TESTING OF AN AUTONOMOUS VEHICLE USING VR

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Abstract:

We need 3D generated content for every field like making vfx, game worlds, and animated movies. We need more characters for animated movies which are hard to make each of them unique. But by using procedural generation we can make it simple there are countless

combinations which can make variations among them. Unique worlds can be created within some minutes easily. We can also make dynamic objects such as clouds, water etc. even though procedural generation already exists for years. We can add procedural generated cars, spacecraft,

building blueprints can be used in real worlds. Real world wind,cyclones. We can predict the damages that can be caused by some disaster the future of metaverse depends upon this procedural generation. We can use this procedural city to train self-driving cars virtually

Related work:

Virtual installation, which involves testing the features of an AGV simulation, can aid in the creation of automated guided vehicles (AGV). When AGVs collaborate, evaluating their functionalities necessitates including a human and an interaction device in the simulation in addition to the AGV itself. Therefore, this article shows a setup, that integrates a human using motion capturing and emulates a smartwatch as interaction device. Also, the simulation is visualized by a head-mounted display and offers extra data for the evaluation

and study of test cases. As a result, it makes it possible to hire combined AGVs virtually[1].

Currently, the development of automobile automation is ongoing that includes testing, validation, and trials. There is a significant need to hasten the development and implementation of autonomous infrastructure and cars because these technologies have the potential to greatly enhance road safety. As a result, the evaluation Vehicle_In_the_Loop is crucial in the all over development levels. This research provides an innovative test environment approach that may simulate realistic traffic surrounding the autonomous test vehicle as a potential response to this issue. So, by using real time microscopic traffic simulation, the test automobile may be placed into a hypothetical transportation network, enabling safe vehicle testing. With an autonomous car in the real world, the proposed test environment was shown[2]

The development of autonomous machines has benefited greatly from virtual reality (VR). VR has been used in a variety of applications, from Computer Aided Design (CAD) to simulators for testing automation algorithms without risking costly equipment. Most recently, Autonomous Vehicles (AV), a special application of autonomous robots, became an important focus of the scientific and practitioner community to improve road and vehicle safety. In order to meet those safety standards, new safety challenges must be overcome, as demonstrated by recent AV accidents. In order to create a vision of how VR will play a significant role in the development of AV safety, this paper provides a systematic literature mapping on the use of VR for AV safety[3].

Driver involvement with increasingly automated vehicles necessitates prior system knowledge, operational expertise to operate novel automobile equipment, reactivity to unforeseen scenarios. For the purpose of preparing drivers for autonomous driving, sixty novice participants in a between subject analysis received training using an on-board video lesson, an augmented reality (AR) application, and a virtual reality (VR) simulator. A test drive on public roads was done while using the Wizard of Oz (Woz) methodology for the first time under these circumstance so as to gauge how well training adapted to real-world driving scenarios. The findings imply that training in virtual reality and augmented reality can promote knowledge acquisition and optimize take-over request reaction time performance. As an added bonus, participant behaviour during the test drive demonstrates the ecological validity of the experiment thanks to the effective implementation of the Woz methodology [4].

The art work was completely self-driving car must give peoples and other innocence road users a clear signal of their status and intentions in order to fixed activities. A variety of external interfaces have been said pasted years, uses different models paradigms and technologies, more as vehicle fitable devices (like as LED plates and panels), short-range on the road projects of projections light, and actes on road structure. This actes are been tested in multi settings by mockups, specially made vehicles, or virtual environments, with the anomalous of evaluation methods. Effectiveness and usability tests have not yet been conducted on promising Augmented Reality (AR)-based user experiences. By comparing cutting edge interfaces and fresh designs under realistic situations, this paper seeks to supplement that corpus of literature. . An realistic VR-based simulation was created to achieve this goal, reforming a known situation shown to people crossing in the city roads settings outside of the bounds of the law. The investigation of the different aspects of vehicle-to-pedestrian interaction was then done through a user study using both objective and subjective metrics. Despite the fact that no interface stood out over all the variables taken into account, one of the AR designs obtained cutting-edge outcomes by the words safety, truth, though the expense of more intellectual action and less opacity than LED plates and panels with Zoomorphic features. Indicators about the benefits and disadvantages for different methods that used in this research, along with rankings on the various dimensions, could offer crucial information for future developments in the field[5].

Automotive engineers are increasingly using virtual reality to safely assess and validate autonomous cars. Virtual testing settings must be designed and created, which is a difficult process. Engineers must use desktop-based authoring tools, which require a high degree of expertise. Faster design iterations are made possible by conducting scene authoring entirely within VR. In order to achieve this, we suggest a VR authoring environment that allows engineers to create road networks and traffic scenarios based on free-hand interaction for automated vehicle testing. We show a 3D interaction method that is used on a 2D panel to successfully place and choose virtual objects. In a user study comparison, our interaction method outperformed other methods in terms of accuracy and job completion time. Furthermore, we conduct an in-depth user survey with subject-matter experts to show the system's efficacy [6].

Virtual reality (VR) is being used in more research to assess how autonomous vehicles (AVs) interact with pedestrians. Virtual reality simulators are praised for their affordability, adaptability in creating different traffic situations, safety in user studies, and acceptable ecological validity. We discovered 31 factual studies using VR for testing tool for both covert and overt dialogue after reviewing the literature between 2010 and 2020. By conducting a methodical analysis, we were able to determine the key use cases that are currently covered, compile a detailed account of the variables affecting pedestrian behavior in traffic modeling, and evaluate evaluation tools. Our recommendations for using VR pedestrian simulators are based on the findings, and we also suggest areas for future study [7].

An urban area's air travel system for people and small loads is commonly referred to as urban air mobility (UAM). Other urban Unmanned Aerial System (UAS) services are also included in the UAM framework, and they will be supported by a combination of onboard, ground, piloted, and autonomous operations. In recent years, UAM research has generated significant attention from businesses and government organizations as a novel on- demand transportation choice that can help boost mobility in urban areas while reducing traffic congestion and pollution. To guarantee safe and effective operations, research on the principles of UAM/UAS operation in the National Airspace System (NAS) is still ongoing. It is a need for techniques to integrate and test different UAM framework components in light of recent advancements in smart vehicle design and air traffic control infrastructure. In this article, we discuss the creation of a virtual reality (VR) testbed for human automation teaming and UAM airspace operation study using the Cave Automatic Virtual Environment (CAVE) technology.The CAVE offers an immersive virtual world with real-time full body tracking capability using a four-wall projection system with motion capture. We built a virtual environment that includes the city of San Francisco and a passenger plane that can travel between a spot in the downtown area and the San Francisco International Airport. A single pilot can fly the aircraft directly or autonomously by directing it with a flight control joystick. A virtual cockpit display with heading, position, and speed data is located inside the airplane. For later processing, the device can capture flight information and simulation activities. The CAVE VR testbed offers a flexible method for the development and assessment of the UAM framework because the system parameters can be altered for various flight scenarios [8].

Swarms of drones with populations in the hundreds can now be launched. The use of such swarms for protection is becoming more and more popular, so it only makes sense to program them with bio-mimetic motion models like swarming or flocking. These motion models, however, didn't develop to fend off modern weapons; rather, they did so to live against predators. The experimental data provided in this article compares the viability of various motion models for a large number of drones. Since flying a large swarm of drones in a testing environment is prohibitively costly, technically challenging, and could be dangerous, this project tests drone swarms in virtual reality (VR). It simulate the behavior of drone swarms flying in both dense and dispersed groups along parametric paths. To complicate path prediction and targeting, random motion is added to the overall motion plan. We outline a VR environment where these flight routes are implemented as game levels. After that, we give users the ability to fire at the drones in order to compare how different flocking and swarming behaviors affect drone survivability [9].

Procedural generation vs random generation:

· Random generation means it generates unique worlds that do not contains any conditions for generating some objects.

· Procedural generation means it generates unique worlds that have some common conditions and uniquely generated worlds with unique nature.

Noise:

It is a computer generated algorithm that will generate the height of the terrains randomly and procedurally.it is a black and white image. The white area represents the height of the terrain and the Black area represents the depth of the terrain

Diamond square algorithm:

A two-dimensional square array of width and height 2n + 1 is the starting point of the diamond-square method. The array's four corner points must first be given initial values. After that, until all array values have been set, alternate between the diamond and square steps. The diamond step entails setting the midpoint of each square in the array to be the average of its four corner points plus a random number. The square step is to set the midpoint of each diamond in the array to be the average of its four corner points add a random number. magnitude of the random value be multiplied by 2h at each iteration, where
h is a number between 0.0 and 0.1 (lower bound).

APPLICATIONS:

Several implementations of this method, which can be used to create realistic-looking landscapes, are utilized in computer graphics programmes like Tarragon. It can be used as a typical element in generated textures

ARTIFACTS AND WORD EXTENSIONS:

Gavin S. P. Miller examined the diamond-square technique at SIGGRAPH 1986[and concluded that it was incorrect since the algorithm produced observable vertical and horizontal "creases" as a result of the most significant disturbance occurring in a rectangular grid. J.P. Lewis presented a generalised approach that addressed the grid artifacts. In this variation, instead of being fixed, the weights on the adjacent points are derived by solving a tiny linear system inspired by estimate theory. Furthermore, non-fractal heightmaps like rolling hills or ocean waves can be created using the Lewis algorithm. Fourier synthesis can be used to efficiently produce outcomes that are similar, but the option of adaptive refining is lost. The book reviews the diamond-square algorithm and its improvements

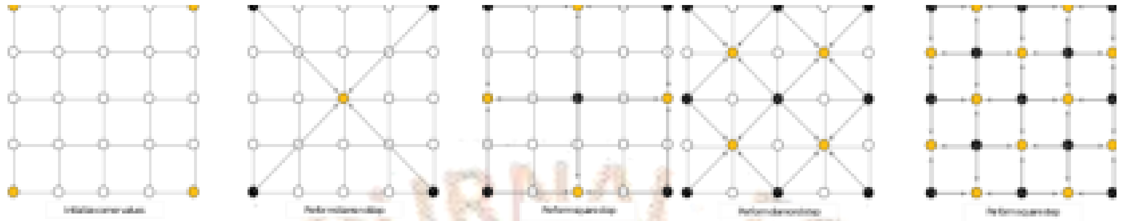


Fig.1 diamond-square algorithm and its improvements

FORMULA:

Diamond-Square requires that the array's width and height be 2n + 1 to begin. For instance, the dimensions I'm using are 17x17, 24 + 1. Filling in an array with computed values depending on previously calculated values is the goal of the Diamond-Square algorithm.

Value noise:

A Common form of cacophony used as a randomized crispness primitive in digital effect is value noise. It significantly differs from gradient noise, instance of which include Perlin noise and simplex noise, and is routinely confused with it. This Methodology includes developing a web of coordinates and designating them numeric values. The interpolated number is then generated by the noise function according to the scores of the neighboring lattice segments.
Akin with how Perlin noise and Simplex noise can be blended to construct fractal noise, multiple dynamic content that interacts of this noise can be synthesized and then layered together for a wide variety of uses.

Fig.2 Value noise

REFERENCE:

<table>
<tr><td colspan="4">COHERENT PROCEDURAL NOISE</td></tr>
<tr><td rowspan="3">STRATEGY</td><td rowspan="2">BASED ON LATTICE</td><td>GRADIENT VOLUME</td><td>OPENSIMPLEX NOISE,PERLIN NOISE,SIMPLEX NOISE,SIMULATION NOISE,WAVELET NOISE</td></tr>
<tr><td>NOISE VALUE</td><td>VALUE NOISE</td></tr>
<tr><td>BASED ON POINT</td><td colspan="2">THE WORLEY NOISE</td></tr>
<tr><td colspan="2">APPLICATION</td><td colspan="2">Computer graphics, video games, procedural generation, andfractal landscape</td></tr>
</table>

Perlin noise:

Gradient noise is known as Perlin noise was developed by Ken perlin in 1983.It can be suitable for a wide range of purposes, such as generating landscape procedural, updating a Simplex noise scales to larger dimensions (four dimension, five dimension) with a great deal less computational expense; the complexity is (2) for dimensions as opposed to (2) for classic noise.

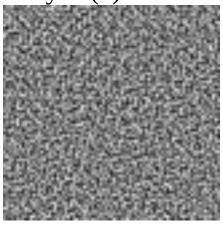
, 

Fig.3 Perlin noise

Worley noise:

Steven Worley first introduced the Worley noise function in 1996. In computer graphics, it is used to generate generated textures, or textures that can be automatically produced with any level of precision and do not need to be manually created. Worley noise very closely to resembling the textures of biological cells, stone, or water.

simple algorithm:

The algorithm chooses random location in space and then uses combination of the distances from every location in space to the nth-closest point to control colour information (notice that dn+1 > dn). More specifically

· Distribute feature points at random among energy grid cells in space. In reality, there is on storage necessary; it is done (as a procedural noise). The original method used a variable number of seed points per cell so as to simulate a poission distribution, but many implementations just put one.

· Extract the dn distances between the specified location and the nth-closest seed point at runtime. Visitations to the current cell and its neighbours are an effective method todo this.

· Formally, the user to user combines the vector of distances along with the corresponding seed ids to generate noise W(x)

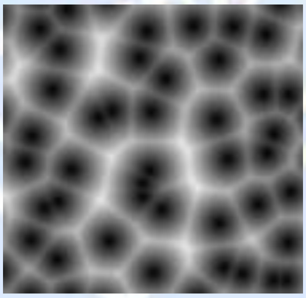


Fig.4 Worley noise

Plans of using:

We can build detailed worlds with many different types of NPC and make the world more living. Now it is possible the build many big worlds easily.

· Procedural clouds
· Procedural climate
· Procedural NPC
· Procedural houses and building
· Procedural assets
· Procedural vehicles
· Procedural Mountains
· Procedural lakes and seas
· Procedural trees

Aim:

By using this even a normal person can make a bigger worlds. So let us take a example if we want to make a bigger mansion. The user wants to enter the size of the mansion and the number of rooms, halls, windows etc. We also need to thus the user needs basement or not. Creating enemy AI with tree. The user can just modify the given model by changing the lighting, texture and shader packs.

Instead of training a self-driving car in real life we can simulate a city and train it in the city

Social simulation:

Social simulation is a new modeling paradigm that allows representing and inquiring social system from a bottom-up perspective. That is, social system entities like humans and organizations represented by their own decision making logic and simulated to understand emerging aggregated patterns. Geographical data can be used to build the cities. Future population of the cities can be predicted using this. Natural disasters can be simulated to the city model and the damage can be predicted. The depth of the city is taken and was converted to noise image and was converted into city using procedural generation. Animation, people, houses are added to the mesh of that city any development of the city can be tested in here and see its impact .which may be useful for the development of the city. A input which can be the noise of the city is given and the output is processed through the given algorithm which may the city or the environment .let us see this briefly about how this work through flow chart.

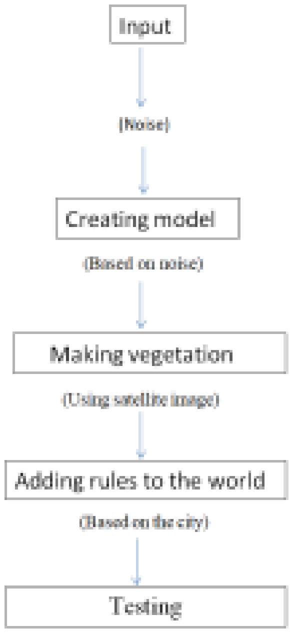


Fig 5 Total model representation

Autonomous automobiles:

Technology for autonomous automobiles are powered by AI.To develops techniques that can drive autonomously, autonomous vehicle makers mix huge quantity of information from recognition of image systems with machine learning and artificial neural networks. The algorithm for machine learning provides the trends which the neural network finds in data. Images recorded by autonomous vehicle sensors constitute some of the source of information used by neural networks to teach its own to identify the items such as traffic lights, trees, pedestrains, street signs and other various parts of a specific travelling environment.

Training a self driving car:

We can use the generated city to train a self-driving car. It can even be tested in various test cases for it to adapt to it. We can make it react to speed limit, understanding traffic signs.it has to stop for the red signal, and start for the green. It can be trained how to get rid of the traffic in a best manner.

Machine learning in autonomous automobiles:

Autonomous vehicles makes decisions based on object recognition as well as object classification methods, autonomous vehicles are able to identify objects, analyze situations and make decisions. By identifying objects, classifying them, and figuring out what they are, they achieve this. In order to help the machine learning algorithm to developing the ability for select optimal decisions when going through the roads, Mindy help gives complete data Labeling options
ML use cases for autonomous vehicle:

· Driving observation
· Driving assistance
· Engine monitoring
· Cybersecurity
· Security and privacy for data

DRIVING OBERVATION:

In regards to tracking the driver and their behavior in self driving cars, neutral network models can detect patterns. For illustration, software that recognizes faces may be implemented to identify a driver and evaluate whether or nor they are authorized to be in the vehicle, assisting in avoiding theft and illegitimate use. Algorithms for indoor localization are additionally available to the automated vehicle system to augment the voyage for other occupants. According to the variety and location of occupants, the have system may automatically update.

DRIVING ASSISTANT:

Advanced driver-assistance system(ADAS),typically known as driver assistance, are innovation that contribute to the security of motor vehicle travel by automating, extending, or adjusting part or all of the involve a degree in the act of driving. Driving is considerably better convenient and simple with the advent of adaptive cruise control, which also improves and pedestrian safety. While some sensors aids in driving, others, notably lane departure and tiredness detection, warn the driver of mistakes or dangers. Driver assistance can also refer to other driving activities including navigation, route planning, and obstacle detection in supplementary to control vehicle control. Both uncomplicated mechanisms, like anti lock restraints and steps are being taken, like the software and technology used for running a driverless automobile, would be included within driver guidance. Radar, laser, machine, vision, and other leadership role technologies constitute a few of the most sophisticated apparatus that take over the handling of the vehicle

CYBERSECURITY:

Vehicle cyber security has become a greater focus as vehicles gain computer networks and network connectivity. And that's the point when machine learning will become a prominent role. It can be used , in addition to recognize attacks and irregularities and ultimately deal with them. A vehicle may be endangered by a hacker which gains access to its systems or utilize its data. In order to maintain its occupiers and the road safety, ML models aid in sensing such attacks and anomalies. It is not considered that the autonomous car classification systems might be a subject to malicious attack. Such violent attacks can intentionally lead to the vehicle to misread and misclassify the object. A vehicle might be misidentified as a consequence of an attack, like when a stop sign is mistaken for a speed restriction sign.

DATA PRIVACY PROTECTION:

The connected networks that drive cars must be safeguarded against hacking at any and all costs. At most, traffic congestion can be created by many jail broken vehicles. In comparison, too much attack could result in collisions, wounds, and even deaths. Since 2015, more than 25 connected car hacks have been published. Chrysler was forced to recall 1.4 million automobiles due to the greatest software vulnerability occurrence to history. A hacker might take over the car's steering, brakes, and transmission thanks to this flaw. Also, there may be a market for data produced by vehicles. Information on the car's occupants, including their whereabouts and activities, is available. By 2030, the market for vehicle-generated data is predicted to be worth $750 billion. though these facts

How VR used in autonomous vehicle?

Self-driving cars are becoming more advanced every day. The primary problem with self-driving cars is how they are tested. They try their autonomous vehicles on public roads because they see so many collisions. Virtual reality (VR) is the approach we're using to get past the issue. Using the Unreal Engine and other software, we will build a real-world city in this project.After building a real-world city, we'll use virtual reality to test drive self-driving vehicles there. The provided algorithm processes the given input, which could be the city's noise, to produce the output, which could be the environment or the city. Our mission is to prevent traffic accidents caused by autonomous vehicles and to save human lives.

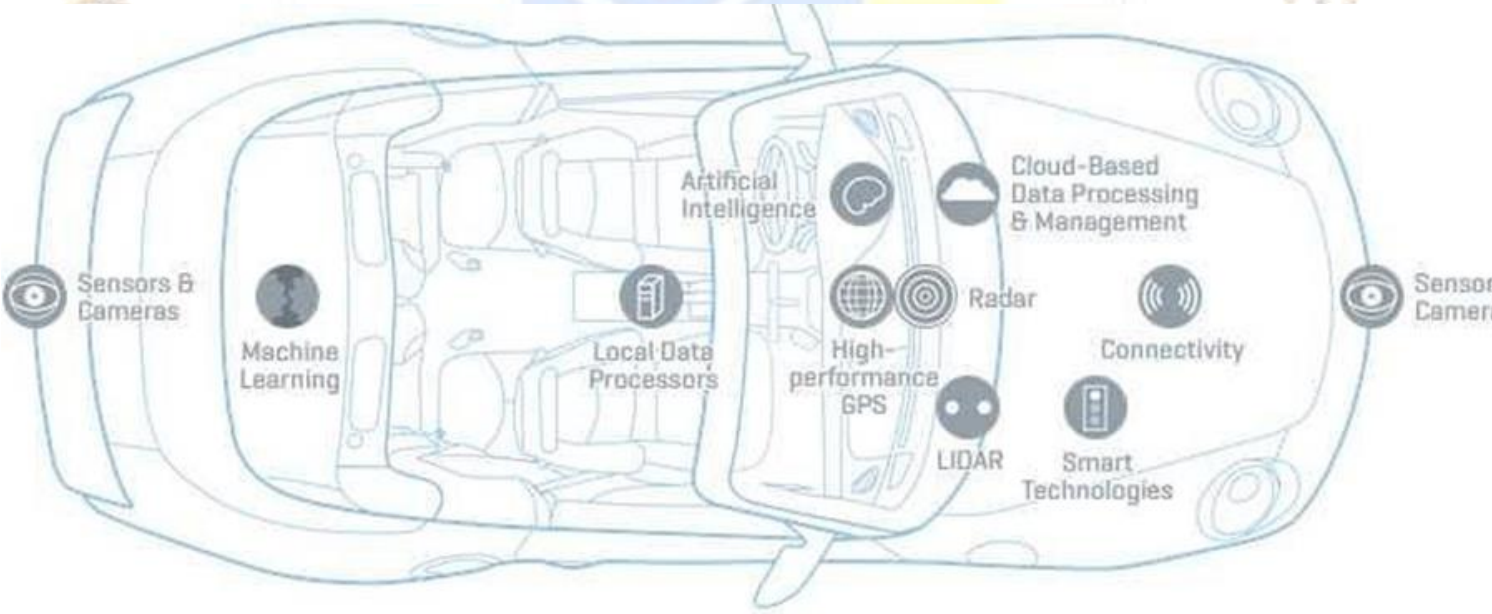


Fig 6 Components in self-driving car

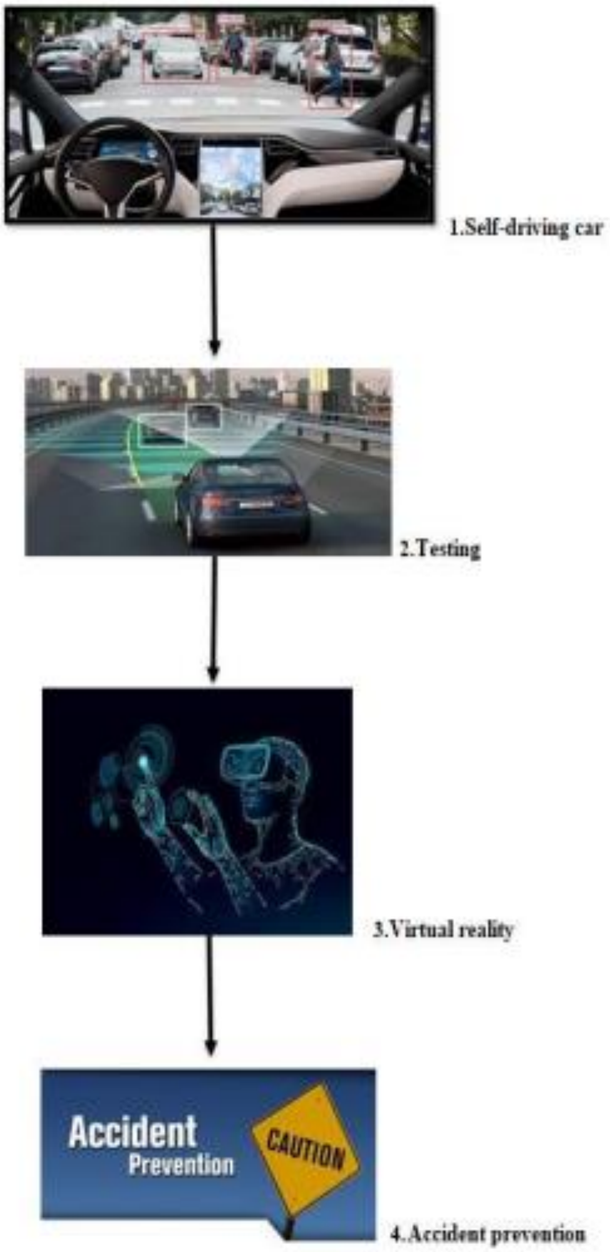


Fig 7 Working of a self-driving car using VR

CONCLUSION:

That we infer from the aforementioned data is that switching a test drive from a real-world setting to a virtual one is safer and helps to prevent traffic fatalities. A self-driving car can be tested safely and protected from damage simply by doing it in a virtual environment.

REFERENCES:

[1] Virtual Reality for Virtual Commissioning of Automated Guided Vehicles,Christoph Allmacher; Manuel Dudczig; Sebastian Knopp; Philipp Klimant, 2019 IEEE Conference on Virtual Reality and 3D User Interfaces (VR), 23-27 March 2019.

[2] Vehicle-In-the-Loop Test Environment for Autonomous Driving with Microscopic Traffic Simulation, Tamás Tettamanti; Mátyás Szalai; Sándor Vass; Viktor Tihanyi, 2018 IEEE International Conference on Vehicular Electronics and Safety (ICVES), 12-14 September 2018

[3] The Role of Virtual Reality in Autonomous Vehicles' Safety, Alexandre M. Nascimento; Anna Carolina M. Queiroz; Lucio F. Vismari; Jeremy N. Bailenson; Paulo S. Cugnasca; João B. Camargo Junior; Jorge R. de Almeida, 2019 IEEE International Conference on Artificial Intelligence and Virtual Reality (AIVR), 09-11 December 2019.

[4] On-Road Evaluation of Autonomous Driving Training, Daniele Sportillo; Alexis Paljic; Luciano Ojeda, 2019 14th ACM/IEEE International Conference on Human-Robot Interaction (HRI), 11-14 March 2019.

[5] Autonomous Vehicle-to-Pedestrian Communication, F. Gabriele Patticò; Fabrizio Lamberti; Alberto Cannavò; Lia Morra; Paolo Montuschi, IEEE Transactions on Vehicular Technology (Volume: 70, Issue: 2, February 2021), 25 January 2021.

[6] Design and Evaluation of a Free-Hand VR-based Authoring Environment for Automated Vehicle Testing, Sevinc Eroglu; Frederic Stefan; Alain Chevalier; Daniel Roettger; Daniel Zielasko; Torsten W. Kuhlen; Benjamin Weyers, 2021 IEEE Virtual Reality and 3D User Interfaces (VR), 27 March 2021 - 01 April 2021.

[7] A Review of Virtual Reality Studies on Autonomous Vehicle–Pedestrian Interaction, Tram Thi Minh Tran; Callum Parker; Martin Tomitsch, IEEE Transactions on Human-Machine Systems (Volume: 51, Issue: 6, December 2021),21 September 2021.

[8] Urban Air Mobility System Testbed using CAVE Virtual Reality Environment, Panadda Marayong; Praveen Shankar; Jessica Wei; Hanson Nguyen; Thomas Z. Strybel; Vernol Battiste, 2020 IEEE Aerospace Conference, 07-14 March 2020.

[9] Investigating the survivability of drone swarms with flocking and swarming flight patterns using Virtual Reality, Daniel Biediger; Arun Mahadev; Aaron T. Becker, 2019 IEEE 15th International Conference on Automation Science and Engineering (CASE), 22-26 August 2019.