IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed journal & Refereed journal ⁜ Vol. 12, Issue 11, November 2023

DOI: 10.17148/IJARCCE.2023.121121

Obstacle Detection And Avoidance In Autonomous Cars

Prof. Nilam Honmane[1], Aniket Vadar[2], Zahir Mulla[3], Sarthak Samgir[4], Aditya Rakate[5]

Department of Information Technology, Zeal College Of Engineering And Research, Narhe[1-5]

Abstract: In our dynamic and ever-changing world driven by relentless technological progress, the forefront of innovation shines a spotlight on the concept of autonomous vehicles powered by the Internet of Things (IOT). These vehicles are a remarkable fusion of cutting-edge technology and artificial intelligence. At their core, they utilize essential components to fuel their intelligence and capabilities. The central processing unit is managed by the Raspberry Pi, which processes data from an array of sensors and cameras. Meanwhile, the Arduino Uno takes control of motor functions, interpreting commands and guiding the vehicle's movements. Motor drivers play a crucial role in ensuring precise control over speed and direction. Furthermore, the inclusion of OpenCV, an Open Source Computer Vision Library, equips these vehicles with the ability to interpret the visual data they gather

Keywords: Autonomous Vehicle, Raspberry Pi, Arduino UNO.

I. INTRODUCTION

In our ever-evolving world shaped by continuous technological advancements, the forefront of innovation spotlights the concept of Internet of Things (IOT)-based autonomous vehicles. These vehicles represent a fusion of state-of-the-art technology and artificial intelligence. At their core, they employ crucial components to drive their intelligence and capabilities. The Raspberry Pi acts as the vehicle's central processing unit, handling data from an array of sensors and cameras. Additionally, the Arduino Uno takes charge of motor functions, interpreting commands and guiding the vehicle's movements. Motor drivers play a pivotal role in guaranteeing precision in speed and direction control. Furthermore, the incorporation of OpenCV, an Open Source Computer Vision Library, equips these vehicles with the ability to make sense of the visual data they collect. These IOT-based autonomous vehicles offer an impressive array of functionalities. They can not only detect and adhere to lane markings on the road but also adapt to changing paths and road conditions. They possess the capability to identify obstacles in their vicinity and move both forward and backward as necessary. In essence, these vehicles are a convergence of IOT, computer vision, and intelligent control systems, propelling us into an era where self-driving cars are no longer confined to science fiction but are rapidly transitioning into a tangible and promising reality.

The notion of IOT-based autonomous vehicles represents a captivating fusion of multiple cutting-edge technologies. These vehicles harness the power of the Internet of Things (IOT) for connectivity and data exchange, enabling real-time decision-making and remote monitoring. The integration of IOT permits these vehicles to communicate with smart infrastructure components and gather valuable data from external sources, thus amplifying their autonomous capabilities. OpenCV, a widely adopted computer vision library, assumes a pivotal role in tasks like lane detection, which is fundamental for autonomous navigation. The Raspberry Pi serves as a versatile computing platform, while the Arduino Uno, with its programmable microcontroller, provides precise control over vehicle functions. Motor drivers ensure finely-tuned movement, enabling navigation, obstacle detection, and precise forward and backward maneuvers. These components collectively form a comprehensive ecosystem that underpins the functionality of IOT-based autonomous vehicles, positioning them as a promising technology for the future of transportation. The integration of data from a variety of sensors and AI-based systems further enhances the vehicle's positioning and orientation, thereby ensuring safe and efficient autonomous navigation."

II. LITERATURE SURVEY

H. MUSLIM & team, in “Cut-Out Scenario Generation With Reasonability Foreseeable Parameter Range From Real Highway Dataset for Autonomous Vehicle Assessment”, [1] This literature review focuses on the generation of test cases for the scenario-based assessment of automated driving systems (ADS) in the context of cut-out maneuvers. In this scenario, the lead vehicle changes lanes, revealing a new lead vehicle, which can sometimes be slower than the original lead vehicle. The study extracts cut-out scenarios from real-world traffic data recorded on Japanese highways and defines them using vehicle kinematic parameters, including velocities and distances. The analysis is based on the correlation between consecutive vehicles, distinguishing between the rear part (following vehicle and cutting-out vehicle) and the frontal part (cutting-out vehicle and preceding vehicle).

International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ⪤ Peer-reviewed journal & Refereed journal ⪤ Vol. 12, Issue 11, November 2023
DOI: 10.17148/IJARCCE.2023.121121

Irfan Ahmad and Karunakar Pothuganti [2] in "Deep Learning Techniques for Obstacles Detection and Avoidance in driverless Cars" state that current challenges in Vehicle-to-Infrastructure (V2I) communication, which refers to the vehicle's ability to communicate with infrastructure elements such as traffic lights and road signs. The lack of reliable V2I communication can limit an autonomous vehicle's ability to access real-time data that is crucial for navigation and decision-making on the road.

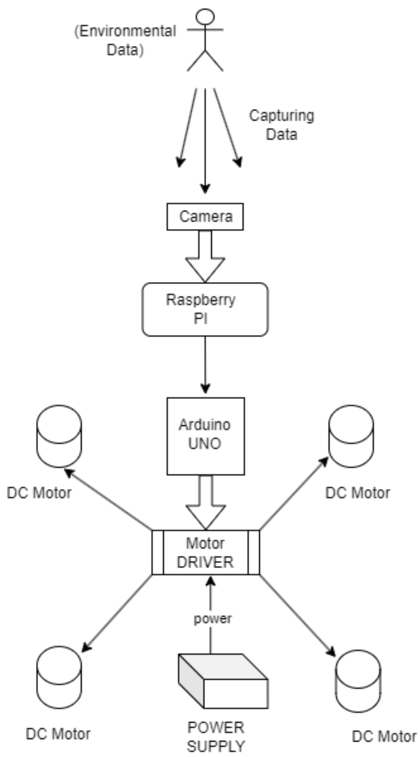
Mehdi masmoudi & et, [3] states that in "A Reinforcement Learning Framework for Video Frame-Based Autonomous Car-Following", The research paper explores the significance of car-following theory in the context of autonomous vehicles (AVs). While car-following has been a core component of Intelligent Transportation Systems, its application to AVs is an underexplored research area. AVs aim to enhance driving safety and convenience by minimizing human error, requiring advanced recognition of other drivers' behaviour . The paper presents an end-to-end car-following framework for AVs that relies on automated object detection and navigation decision modules, enabling AVs to follow other vehicles based on RGB-D frames. The approach combines the YOLOV3 object detector and reinforcement learning (RL) algorithms, specifically Q-learning and Deep Q-learning, to make real-time decisions.

Pavol Bistak & team , [4] in "Teaching IOT Using Raspberry Pi Based RC-Car",, This literature review discusses the significant impact of the Internet of Things (IOT) on human lives, with a particular focus on education. It highlights the importance of implementing new technologies to motivate and assist students in their studies. The paper provides a comprehensive description and evaluation of an IOT-focused course. The course's curriculum, including lecture topics and practical labs, is designed to align with specific educational goals. The paper delves into the details of the final project within the course, which involves students solving real-world examples. Notably, the course employs a project-based learning approach, which is evaluated carefully by students. This evaluation aims to enhance the quality of the course for future iterations.

Karthik Krishn and team, [5] in “"Research Challenges in Self-driving Vehicle by Using Internet of Things (IOT)", This literature review summary on following content discusses the significant impact of the Internet of Things (IOT) on human lives, with a particular focus on education. It highlights the importance of implementing new technologies to motivate and assist students in their studies. The paper provides a comprehensive description and evaluation of an IOT-focused course. The course's curriculum, including lecture topics and practical labs, is designed to align with specific educational goals

III. METHODOLOGY

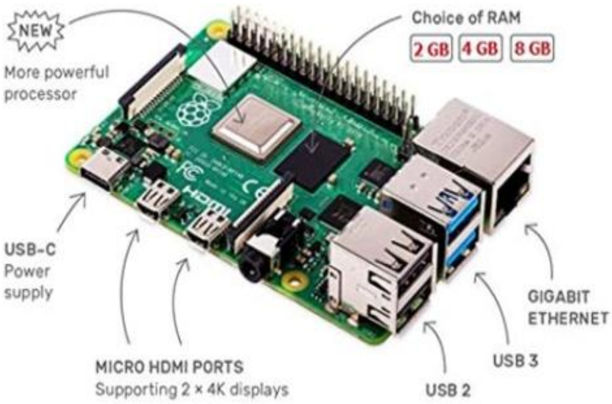
3.1) Block Diagram



International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ※ Peer-reviewed journal & Refereed journal ※ Vol. 12, Issue 11, November 2023
DOI: 10.17148/IJARCCE.2023.121121

3.2) Components

1. Raspberry-pi



Raspberry Pi serves as the brain of the autonomous vehicle, acting as a central processing unit. It runs the main software stack that processes sensor data, controls the vehicle, and makes decisions. Utilizes its computational power for real-time data analysis, path planning, and decision-making. Communicates with other components and sensors to orchestrate the vehicle's movements.

2. Raspberry-pi Camera

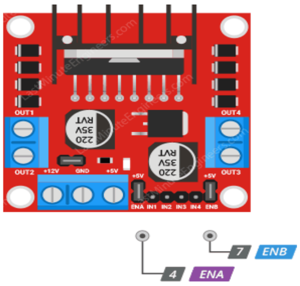
The Raspberry Pi camera is used for capturing visual data, providing a critical input for navigation. It continuously records the surroundings of the vehicle, allowing it to detect and identify objects, lanes, and obstacles. The camera's data is processed by computer vision algorithms to make informed driving decisions. It aids in lane tracking, object detection, and image recognition.

3. Arduino UNO

Arduino boards are responsible for interfacing with various sensors and controlling actuators. They manage sensor data, such as GPS, ultrasonic sensors, and IMU, and send it to the Raspberry Pi. Arduino boards can also control servos, motors, and other actuators for vehicle movement. They provide low-level control and real-time responsiveness to ensure safe and precise operation.

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940
International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ⁎ Peer-reviewed journal & Refereed journal ⁎ Vol. 12, Issue 11, November 2023
DOI: 10.17148/IJARCCE.2023.121121

4. L298 Motor Driver

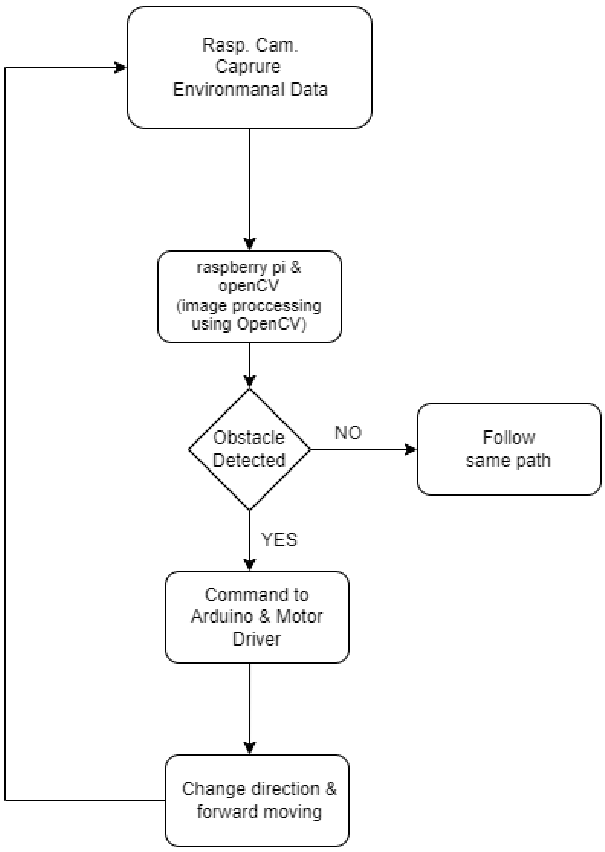


The L298 motor driver is a crucial component for controlling the vehicle's motors. It interprets the commands from the Raspberry Pi and Arduino to regulate the speed and direction of the motors. Ensures the autonomous vehicle can navigate, turn, and stop as per the control algorithms. Offers motor protection and efficiency, preventing overheating or overloading.

5. OpenCV

OpenCV is a vital software library used for image and video analysis in the autonomous vehicle system. It includes various computer vision algorithms for tasks like object recognition, lane detection, and image processing. OpenCV helps the Raspberry Pi interpret visual data from the camera and make real-time decisions based on what it "sees."

3.3) Flow Chart :



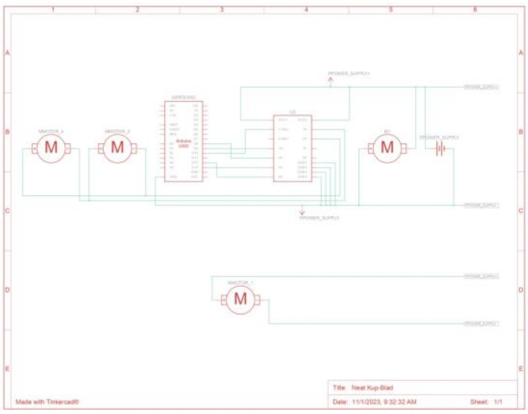
ISSN (O) 2278-1021, ISSN (P) 2319-5940
International Journal of Advanced Research in Computer and Communication Engineering
Impact Factor 8.102 ⁓ Peer-reviewed journal & Refereed journal ⁓ Vol. 12, Issue 11, November 2023
DOI: 10.17148/IJARCCE.2023.121121

3.4) Proposed System

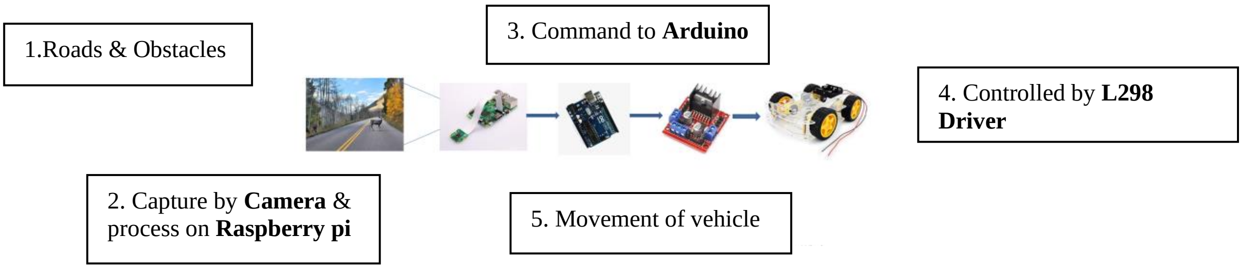
In this autonomous car system, we use machine learning. The system is trained with machine learning, deep leaning and openCV. Raspberrypi cam which is like the car's eyes that see the road. It takes pictures and sends them to the mini computer of our system called Raspberry Pi. The Raspberry Pi collects the pictures from a camera, processes them with openCV, and looks for obstacles. If an obstacle is found, the Raspberry Pi tells another part of the system called Arduino, which decides if the car should keep moving or stop at its current position

- Assemble the physical components, including the Raspberry Pi, Arduino Uno, Raspberry Pi Camera, and L298 Motor Driver, on the vehicle platform.
- Connect the motors to the L298 Motor Driver, and establish connections between the Raspberry Pi and Arduino Uno.
- This process involves the integration of hardware and software components to create an intelligent and autonomous vehicle that can navigate, respond to environmental cues, and perform tasks as commanded.

3.5) Circuit Design



3.6) Vision Architecture



3.7) Process Flow

- ➢ The Raspberry Pi Camera captures real-time images of the vehicle's surroundings.
- ➢ These images are then transferred to the Raspberry Pi for further processing.
- ➢ Implement OpenCV algorithms on the Raspberry Pi to analyze the captured images. These algorithms can include object detection, lane detection, and obstacle recognition.
- ➢ OpenCV processes the images to identify obstacles, lanes, and other relevant features.
- ➢ Based on the image analysis, the Raspberry Pi determines the appropriate action for the vehicle. This could involve identifying obstacles and deciding whether to stop or change direction, recognizing lanes for navigation, or detecting commands for turning left or right.
- ➢ The Raspberry Pi communicates with the Arduino Uno to control the motors via the L298 Motor Driver.
- ➢ Commands from the Raspberry Pi instruct the motors to move forward, backward, stop, or turn left and right.
- ➢ Continuously monitor the environment with the camera and update image processing and motor control in real time.

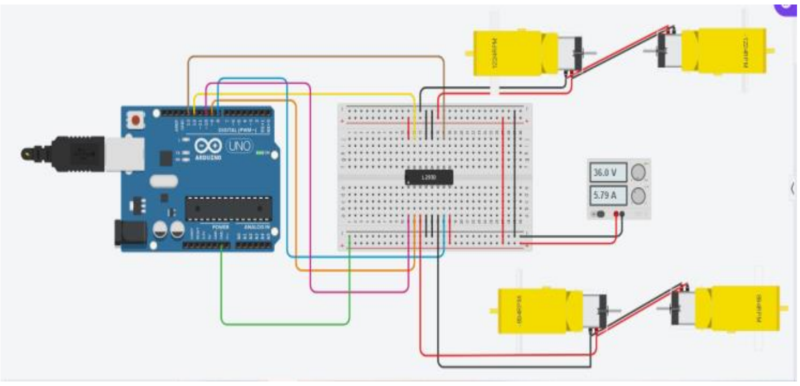
IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed journal & Refereed journal ⁜ Vol. 12, Issue 11, November 2023

DOI: 10.17148/IJARCCE.2023.121121

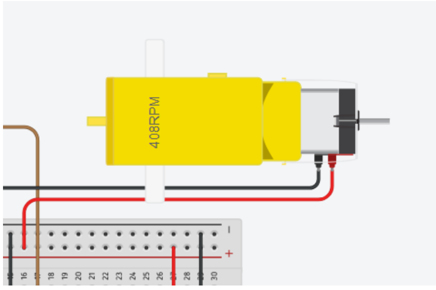
3.8) Simulation



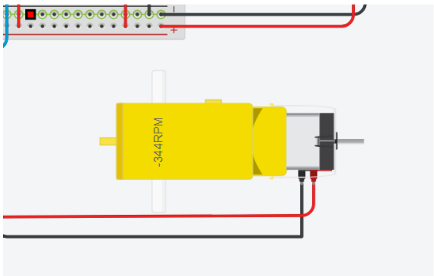
The Arduino Uno, paired with the motor driver, brings precision and efficiency to the vehicle's movements, facilitating dynamic forward-backward motion, and speed regulation. This integration of hardware and software showcases the project's potential to revolutionize transportation through autonomous capabilities, enhancing safety and efficiency on the road.

Expected Rotation :

1st motor = 408 rpm

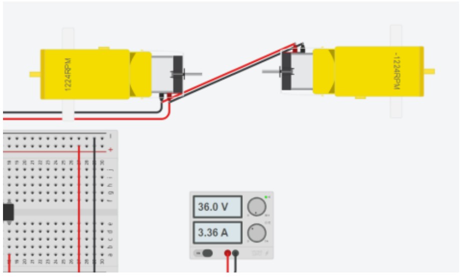


2nd motor = -344 rpm (same as 1st motor but in reverse direction because the motors are placed parallel to each other.



Rtation of parallel motors w.r.t. increasing power supply (managing speed i.e. rotation of wheels) :

1)

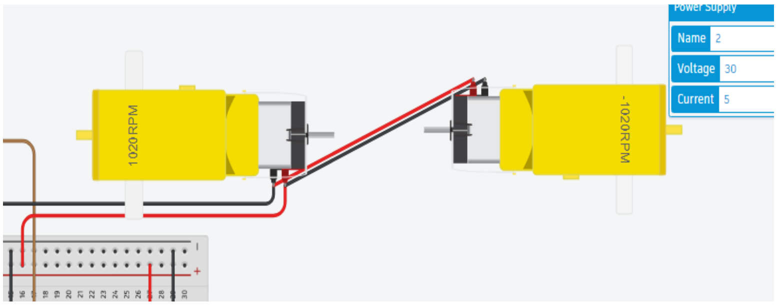


International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁜ Peer-reviewed journal & Refereed journal ⁜ Vol. 12, Issue 11, November 2023

DOI: 10.17148/IJARCCE.2023.121121

2)



IV. CONCLUSION

In conclusion, the integration of IOT (Internet of Things) technology with autonomous vehicles (AVs) represents a transformative leap in the field of transportation. IOT provides AVs with the ability to collect, exchange, and analyze real-time data from various sensors and sources, enabling these vehicles to make informed decisions and navigate autonomously. The fusion of data from different sensors, combined with AI-based algorithms, plays a pivotal role in AV positioning, orientation, and environmental perception.

As AV technology continues to advance, it promises safer, more convenient, and environmentally friendly transportation solutions. The synergy between IOT and AI-enabled AVs is poised to address complex challenges and revolutionize the way we perceive and interact with self-driving vehicles. With the potential to enhance road safety, reduce traffic congestion, and create more sustainable transportation systems, IOT-enabled AVs represent a promising future of mobility.

REFERENCES

[1] H. MUSLIM, S. ENDO, H. IMANAGA “Cut-Out Scenario Generation With Reasonability Foreseeable Parameter Range From Real Highway Dataset for Autonomous Vehicle Assessment”, VOLUME 11, 2023

[2] Irfan Ahmad and Karunakar Pothuganti , “Deep Learning Techniques for Obstacles Detection and Avoidance in driverless Cars”

[3] Mehdi Masmoudi, an team, "A Reinforcement Learning Framework for Video Frame-Based Autonomous Car-Following" Date of publication 24 May 2021: date of current version 1 June 2021.

[4] Pavol Bist´ak, Reza Moezzi, Francesco Semeraro, Giuseppina Nicassio "Teaching IOT Using Raspberry Pi Based RC-Car", 978-1-7281-4381-1/20/$31.00 © 2020 IEEE

[5] Karthik Krishna, Naga Karumuri, Cyril Christopher, N. Jayapandian, "Research Challenges in Self-driving Vehicle by Using Internet of Things (IOT)" 978-0-7381-1327-2/21/$31.00 ©2021 IEEE

[6] H. MUSLIM, S. ENDO, H. IMANAGA “Cut-Out Scenario Generation With Reasonability Foreseeable Parameter Range From Real Highway Dataset for Autonomous Vehicle Assessment”, VOLUME 11, 2023

[7] Zhouqiao Zhao, Ziran Wang "Personalized Car Following for Autonomous Driving with Inverse Reinforcement Learning", May 2022 DOI: 10.1109/ICRA46639.2022.9812446

[8] Abdul Muis, Johannes Mae "Simple Road Side Detection and Tracking on Embedded PC" 978-1-5386-1946-9/18/$31.00 ©2018 IEEE

[9] Brilian Tafjira Nugraha, Shun-Feng Su "Towards Self-driving Car Using Convolutional Neural Network and Road Lane Detector" 978-1-5386-0510-3/17/$31.00 ©2017 IEEE

[10] Bhaskar Barua, Clarence Gomes ,Shubham Baghe, Jignesh Sisodia "A Self-Driving Car Implementation using Computer Vision for Detection and Navigation" 978-1-5386-8113-8/19/$31.00 ©2019 IEEE

[11] Yufan Zhang "Online Car-hailing Service Based on Driverless Mode under Artificial Intelligence Technology" 978-1-7281-9004-4/21/$31.00 ©2021 IEEE

[12] Hiral Thadeshwar, Vinit Shah, Mahek Jain "Artificial Intelligence based Self-Driving Car" 978-1-7281-6509-7/20/$31.00 ©2020 IEEE

[13] Bharathwaj Krishnaswami Sreedhar, Nagarajan Shunmugam "Deep Learning for Hardware-Constrained Driverless Cars", Volume November 01,2020

[14] Suriya Prakash, Vigneshwaran D, Seenivasaga Ayyalu R "Traffic Sign Recognition using Deeplearning for Autonomous Driverless Vehicles" June 21,2021 at from IEEE Xplore

[15] Yevgeniy Byeloborodov, Sherif Rashad "Design of Machine Learning Algorithms for Behavioral Prediction of Objects for Self-Driving Cars" 978-1-7281-9656-5/20/$31.00 ©2020 IEEE

IJARCCE ISSN (O) 2278-1021, ISSN (P) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering

Impact Factor 8.102 ⁒ Peer-reviewed journal & Refereed journal ⁒ Vol. 12, Issue 11, November 2023

DOI: 10.17148/IJARCCE.2023.121121

[16] Mohammad Rubaiyat Tanvir Hossain, Md. Asif Shahjalal, Nowroz Farhan Nur "Design of an IOT Based Autonomous Vehicle with the Aid of Computer Vision" 78-1-5090-5627-9/17/531.00 ©2017 IEEE

[17] Ze Liu, Yingfeng Cai ,Hai Wang ,Long Chen ,Hongbo Gao "Robust Target Recognition and Tracking of Self-Driving Cars With Radar and Camera Information Fusion Under Severe Weather Conditions", 1558-0016 © 2021 IEEE.

[18] Song Zhiwei, Huang Weiwei, Wu Ning, Wu Xiaojun, Wong Chern Yuen Anthony "Map Free Lane Following based on Low-Cost Laser Scanner for Near Future Autonomous Service Vehicle" 978-1-4673-7266-4/15/$31.00 ©2015 IEEE

[19] Q. Popescu and et al., "Automatic incident detection in intelligent Sansportation systems using aggregation oftraffic parameters collected through v2i communications," IEEE Intelligent Transportation Systems Magazine, vol. 9(2). pp. 64-75, 2017.

[20] R. Atallah, M. Khabbaz, and C. Assi, "Multihop v2i communications: A feasibility study, modeling, and performance analysis," IEEE Transactions on Vehicular Technology, vol. 18(2), pp. 416-430, 2017.