Autonomous Vehicles and Insurance

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Autonomous Vehicle (AV) is defined as a motor vehicle that uses artificial intelligence (AI), sensors, cameras and global positioning system to perceive and cognize its environment, decide what route to take to its destination, and drive without any human input. The term AV is broadly used to denote autonomous trucks and autonomous cars. Currently, every major automobile manufacturer is researching extensively to make AVs a commercial reality. It is predicted that an entirely autonomous car, also known as a driverless car or self-driving car, will be a reality in the next two decades. It is forecasted that when it happens, our roads will be safer as the driverless cars will always be attentive to the environment, obey the traffic rules, and never get tired, distracted, drunk or have fits of road rage.

This article attempts to provide an overview regarding the levels of automation in AV and the impact AVs will make on industries including auto and insurance. It may be easy to guess that before AV becomes a reality, it will have to overcome a lot of technological, operational, and regulatory challenges. This article also talks about two such interesting challenges: the first one is about ethical decision making that AVs must learn and the second is with respect to determining who is to be held liable for the AV crashes and accidents.

Keywords - Autonomous Vehicles, Autonomous Cars, Autonomous Vehicles and Ethical Concerns, Autonomous Vehicles and Insurance, Insurance Liability in Autonomous Vehicles

Levels of Autonomy

The Society of Automotive Engineers (SAE) International has created a set of international standards for automakers to follow called "Taxonomy and Definitions for Terms Related to

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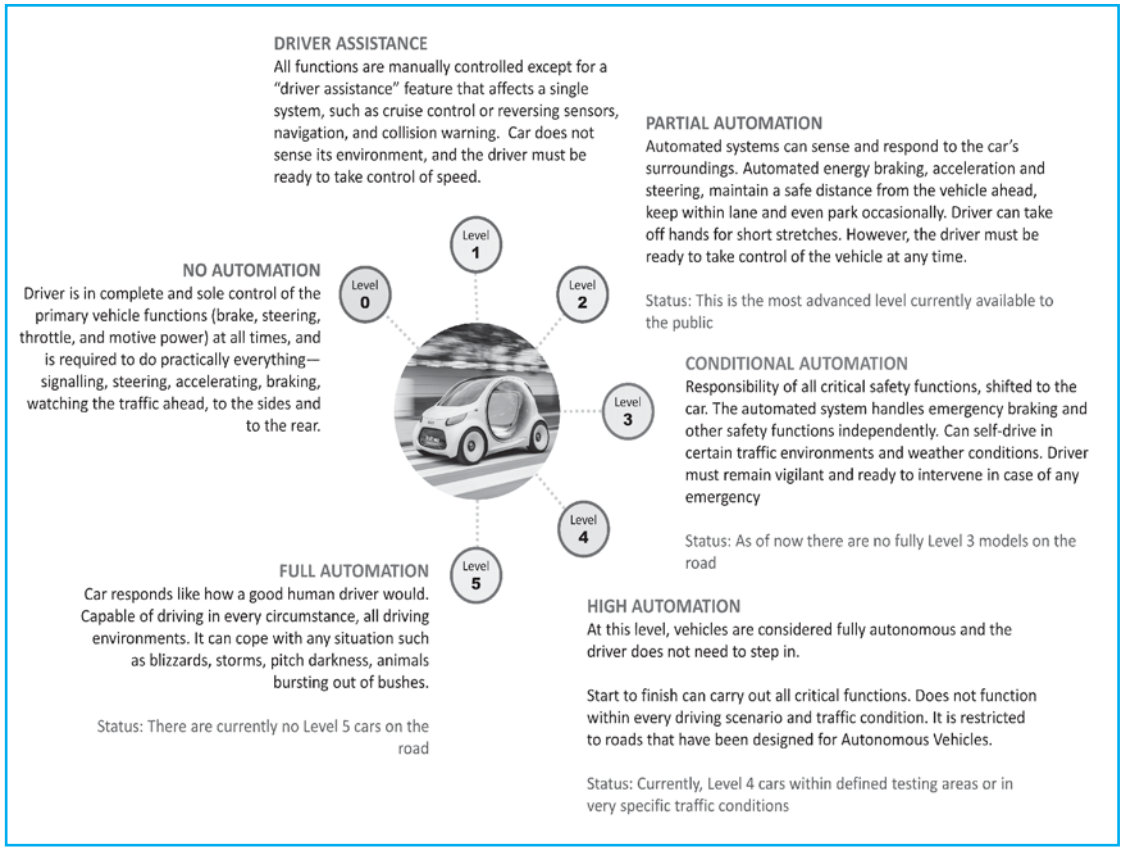
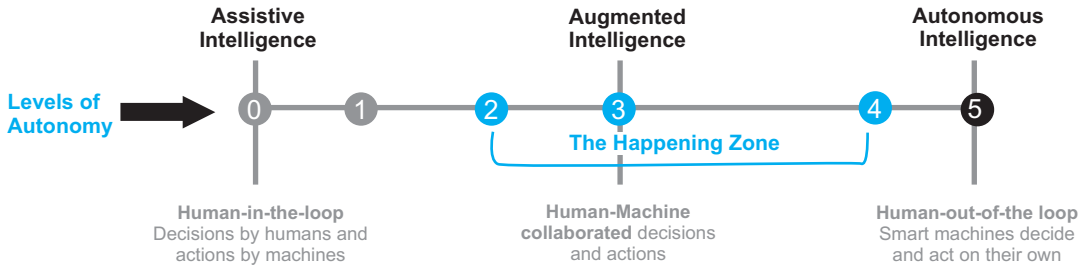
Driving Automation Systems for On-Road Motor Vehicles". The taxonomy defines six levels of autonomy to classify AVs.

Figure 1
Society of Automotive Engineers International - Six Levels of Autonomy



The AVs of today are in level-2 and slowly stepping into level-3. An alternative initiative is also being considered to skip level-3 and directly move to level-4. AI being the brain that operates an AV, these levels of automation can be mapped to the stages in AI, as it advances through the man-machine intelligence continuum.

Figure 2
Intelligence Continuum and Levels of Autonomy



Ethical Challenges

To become fully autonomous, AVs will have to overcome several challenges and the major one being the development of the required software. AVs of level-4 and level-5 should be able to understand all the traffic rules, anticipate the actions of others on the road and then be capable of initiating a reflex response to handle on-the-fly external situations. AVs must learn how to negotiate driving patterns involving both human drivers and other AVs. It should recognize various unexpected and surprising situations on-road with respect to human driver behavior, cyclists, pedestrians, obstacles and barriers, and must be capable of taking appropriate decisions while facing ethical problems involving a moral dilemma. Two such ethical challenges are mentioned below.

- **Trolley problem:** Trolley problem is a thought experiment that was introduced in 1967. The recent growth of AVs has renewed the interest in it. In a classic scenario, a trolley is going down the tracks towards five people. The trolley cannot be stopped and the only thing the observer can do is to pull a lever to redirect the trolley to an alternative track on which one person is struck. The scenario exposes the moral tension between actively pursuing a task versus remaining passive and both cases resulting in harming someone. Is it morally acceptable to kill one to save five, or should five be allowed to die rather than actively hurt one? The moral problem gets complicated when the five, are aware that it is an active track on which they are standing and the one on the other track is equally aware that it is an inactive track. This leads to a good or bad versus right or wrong dilemma. With respect to AVs, this problem gets slightly altered. If a car is in a situation where any action will put

either the car passenger or someone else in danger, for example, there is a truck crash ahead and the only options are to swerve into a motorbike or off a cliff, in that scenario how should the car be programmed to respond?

- Goat on the road problem: Imagining a scenario in which an AV is speeding in the highway and from nowhere a goat suddenly jumps on the road. The AV does not know anything about a goat, as no info about a "goat" was available in the training datasets which was used to build the models and algorithm that drives it. Hence, the AV is unskilled for handling the unknown-unknown (does not know, and does not even know that it does not know) situation and the appropriate responsive action it should take when it sees a goat. In such a never seen or contemplated before situation, what will a driverless car do? Will the AV treat the goat as a live traveler on road, as another vehicle, or merely as an obstacle on the road? The analysis and decision made by the AV on how to treat the goat on the road will make the vehicle to slow down, stop or speed up and proceed to hit the goat.

Various perspectives such as rule-based, virtue-based, utilitarianism-based, etc., are adopted to debate and ascertain the action that could be considered as an ethical one in these circumstances. Analyzing these type of random situations of moral dilemmas, where the AV needs to choose the lesser of two evils, helps to decide on how to moderate the behavior of the AV, bring in explainability and makes it trustable. Notwithstanding the debates, the answers are still inconclusive and robot ethicists seem to be inclined to adopt a rule-based approach that sees ethics as merely a set of rules to be followed in accordance to a monotonic first-order based logic.

Impact of Autonomous Vehicles

AVs are expected to disrupt and displace various industries and businesses. The mind-map below depicts the indicative impact that autonomous vehicles could make on the auto industry, society, other businesses and customers.

Table 1

Impact of Autonomous Vehicles on Businesses, Society and Customers

Impact of Autonomous Vehicles	
Auto Industry	• Retail sale plunges as more fleet operators emerge • Car dealers become disintermediated as driverless cars may be sold as large fleets • Increased car-sharing via driver-less taxis to destroy current auto business models

- Auto finance will be affected as people shift to shared usage resulting in a drop in car sales
- Increased vehicle utilization causing accelerated replacement cycles
- No more local mechanics, car dealers, consumer car washes, auto parts stores or gas stations
- Crash economy businesses (body/repair shops) suffer due to lack of business
- Many parts disappear from cars, thereby affecting many existing manufacturers and suppliers
- Manufacturers own responsibility for hardware/software failure liabilities

Other Businesses

- Driving licenses and the associated jobs become redundant
- Traffic policing will become redundant
- Parking operators and municipal revenues undermined as vehicles are constantly on the move and do not require parking
- Supply chains will be disrupted. Trucks will be fuller and latent capacity will be priced cheaper
- Restaurants lose footfall as people prepare and eat meals in their cars
- Hotels and Motels lose business as people do not stop the vehicle during travel but prefer to sleep in comfort of self-driven vehicles and wait until reaching the next prominent location
- Hospital and health insurer revenue could be reduced as car-related injuries plummet
- Many lawyers will lose sources of revenue as traffic offenses, crash litigation (people-people) reduce dramatically
- However lawsuits between people-corporate and corporate-corporate set to increase

Society

- Autonomous vehicles will be much safer than human motorists (Currently, driver errors are responsible for 95% of accidents)
- Safer roads as traffic accidents reduce by 90%.
- Driving such as jobs drivers, driving schools, driving test and sobriety checks will get replaced

	• Government loses revenue from fines as autonomous vehicles always obey traffic laws • Hacking of vehicles will be a serious issue • Criminal and terrorist activities (including cyber risk) set to increase • Reduction in pollution levels (fuel conservation, reduction in on-road vehicles, decreased need for road maintenance) • Transport will be delivered as a service from companies who own fleets of self-driving vehicles • Organ donation for transplantation plummets as road accident which is a major source of organ supply is reduced
Customers	• Shift from the model of ownership to shared access of vehicles • Increased overall usage of the car (Cars are now underused for about 95% of the day) • Faster reflexes and decreased accidents • Attention to traffic without tiredness • Efficient driving resulting in reduced energy consumption • No driving under the influence (DUI), aggressive driving, fits of road rage or driver distraction • Better usage of travel time

With respect to the insurance industry, the foremost impact of AVs would be a steep fall in the auto-insurance premiums due to a reduction in the frequency and severity of accidents. KPMG describes the stages between level-2 to level-4 as the "chaotic middle" which would be a period of radical change that is bound to reshape the insurance industry. They predict that this period could stretch for two decades or more.

The insurance industry is built on understanding risk: assessing, predicting, classifying, selecting and pricing risk. The impact of autonomous vehicles on the insurance industry would vary as they progress through various levels of autonomy.

Table 2
Impact of AV on Insurance

Level	*Impact of AVs on Insurance Industry at levels 0 to 3*
0	• None. Insurance rating continues as it is currently performed, using the past claims history and other risk factors about the driver
1	• Minor rating changes because of reduction in claims. Would depend on each case. Claim history and driver behavior are still important factors
2	
3	• Potential for favorable insurance rating, but depends on the individual vehicle owner's driving pattern. For example how many journeys were made and if the roads permitted automated driving

As the automation reaches levels 4 and 5, they would have a larger impact on the motor insurance products and the processes

Table 3
Impact of AV on Insurance

Insurance Concept / Business Process	**Impact of AVs on Insurance Industry at levels 4 and 5**
Risk Types	• New products to cover the liabilities of a passenger • New products to cover risks in hybrid products • Need for new insurance products for varying ownership models (shift from ownership to access basis) • Emerging new risks for equipment breakdown, ransom-ware, public infrastructure • New stakeholders purchasing insurance (Manufacturers, auto-part providers, body/service shops, network providers, AV software providers, infrastructure providers) • The decrease in third-party insurance and fraudulent claims in the long-term • Increase in cyber risk, product recall, reputation, ransom-ware risks

Risk Classification	• Driver behavior will lose significance, in the place of that behavior of the owner in maintaining the vehicle will become important • Class codes for hybrid insurance classification to evolve (Now exists for auto components and computers separately)
Underwriting	• As machines drive, underwriting and claims will heavily depend on telematics devices • As the risk of driver behavior ceases to be a risk factor, details of where and when the AV is driven and parked become key factors for underwriting • Insurers should overhaul their existing rating algorithms to reflect the changing risk profiles of customers and the emergence of new risks
Premium	• As accidents decrease 90% of personal auto premiums set to decline • Automation level of the vehicle, operating system, software version, and intelligence level of the AV will be influencing factors • During coexistence of automated and manual vehicles, underinsured and motorist's coverage to steeply increase • Other factors like new part costs and liability complexities to increase premiums
Claims	• Liability keeps shifting to different stakeholders depending on the levels of autonomy • Claim frequency and severity may decrease, but paradoxically the claim cost may increase due to the high cost of the parts and repair • Subrogation gets complex in the short-term and becomes simple and automated in the long-term • Increase in insurance lawsuits Ethical issues to emerge to decide the at-fault vehicle
Miscellaneous	• Some insurance jobs may become redundant (Surveyors, Adjusters)

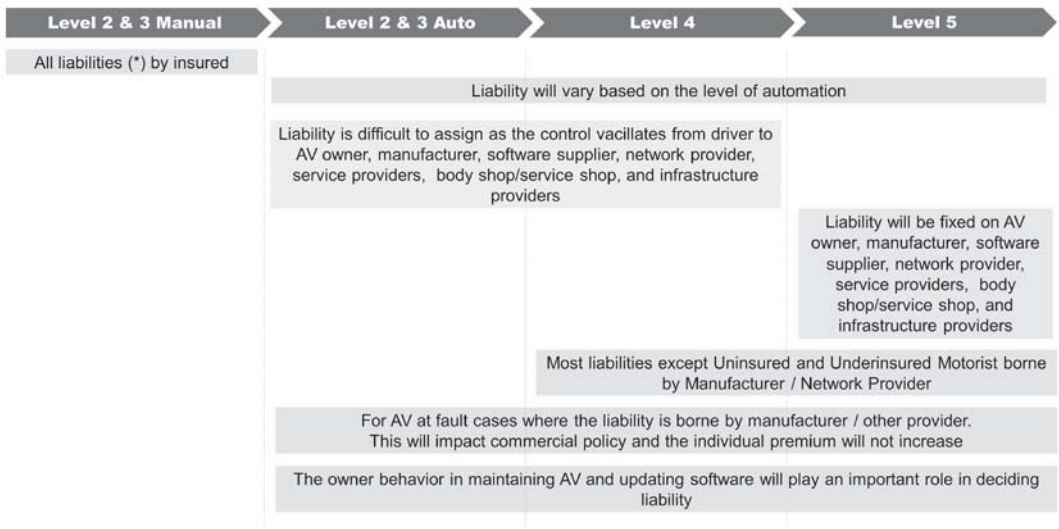
Autonomous Vehicle Liability

As AVs traverse through varying levels of autonomy, they are likely to pose the insurance industry with many challenges with respect to risk segmentation, classification, pricing and claims. One

such specific challenge is related to the difficulty in determining who is liable when an AV crashes and causes physical damage to persons or property.

The liability is prone to vary based on the level of autonomy of the AV and with AVs becoming fully automated, the responsibility of the driver reduces and hence it will be easy to shift the responsibility to the manufacturer. Till such state is attained, it will be difficult to ascertain the liability as the control of the vehicle vacillates among the driver, manufacturer, software supplier, network provider, service providers, body/service shops and infrastructure providers. At the levels of 2 and 3, whether the AV was under manual control or in a self-drive mode would be the most important factor to consider. This gets further complicated, when a crash happens during the period of control transfer from self-drive to manual mode or where two or more AVs are involved. In complex cases that involve a moral dilemma, fixing the liability may have to be dealt with on a case-by-case basis in the court.

Figure 3
Determining Insurance Liability



One thing that can be easily predicted with respect to liability is that, as vehicles become more autonomous, manufacturers and suppliers will have to assume greater responsibility resulting in a surge in the purchase of product liability insurance.

Conclusion

Currently, extensive research and work is in progress with respect to all the core building blocks of AV, such as perception and object analysis, drive control, decision making, vehicle-to-vehicle, vehicle-to-human and vehicle-to-infrastructure communications, test roads for AV, the computing power of AV, electric vehicle infrastructure etc. Research is also happening on how to design ethically aligned AI systems using deep learning algorithms and neural networks, and to make them explainable. As of now, there are no common rules or regulations governing the operation of AVs. However, many countries are enacting regulations for testing AVs, permitting them on public roads and for ensuring their safe usage.

Guidelines regarding the ethical practices are also being enunciated to handle moral dilemmas. The AV ethics proposed specifies that it should prevent accidents wherever it is practically possible. They must be designed in such a way that critical dilemma situations in which the AV has to decide between two evils do not arise and wherever such situations are unavoidable the protection of human life must be accorded top priority. Any distinction or discrimination based on personal features such as age, gender, physical or mental constitution is to be avoided. The core objectives of these guidelines are to ensure the creation of responsible AVs, the actions of which are fair, accurate, transparent, auditable and explainable.

Assessing the pace at which every technological building block of AV is growing, it seems increasingly possible, that we may get a chance to enjoy hands-free travels in fully autonomous vehicles within our lifetimes.

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