETWEEN AUTONOMOUS AND MANUAL VEHICLES

A. Shockwaves

In manual traffic, the transients caused by a single vehicle changing speed cause a 'shock wave' that travels against the traffic flow. These transients are caused due to shift in gears, change in lanes or driving recklessly. Since people have slow reaction speeds, they often overreact to these changes in speed often slowing down or accelerating more than required and thus amplifying the shock wave [5] [6]. This abrupt change in acceleration/deceleration leads to unnecessary fuel wastage.

These shock waves can be dampened using automated vehicles because they can estimate the speed of the vehicle in front more accurately and be programmed to reduce their speed slightly less than the vehicle in front. Also, since automated vehicles can drive right in the middle of the leading and trailing car, they can reduce the need to apply the brakes hard and do away with ghost traffic jams [7]. Advisory and autonomous cooperative driving systems.

B. Safety

Majority of the fatal accidents are caused because of drunk driving and fatigue. Automated vehicles would prevent a person who is drunk/fatigued from handling the vehicle. inexperience in driving, indecisiveness and being unaware of road signals are also major causes of motor accidents. The usage of mobile phones and other such devices while driving further worsens the situation [1].

Since computers can perform calculations much faster and much more accurately than humans, automated cars will not be subjected to indecisiveness and be immune to distraction. Automated vehicles will eliminate this issue because they will need to be programmed just once. They will also not remain unaware of road signals like us and will therefore make travel a lot safer [8].

People are driven by emotions. Some drive recklessly just for fun, some are in a rush and are trying to get to the destination as fast as possible without regard to the safety of themselves and others. They get angry when things do not happen their way and behave in a way that yields unfortunate consequences like accidents. If cars were to be automated, our emotions would not have any effect on the flow of traffic in any way, leading to a decline in accidents and cases of road rage. The road would become a much safer place.

C. Disorder

People who are in a rush try to overtake other cars and create new shock waves while doing so.When they see an empty space on the road, they try to take it so that they can get ahead of the vehicle they were behind. Often they take the faster moving lane even if they should be in a different lane. When people get confused, search for parking space on the roadside or the engine stalls, they disturb the traffic flow because they tend to slow down or come to a stand still. Often the vehicles behind have no choice but to change their lanes. This bottlenecks the entire road and significantly reduces the traffic flow rate.

In some crowded cities, this increase the number of cars travelling parallel to each other beyond what the road is designed to handle. Often there is not enough space left on the road even for emergency vehicles. Automation can successfully do away with this disorder. The absence of human drivers would reduce the chances of engines stalling and vehicles slowing down till the driver can make a decision. The vehicles can be programmed to avoid changing lanes if it is not needed. This will enable vehicles to travel without disturbing each other.

Once the disorder is removed, it will be safe for vehicles to travel closer to each other. This would increase the road capacity. The AV's will also allow coordinated platooning of cars which will further increase traffic density [8].

D. Other cases

When travelling from one place to another, we usually take the same route each time. We rarely bother to check whether there is a shorter route to the destination. Automated cars, on the other hand, could check for the fastest route every time. Since AVs do not get fatigued like us, they can run for hundreds of kilometers without compromising safety or

increasing the disorder. The reduced count of accidents will also reduce the burden on the health care. AVs will even allow people who are unfit to drive to travel from one place to another independently.

E. Impact on the driver's day to day life

The presence of fully automated vehicles would free up the driver to do whatever he needs to do. People will be able to do something useful during transit. In an online survey by SurveyMonkey (www.surveymonkey.com) a using a questionnaire by Schoettle and Sivak, it was found that about 50 percent of the surveyed people would prefer to text or talk with friends/family, work, read, watch movies or sleep during transit if they didn't have to drive the vehicle [9]. Since the driver will not have to go pay attention all the time, he will be able to reach his destination with less fatigue.

If automated parking systems are also employed, we will no longer need to search for a parking spot because our vehicle will know exactly where to head. Technologies like RFID will make check ins and checkouts faster and remove the need for stopping at circulation points. They will also make the payments very easy [10].

The increased safety and increased order will allow us to increase the speed limits which will save a lot of time and let us on more other important things.

IV. CHALLENGES TO FULL AUTOMATION

Before we can reach reliable and complete automation, we will be dealing with mixed traffic. The situation will be worse in developing and crowded countries like India because the roads lack order. Every now and then a situation arises which requires years of driving experience. Training AV's for all such situations is not an easy task [11]. Majority AVs use lasers, radar or cameras to scan roads for obstacles. This makes the detection of pedestrians, cyclists and other vehicles easy but detecting potholes and ignoring shadows is a major challenge. Potholes and other damages are hard to detect at higher speeds as they lie below the road surface and have small apparent diameter. Shadows can easily fool a camera and be mistaken for another object, pothole, puddle or oil spot [11].

Poor weather can cause major problems to AVs. Cameras become useless without clear visibility. LIDAR can handle it but using multiple technologies will only increase the cost and weight of the vehicle [9]. AVs will also take time before they can tackle, recognise and handle wet roads, ice and snow. Different people drive differently so handling their presence on the road in mixed traffic would not be a very easy task. A large database would be needed and the vehicle would have to be able to react when a driver makes a mistake.

Since the fully autonomous vehicles would be connected to the internet, they will require a significant amount of security. There will also be a fear of system failure. The lack of trust over the vehicle would reduce the number of people interested in the technology [9]. Another reason people would avoid purchasing an automated vehicle is the price [9]. For quite some time, the automated vehicles will remain expensive. This will simply slow down the transition to roads with solely fully automated vehicles.

Once full automation is achieved, people will become lazy and empty vehicle travel will increase. Today, a large number of people use public transport because of the inability to drive their own vehicle. Once the need of learning to drive is removed, people would prefer private vehicles over public transport.

V. ASSISTED DRIVING

One solution to almost all the above problems is assisted driving. Unlike the other levels semi automated driving, where specific functions are automated, this type of automation will mitigate the decisions made by the driver. The driver will have enough freedom to make the car go the way he wants it to just by using small amounts of force but the car will keep trying to correct his decisions.

It would include technologies like Intelligent Cruise Control, Advisory Acceleration Control and Cooperative Adaptive Cruise Control. Since the automation increases the reaction speed, this would allow the car to start changing speed before the driver could even notice the need [12]. It would reduce/increase the throttle and braking force before the driver can. This could reduce the fuel consumption slightly. This would be really useful if the driver were accelerating and the leading car slowed down suddenly. By the time the driver would hit the brakes, the automation would drop the speed slightly and hence the the driver would not have to brake as hard as he would have otherwise. Once the

leading car starts accelerating, the automation would start accelerating almost instantaneously while the driver would still be trying to slow down. If implemented properly, this would reduce the time spent on traffic lights and reduce the frequency of engines stalling.

This will allow these SAVs too will be able to smoothen the flow of traffic as they will start slowing down or accelerating as soon as the one in front starts to. If they are programmed to slow down less than the leading vehicle and accelerate right away, and also by driving in the middle of the leading and trailing vehicle, they too will be able to dampen the shockwave and prevent ghost/phantom traffic jams [13].

Systems like assisted steering and lane guidance will keep the vehicle centered by reducing drifting that happens. Their presence would also mean that the driver would not be able to change the lane suddenly, which would make it easier for other vehicles to react when he changes the lane. Since the vehicles would be turning less, tyre wear could be reduced.

Since these vehicles would not need a connection to the internet, they would reduce network usage significantly. They would also not have problems of security and data privacy. The people who are averse towards AVs, would prefer these semi-autonomous vehicles (SAVs). Most of the automation of vehicles today is limited to highways, where the traffic flow is relatively uniform. SAVs will make automation on smaller roads easier as a human would still be in control when the automation fails. They can also be used to collect data needed for future training of AVs.

VI. LIMITATIONS AND POSSIBLE IMPROVEMENTS

The mitigation might reduce the smoothness of accelerating and changing lanes. Since the car would try to stay in the lane, avoiding potholes would become harder as it usually requires quick maneuvers. The increased safety might encourage risk taking.

The required hardware would increase the weight and the processes running in the CPU might increase the power consumption and reduce the mileage.
The effect on the flow of traffic would be minimal if the ratio of semi automated to manual vehicles is small.

Today's ICC (Intelligent Cruise Control) is unable to handle situations when involving multiple leading vehicles and changing lanes.

VII. CONCLUSION

Through the course of this paper we examined the various aspects of automated vehicular travel. The implementation of various technologies like Intelligent Cruise Control, Advisory Acceleration Control and Cooperative Adaptive Cruise Control decrease the overall workload on the driver. Thereby decreasing overall travel time, fatigue, fuel consumption and casualty rate in road rage accidents. Automated driving would provide the differently abled to own and operate vehicles. It would also provide the means for senior citizens to operate vehicles in a safe and secure manner.

But there are various challenges to the implementation of fully/semi automated vehicles. The whole transport infrastructure of a country would have to be overhauled and various radar/sensor technologies would have to be implemented on wide scale. The cost of this alone would be huge. Furthermore automated vehicles would be susceptible to cyber attacks/cyber terrorism activities hence automated vehicles need to have highly secure and encrypted systems before they can be actually implemented in practice.

But the advantages of automated system far outweigh the problems plaguing the initial implementation of these systems. Hence automated vehicular travel is the future for transportation.

Transitioning to fully autonomous vehicles is necessary as they offer significant advantages over manual vehicles. Challenges like poor weather, system server failure, etc. can be removed with the help of technologies like Intelligent Cruise Control, Advisory Acceleration Control and Cooperative Adaptive Cruise Control. These technologies would also accelerate the speed of the transition.

Usage of assisted driving can also help in reducing workload on drivers and reduce the amount of pollution due to vehicles.

VII. REFERENCES

[1] Ruikar, M. (2013). National statistics of road traffic accidents in India. *Journal of*

Orthopedics, Traumatology and Rehabilitation, *6*(1), 1.

[2] Labuhn, P. I., & Chundrlik Jr, W. J. (1995). *U.S. Patent No. 5,454,442*. Washington, DC: U.S. Patent and Trademark Office.

[3] Van Arem, B., Van Driel, C. J., & Visser, R. (2006). The impact of cooperative adaptive cruise control on traffic-flow characteristics. *IEEE Transactions on Intelligent Transportation Systems*, *7*(4), 429-436.

[4] Syed, F. U., Filev, D. P., & Tseng, F. (2016). *U.S. Patent No. 9,361,272*. Washington, DC: U.S. Patent and Trademark Office.

[5] Bose, A., & Ioannou, P. A. (2003). Analysis of traffic flow with mixed manual and semi automated vehicles. *IEEE Transactions on Intelligent Transportation Systems*, *4*(4), 173-188.

[6] Bose, A., & Ioannou, P. (2003). Mixed manual/semi-automated traffic: a macroscopic analysis. *Transportation Research Part C: Emerging Technologies*, *11*(6), 439-462.

[7] van den Broek, T. H., Ploeg, J., & Netten, B. D. (2011, January). Advisory and autonomous cooperative driving systems. In *Consumer Electronics (ICCE), 2011 IEEE International Conference on* (pp. 279-280). IEEE.

[8] Sivak, M., & Schoettle, B. (2015). Road safety with self-driving vehicles: General limitations and road sharing with conventional vehicles.

[9] Schoettle, B., & Sivak, M. (2014). Public opinion about self-driving vehicles in China, India, Japan, the US, the UK, and Australia.

[10] Tang, V. W., Zheng, Y., & Cao, J. (2006, August). An intelligent car park management system based on wireless sensor networks. In *Pervasive Computing and Applications, 2006 1st International Symposium on* (pp. 65-70). IEEE.

[11] Boudette, N. E. (2016). 5 Things That Give Self-Driving Cars Headaches.

[12] https://news.ycombinator.com/item?id=12178863

[13] https://www.npr.org/2013/11/29/247825768/phantom-traffic-jams-what-causes-mysterious-highway-backups

[14] Bojarski, M., Del Testa, D., Dworakowski, D., Firner, B., Flepp, B., Goyal, P., ... & Zhang, X. (2016). End to end learning for self-driving cars. *arXiv preprint arXiv:1604.07316*.

[15] Litman, T. Autonomous Vehicle Implementation Predictions. Implications for Transport Planning. Victoria Transport Policy Institute, 27 February 2017//[Electronic resource].

[16] Greenblatt, J. B., & Saxena, S. (2015). Autonomous taxis could greatly reduce greenhouse-gas emissions of US light-duty vehicles. *Nature Climate Change*, *5*(9), 860.