International Journal of Scientific Research in Science and Technology
Available online at : www.ijsrst.com
OPEN ACCESS
Print ISSN: 2395-6011 | Online ISSN: 2395-602X
doi : https://doi.org/10.32628/IJSRST

Autonomous Self Driving Car

D Srilatha[1], L Nandini[2], K Gayathri[3], L Kathyayani[4], K Jamal Reddy[5], S Ijaj Ahmad[6]

[1]Assistant Professor, Department of Electronics and Communication Engineering, SV College of Engineering (SVCE), Tirupati, A.P. India

[2,3,4,5] UG Students, Department of Electronics and Communication Engineering, SV College of Engineering (SVCE), Tirupati, A.P. India

ARTICLEINFO

Article History:

Accepted: 03 March 2024

Published: 15 March 2024

Publication Issue :

Volume 11, Issue 2

March-April-2024

Page Number :

241-247

ABSTRACT

This paper presents the design and implementation of an autonomous self-driving car system utilizing a combination of Raspberry Pi, Arduino Uno, and various auxiliary components. The system integrates a Raspberry Pi single-board computer with a camera module, an L298N motor driver, an Arduino Uno microcontroller, an indicator controller, and a DC power supply rated at 11.2 volts.The Raspberry Pi serves as the central processing unit for the autonomous driving functionalities. It utilizes computer vision algorithms, leveraging the camera feed to analyze the car's surroundings, identify obstacles, detect lane markings, and make navigational decisions in real-time. OpenCV and PiCamera libraries are employed for image processing and camera interfacing, respectively.The L298N motor driver facilitates motor control for the car's propulsion system. The Raspberry Pi communicates with the motor driver to regulate the speed and direction of the motors based on the detected environmental cues. This enables the autonomous vehicle to maneuver autonomously through its environment. Additionally, an Arduino Uno microcontroller is integrated into the system to manage peripheral devices, such as indicator controllers. The Arduino Uno receives commands from the Raspberry Pi and orchestrates the activation of indicators or other auxiliary components to signal the vehicle's intentions to nearby pedestrians and vehicles. The DC power supply provides the necessary voltage and current to drive the motors and power the electronic components of the autonomous car system. Adequate voltage regulation and power management strategies are implemented to ensure stable operation and prevent damage to sensitive components. Through the integration of these components and the development of sophisticated software algorithms, the autonomous self-driving car system offers a promising platform for research, experimentation, and educational purposes in the field of autonomous vehicle technology. The project contributes to advancing the understanding and implementation of autonomous driving systems using readily available hardware components and open-source software resources.

Keywords: —Autonomous Driving, Raspberry Pi, L298N Motor Driver, Real-time Navigation, PiCamera

I. INTRODUCTION

The concept of autonomous self-driving cars represents ground breaking advancement in transportation technology, with the potential to revolutionize the way we travel and interact with our urban environment. These vehicles are designed to navigate roads and highways without direct human input, relying instead on a combination of cameras, actuators, and sophisticated artificial intelligence algorithms.Autonomous self-driving cars promise numerous benefits, including improved road safety, increased mobility for individuals with disabilities or limited access to transportation, reduced traffic congestion, and enhanced energy efficiency. By leveraging cutting-edge technologies such as machine learning, computer vision, and robotics, these vehicles have the capability to make split-second decisions based on real-time data from their surroundings, enabling them to react to changing road conditions, obstacles, and other vehicles with unparalleled precision.

The development of autonomous self-driving cars is fueled by a convergence of advancements in various fields, including data analytics, connectivity, and software engineering. Key components of these vehicles typically include:

Computer Vision: Cameras capture and analyze visual data, allowing the vehicle to detect lane markings, traffic signs, pedestrians, and other objects on the road.

Artificial Intelligence: Advanced AI algorithms process sensor data in real-time to make decisions about vehicle control, navigation, and interaction with the environment.

Actuators: Actuators control the vehicle's steering, acceleration, and braking systems, enabling precise maneuvering based on AI-driven commands.

Connectivity: Autonomous cars often rely on high-speed internet connectivity and communication protocols to interact with other vehicles, infrastructure, and centralized control systems.

Safety Systems: Redundant safety systems, fail-safe mechanisms, and rigorous testing protocols are implemented to ensure the reliability and safety of autonomous driving technology.

With the invention of self-driving cars, manual driving problems are being addressed, but not entirely resolved. For instance, machines do not need sleep, providing continuous operation. However, the development of self-driving cars introduces challenges in handling large and complex calculations, as well as high-definition feature extraction.Looking into the history of self-driving cars, the first proposed model in 1939 by General Motors, guided by radio-controlled electromagnetic fields with magnetized metal spikes embedded in the road, is a myth rather than a reality. There is no evidence supporting the existence of such a model. In 1969, John McCarthy, a notable AI researcher, contributed to artificial intelligence concepts like neural networks, but he did not invent the modern autonomous vehicle. The development of self-driving cars is a collective effort spanning decades and involving numerous researchers and engineers, with no single inventor solely responsible for their creation.The below figure 1 shows basic model of self driving car.

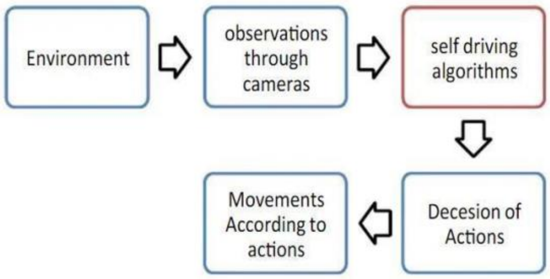

Figure 1. Basic model of self driving car

The organizational framework of this study divides the research work in the different sections. The Literature survey is presented in section 2. In section 3 and 4 discussed about Existing and proposed system methodologies. Further, in section 5 shown Simulation Results is discussed and Conclusion and future work are presented by last sections 6.

II. LITERATURE SURVEY

The research article "Working Models for Self-Driving Cars with Convolutional Neural Networks, Raspberry Pi, and Arduino" by Aditya Kumar Jain. The proposed approach uses a pie camera mounted on a raspberry pie in the car to capture the image. The Raspberry Pi is connected to the same network as the laptop, and the Raspberry Pi delivers the captured image to a convolutional neural network. The image is converted to grayscale before it is sent to the neural network. The model predicts one of four possible outcomes: left, right, forward, or stop. When the result is predicted, the Arduino signal will be activated and the car will be able to drive in a particular direction using the controller[1].

The research paper “Self Driving Cars: A Peep into the Future” presented by T. Banerjee, S. Bose, A. Chakraborty, T. Samadder Bhaskar Kumar, T.K. Rana. This research paper describes the design of embedded controller for self-driving, electric, impact resistant, and directional GSM vehicles. The vehicle's position, starting point, and destination are properly tracked by the GPS module and the coordinates are mapped to allow navigation. When the vehicle is visible from the front, the speed of the vehicle is automatically adjusted by maintaining a safe distance, which is a function of speed. A stepper motor-driven rotational distance measuring sensor continuously monitors the distance between the vehicle in front and the vehicle on the side and adjusts the speed limit and lane change accordingly[2].

“Self-Driving and Driver Relaxing Vehicle” entitled paper published by a Qudsia Memon, Muzamil Ahmed, Shahzeb Ali, Azam Rafique Memon, and Wajiha Shah In this study, they had created two self-driving car application that allows drivers to rest for a short period of time. It also presents a concept centered around the modified Google car idea, where Google cars need to arrive automatically at static destinations. In this prototype, they created a dynamic target. Here, self-driving cars track vehicles traveling along a given route. This vehicle is followed by this prototype[3].

ChunChe Wang, ShihShinh Huang, LiChen Fu, Pei Yung Hsiao article "Driving Assistance System for Night Vision Lane Recognition and Vehicle Detection". The purpose is to improve driving by developing a support system. This study combines lane detection with vehicle identification technology to improve driver safety at night. It can detect lanes and help locate markers. To extract an edge, use a cenny edge detection operation, followed by the selection of potentials edge points[4].

The paper "A Vision-based Method for Improving Safety of Self Driving" by Dong, D., Li, X., and Sun gives details about a simulator that can recognize traffic signs, lanes, and road segmentation[5].

R.Mohanapriya, L.K. Hema, Dipesh Warkumar Yadav, Vivek KumarVerma's published "GPS-based autonomous vehicles for future public transport". The four-wheeled robot is equipped with a GPS and GSM system. The robot is guided by a GPS system and can move from one place to another without human intervention. In the former case, it promises to report any theft in the GSM system. Vehicle owners can receive SMS notifications notifying them of problems and turn off the ignition. In the latter case, the project was designed that way that the vehicle can only be turned on if an authorized person sent the predefined location to the vehicle [6].

III. EXISTING METHOD

Autonomous vehicles are classified into different levels of autonomy based on their capabilities. The Society of Automotive Engineers (SAE) International has defined six levels of autonomy:

Level 0: No driving automation. The driver is in complete control of all driving tasks, including steering, braking, and acceleration.

Level 1: Driver assistance. The vehicle can assist with some driving tasks, such as lane keeping or adaptive cruise control, but the driver must always be ready to take over control.

Level 2: Partial automation. The vehicle can control some driving tasks, such as steering and braking, in certain situations, but the driver must still monitor the vehicle and be ready to take over control at any time. **Level 3:** Conditional automation. The vehicle can control all aspects of driving in certain situations, such as on highways.

Level 4: High automation. The vehicle can control all aspects of driving in most situations, regardless of the environment. The driver can safely disengage from driving tasks and may not need to take over control unless there is an emergency.

Level 5: Full automation. The vehicle can control all aspects of driving in all situations, without any human input.

Autonomous vehicles are still in the early stages of development, but they have made significant progress in recent years. A number of companies are developing and testing autonomous vehicles, including Waymo, Cruise, Uber, and Tesla. Some companies have already begun offering limited commercial services, such as robo taxi services in certain cities. the development of autonomous vehicles has continued to progress, and several noteworthy advancements have been made in the field.

Figure 2. current version of self driving car

Examples of Existing Autonomous Vehicle Systems

Here are some examples of existing autonomous vehicle systems:

Waymo: Waymo is a subsidiary of Alphabet, Google's parent company. Waymo has been developing autonomous vehicles for over a decade and has accumulated millions of miles of test drives. The company has launched a commercial robo taxi service in Phoenix, Arizona.

Cruise: Cruise is another company developing autonomous vehicles. Cruise was acquired by General Motors in 2016 and is currently testing its vehicles in San Francisco, California. The company plans to launch a commercial robo taxi service in San Francisco in 2023.Figure 2 shows current version of self driving car.

IV. PROPOSED METHOD

The figure 3 depicts the primary components and their interactions in an autonomous self-driving car system. These components can be categorized into three main stages:

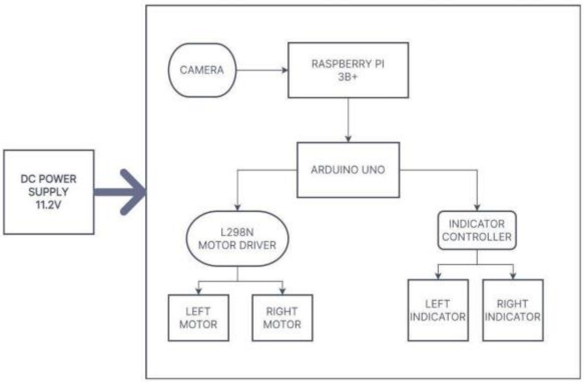

Figure 3. Block diagram of proposed method

Perception: This stage focuses on understanding the car's surroundings by gathering and processing data from various sensors.

Planning: This stage utilizes the perceived information to determine the optimal path for the car to reach its destination safely and efficiently and It Controls, This stage translates the planned path into actionable commands that manipulate the The Raspberry Pi processes the images and videos and sends the appropriate commands to the motor driver and indicator controller. The motor driver controls the speed and direction of the motors,the Raspberry Pi could be programmed to take a picture of a moving object and then turn on a red LED if the object is too close. The camera captures images and videos and sends them to the Raspberry Pi.The Raspberry Pi processes the images and videos and sends the appropriate commands to the motor driver and indicator controller. The motor driver controls the speed and direction of the motors. The indicator controller controls the LEDs. Arduino can controls the car mechanism.

In our system we have used a pattern matching approach that uses a camera to recognize a unique pattern printed on the road. The camera collects this pattern, processes it using the Raspberry Pi, and then tells the car to go in the desired direction. The camera also collects images of the surroundings to identify various obstacles in the area. If an obstacle gets too close to the vehicle then the vehicle will stop and change the path accordingly. Special patterns and road signs are placed along the route to determine which type of operations needs to perform on a vehicle.

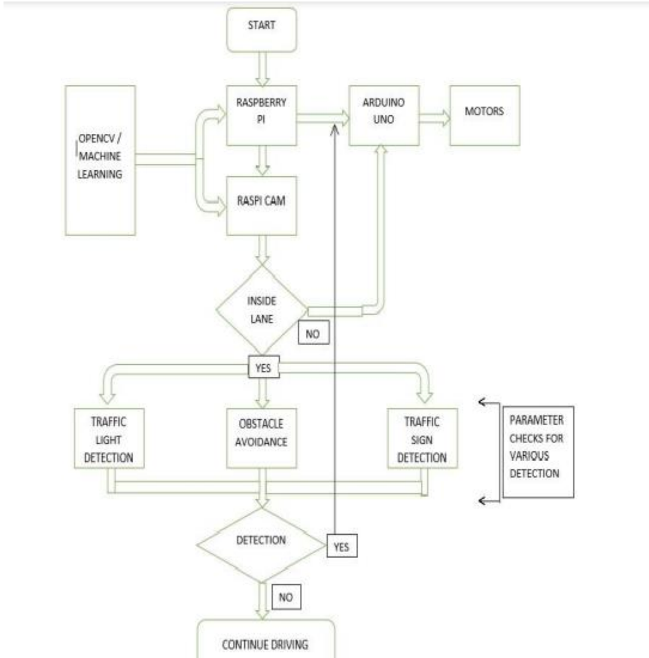

Figure 4. Flow Diagram

Start: The system begins its operation.

Initialize Raspberry Pi: The Raspberry Pi board is initialized to start processing.

Initialize Raspberry Pi Camera: The camera module connected to the Raspberry Pi is initialized to start capturing images.

Loop: The system enters a loop to continuously capture and process images.

Capture Image using Camera: An image is captured using the Raspberry Pi camera.

Pre-process Image: The captured image may undergo pre-processing steps such as resizing, color normalization, or noise reduction.

Inside Lane Detection: The system checks if the car is within the lane. If yes, it continues driving along the lane.

Traffic Light Detection: Detection of traffic lights in the image. If found, the car stops at the traffic light.

Traffic Sign Detection: Detection of traffic signs in the image. Based on the detected sign, appropriate actions are taken (e.g., stop, yield, etc.).

Obstacle Detection: Detection of obstacles in the image. If any obstacle is detected, the car takes evasive action to avoid collision.

Check if Any Detection Found: Check if any detection (inside lane, traffic light, traffic sign, or obstacle) is found in the image.

Analyze Data using OpenCV or Machine Learning: If any detection is found, the data is further analyzed using OpenCV or machine learning algorithms to refine the detection results or make more complex decisions.

Continue Driving: If no specific detection is found or after analyzing the detection results, the car continues driving.

Loop Back to Capture Image: The system loops back to capture the next image and repeats the process.

V. RESULTS AND DISCUSSIONS

The model can identify the specific pattern and can also detect barriers in the environment, as seen in the preceding photographs. As a result, the model is capable of doing all of the aforementioned tasks. Detections: In this time span of the project, we experimented with various types of detections on our trained model which makes it work in autonomous mode. The figure 5(a),(b) shows lane detection.The figure 6(a),(b) shows speed limit and direction detection. Figure 7(a),(b) indicates traffic light detection.

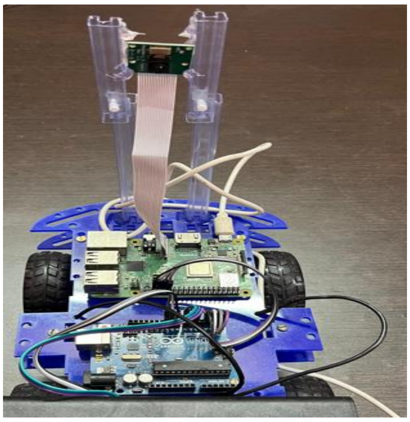

Figure 5(a). Lane detection 1

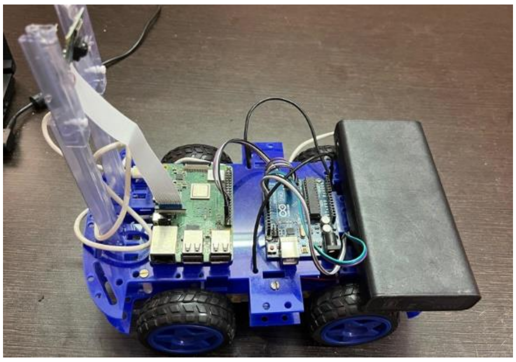

Figure 5(b). Lane detection 2

Figure 6(a). Speed limit of 50.

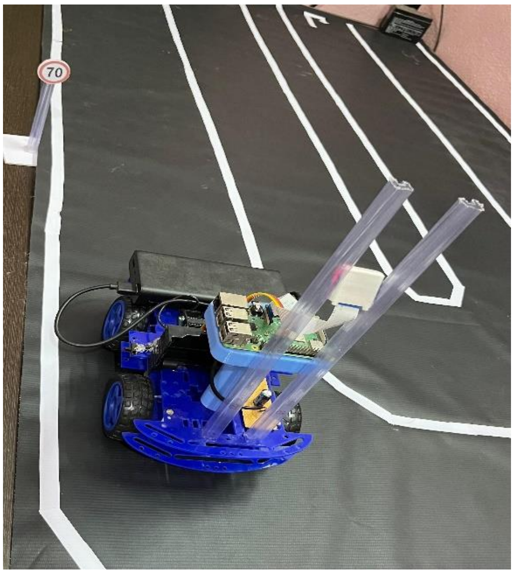

Figure 6(b). Speed limit of 70.

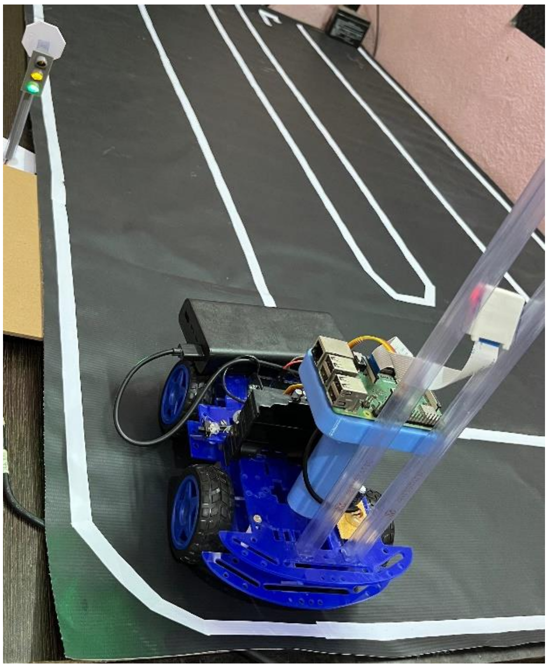

Figure 7(a). Traffic Light detection with green light

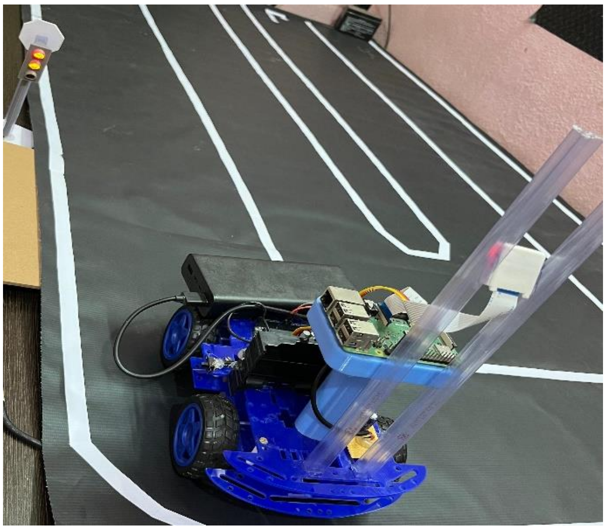

Figure 7(b). Traffic Light detection

The figure 8,and 9 shows different directions and stop signal.

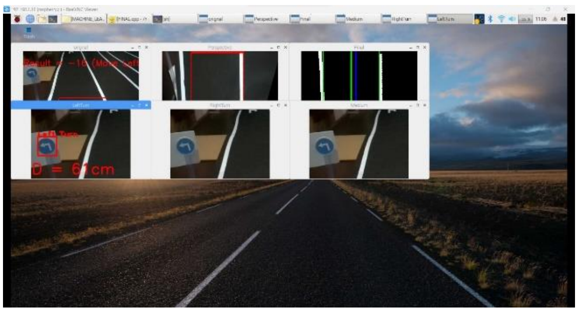

Figure 8. direction indication

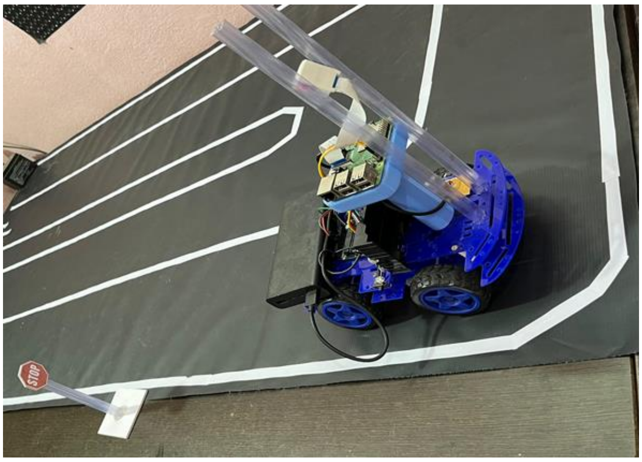

Figure 9. stop sign detection

VI. CONCLUSION AND FUTURE SCOPE

Self-driving cars are a cost-effective and environmentally friendly means of transportation that can reduce accidents and make commuting more comfortable. Self-driving cars are no longer science fiction novels and will soon become commonplace. We are living in a new era of transportation where human-powered transport vehicles are being replaced by computerized self-driving cars.Some car companies are rapidly developing self-driving cars to make them more accurate and safe. Self-driving cars are a major advance in the automated realm of the future. This project focuses on making changes in road safety and commuting through continuous learning of the system, and significantly reducing accidents and human error.

FUTURE SCOPE

The future scope of autonomous self-driving cars is vast and holds promise for transformative changes across various sectors. Here are some key areas where the technology is expected to evolve:

Future autonomous cars will prioritize user experience and human-machine interaction, offering intuitive interfaces, personalized preferences, and adaptive control systems to enhance passenger comfort, convenience, and trust in autonomous technology.

Autonomous vehicles have the potential to improve healthcare access and mobility for elderly individuals, people with disabilities, and underserved communities.

ACKNOWLEDGEMENT

It gives us great pleasure in presenting the preliminary project report on. I would like to take this opportunity to thank my guide Ms.D.Srilatha M.Tech, Assistant Professor and Dr. D. Srinivasulu Reddy, Ph.D., Professor, & Head of the Department (HOD) of Electronics and Communication Engineering, SV College of Engineering (SVCE) (Autonomous), Tirupati, Andhra Pradesh India, for giving me all the help and guidance I needed. I am really grateful for their kind support and valuable suggestions were very helpful. Thank you all!

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Cite this article as :

D Srilatha, L Nandini, K Gayathri, L Kathyayani, K Jamal Reddy, S Ijaj Ahmad, "Autonomous Self Driving Car ", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 11 Issue 2, pp. 241-247, March-April 2024.
Journal URL : https://ijsrst.com/IJSRST52411238