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eCHAUFFUR

Mr. BANAVATU VENKATESWARA RAO [1], V Valli Kumari[2]
[1]DEPARTMENT OF COMPUTER SCIENCE AND SYSTEMS ENGINEERING (A), ANDHRA UNIVERSITY, VISAKHAPATNAM-530 003.
[2]Professor in DEPARTMENT OF COMPUTER SCIENCE AND SYSTEMS ENGINEERING (A), ANDHRA UNIVERSITY, VISAKHAPATNAM-530 003.

ABSTRACT
A self-driving automobile can assess its environment and avoid human involvement while navigating through traffic and other obstacles. TESLA was able to successfully develop this most recent and upcoming technology in the automotive industry, despite the fact that it has been discussed and worked on for a very long period. Similar cars have recently started to show up in other markets as both private and public transportation (taxis, for instance). This product is being developed by numerous companies, including Waymo, UBER, Nissan, and Nvidia. With this kind of vehicle, vehicular transportation's overall safety, security, and efficiency are increased, human error may be avoided, and the journey is optimised. The first problem with this strategy would be to adapt and incorporate existing technology in a working prototype in order to fully comprehend and test them for the driverless car of the not too distant future.This project attempts to move along a trial track in a straight path without changing course or running in a zigzag fashion. It offers a strategy for comprehending and remaining in one's lane. The field of self-driving automobiles has benefited from the work of numerous researchers. The conventional methods up till now have been Hough Transform and Grayscaling. CNNs (Convolutional Neural Networks) are a well-known technique for locating lanes and making the right choices.In this project, we implement image processing techniques into the machine learning (ML) prototype model using OpenCV. Making it as stable as you can without a tripod is the aim. any twists. We adjust it using various setups till we get a precise result. The paper will also go through the fundamental image processing methods and the execution code.

1 INTRODUCTION

A self-driving car, or eCHAUFFEUR, is a vehicle that can navigate and run without human assistance. Self-driving cars make decisions about how to navigate the roadways by using a variety of sensors, cameras, and software to detect and understand their environment.
Self-driving cars have recently gained popularity in the automotive industry due to its potential to completely change how we travel. Self-driving cars are positioned to play a significant role in the future of transportation because they have the potential to lower accidents, relieve traffic congestion, and increase mobility for individuals who are unable to drive.
The technology underlying self-driving cars, their potential advantages, and the difficulties that must be addressed to make them a reality are all covered in this project report. market. We'll also look at the state of self-driving car technology right now and give a rundown of the businesses and groups who are pioneering this fascinating industry.
Several academic fields, including computer science, electrical engineering, mechanical engineering, and artificial intelligence, are involved in the creation of self-driving cars. Machine learning, which enables the vehicle to learn from its experiences and enhance its performance over time, is the fundamental technology behind self-driving cars.
Depending on how automated they are, self-driving cars can be categorised into levels ranging from level 0 (no automation) to level 5 (complete automation). While level 2 and level 3 cars have some automation but still need a human driver to operate them, level 0 and level 1 automobiles do not. still need to be overseen by people. Level 4 and level 5 vehicles are completely autonomous and don't need any kind of human driver.
As they can identify and react to possible risks considerably quicker than a human driver, self-driving cars have the potential to drastically reduce the amount of accidents that occur on the road. Due to their ability to interact with other cars and change their speed and path accordingly, they can help facilitate traffic flow and lessen congestion.
The development of self-driving cars is not without its difficulties, though. Technical obstacles like enhancing sensor

and algorithm accuracy are one of these. Regulatory and legal obstacles pertaining to liability and safety standards are another. Additionally, when making decisions on self-driving, there are ethical considerations. automobiles, especially in circumstances where human lives may be in danger.

Overall, self-driving cars offer a bright future for transportation, but much effort needs to be done to ensure their reliability, safety, and widespread acceptability. This project report will go further into these subjects and offer a thorough analysis of the state of autonomous vehicle technology.

Background:

Although the concept of self-driving cars has been around for a while, it wasn't until the 2000s that substantial advancements in the technology were made. The Grand Challenge was a 2004 US Defence Advanced Research Projects Agency (DARPA) competition that asked teams to create autonomous vehicles that could travel a desert route. Despite the fact that none of the teams succeeded in completing the task, the competition additional field development and study.

Many businesses, like Google, Tesla, and Uber, have made large investments in self-driving car technology recently and have worked hard to commercialise it. Before self-driving cars be a common sight on our roads, however, there are still a lot of technological, governmental, and social issues that need to be resolved.

Objectives:

The main goals of our self-driving car project are to: • Design and construct a working prototype of a self-driving car that can navigate through a simulated environment; • Show the capabilities and limitations of self-driving car technology, including perception, decision-making, and control; and • Assess the performance of our system using metrics like accuracy, reliability, and speed. To develop self-driving car technology and its potential social advantages by examining the ethical, technological, and legal issues surrounding self-driving automobiles, including privacy, cybersecurity, and liability.

Methodology: To accomplish our goals, we used a methodical process that includes the following steps:

Research: We reviewed the literature extensively on self-driving cars, looking at both technical and non-technical aspects of the technology, potential and difficulties, and the state of the art at the time. We also looked at the performance parameters of current self-driving automobile systems.

Design: Informed by our study, we created a self-driving car prototype system that included both software and hardware elements. The hardware elements included sensors, cameras, and a computer, while the software elements included deep learning algorithms, computer vision methods, and control systems.

Actualization: We By building the hardware parts and creating the software parts using programming languages like Python, TensorFlow, and ROS, we were able to put our plan into practise. We also combined the various parts and checked the dependability and performance of the system.

2. LITERATURE SURVEY AND RELATED WORK

The books listed below were reviewed to get a better knowledge of the methods previously employed to operate a self-driving car.

2.1 Sensor and Perception Technology for Self-Driving Cars

Self-driving cars are expected to revolutionise the auto industry, but they will only be successful if manufacturers can solve a number of technological challenges. The development of vision and sensor technologies, which will enable autonomous vehicles to operate safely and effectively in a range of settings, is one of the most crucial. An overview of recent studies on perception and sensor technology for self-driving cars is given in this survey of the literature.

The study begins by explaining the various sensors, including cameras, lidar, radar, and ultrasonic sensors, that are utilised in self-driving cars. the need for robust and trustworthy sensors, the challenges of processing Among these challenges are the need for precise and trustworthy perception algorithms and the enormous amounts of real-time sensor data.

The article "A Survey on Self-Driving Vehicles" by Junqing Zhang and Jianming Hu was published in IEEE Transactions on Intelligent Transportation Systems (2019). This article provides a thorough analysis of the state-of-the-art in self-driving car technology, covering the many sensors and algorithms used as well as the remaining challenges.

The International Journal of Computer Science and Information Security (2017) published "Self-Driving Cars: A Survey" by Ehsanul Haque Kanan. The essential elements of a self-driving car, such as sensors, control systems, and machine learning approaches, are examined in detail in this paper. Lastly, this literature review offers a summary of the current state of the state-of-the-art in self-driving car sensor and perception technology. The report looked at the many sensors used in self-driving cars and how they are used in different contexts. The numerous perceptual algorithms used in self-driving cars and how they work were also covered in the survey. The survey also covered the challenges that manufacturers of autonomous vehicles face when integrating perception and sensor technologies.

2.2 Artificial Intelligence and Machine Learning

Due to their potential to boost mobility for people who cannot drive, reduce traffic congestion, and improve road safety, autonomous vehicles, often known as self-driving cars, are becoming more and more popular. Self-driving automobile technology heavily utilises artificial intelligence and machine learning methods. This literature review provides a summary of the most recent research on the issue of self-driving automobiles, with a focus on how machine learning and artificial intelligence are used.

Machine learning and artificial intelligence are crucial in the development of self-driving cars. These techniques enable the car to perceive its environment, form opinions, and control its behaviour. Machine learning algorithms of many types, such as supervised learning, unsupervised learning, and reinforcement learning, are used in self-driving cars. Models are trained using supervised learning to recognise objects in their environment, such as people, cars, and traffic signs. These models are developed using labelled datasets, where each image has a tag that identifies the object it contains.

Models that can make decisions based on their surroundings are trained via reinforcement learning. The model is educated utilising a system of rewards where acts that lead to desired outcomes are rewarded positively, while actions that lead to undesirable outcomes are penalised negatively. In self-driving cars, reinforcement learning is frequently used for control and decision-making.

The application of AI and machine learning in self-driving cars has drawn the attention of numerous academics. In their study, Huang et al. (2019), for instance, presented a reinforcement learning-based approach for autonomous driving. They trained a neural network to learn how to operate a car safely in a simulated environment.

Raquel Urtasun and Trevor Darrell's article, "Self-Driving Cars: An Overview," appeared in the 2017 IEEE Intelligent Transportation Systems Magazine. The many sorts of self-driving automobiles are described in this essay, from completely autonomous vehicles to semi-autonomous vehicles. 2.3 Navigation and Mapping in Self-Driving Cars

Self-driving cars have drawn a lot of attention recently as a promising technology with the potential to revolutionise the transportation industry. Self-driving cars need navigation and mapping because they enable the vehicle to perceive and understand its surroundings. While mapping refers to the creation and upkeep of an accurate and current map of the environment, navigation refers to the ability to plan the course of the car based on its current location and destination. In order to analyse the current state-of-the-art in self-driving automobile navigation and mapping, this literature study will focus on its challenges and future potential. The procedure for determining the car's location and figuring out its route to Navigation is the process of reaching the desired location. The main challenge in navigation is maintaining efficient and comfortable travel while assuring the safety of passengers and other road users. The following sections go through

Lidar-based mapping is the process of using lidar sensors to create a three-dimensional map of the surrounding area. A point cloud describing the environment is created by using the reflections of laser pulses from lidar sensors off nearby objects. Although lidar-based mapping has the advantage of producing accurate and detailed maps of the environment, it also has disadvantages, such as the high cost of lidar sensors and the challenge of creating maps in complex urban environments. The creation of a two-dimensional map using cameras It is referred to as camera-based mapping. Camera-based mapping is a cost-effective strategy because cameras are generally accessible and inexpensive. However, there are certain disadvantages to camera-based mappings, including the challenge of properly detecting the depth of objects in the environment and the sensitivity of cameras to outside elements like weather and lighting.

2.4 Safety Rules for Self-Driving Cars

The automobile business could be completely transformed by self-driving cars, but this depends on how safe and compliant they are with laws. Understanding the safety issues posed by autonomous vehicles and the regulatory environment in which they operate is crucial as they proliferate on our roads. An overview of the existing state of the art is provided by this literature review. laws and safety for autonomous vehicles.

Marco Pavone's article, "Challenges and Opportunities for Autonomous Cars," was published in the IEEE Proceedings in 2018. This study looks at the various technological challenges, including as perception, planning, and control, that must be overcome to create reliable and safe autonomous vehicles. Lastly, this literature analysis has provided a summary of the safety and legal issues that surround self-driving cars. The research discussed the safety issues of self-driving cars and how the industry is addressing them.

3 PROPOSED WORK AND ALGORITHM

An important stage in the creation of autonomous cars is the training phase of the project. In order to determine the lane, the initial stage in this process is to execute video sampling on the movies that were captured with the use of the car's keyboard module. We take numerous screenshots from the movie and give them to the automobile as a dataset so it can teach itself to recognise lanes.

After that, we use the three lane detection module approaches of grayscaling, warping, and histogram creation.

The act of transforming a picture from several formats to a black and white image is known as grayscaling or thresholding. Here, we begin by converting the RGB colour space, which is the default, to HSV. The minimum and maximum values can be altered We can convert an image of the HSV into a full or partial black and white image.

Images can be changed from a front view perspective to a birds eye view perspective by warping. By doing this, we may clear the front view of any backdrop elements and concentrate just on the lane.

A method for converting an image into a graphical representation of its intensity distribution is histogram creation. As it accepts the warped image as an input and transforms it into a histogram representation, we use this after warping. The fact that the car will stay in its lane and not move in an erratic manner in the lane is another reason we adopt this technique.

By completing all Using these methods, we collect lane data.

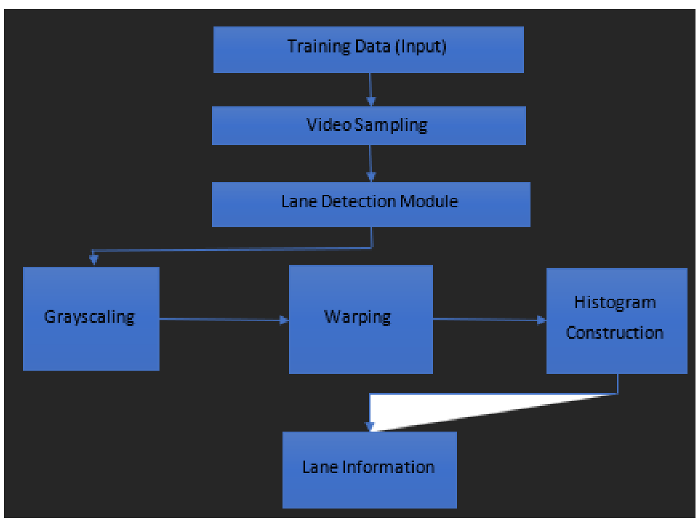

Fig1 : System architecture

4 METHODOLOGIES

PYTHON

The preferred language for this project was Python. Choosing this was simple for a number of reasons:

A high-level, all-purpose programming language is Python. Code readability is prioritised in its design philosophy, which makes heavy use of indentation.

Python uses garbage collection and dynamic typing. It supports a variety of paradigms for programming, such as structured (especially procedural), object-oriented, functional, and more. Due to its extensive standard library, it is frequently referred to as a "batteries included" language.

Python has a wide range of reliable computational tools for science. Examples of free and well-documented Python packages are NumPy, Pandas, and SciPy. These kinds of packages can significantly cut down and streamline the amount of code needed to create an application. This enables quick iteration.

NUMPY

A collection of Python modules is called NumPy. These allow for more advanced mathematical and scientific ideas. Since they would alter the semantics and syntax of the code, mathematical abstractions like f(x) cannot be used in the majority of programming languages. To make use of such functions in our programming, we can use NumPy. The Python language's array type from NumPy offers an effective data structure for numerical operations like manipulating matrices.

CV OPEN

The open-source library for image processing, machine learning, and computer vision is called OpenCV.

Artificial intelligence research in the area of computer vision teaches robots to comprehend and interpret the physical world. Machines can accurately classify and identify items on their own using tools like cameras, movies, and deep learning models. They may then make decisions based on the data they understood. a modern computer Image segmentation, object detection, edge detection, facial recognition, pattern detection, and other tasks all involve the use of vision.

Our project utilised OpenCV for lane detection.

OS RASPBIAN

Based on Debian GNU/Linux and designed specifically for the Raspberry Pi hardware, Raspbian is a free and open-source operating system. One of the most well-liked options for hobbyists, manufacturers, and educators, it is the suggested operating system for Raspberry Pi single-board computers.

Several software programmes, including the LXDE desktop environment, the Chromium web browser, and the Python programming language, are pre-installed on Raspbian. Additionally, it contains a number of utilities and tools designed especially for the Raspberry Pi, such as the Raspberry Pi Configuration tool, which enables users to customise a number of system settings. alter the CPU's clock speed.

The Raspberry Pi Foundation frequently updates Raspbian, and new editions are made accessible for download on their website. "Raspberry Pi OS" is the name of the most recent Raspbian release, as of the knowledge cutoff date of this note, and it is based on the Debian Buster release.

Overall, Raspbian is a user-friendly, lightweight operating system that works well on the Raspberry Pi for a wide range of projects and applications.

5. RESULTS AND DISCUSSION SCREENSHOTS

The results of the self-driving car are self-satisfactory. It was able to move in desired lanes and it was able to detect curves and the required angle to turn. But before that, we would like to show the results in order to get a more understanding approach.

The first one would be the completed car design:

Fig 2 :Front View

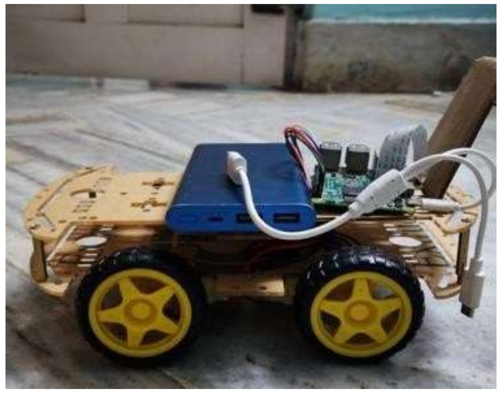

Fig 3: Side View

The camera at the front is slightly tilted towards the ground to try to cover as much of the track needed and little background to reduce the noise.
The whole car is made up of two levels, the first level consisting of the motor and its power source and the second level consisting of the Raspberry Pi, Power bank, and camera board module.
The second result of the self-driving car would be the remote-controlled phase of the self-driving car. Turn on the Raspberry Pi and execute the main module for the remote-controlled car to start the car and for it to be ready for the instruction given through the keyboard. In the given below figure, we only show the turning of the car but it will execute other functions as well.

Fig 4 : Starting Point

Fig 5 : Turing

Now the final and essential part of the self-driving car process. In this process, we will show you each part of the process i.e., masking, top view, histogram, etc. The first would be the masking process:

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Fig 6 : Actual Image

The above image is the original image of the track now by using the thresholding function we will change the image into black and white with the lane being the white color in the whole image. The result of thresholding is shown in the image below.

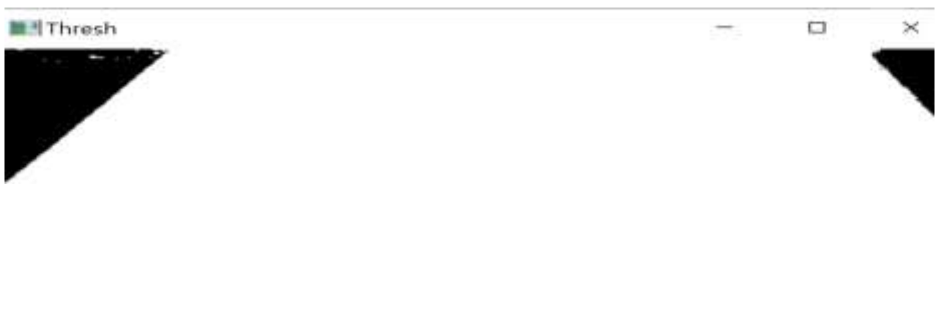

Fig 7 : Masked Image

The above image is the result of masking. As you can see there is some noise in the upper right corner but it can be diminished by changing the hue and saturation values.
The next part would be the top view of the image the result consists of the trackbar values, image points, and actual top view.

Fig 8 : Trackbar

Fig 9 : Image Points

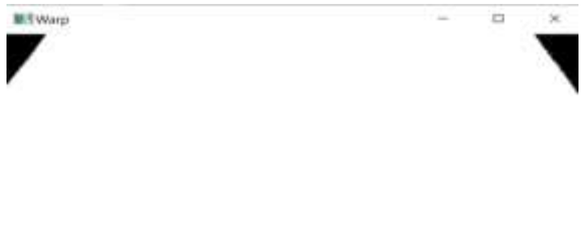

Fig 10 : Top View Image

The above results are default and are not changed to any given values. These are shown to show the changes that occur due to the manipulation of default values. The figures shown below are the actual result.

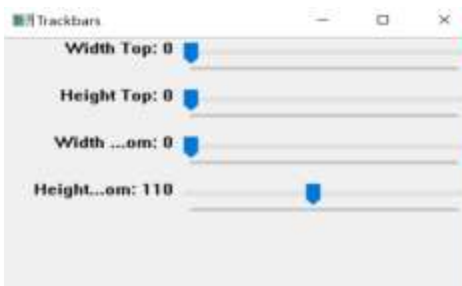

Fig 11 : Actual Trackbar

Fig 12 : Actual Image Points

Fig 13 : Actual top view

And finally, the histogram and the resulting image which shows the curve turning value along with the image.

Fig 14 : Histogram

Fig 15: Result

The small ball at the bottom of the histogram image gives the result based on its position in the image and the value is imprinted into the resulting image to show us the value and to confirm its working or not.
All the above images can be made into one single image using the stack image's function.

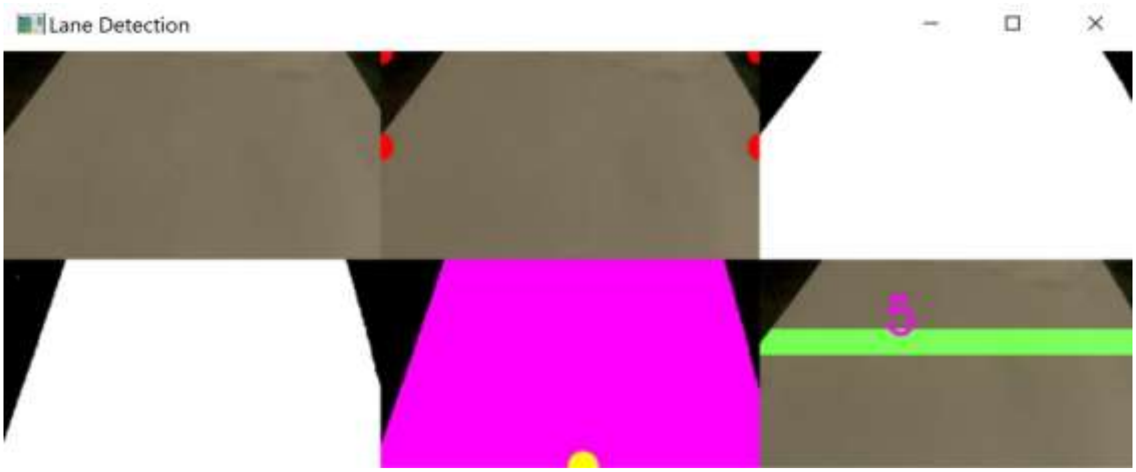

Fig 16: Stacked

And finally, the car will ride in the given lane as shown in the image below.

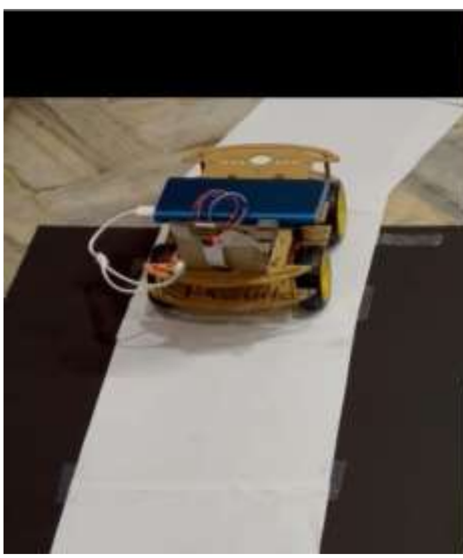

Fig 17 : Car Start

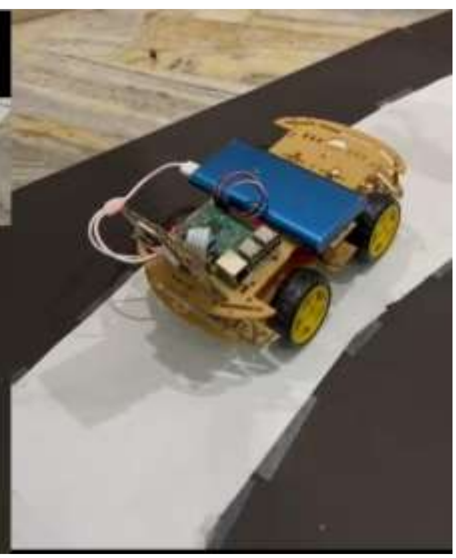

Fig 18 : Car Turining

6. CONCLUSION

In conclusion, self-driving car technology has the potential to completely transform the transportation sector by lowering the amount of accidents brought on by human error, enhancing traffic flow, and giving individuals who are unable to drive mobility. Although the accuracy of the self-driving system has significantly improved over the past few years, there is still room for improvement in challenging driving conditions and bad weather. It is crucial to address the self-driving car's performance in terms of safety before the technology can be extensively used. However, there are still problems that need to be fixed, such as improving sensor dependability, strengthening decision-making algorithms, and ensuring the safety of both pedestrians and riders. We can make the most of self-driving cars' potential to create a safer and more efficient a collaborative, ever-evolving transport network. In conclusion, the self-driving car project has made significant progress and has a lot of promise for the future of transportation. After extensive research and development, we have created a functioning prototype that can travel through a variety of environments and conditions securely and accurately.

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