

# Autonomous Driving Using Machine Learning

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**Abstract:** An autonomous car is a vehicle which is capable of operating i.e. driving on its own without human intervention. Until 2015, a fully autonomous car was just a dream. But due to rapid technological advances, the dream eventually became a reality. Autonomous vehicles which were able to perform just basic operations like moving forward or backwards with the help of a remote control are becoming fully autonomous by the day. The hideous looking autonomous car which had a ton load of sensors mounted on the roof is now becoming sleeker and nattier. Autonomous vehicles detect the surroundings using various techniques such as RADAR, LIDAR, GPS, odometer and computer vision. Advanced control systems interpret sensory information to identify appropriate navigation paths, as well as obstacles and relevant signage viz. wrong way, no right turn, no left turn, etc. Autonomous cars have control systems that are capable of analysing sensory data to distinguish between different cars on the road, which is very useful in planning a trajectory in which the car should manoeuvre in order to avoid a collision. This paper focuses on autonomous driving and demonstrates how a car will be able to drive without any human intervention by processing the input data taken from the sensors and applying various machine learning techniques to it, and thus making the correct decisions.

**Keywords:** Deconvolution, Hough transform, Internet of things, Lane detection, Machine learning, Neural networks, Swarm intelligence.

## I. INTRODUCTION

An autonomous vehicle is a vehicle which is able to drive by itself, intelligently without any human intervention. We've come a long way since the time when the first vehicle was invented by Ferdinand Verbiest. The vehicle was steam powered and had more problems than advantages. Since then, constant innovations within the automotive sector have created safer, cleaner, and more affordable vehicles. The industry now appears close to substantial change, engendered by autonomous, or "self-driving," vehicle technologies. This technology offers

the possibility of significant benefits to social welfare - saving lives; reducing crashes, congestion, fuel consumption, and pollution; increasing mobility for the disabled; and ultimately improving land use. You just type in your destination in the car and you're good to go! The car will navigate itself without you having to do a thing. Industry leaders like Ford, Mercedes Benz, BMW, Volvo, Tesla are investing significant amounts of money to perfect this technology.

While we may have witnessed what a self-driving car is recently in the past 2 or 3 years, researchers have been experimenting with this technology since the past 45 years. The first self-sufficient (and therefore, truly autonomous) cars appeared in the 1980s, with Carnegie Mellon University's NavLab and ALV projects in 1984 and Mercedes-Benz and Bundeswehr University Munich's Eureka Prometheus Project in 1987. Since then, numerous major companies and research organizations have developed working prototype autonomous vehicles.

An important point to note here is that Autonomous should not be confused as automated. Autonomous has a broader meaning in this context - it means the power for self-governance. An important distinction between the two points can be illustrated by the following example - An automated car is a vehicle which is programmed to drive itself continuously in a straight line without considering the obstacles that might come in front of the car, while an Autonomous car is vehicle which is programmed to drive itself continuously in a straight but with additional decision making power like stopping before an obstacle, following the correct signage on the road, etc.

Among the main obstacles and disadvantages due to a widespread adoption of autonomous vehicles, in addition to the technological challenges, are disputes concerning liability; the time period needed to turn an existing stock of vehicles from non-autonomous to autonomous; resistance by individuals to forfeit control of their cars; consumer concern about the safety of driverless cars; implementation of legal framework and establishment of government regulations for self-driving cars; risk of loss of privacy and security concerns, such as hackers or terrorism; concerns about the resulting loss of driving-related jobs in the road transport industry; and risk of increased

suburbanization as driving becomes faster and less onerous without proper public policies in place to avoid more urban sprawl.

## II. METHODOLOGY

### A. Swarm Intelligence

#### 1. What is Swarm Intelligence?

Swarm Intelligence (SI) is the collective behavior of decentralized, self-organized systems, natural or artificial. The concept is employed in work on artificial intelligence.

SI systems consist typically of a population of simple agents or boids interacting locally with one another and with their environment. The inspiration often comes from nature, especially biological systems. The agents follow very simple rules, and although there is no centralized control structure dictating how individual agents should behave, local, and to a certain degree random, interactions between such agents lead to the emergence of “intelligent” global behavior, unknown to the individual agents. Examples in natural systems of SI include ant colonies, bird flocking, animal herding, bacterial growth, fish schooling and microbial intelligence.

The application of swarm principles to robots is called swarm robotics, while ‘swarm intelligence’ refers to the more general set of algorithms. ‘Swarm prediction’ has been used in the context of forecasting problems [7].

#### 2. How does Swarm Intelligence work with Autonomous Driving?

The Four main pillars for Autonomous Driving are:

- Long distance RADAR system that can virtually see through anything, that means even through sand, dust, rain, snow - through all the things that are nebulous to the human eye.
- Cameras with image recognition software.
- Ultrasonic Sensors.
- Satellite imagery with real time traffic.

When all these are integrated with each other, we get a very robust overall system that almost acts like a digitally extended safety cushion for the car [7].

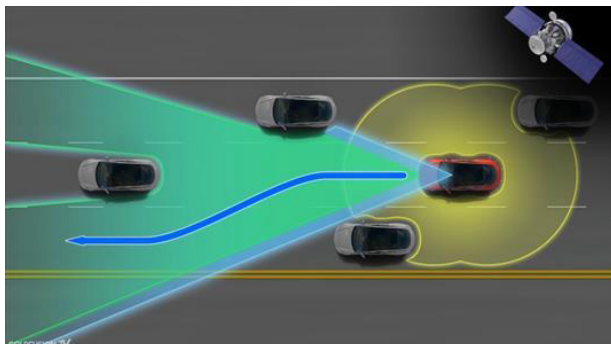


Fig. 1: Image Courtesy - youtube.com/coldfusionTV

The above image shows us how the vehicle decides in which trajectory it should be maneuvered in order to overtake the adjacent vehicles. It uses all systems - RADAR, GPS, Camera and the onboard sensors.

#### 3. Actual Working in Autonomous Driving

We learnt previously that in order to implement machine learning algorithms, we need to give a set of inputs first to algorithm so that it learns and classifies data or forms patterns according to the need. If SI is used in Autonomous Driving, each and every car is used to gain input for the algorithm. Let us take an example - Suppose company X wants to utilize SI in all of their cars. First, all cars of company X will be sold with the SI system present on the on board computer, but not in its deployed state. The system will still be in its learning phase i.e. the vehicle will only be drivable with human input - like a normal vehicle. When a substantial amount of company X's cars have been sold, the learning process will begin. Each and every habit of each and every driver will be examined and those driving habits will be used as inputs for the machine learning algorithms. How a driver negotiates a turn, how a driver controls the vehicle when there is heavy traffic, how a driver drives the vehicle on the freeway, how a driver drives the vehicle in hilly areas - everything will be taken into consideration. This driving habit of the driver in a particular area is clubbed together with the data from GPS. This data from a single car is collected and sent to a main computer. This main computer receives data from all of company X's cars, thus acting as a hive mind for controlling all of company X's cars. So, when one car learns how to drive in area Z, it is actually teaching all other cars how to drive in area Z. Due to this technique, millions of miles can be added to the data set and the cars will learn quickly how to drive in a particular area [7].

### B. Integration of all Systems for Safe Driving

A vehicle will still not be able to drive autonomously with the help of swarm intelligence. A vehicle has to respond to real time situations like a red light, a pedestrian crossing the road or any obstacle that comes in front of the vehicle. This is where the sensors mounted on the vehicle come into picture. These sensors include RADAR, camera, proximity sensors, gyroscopic sensors, etc. The sensors constantly collect data and send to the local computer on the vehicle. The local computer processes this data and takes decisions accordingly [7].

### C. Machine Learning for Image Processing

The images captured from the camera are worthless if some meaningful patterns are not detected in them. Machine learning techniques can be used to correctly identify a text or a sign in the image. This is highly useful for those the wrong way, one way, no left turn, no right turn signs.



Fig. 2: Image Courtesy - mathworks.com

The boxes are formed for each letter and each letter is fed to the machine learning classifier to understand what exactly does the sign mean [8].

### III. CONCLUSION

We've come a long way in the field of AI, machine learning - which has ultimately led to the possibility of autonomous driving. Just three years ago, autonomous cars seemed like a pipe dream relegated to a far-off decade in the future. The things which were just seen in science fiction are slowly starting to become a reality. As the systems become stronger, human errors are bound to be reduced, thus making the percentage of accidents or life threatening situations very less. But there is also the risk of hackers hacking into these systems and using them for vile purposes. Thus, the level of security systems should also be increased simultaneously, as systems are becoming autonomous by the day with very less human interaction. Some new rules and regulations also must be laid down as for who will be responsible in case any accident occurs. The following table shows us the different levels by which autonomous driving is designated. These levels are chalked out by SAE (Society of Automotive Engineers) [9].

SAE level	Name	Narrative Definition
0	No automation	The full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems.
1.	Driver assistance	The driving mode - specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all the remaining aspects of the dynamic driving task.

SAE level	Name	Narrative Definition
2.	Partial automation	The driving mode - specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all the remaining aspects of the dynamic driving task.
3.	Conditional automation	The driving mode - specific performance by an automated driving system of all aspects of the dynamic driving task with the expectation that the human driver will respond appropriately to a request to intervene.
4.	High automation	The driving mode - specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human does not respond appropriately to a request to intervene.
5.	Full automation	The full - time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver.

#### A. Where we are Today?

Today's most advanced fully autonomous features can be found in Teslas and a few other cars that allow drivers to take their hands off the steering wheel on a highway. Using a series of sensors and cameras, cars can also merge, self-park, stay within a lane and brake as needed. A lot of companies including renowned companies like Google, Uber, etc. are jumping on the autonomous bandwagon are trying to make autonomous driving safer and more reliable [7].

#### B. What can be Expected from the Future?

Currently we are at the level 3 of SAE automation level i.e. Conditional automation. In this, the human driver is expected to intervene in fallback performance of dynamic driving tasks. Efforts are being made to develop the software to the level 5 stage i.e. the full automation stage. We can expect to see fully

autonomous taxis by Uber in the near future. The Taxis will be summoned to a person by a mobile application and will take the customer to the destination of their choice. This will also make fleet management easier for the Taxi companies as each and every taxi can be remotely controlled. We can also expect Driver-assistance features get more sophisticated, and will sync up with GPS and navigation. So a driver should be able to input a destination while driving on a highway, turn on adaptive cruise control and let the car drive itself. When it gets to the appropriate exit, the car will return control to the driver. Trucks and Lorries which deliver goods can also be made autonomous using the software. In this way, the trucks will be able to deliver goods safely even if the driving conditions are treacherous and potentially life threatening to the driver. A lot of time can also be saved using the process because when a driver delivers goods after driving for - let's say 5 days, the driver may take 1 or 2 days as rest. These 1 or 2 can be saved and the truck which can drive by itself can immediately start with the delivery of new goods.

A look at the bigger picture posits that this technology is within our reach and these results are achievable. Though there are many implications of using this technology - for instance, possibility of hackers hacking the entire fleet of taxis or trucks and taking control of them or the AI system going haywire and controlling the fleet all by itself and not according to what it had been programmed to, the advantages are far more than the disadvantages. Still, the disadvantages can be reduced by improving security protocols and while progress must be made in the artificial intelligence field, it has to be made prudently [7].

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#### REFERENCES

- [1] T. Gu, J. M. Dolany, and J. W. Lee, "Automated tactical maneuver discovery, reasoning and trajectory planning for autonomous driving," *2016 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, IEEE, 9-14 October 2016.
- [2] F. Schneemann, and P. Heinemann, "Context-based detection of pedestrian crossing intention for autonomous driving in urban environments," *2016 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, IEEE, 9-14 October 2016.
- [3] M. Althoff, O. Stursberg, and M. Buss, "Model-based probabilistic collision detection in autonomous driving," *IEEE Transactions on Intelligent Transportation Systems*, vol. 10, no. 2, pp. 299-310, June 2009.
- [4] X. Chen, K. Kundu, Z. Zhang, H. Ma, S. Fidler, and R. Urtasun, "Monocular 3D object detection for autonomous driving," *2016 IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, 2016.
- [5] P. Amaradi, N. Sriramoju, L. Dang, G. S. Tewolde, and J. Kwon, "Lane following and obstacle detection techniques in autonomous driving vehicles," *2016 IEEE International Conference on Electro Information Technology (EIT)*, IEEE, 19-21 May 2016.
- [6] CNET [www.cnet.com](http://www.cnet.com)
- [7] ColdfusionTV [www.youtube.com/coldfusiontv](http://www.youtube.com/coldfusiontv)
- [8] Coursera Machine Learning Course [www.coursera.org](http://www.coursera.org)
- [9] SAE [www.sae.org](http://www.sae.org)
- [10] Tesla Motors [www.tesla.com](http://www.tesla.com)