Application of Machine learning Algorithms in Autonomous Vehicles Navigation System

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Abstract. Autonomous vehicles are the future of transportation and it also expected to become a fully-fledged reality within a decade. The major giants in the automotive industry like Toyota with Microsoft and Amazon, Mercedes with Bosch, Audi with Huawei, etc. are hard pressing their transition from conventional vehicle to autonomous vehicles. The state of Karnataka, for instance, had approximately 205,200 registered taxis higher than Madhya Pradesh 174,900 registered cabs from 2014 to 2015. This results in higher traffic congestion, pollution and high fuel consumption due to unorganized driving practice. As a consequence, this presents a great deal of opportunities for autonomous cars as they can significantly reduce the accident rate and improve effective and stress free parking, optimal running time, fuel economy etc. It also reduces traffic congestion as all the autonomous cars can be synchronized together through cloud. But the crucial part is their navigation system. Although a number of sophisticated forms of technology like such as radars, lasers, and high definition cameras for mapping, localization, obstacle detection, etc, are used, autonomous vehicles are still trying to reach perfection to navigate precisely under uninformed terrains and dynamics obstacles on the way like pedestrians, erratic drivers, traffic and climatic conditions. Events like heavy snow and rain, improper lane marking makes it hard to detect an obstacle on the road for evasive maneuver within limited response time period. Machine learning is one of the fast growing technologies that provide optimal solution to overcome the challenges in the autonomous navigation system. This paper focuses on the application of different machine learning algorithms and compares the use, challenge and scope of the same. The paper also focuses on the future direction of machine learning with reference to autonomous navigation system.

1. Introduction

An autonomous vehicle is one that can manage itself and perform important conditions with no human intercession, through the capacity to detect its environment. The future relies on autonomous vehicles, where the driving is no longer controlled by humans rather the computers would take control. With drivers controlling the vehicle, making left-hand turns (right-hand turns in India) are dangerous, as one needs to drive across approaching traffic. Drivers of immense trucks have obliged detectable quality and tremendous outwardly debilitated zones around them, which infer they most likely won't have the alternative to see you. Along these lines, driving around tremendous trucks can be a driving test and...
maybe extensively progressively irksome in poor atmospheric conditions. Likely the best issue when driving around night time is diminished detectable quality. Your view is confined to the partition illuminated by your vehicle's headlights, and you don't have the upside of concealing and multifaceted nature that you have during the daytime. Today, various drivers are working their vehicles even more commandingly. This happens when a driver outperforms beyond what many would consider possible, follows too eagerly, fails to obey traffic controls and makes less than ideal turns and moves, among other mighty driving practices.

Prior Intel picked India for its robotized driving arrangements, beginning to assemble information on traffic designs, side of the road conduct and foundation conditions in the nation. The organization intends to use the information gathered to make calculations that could be utilized in India alongside abroad to advance robotized driving. As of late Mahindra and Mahindra displayed a semi-autonomous tractor and unveiled designs for a completely autonomous one in the coming years. The organization, which is presently the biggest tractor maker on the planet by volumes, is intending to take ranch automation to an unheard-of level. Besides, organizations, for example, Ati Motors look to use autonomous innovation to support a substantial body that necessities to dock at a progression of getting together stations. Right now, an organization is building up a self-sufficient load vehicle that will run inside an enormous processing plant edifice. Its answer can in a split second supplant a trolley conveying substantial parts that are moved starting with one spot then onto the next, either by people or a physically worked pull. In any case, autonomous vehicles in a nation like India would mean better street and transport framework, town arranging, organize, and propelled remote availability.

2. Autonomous Vehicles
An autonomous vehicle can move along a clueless landscape independently, with the resource of data received from various sensors used in the vehicle. This occurs with no human intercession. This used to be a fantasy yet because of the improvement of innovative work of innovation, autonomous vehicles would come into existence within the next 5 to 10 years. This has become possible due to the sustainable development of sensor technologies like lasers and radars, GPS route, non-freezing stopping mechanism, voyage control, closeness sensor, etc and other methods that provide all the vital data necessary for the efficient functioning of an autonomous vehicle. With developing interest and progression in computerized reasoning and machine learning, autonomous vehicles is being given keen concern and are awaited to be in the roadmaps of every country shortly.

Without contention, computers are known for their speed and accuracy, the flaws done by human intervention is significantly reduced when implemented in an autonomous vehicle. Due to computerization in an autonomous vehicle, a tremendous decrease in road blunders could be evident. At the point when associated with one another through a system, autonomous cars are a lot of fit for working in an exceptionally synchronized swarm of vehicles. This associated system of autos can decidedly influence the traffic stifling during the top hour in significant urban areas. As odd as it might sound, an autonomous vehicle is equipped for decreasing CO2 emanation. This is a result of the insightfulness of the PC that is behind the independent.

Scenes of improving the quality of life and comfort are infinite. The elderly and physically handicapped can be independent of others. Autonomous vehicles can significantly reduce urban CO2 emissions by 80%, lowering traffic congestion & transportation costs by limiting fuel consumption and can improve walkability and liveability.

An enormous number of car and innovation mammoths, for example, Tesla, Waymo, Uber, GM, Ford, BMW, and Mercedes Benz, are attempting to make the autonomous vehicle a reality. The hardware parts empower the vehicle to finish such assignments as observing (through sensors), conveying (through V2V innovation), and traveling (through actuators). While the software resembles the brain, which forms data about the earth with the goal that the vehicle comprehends what move to make — regardless of whether to move, stop, slow down, and so forth. Autonomous vehicle software can be sorted into three frameworks: observation, arranging, and control.
3. Challenges in Autonomous Vehicle

3.1. Advanced techniques and sensors used in AV
Autonomous vehicles depend on cameras set on each side for a 360-degree perspective on their condition. A few cars even incorporate blind-spot detection cameras with super-wide focal points that give the driver a wide perspective of what's behind the vehicle. Even though they give precise visuals, the camera finds it difficult to identify objects under conditions like low perceivability, similar to mist, downpour or evening time. Here, radar sensors can enhance camera vision and improve location for self-driving vehicles. The radio waves from the radar strike an obstacle and reflect, giving information like its speed and separation; in any case, they can't recognize various kinds of vehicles. That is the place Lidar comes in. Lidar technology gives a three dimensional perspective of encompassing vehicles and people by emitting lasers in every possible direction [1]. By emanating undetectable lasers at fantastically quick speeds, Lidar sensors can paint a point by point 3D picture from the signs that bob back momentarily.

3.2. Challenges of AV in different systems and components
Current technology in autonomous vehicles is not well equipped to be put under varying climatic conditions like a substantial downpour, snowfall, etc. In the case of dips and ongoing changes in roads, the system fails to identify the same. A minute malfunction with the software can lead to a devastating situation for both the vehicle and the passenger. [2]. Autonomous cars can learn the way the driver drives: slow, moderate or even faster. On a street imparted to human drivers, they might be irritating to explore around for human drivers. The assassin would take an edge over autonomous vehicles by stacking them with explosives and other mass destructive weapons.

3.3 Challenges for AV for Indian Scenario
Earlier the road transport and highways minister Nitin Gadkari said autonomous driving won't be permitted in India on the grounds that the administration won't advance any innovation that comes at the expense of employment. The nation has 40 lakh drivers and there is a lack of 25 lakh drivers, and that driving abilities can give work, bombing which occupations of 1 crore individuals would be in question. Indian engine vehicle rules will likewise be a test for autonomous vehicles as the Indian Motor Vehicles Act, 1988 don't right now permit completely computerized frameworks in the nation. That is the reason major remote car players don't consider India to be a good market for autonomous vehicles. Impoverished road and transport infrastructure is another hindrance in the nation for autonomous vehicles. Be that as it may, Indian companies such as Tata, Mahindra, and few other software companies have not quite their research in innovating autonomous vehicles.

4. Autonomous Vehicle Navigation System
A navigation system is an electronic framework that decides the situation of a vehicle and instructs the driver about the courses to a particular area. The navigation system decides the present position and course of the vehicle employing GPS signs, sensors or other information from the outer sources.

It has 3-components in particular GPS collectors, microcontrollers and memory. The first GPS beneficiary gets a signal from GPS satellites. The received signs furnish with data, for example, longitude, scope, ground speed and substantially more. Next, the controller peruses this sign and does all the handling structure the given information. At long last, the data that is put away in memory appears on the screen. The self-ruling vehicle route framework gets information constantly from GPS satellites, installed sensors and gives momentary areas of the vehicle, street arrange, traffic information, and so on. The autonomous vehicle navigation system utilizes essential sensors like Camera, Radar, and LiDAR. Together, they furnish the vehicle with rich data about its environment.
4.1. Challenges of Navigation System in AV

4.1.1. Street conditions. Road conditions could be exceptionally eccentric. There are both smooth and obviously checked expansive expressways and profoundly disintegrated streets with no path stamping. In addition to this, the roads are damaged and there are no clear outside directions for tunnels.

4.1.2. Climate conditions. Weather conditions play another spoilsport. The autonomous vehicle needs to be able to equally perform under all sorts of climatic conditions.

4.1.3. Traffic conditions. Autonomous vehicles would need to get onto the street; where they encounter other autonomous vehicles and people-driven vehicles as well. Any place people are included; regularly individuals might be disrupting traffic norms. Something may intervene suddenly, and the vehicle needs to perform spontaneously to avoid a collision.

4.1.4. Radar Interference. Autonomous vehicles use lasers and radar for a route. While in operation, the vehicle transmits and receives radio waves when bounces back from the foreign objects. But, the vehicles would not distinguish between the waves as this innovation is utilized for every autonomous vehicle. Although there are different frequencies, it won’t be sufficient for each vehicle that’s to be produced [4].

4.2. Different Methods in Navigation System

In an autonomous vehicle, a vision based route framework is ordered into map-based, map – building based and map-less route framework. In a map-based route, it is basic to furnish the autonomous vehicle with an arrangement of tourist spots expected to be found during the route, so an independent vehicle can utilize the guide to gauge its situation by coordinating the perception against the desired portrayal in the information base. Though in map building based methodology, the autonomous framework involves looking through the earth and building a portrayal of it. In any case, the downside with the entire framework was execution, which took five hours to go 20 meters. In conclusion, is the map-less route framework, right now are centering at this framework. The map-less route is barely new contrasted and the recently characterized arrangements. The map-less visual route systems talked about here are arranged as per kinds of intimations utilized during the route which are optical stream, appearance-based, and object acknowledgment route procedures dependent on include following [5].

4.2.1. Optical Flow Method. Utilizing the optical stream route, the framework can recognize that the items’ course of movement from the development of these articles. Contingent upon the scope of activity can be adjusted by changing the overall speed of the vehicle. For example, highlights, for example, "time-to-contact" (contingent upon speed) is more important than separation when it is important to maintain a strategic distance from a snag [6].

4.2.2. Appearance-Based Method. Appearance-put together strategies in a general sense depend with respect to retaining the workplace. The fundamental thought is to store pictures or formats of the earth and partner these pictures with directions that will control the vehicle to its last goal. These strategies fundamentally comprise of two techniques. The first is the preparation stage in which pictures or conspicuous highlights of the earth are put away as model layouts. Also, in the route arrange, the vehicle needs to distinguish the earth and restrict itself by coordinating the present picture with the put-away layouts.

4.2.3. Object Recognition: Rather the retaining the earth, the vehicle fabricates a guide called an "S-map" which is a 2D lattice that stores the projections of the watched milestones as they are perceived.
After the area of the milestone is anticipated into the s-map, the vehicle produces the way of utilizing a GPS-like way organizer and utilizes an odometer to arrive at the objective.

4.2.4. Route Techniques Based on Feature Tracking. Following the movement of moving components, including lines, corners, or explicit locales in a video arrangement has become a mainstream and vigorous method for performing route. It decides the direction and movement of the articles by following and discovering relative changes in the situation of separated highlights. Highlight based strategies essentially fragment depiction and current pictures into tourist spots and foundation.

5. Machine Learning Algorithm in Navigation

Machine learning is a subset of artificial intelligence that allows the user to equip their system to work in the grey area of fuzzy logic similar to human intelligence. Machine learning is capable of altering the rigidity of programming by providing more options for the computer to make a rational and moral decision on its own through rigorous training and experience. The aim is to make the system more smart and intelligent by allowing it to learn, relearn and unlearn based on experience to make the experience more and more efficient and effective and most of all, adaptable to the situation.

Reinforcement learning is one of the three major subdivisions of machine learning models where it uses the ability to learn to be incorporated under a system. The central theme of reinforced learning is to engage in a different activity and learning the pros and cons by experience through rewards and mistakes respectively. This method allows the machine to decide autonomously the right way of doing things rather than to be dictated by an operator or a programmer. And every time the system makes a wrong judgement it integrates the bad learning to the next iteration and thereby it reinforced the next decision to mitigate the possibilities of error. In other words, for every trial done, the machine learns to move forward and does lesser error than the previous trials.

5.1. Regression algorithms

To develop an image-based model for prediction and feature selection is the biggest challenge and it is done by regression algorithms. Autonomous cars can use regression algorithms like neural network regression, decision forest regression, and Bayesian regression [7].

5.2. Pattern recognition algorithms (classification)

Sensors provide us with a wide range of natural information; sifting of the pictures is required to perceive examples of an article classification by precluding the insignificant information focus [8]. Pattern recognition algorithms are acceptable at precluding uncommon information focuses. Acknowledgment of patterns in an informational collection is a significant advance before characterizing the items. These kinds of an algorithm can likewise be characterized as data reduction algorithms.

5.3. Clustering

At times the pictures got by the framework are not clear and it is hard to recognize and find objects. With the help of information focuses, the clustering algorithm is capable of recreating patterns. It depicts both issues and techniques like regression [9]. Centroid-based and various leveled are the displaying approaches by which clustering techniques are commonly composed. The most ordinarily utilized sort of algorithms is K-means and Multi-class Neural Network [10].

5.4. Decision matrix algorithms

Decisions of a vehicle like accelerating, turning, braking, etc., is made by decision matrix algorithm. Several decision models are trained independently and the predictions of every decision model combinedly make the final decision with minimal possibility for flaws. Adaboosting and gradient boosting (GDM) are the generally used decision matrix algorithms.
6. Future Scope of ML in Autonomous Vehicle

Utilizing machine learning (AI) in the car industry has prompted the advancement of a completely autonomous driving vehicle. AI has the accompanying favorable circumstances like:

6.1. Self-Driving

Computer-based intelligence permits vehicles to learn, and that is the thing that driving requires. Artificial intelligence gives vehicles the capacity to learn and modify their principles. Moreover, all the data a vehicle gathers is accessible to the remainder of the fleet. This makes a system of cars that learn as they go.

6.2. Driver Assistance

A portion of the driver collaborator highlights, for example, blind-spot surveillance cameras, lane departure warning, parking assistance, and the emergency braking exists for the travelers’ wellbeing. It helps the driver for safe and assisted ride. In case of emergency, the system would take over the control leaving no damage for the vehicle as well as the driver.

6.3. Prescient Maintenance

Man-made brainpower screens all the sensors inside one, which can without much of a stretch recognize any changes, which may demonstrate disappointment, sometime before it could influence the vehicle's presence.

6.4. Cloud Services

Associated vehicles create noteworthy measures of information. Normally, independent vehicles will make 4,000 GB every day. Man-made intelligence cloud stages guarantee that this information is accessible at whatever point it's required. Artificial intelligence-based cloud stages are the ideal arrangement. The robust and flexible infotainment system can be customized according to the driver’s needs.

7. Conclusion

Autonomous vehicles are no longer a farfetched dream but are current realities and are just around the corner to be made into a fully-fledged reality. Driverless autonomous cars can be the one point solution to many of the problems that are faced in transportation and that too in an overpopulated country like India where accidents due to lack of systems, driver attitude and other problems like traffic congestion, erratic transport planning, and execution are the most common problems. Autonomous vehicles provide much greater customer experience along with safety. It ensures the rightful use of resources is properly and orderly carried out right from fuel, electricity, infrastructure, etc., making it independent of human interventions provides much precise and safer driving experience and reduces the mental-physical pressure a driver has to undergo from time to time. The latest development in fields of sensors, electronics, processors, manufacturing processes and advanced techniques of artificial intelligence has opened the doors of reality for these autonomous vehicles far and wide. Despite the advances in technology, there is still a long road before autonomous vehicles obtain perfection in navigating in a real-life road condition where there is an infinite number of variables to which the system should adapt itself to. Navigation in actual road case scenario especially for a country like India needs more development and thought processes to be put in action. Some many different methods and technologies are used to overcome different barriers in real-world navigation and artificial intelligence in its sense can provide the versatility that is needed to dynamically adapt and change the course of the vehicle navigation in a split second. Machine learning provides that humans like intuition to decide on the go which is not possible in many other technologies. When ML is integrated with the navigational system of the vehicle, it powers the
technology to be more dynamic and gives the ability to work in a fuzzy and grey area just like how the human mind perceives it. On the whole, machine learning and artificial intelligence, in general, can transform the field of autonomous vehicles and its full potential is yet to be studied and utilized to its fullest.

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