

# AI in Self-Driving Cars

Manjot Kaur Bhatia<sup>1</sup>, Rishabh Jain<sup>2</sup>, Gurnish Kaur<sup>3</sup>, Ritik Garg<sup>4</sup>

<sup>1</sup>Dept. of Information technology, Jagan Institute of Management Studies, Sector-5, 3-Institutional area, Rohini, Delhi, India.

<sup>2</sup>Dept. of Information technology, Jagan Institute of Management Studies, Sector-5, 3-Institutional area, Rohini, Delhi, India.

<sup>3</sup>Dept. of Information technology, Jagan Institute of Management Studies, Sector-5, 3-Institutional area, Rohini, Delhi, India.

<sup>4</sup>Dept. of Information technology, Jagan Institute of Management Studies, Sector-5, 3-Institutional area, Rohini, Delhi, India.

## ABSTRACT

The paper discusses the usage of ARTIFICIAL INTELLIGENCE in cars. AI can transform, the cars into self-driving cars. The technology uses the hardware which is made of silicon, auto pilot mode, various sensor installed for taking the data and then in turn helping for the navigation, driving, detecting the objects and much more. With the help of AI, the world is moving ahead with the exponential growth.

## KEYWORDS

Autopilot, cameras, lidar, self-driving cars, Tesla, Waymo, artificial intelligence, API, automated cars, AI, model S, model X, model Y

## 1. INTRODUCTION

*“NECESSITY IS THE MOTHER OF THE INVENTION.”* in the modern, upgrading world of the technologies, humans are paving their ways to achieve a better lifestyle by doing various short sighted and reckless activities. Due to which, environment is coming to the stage of threat. Protecting the environment and saving the natural resources have become “buzzwords” to conserve them. Various policies are being made by the government so as to continue the existence of human race.

From every field, environment is being devastated. But the major contribution in this are the vehicles. The emission of various harmful gases, their technologies and increase in the number of vehicles have led to the depletion of resources by hook or crook. Since 1980s, there is the acceleration of the private vehicles leading

to the smoggy bowls in the atmosphere. The alarming sound of mother earth has led to the formation of many environmental organizations on a global platform. United states has become a leader by the pollution levels in some areas such as California who got caught under the umbrella of forest fires. 70% of the harmful emissions are ejected from the cars to the atmosphere. As per the record, 22 million tons of pollutants which have different origins: oxides, Sulphur, carbon dioxide hydrocarbons, leads, aldehydes and many more are degrading the biodiversity. In addition to this, on average every year the graph increases by 3.1 %.

The roof of hazardous atmosphere comprising of contaminated water bodies, deposition of dusts in the lungs of humans, land degradation, poisonous air to breathe, living around various radioactive elements, huge noisy decibels, causing various disease, harming the human race.

The automobile industry is on the boom on its way. Burning the mid night oil, the industry is coming up with upgradation along with technology to show its true colours through their new cars on the stage. With the heavy horse power, fast and furious speed, the upcoming newly cars are definitely eye catching. But one should remember that every coin has its two sides, and each of them are pivotal. Similarly, with advantages, disadvantages, always go hand in hand. It is quite necessary to keep pace with modern world and modern technology. But apart from it, the automobile industry is giving its lion's share in the destruction of the resources.

## 2. Literature Survey

In 1998, California air resources board (carb) adopted the decision which indicated the number of cars with zero exhaust sold per year. In the same year, this percentage was 2% and by 2003 it has come to over 10%. The EU government announced the transition to electric vehicles during the period of 2015-2020 and reinforced this decision on one by hand by imposing a substantial fine for excess of co2 emissions by upcoming new vehicles which were produced in 2015. These were for the rate of 130 grams per kilometers. In 2020 the rate of c02 per kilometer was 95 grams. But on other hand to get the super credits on the production of clean cars which was until 2016.

Artificial intelligence, adding fuel to the fire of technology, is enhancing the human intelligence machines which are programmed in such a way that they think and mimic actions of the humans. The machines are built up for exhibiting the traits, linked with the creative human mind. The goal of ai is to bring those computers which will perform intellectual tasks, decision making, solving the problem, understanding the communication which take place between the humans. During the 1930s, a blind test was conducted by Alan Turing in which if a person is not able to see the elements such as humans and computers, he/she will not able to judge the thing. With AI Technology used in the different fields and tested, it is giving boom in the health, National Economy, and vehicles.

The period of maturation of ai was started in 1943 by proposing the model of artificial neurons by warren McColloch and Walter. Further, it was led by Donald herb who came up with the new learning of Hebbian learning in 1949. Alan Turing, in 1950, published computing machinery and intelligence. The birth of artificial intelligence took place when Allen Newell and Herbert a. Simon created the first artificial intelligence program named logic theorist. Not only this, ai was regarded as academic field by john McCarthy. Turning back the golden pages of ai history, the first ever chatbot, Eliza, was developed by joseph Weinbaum to solve the mathematical problems. In addition to it, wabot-1, the first intelligent humanoid robot took its birth in japan. The period from 1974-1980 is titled as the first duration of ai because of decrease in the funding and lack of publicity.

Turning the table upside down, with expert system, in 1980, ai came back with-it full energy to open the eyes of the world in terms of decision making. Entering the home by taking the form of vacuum cleaner, Roomba, in 2002, gave the world a new thought. Besides this, social media sites, also started to make the usage of ai. With exponential growth, the concept of deep learning and big data accelerate the usage of ai in every sector of the world.

The inventors exploding their minds with the idea of electric car, is environment friendly which does not use any combustible mixtures, no harmful emissions and reduction in the explosiveness. The energy which is used in these cars are quite cheaper than those of fossil fuels. Using the solar energy for charging the batteries simply design, easy to assemble, low noise, results in the saving for the owner.

AI (Artificial Intelligence) in cars is done through five core stages. Collection of data through sensors, fusion of sensors, updating the virtual model, planning the actions which will be taken by the AI on the basis of the data given by sensors and controlling the model of the cars helps in the making of Self Driving Car. Besides this, Application Programming Interface is also installed which comprises of three components, state and commands, telemeter streaming and facility of auto-parking.

This research paper discusses the concept of artificial intelligence used in the self-driving cars. The paper talk about the technology used in these cars, their progress, tests and experiments. All is being done for the human welfare.

### 3. Review of AI in Cars

#### AUTOMATION LEVELS IN SELF DRIVING CARS

Six levels of Automation are described by U.S. National Highway Traffic Safety Administration.

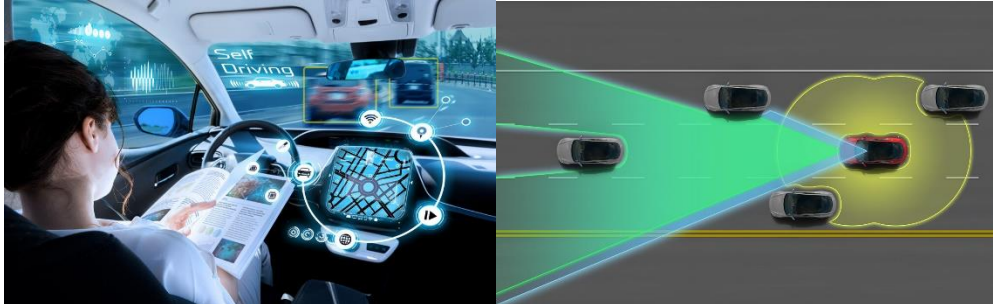
- **LEVEL 0:** cars are being driven by the humans through driver assistance technologies as the medium.
- **LEVEL 1:** Advanced Driver Assistance System (ADS), acting as the support system, helps in aiding the person to drive with steering, brake and accelerate. If the car is drifting out the road lane, then a vibrating seat warns and alerts the person who is driving.
- **LEVEL 2:** if the person who is driving is fully aware behind the wheel but continues to pretend as the driver, Advanced Driver Assistance System will steer and will break or accelerate depending on the situation.
- **Level 3:** Performing all the activities by ADS, the person should be in ready position to take over the control when needed.
- **LEVEL 4:** ADS being reliable during the time of driving or monitoring the surroundings doesn't need the human attention.
- **LEVEL 5:** ADS acts as Virtual Chauffer which implements all the driving skills under various circumstances expecting the humans as the passengers and never to drive through them.

#### FEATURES OF SELF DRIVING CARS

Although the self-driving cars are automated but they are generated to work in the ideal conditions. Override system is also being implemented that can be used when the humans need to drive the car. Highly automated

cars, are not purest in the form. It's similar to the two faces of the coin which have their own importance. But still these cars are standing still, high, expanding the usage of AI with carious features.

- Hands free steering has the job to center the car without the intervention of the human's hands.
- Adaptive cruise control has the responsibility to maintain the perfect distance between the two cars
- Lane centering steering comes to play its role when the person who is driving crosses the marking lane by automatically pushing the vehicle towards the other side of lane.



#### ARTIFICIAL INTELLIGENCE IN SELF DRIVING

- Self-driving cars or Automated cars falls under the new category of vehicles that runs using the combination of sensors, cameras, artificial intelligence to travel from one point to another without any human work. Navigation plays a profound role to determine the destination over the networks of roads. Therefore, this all is accomplished by using the artificial intelligence in the operating system, the sensors and the cameras.
- The main use of AI in self-driving cars is to navigate through the route and controlling the acceleration, turning, reversing and stopping the car.
- Also, AI is used to park the vehicle without driver's control at all.



#### APPLICATION PROGRAMMING INTERFACE (API) IN VEHICLE

Organization of API in the vehicles is done into 3 surfaces.

- **STATE AND COMMANDS:** time to time data is being generated about the state of the vehicle and its control over the functions of the vehicle.

- **STREAMING TELEMETRY:** the data of car's telemetry streams up to half second increments. Streaming HTTP API provides JSON objects at regular intervals.
- **AUTOPARK:** it is a streaming command mode which control the automatic parking of HW1 and HW2 cars. A standard web socket is used that handles for the exchange of JSON objects to convey the information of the state and issue the commands.

## AI IN AUTOMATED CARS

### CORE STAGES OF AI SELF-DRIVING CARS

When the self-driving car is in the action, it goes through five stages:

- **Sensor's data collection and interpretation**
- **Sensor fusion**
- **Virtual world model updating**
- **AI action planning**
- **Car controls commands issuance**

### APPLICATIONS OF AI IN SELF DRIVING

- **SENSOR DATA PROCESSING:** A lot of sensors are used which provide the data of the vehicle during its operations. Information about the roads, other vehicles on the roads and impediments are being noticed are taken into consideration according to which the action is taken.
- **PATH PLANNING:** To optimize the trajectory of the car path planning is of paramount importance as it leads to better patterns of traffics. Reducing delays and avoiding congestion on roads, is only because of the planned AI algorithms.
- **PATH EXECUTION:** when the path is planned, the car is ready to navigate the conditions of the roads by detecting various objects around itself while reaching to its destination.
- **MONITORING VEHICLE'S CONDITION:** Predictive maintenance helps in predicting the future problems which save a lot time and money. Through, these predictions only there is more enhancement in the decision making.






### WORKING OF SELF DRIVING CARS

Artificial Intelligence is the principle of self-driving cars. Usage of huge amount of data from recognition of image systems with the help of machine learning and neural networks show the footsteps for making the drive autonomously. Patterns are being identified in the neural networks which are being fed by the machine learning algorithms. The data which is brought up includes the images which are captured by the cameras

placed on the self-driving cars. Through these pictures only, neural network identifies various objects such as traffic lights, sign boards, trees and other parts of the surroundings.

Give

As of now, there are two companies providing self-driving cars:

<u>COMPANY</u>	<u>MODEL</u>	<u>PICTURE</u>
Tesla	Model S	
Tesla	Model X	
Tesla	Model 3	
Tesla	Model Y	
Google	Waymo	

## TESLA COMPANY

TESLA MOTORS is considered appropriate to be one of the leaders in the field on automobile manufacturing industry. The company placed their milestone in 2003 by our enlightenments: - MARTIN EBERHARD, MARC TARPENNING, JEFFERY B. STRAUBEL, IAN WRIGHT. ELON MUSK, a man with a bright, sharp vision, joined THE CHAIRMAN OF THE BOARD in February 2004, where he shared the first major sales.

As per the records, in the first half of 2016, the company holds the second rank in the sale of electric cars (21.6 thousand hatchbacks of Model S) as compared to the world leader Nissan. A speedy rapid development can be seen by the shared part of NICOLA TESLA, financial investment and innovation policies.

Tesla Company develop and deploy autonomy on a wider spectrum and believed in the approach which is built on AI for the vision and planning which is quite supported by the efficient use of hardware to achieve the goal of self-driving.

### Hardware

Build silicon chips that power our full self-driving software from the ground up, taking every small architectural and micro-architectural improvement into account while pushing hard to squeeze maximum silicon performance-per-watt. Perform floor-planning, timing and power analyses on the design. Write robust, randomized tests and scoreboards to verify functionality and performance. Implement compilers and drivers to program and communicate with the chip, with a strong focus on performance optimization and power savings. Finally, validate the silicon chip and bring it to mass production.

### Neural Networks

Cutting edge research, I being applied for the deep neural networks on problems which ranges from perception to control. The per camera networks analyze the raw images for performance of semantic segmentation, object detection and monocular depth estimation. The birds-eye-view networks take video from all cameras to output the road layout, static infrastructure and 3D objects directly in the top-down view. The networks learn from the most complicated and diverse scenarios in the world, iteratively sourced from our fleet of nearly 1M vehicles in real time. A full build of Autopilot neural networks involves 48 networks that take 70,000 GPU hours to train. Together, they output 1,000 distinct tensors (predictions) at each timestep.

### AUTONOMY ALGORITHMS

Develop the core algorithms that drive the car by creating a high-fidelity representation of the world and planning trajectories in that space. In order to train the neural networks to predict such representations, algorithmically create accurate and large-scale ground truth data by combining information from the car's sensors across space and time. Use state-of-the-art techniques to build a robust planning and decision-making system that operates in complicated real-world situations under uncertainty. Evaluate your algorithms at the scale of the entire Tesla fleet.



### CODE FOUNDATIONS

Throughput, latency, correctness and determinism are the main metrics we optimize our code for. Build the Autopilot software foundations up from the lowest levels of the stack, tightly integrating with our custom hardware. Implement super-reliable bootloaders with support for over-the-air updates and bring up customized Linux kernels. Write fast, memory-efficient low-level code to capture high-frequency, high-volume data from our sensors, and to share it with multiple consumer processes— without impacting central memory access latency or starving critical functional code from CPU cycles. Squeeze and pipeline compute across a variety of hardware processing units, distributed across multiple system-on-chips.

### EVALUATION INFRASTRUCTURE

Build open- and closed-loop, hardware-in-the-loop evaluation tools and infrastructure at scale, to accelerate the pace of innovation, track performance improvements and prevent regressions. Leverage anonymized characteristic clips from our fleet and integrate them into large suites of test cases. Write code simulating our real-world environment, producing highly realistic graphics and other sensor data that feed our Autopilot software for live debugging or automated testing.

#### Fatal crashes of Tesla Self-driving cars since launch:

- Handan, China (January 20, 2016)
- Williston, Florida (May 7, 2016)
- Mountain View, California (March 23, 2018)
- Kanagawa, Japan (April 29, 2018)
- Delray Beach, Florida (March 1, 2019)
- Arendal, Norway (May 29, 2020)
- The Woodlands, Texas (April 17, 2021)
- Fontana, California (May 5, 2021)

#### WAYMO – GOOGLE’S SELF DRIVING CAR

Google being a multinational, technological company, is also nailing the world by introducing its first self-driving car project named Waymo. It uses the creative technology which consists of sensors, detection of light and its range and cameras originated by humans. All together giving the information to rectify the object in its way and how to react. The duration of this work takes place in milliseconds. More data is incorporated when the system is being driven more and more.



## WORKING OF WAYMO

- The person sets the destination point. When he/she sets the destination point, the software of the car will automatically calculate the distance and the best route.
- Lidar, which is a rotating, roof-mounted light detection, monitors the range of 60 meters around the car. Through this a 3D map which is dynamic is created.
- A sensor is already placed on the left rear wheel. It has the responsibility for monitoring the sideways movements to detect the position of the car, relative to the 3D dynamic map.
- For calculating the distance between the car and the obstacles, radar systems are already installed in the front and rear bumpers.
- All the sensors in the cars are connected to Artificial Intelligence through the inputs are being collected from Google Sheet and video cameras present in the cars.
- Using Deep Learning, AI stimulates human perceptual and decision-making which helps in controlling the brakes and steering.
- If a human wants to take over the control, then he/she can access the override facility.

## CONCLUSION

In the world of technology, AI is playing a crucial role in every field, leading to the growth of industry. AI in self-driving cars has not only reduced the fatal accidents but also reduced the level of carelessness of the drivers. Every company is running and implementing on their own ideas from sensors to training of AI in self-driving cars and with the advent wheel of time, the technology is at its exponential growth which is easing the lifestyle of the human race.

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