Application of Self Driving Cars (With detection of sidewalks, road lines, etc.)

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# INTRODUCTION

This section will discuss autonomous vehicles and their significance in daily life.

Autonomous cars are self-driving vehicles that operate in autopilot mode with little or no human input, employing sensors such as adaptive cruise control, GPS navigation technology, anti-lock braking system, and active steering. The roadways are navigated using sensors such as lasers and cameras. All those sensors are employed by Artificial Intelligence

Vehicles are now operated by humans, which is the first of five stages of automation, including technologies like as cruise control and parking sensors. With level five, the cars will drive themselves; all we should do is sit back and tell them where they are going. The biggest benefit can be safety. More than a million people are killed in vehicle accidents each year. Human mistakes are responsible for 90% of them: people become fatigued, lose attention, or just drive incorrectly. Greater autonomy can eliminate unsafe and harmful driving habits. Reduced devastation from intoxicated driving, narcotic driving, unbelted car occupants, speeding, and distraction may hold the most potential. To make automobiles safer, we must be able to make rapid judgments in a variety of situations and share the road with other vehicles, pedestrians, and bicycles. Greater independence would be another advantage. People with impairments or even seniors who are unable to drive can be self-sufficient. Automated cars can assist individuals in living the life they desire. As automated technology improves safety, it will assist in lowering costs and saving money by lowering medical bills, insurance, and car maintenance costs. We might engage in enjoyable activities such as replying to email or viewing a movie in a completely autonomous car, resulting in increased productivity. Autonomous vehicles may cut fuel use by increasing the economic attraction of electric vehicles.

There will be much work to be done, but self-driving cars have the potential to drastically reduce the number of road accidents and save millions of lives. Underpinning AI methods like as computer vision, machine learning, and others can be used to govern how autonomous cars perform. Waymo began as a Google self-driving car project, which was one of the first completely autonomous cars in the world. Steve Mann, who was legally blind, drove the automobile on a public road in October 2015. There was no steering wheel, no dashboard, and only an emergency stop button in that automobile. Despite this, we are still a long way from having a completely autonomous car that can operate without human interference.

The working of autonomous cars and transportation, as well as their applications, intelligence behind it will be the focus of this paper.

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Figure 1 Infographic of Self driving car and sensors

# BACKGROUND AND PROBLEM SPACE

This section will provide a brief history of autonomous vehicle development, as well as an explanation of how autonomous vehicles see and the function of artificial intelligence in this application.

Long before today's digital giants rose to prominence, a group of German engineers led by Ernst Dickmanns developed a car that could maneuver through French traffic without the assistance of humans. The notion of self-driving automobiles first appeared at a **New York City show in 1939**. **General Motors** only had a vision of self-driving vehicles at the expo, and they wanted to show the world how they will appear in the future. They had already realized their aim by the year 1958. They made some significant changes to the existing autonomous car idea. They fitted pickup coils to the front of the automobiles, which would detect the current of passing air and steer the vehicle to the left or right. The more inventive concept came from the Japanese. To steer the car, they employed a camera system to analyze and analyze the image of the road; nevertheless, the technology had its own limitations: it could only go at a maximum speed of 20 miles per hour. Germans eventually fixed these issues. They devised the innovative new system known as vammers. They deployed a sophisticated and complex camera system to quickly analyze images of the road conditions.

When it comes to how the autonomous car sees, there are **laser sensors** and **a camera** in the front, **radar sensors** in the back, **a top-down camera**, and **a large computer** in the trunk; however, all this visual data can be combined so the car can figure out what to do. A picture containing text, road

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Figure 2 Sensors in Autonomous Cars.

Despite the best efforts of many of the world's major companies and automakers, completely autonomous vehicles are still a long way off, save in limited pilot projects. Driving is one of the most difficult things that humans undertake on a regular basis. Following a set of rules isn't enough to drive like a person, because humans do things like establish eye contact with other drivers to affirm who has the right of way, respond to weather conditions, and make other decisions that are difficult to codify in rigid rules. Even seemingly easy aspects of driving, such as following things surrounding a car on the road, are far more difficult than they appear. All of information is combined by the car's computers to create a picture of where other vehicles, bicycles, pedestrians, and barriers are located and how they're going. This phase requires a large amount of training data, since the automobile must rely on millions of kilometers of driving history to create assumptions about how other objects could move. Because there isn't enough training data on the road, the cars must rely on simulation data to train. However, engineers must ensure that their AI systems will generalize appropriately from simulation data to the real world.

Artificial intelligence is just machine intelligence. We didn't have enough data to train the machines or enough CPU capacity to process it until lately. **A computer can learn from observational data using a deep learning neural network.** Deep learning is a collection of techniques used by computers to learn within neural networks AI. If we wish to operate an autonomous vehicle, **the vehicle must be able to learn on its own and efficiently handle complicated issues.**

If we want to successfully operate autonomous driving, we need to address three major technological foundations. The first is sensing, which is defined as **object recognition and second one is mapping with high accuracy and third is right driving policy.** Combination of all these would guarantee a safe safety, if done right. The first method is to utilize a 3d sensor such as a laser scanner to identify automobiles and people, which are then characterized as the car's 3d coordinate system, and the car is then located in an HD map. All that remains is for you to spin the car. Step one detects vehicles and pedestrians, which are then recorded on the high-definition map. Every sensor that is added must be raised to 3D. The transition from 2D to 3D is quite difficult. Another method is to utilize a camera to identify both automobiles and people, as well as drivable pathways. By projecting the automobile onto the picture space, you can locate it on the HD map. Making driving judgments, which is a distinct machine learning technique called **reinforcement learning** in which you interact with the environment, is the third way. The actions or predictions in supervised learning have no impact on the environment. As a result, we can gather all the information ahead of time.

**AI has made significant progress in areas such as object identification and computer vision.** All these developments have aided in the development of self-driving automobiles. However, because this is a real-world challenge, it is challenging for AI to determine the level of dependability required for application implementation. One issue is the need for a large amount of training data. Because machine learning works better with increased data, presenting self-driving cars billions of hours of camera video of driving behaviors is a good approach to train them. And because some scenarios are uncommon — such as observing a vehicle collision ahead or meeting road debris — the automobile may be out of its depth because it has only met the condition once in its training data.

# LITERATURE REVIEW

## Artificial Intelligence Integrated Blockchain for Training Autonomous Cars

Integrated Artificial Intelligence Blockchain proposes combining Artificial Intelligence with Blockchain Technology, two of the most cutting-edge technologies available today, to create a wide range of potential that may be described as revolutionary in the realm of technology. By leveraging blockchain for transmitting acquired knowledge, this notion of an artificially intelligent blockchain may be utilized to considerably ease the learning process of autonomous, driverless, self-learning autos. Reinforcement learning is used by autonomous vehicles to learn. Consider teaching a self-driving car to apply the brakes when it gets too close to a wall. The automobile first continues to drive until it collides with the wall many times. The automobile first continues to drive until it collides with the wall many times. These events are recorded in the car's memory, and after a few crashes, the car learns from its mistakes that it must stop when it gets too close to a wall. In today's business, each automobile is uniquely educated until it understands when to stop automatically to avoid an accident. This study suggests that each automobile be connected to a shared public ledger where they may exchange their experiences so that all cars using that shared ledger can learn when to stop from the experience of a single car, avoiding the time-consuming job of training each car individually. Blockchain technology may be used to facilitate this communal learning (Gandhi & Salvi, 2019).

This idea of a shared public ledger can help with the difficulty of training thousands of automobiles in a parking lot. The suggested approach intends to teach many automobiles by training only one car and then using blockchain technology to share that car's expertise with all other cars on the network.

## Autonomous Car Based on Teaching-and-Playback Control

Autonomous automobiles, often known as self-driving cars, are becoming more common. An autonomous vehicle that runs without the usage of high-spec sensors and processors may be constructed in a small workspace. The car will go forward by utilizing the previously taught travel data. The teaching and playback technique is one of the control approaches that allows autonomous cars to be built with a small work area. A remote-control automobile is employed in this study to simulate hardware. When using an android-based remote control to operate the automobile in teaching mode, the data stored in memory is read line-by-line to operate the vehicle. The test results show that straight steering is 80 percent successful, 60 percent right-turning steering is 60 percent successful, 60 percent left-turning steering is 60 percent successful, 70 percent turning right-turning steering wheel to destination is 70 percent successful, and steering turning right turning left according to route and up to 60 percent destination is 70 percent successful (Basjaruddin, Baki, & Suhendar, 2020).

This work created a teaching and playback method for autonomous vehicle control. The proposed method is put to the test using a remote-control automobile and hardware simulation. The findings of this study promote the development of self-driving automobiles for certain work environments.

## Development of an Autonomous Driving Robot Car Using FGPA

Self-driving technology is being actively developed. The autonomous vehicle driving utilizing FPGA is the focus of the FPT 2018 FPGA design competition. We discuss our autonomous driving robot automobile for the design competition in this article. The PL (Programmable Logic) and PS (Processor System) parts of the Xilinx FPGA Zynq 7020 were used to create our robot automobile. The hardware circuitry for detecting dolls used as people is based on PL. PS is a software application that does image processing for lane maintaining, navigation, and motor control. Our system makes use of the PYNQ environment, which allows Python to control hardware (Kojima & Nose, 2018).

The current version of our robot automobile was described in this publication. To create our robot automobile, we established the following development policy: Using a reliable operating system and image processing libraries, for image processing, current FPGA deep learning technologies were used. Using a detachable wireless network adapter to obtain debugging information while driving and repairing or swapping using commonly available components.

The robot car's dimensions are L17cm x W11cm x H28cm (not including cables). The web camera is set high to capture a large region. Our robot's construction is shown in Figure 4. FPGA boards are utilized for our robot automobile to save development time. Arty Z7 and Zybo Z7-20 are Digilent FPGA boards [2]. The Xilinx Zynq 7020 is used on both FPGA boards, and it contains a hardware IP processing system (PS) and programmable logic (PL).

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Figure 3 Photograph of Robot Car

## Design and Development of Smart Cars Model for Autonomous Vehicles in Platooning

The study proposes a prototype concept for a new automobile model that can be driven in platooning. After each portion has been tested in real time individually, the automobile system prototype is built, and the hardware component system is programmed to carry out its job using the C++ programming language. This regulates the car's behavior, which is evolved in real time, as if it might become an autonomous vehicle capable of avoiding collisions and maintaining a safe distance from the vehicle in front of it on the road. The trial findings demonstrate the effectiveness of our automotive model. Furthermore, the implementations on each automobile are created at a minimal cost, which is a benefit (Luu, Ciprian, & Doinita , 2019).

The goal of this novel automobile model prototype design was to provide a more efficient study and examination of the control approaches for navigation purposes, and it was equipped with a "collision avoidance" (CA) system. If a car in front of you approaches and the CA system determines that the vehicle's speed is unsafe, the CA system deploys the brakes to slow or stop the vehicle. To put it another way, the goal of this article was to develop smart automobiles for lane following that can avoid colliding with other vehicles while maintaining a safe distance from cars ahead on the road.

## 3D Objects Detection in an Autonomous Car Driving Problem

The subject of autonomous driving is one of the most pressing issues in both research and industry. Autonomous vehicles are intended to reduce traffic congestion, reduce the frequency of traffic accidents, give the capacity to move items in hazardous situations for humans, and broaden the possibilities for individuals with disabilities to use cars, among other things. To tackle this problem effectively, numerous subtasks must be considered, including localization and mapping, static and dynamic object identification, motion planning, and control. We look at one of the objectives of an autonomous vehicle control system in this paper: 3D object identification and localization. We investigate existing detection algorithms that combine data from a variety of sensors, including cameras, depth sensors, and LIDARs. We undertake experimental tests on actual and simulated data acquired using CARLA, an open-source simulator for autonomous driving research, to assess the effectiveness of these strategies in an autonomous driving challenge (Agafonov & Yumaganov, 2020).

The following challenges should be solved in general while designing a decision-making system: The use of an environmental model that accounts for unpredictably changing environmental conditions, a limited range of perception and visibility, as well as possible noise and uncertainty in the perception and localization systems; interaction with other road users: vehicles, cyclists, and pedestrians.

## A Self-Driving Car Architecture in ROS2

In this paper, we provide a ROS2-based architecture for a self-driving automobile. Self-driving cars must make judgments in real time based on their sensory input, requiring excellent dependability and a high level of functional safety. Self-driving automobiles are, in theory, robots. However, ordinary robot software, and the earlier version of the Robot Operating System (ROS) in particular, does not always match these requirements. The situation has altered with the successor ROS2, which might be considered a solution for automated and autonomous driving. Existing ROS-based robotic software proved insufficient for safety-critical applications such as self-driving automobiles. We propose an architecture for a self-driving automobile that uses ROS2 to provide safe and dependable real-time behavior while maintaining the benefits of ROS, such as a distributed architecture and standardized message formats. Our technique is plausible for autonomous driving under the required real-time conditions, according on preliminary tests using an automated actual passenger car at lower and higher speeds (Reke, et al., 2020).

A novel software architecture based on ROS2 for autonomous driving was introduced and debated. We began by defining software architectural criteria and proposing a feasible secure, reliable, and real-time solution. For several autonomous driving situations, the architecture was effectively assessed in terms of real-time and usability. It is demonstrated that a decent real-time behavior of a ROS2 system is conceivable, but only if all of the particular real-time coding needs are taken into account during implementation.

## Autonomous Cars: Research Results, Issues, and Future Challenges

The automotive industry has made significant progress in producing dependable, safe, and economical automobiles during the previous century. Autonomous automobiles are becoming a possibility thanks to substantial recent breakthroughs in processing and communication technology. In test driving, autonomous automobile prototype models have already logged millions of kilometers. As they prepare for autonomous cars' complete commercialization in the future years, leading technological businesses and automotive manufacturers have invested a stunning amount of money in autonomous car technology. However, several technical and nontechnical issues must be addressed to achieve this goal: software complexity, real-time data analytics, and testing and verification are among the greater technical challenges; consumer stimulation, insurance management, and ethical/moral concerns are among the nontechnical concerns. To address these issues, intelligent solutions must be developed that meet the needs of consumers, business, and government rules and policies. Consequently, we give a detailed overview of current autonomous vehicle technology outcomes. We explore current difficulties that are impeding the development and widespread deployment of autonomous vehicles. We also showcase uses for autonomous vehicles that will help consumers and a variety of other industries. Finally, we highlight numerous problems that designers, implementers, politicians, regulatory bodies, and vehicle manufacturers must overcome (and give helpful recommendations for adoption) to allow cost-effective, safe, and efficient autonomous automobiles (Hussain & Zeadally, 2010).

The cost of an autonomous automobile, digital map generation, software complexity, testing, validation, and simulations were all designated as design and implementation difficulties in this article, and each one was extensively studied. Other problems, such as technical and non-technical obstacles, persist in addition to these.

## Algorithm for Ethical Decision Making at Times of Accidents for Autonomous Vehicles

Before self-driving vehicles can be widely used, automakers must resolve a crucial ethical challenge involving computational morality. In the event of an inevitable collision, autonomous cars must make vital decisions involving the lives of two or more people. These vehicles confront ethical challenges at times like these, including as whether to sacrifice life to reduce the number of deaths. This programming philosophy for self-driving automobiles is shown using an algorithm in this article. To categorize people's lives according to the supplied factors, a priority queue-based min-heap sorting algorithm is utilized. The method uses deletion, insertion, and other operations to prioritize nodes with differing values. We use a BST as a priority queue to aggregate these operations. The phrase probability of survival is also used in this method to describe the likelihood of a person surviving. Customers and automobile manufacturers may make ethical judgments based on their own ethics using a flexible and unstable algorithm (Islam & Rashid, 2018).

In this study, the algorithm is shown in terms of the entire decision-situation and its characteristics, the role of moral and legal duty, and the decision-makers' epistemic state. Finding the value of likelihood of survival under various circumstances is one of our upcoming projects. In the not-too-distant future, self-driving automobiles will be commonplace. As a result, all the issues and concerns surrounding artificial intelligence and self-driving vehicles must be resolved. This is only the first step towards resolving the ethical issue.

## Traffic Sign Detection and Recognition System for Autonomous RC Cars

Traffic signs serve a crucial part in regulating daily traffic by giving drivers with important information. One of the primary problems for autonomous driving systems is real-time and reliable detection and identification of traffic signals. As a result, an autonomous radio-controlled automobile traffic sign detection and identification system is presented. Traditional image processing approaches and deep neural network techniques are integrated in this research. First, the automobile camera's internet video is streamed, and the input frame region of interest is recognized. Second, these potential pictures are recognized using a convolutional neural network. Experiments reveal that the suggested technique is effective for up to 87.36 percent of photos. However, image processing approaches for varied situations require calibration (Sari & Cibooglu, 2018).

A traffic sign detection and identification system were suggested in this research. Detection and recognition are the two key aspects of the system. The first indication is discovered from a real-time video stream, and the observed sign is categorized using a CNN model. Even though the model's accuracy on the test set is 97.42 percent, when the model is fed an internet video stream of an RC car, the success rate drops to 87.36 percent. The color filtering approach is excessively sensitive to the lighting and other items in the test setting, which is the major reason for the drop. As a result of the findings, we decided to abandon traditional image processing approaches in favor of recurrent neural networks for both detection and recognition. Consequently, the final product includes each object in the whole image. This feature can help to eliminate the model's performance decline.

## Controlled parking for self-driving cars

We investigated the issues that may soon be encountered when parking autonomous automobiles in parking lots in this article. For example, where is the autonomous car's nearest parking spot? What's the best way to get there? What kind of parking facilities would be suitable for autonomous vehicles? We also provide an initial solution that employs a central server and a parking lot graph to direct vehicles to the nearest available parking spaces. Experiments have indicated that our suggested solution should be successful for self-driving automobile-controlled parking.

Because operating and navigating an air conditioner in a variety of environments and settings is still relatively new, there is plenty of opportunities to enhance and optimize the way things were done previously. We have a lot more information to digest and make more intelligent judgments based on this knowledge since these automobiles can interact with each other and make decisions on their own. The main goal of this project was to determine what challenges we would have when parking an air conditioner in a parking lot. This research also proposed several considerations for parking air conditioners in parking lots.

# PROTOTYPE

PGDrive is an open-ended and extremely configurable driving simulator that incorporates procedural generation as a fundamental feature (PG). The PGDrive Simulator was used to demonstrate how self-driving automobiles function using artificial intelligence. This simulator specifies a variety of basic barriers with variable parameters, such as a ramp, fork, and roundabout, from which a variety of maps may be created using procedural generation and then transformed into playable scenarios. Through procedural generalization from fundamental traffic building blocks, PGDrive may produce a broad collection of driving situations. The simulator is now being used to investigate the generalization of reinforcement learning-trained driving agents.

PGDrive is based on the Panda3d and Bullet engines, with a system architecture that is optimized. When operating on a single PC, the simulator can achieve up to 500 simulation steps per second. The major feature of this program is procedural map creation, which allows for better analysis and development of end-to-end driving generalization. Other features are detection of sidewalk, detection of misalignments with continuous line.

Following were the steps followed to run this prototype:

1. Since this is an open-source code, the prototype was downloaded from GitHub. This is the GitHub link: <https://github.com/decisionforce/pgdrive>. The system was then initialized in Windows 10 Operating System.
2. Python 3.8 was installed as the latest one had compatibility issues with the prototype.
3. PGDrive was downloaded and installed with "pip install pgdrive" command.
4. The command 'python -m pgdrive.examples.enjoy\_manual' was used in the terminal for the manual mode testing of simulator.
5. The command ‘python -m pgdrive.examples.enjoy\_saver’ was used in the terminal for the saver mode testing of simulator.
6. . The command ‘python -m pgdrive.examples.enjoy\_expert’ was used in the terminal for the fully-autonomous mode testing of simulator.

Some issues were encountered during the installation process such as absence of “gym”, “Cython”, “panda3d”, “opencv-python”, “gltf”, “pygame”. These issues were solved later.

Text

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Figure screenshot showing no “gym” module

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Figure showing showing no “Cython” module

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Figure screenshot showing no “panda3d”, “gltf”, “opencv-python”, “pygame” module.

All the above issues were solved by downloading and installing “Microsoft C++ build tools” from [https://aka.ms/vs/16/release/vs\_buildtools.exe](https://aka.ms/vs/16/release/vs_buildtools.exe?fbclid=IwAR1AoV6AhG-2Q1fW9moy6uSL5oJccg8ju_37MRyynfct5da7iI-IioFFeDk).

A car driving on a road

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Figure Figure Showing PGDrive Simulator in Fully Autonomous mode.

A car driving on a road

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Figure Figure Showing Simulator detecting Sidewalk.

A car driving on a road

Description automatically generated with medium confidence

Figure Figure Showing detection of misalignment with continuous line.

Graphical user interface

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Figure Figure Showing Progressive Map Generation.

# CONCLUSIONS

We examined the applicability of self-driving automobiles in this paper. We began with an overview, including background information, the importance of autonomous vehicles in daily life, and a brief history of autonomous vehicle research and AI relevance in implementation. The PGDrive simulator was used as a prototype to show how self-driving automobiles function. We saw features like sidewalk recognition, misalignment detection with a continuous line on the road, and progressive map development.

# REFERENCES

1. G. M. Gandhi and Salvi, "Artificial Intelligence Integrated Blockchain For Training Autonomous Cars," 2019 Fifth International Conference on Science Technology Engineering and Mathematics (ICONSTEM), 2019, pp. 157-161, doi: 10.1109/ICONSTEM.2019.8918795.
2. N. C. Basjaruddin, K. A. Baki and Suhendar, "Autonomous Car Based on Teaching-and-Playback Control," 2020 International Conference on Applied Science and Technology (iCAST), 2020, pp. 657-661, doi: 10.1109/iCAST51016.2020.9557727.
3. Kojima and Y. Nose, "Development of an Autonomous Driving Robot Car Using FPGA," 2018 International Conference on Field-Programmable Technology (FPT), 2018, pp. 411-414, doi: 10.1109/FPT.2018.00087.
4. D. L. Luu, C. Lupu and D. Chirita, "Design and Development of Smart Cars Model for Autonomous Vehicles in a Platooning," 2019 15th International Conference on Engineering of Modern Electric Systems (EMES), 2019, pp. 21-24, doi: 10.1109/EMES.2019.8795199.
5. Agafonov and A. Yumaganov, "3D Objects Detection in an Autonomous Car Driving Problem," 2020 International Conference on Information Technology and Nanotechnology (ITNT), 2020, pp. 1-5, doi: 10.1109/ITNT49337.2020.9253253.
6. M. Reke et al., "A Self-Driving Car Architecture in ROS2," 2020 International SAUPEC/RobMech/PRASA Conference, 2020, pp. 1-6, doi: 10.1109/SAUPEC/RobMech/PRASA48453.2020.9041020.
7. R. Hussain and S. Zeadally, "Autonomous Cars: Research Results, Issues, and Future Challenges," in IEEE Communications Surveys & Tutorials, vol. 21, no. 2, pp. 1275-1313, Secondquarter 2019, doi: 10.1109/COMST.2018.2869360.
8. M. A. Islam and S. I. Rashid, "Algorithm for Ethical Decision Making at Times of Accidents for Autonomous Vehicles," 2018 4th International Conference on Electrical Engineering and Information & Communication Technology (iCEEiCT), 2018, pp. 438-442, doi: 10.1109/CEEICT.2018.8628155.
9. Sari and M. Cibooglu, "Traffic Sign Detection and Recognition System for Autonomous RC Cars," 2018 6th International Conference on Control Engineering & Information Technology (CEIT), 2018, pp. 1-5, doi: 10.1109/CEIT.2018.8751898.
10. S. Tariq, Hyunsoo Choi, C. M. Wasiq and Heemin Park, "Controlled parking for self-driving cars," 2016 IEEE International Conference on Systems, Man, and Cybernetics (SMC), 2016, pp. 001861-001865, doi: 10.1109/SMC.2016.7844509.
11. An (2017). *An introduction to autonomous vehicles*. [online] YouTube. Available at: https://youtu.be/HgF7E5q9sU4.
12. www.youtube.com. (n.d.). *The role of artificial intelligence in the design of self-driving cars*. [online] Available at: https://youtu.be/So7iOmLst48 [Accessed 28 Nov. 2021].

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