Externally installable ADAS for manual systems

Ms. Shital Dhumane[1], Tejas Gangurde[2], Aakanksha Khole[3], Tejas Bhosale[4]

[1]*Professor, Electronics and Telecommunication*
MVP'S Karamveer Adv. Baburao Ganpatrao Thakare College of Engineering, Nashik
[2]*Student, BE Electronics and Telecommunication*
MVP'S Karamveer Adv. Baburao Ganpatrao Thakare College of Engineering, Nashik
[3]*Student, BE Electronics and Telecommunication*
MVP'S Karamveer Adv. Baburao Ganpatrao Thakare College of Engineering, Nashik
[4]*Student, BE Electronics and Telecommunication*
MVP'S Karamveer Adv. Baburao Ganpatrao Thakare College of Engineering, Nashik

---***---

Abstract - *There is a broad usage of automobile vehicles in the Transport and Logistic industry, In-house transportation as well as roadways transportation. But this process demands for a huge man power which brings up human physical limits in the process. During roadways, drivers are employed to drive the heavy transport vehicles for a long duration which makes transportation slow and less efficient, as human drivers require rest to drive at full focus. This human limitation increases the delivery time. In-House transportation in places such as large warehouses where ample of human labor is employed to load and unload the goods, is still a human dependent process, all these manual driving and transportation can be automated using ADAS (Advanced driver assistance systems) By developing an autonomous self-driving vehicle for transportation of goods in large warehouses, efficiency and productivity of the task is improved and human labor is reduced. The primary purpose of the work is to develop an autonomous vehicle of level 1 to level 2 ADAS for the transport and logistics industry and a self-driving driverless vehicle in large warehouses. This work architecture will be focused on installation of these ADAS systems on pre-existing vehicles externally making the system portable. These autonomous vehicles will consist of LiDAR sensors for 3D mapping and obstacle detection, and microcontrollers will be used to process the data generated by the LiDAR sensor and give inputs to the vehicle accordingly. This work will deliver autonomous vehicle architecture and an externally installable system for the transport and logistics industry.*

Key Words*: *LiDar, Obstacle detection, Obstacle avoidance

1. INTRODUCTION

As we are observing that there is great enhancement in ADAS technology. Due to this Autonomous vehicle are taking a big leap in the automotive industry. In this field the researchers are facing the difficulty of safety of passengers, besides the biggest challenge of self driving cars is to face, judge and react correctly to the obstacles that come across. To face and overcome this difficulty the self-driving cars should be mounted with required sensors that interpret and process the data in real time. The sensors which can be used are Radars, Global Positioning System (GPS), and LIDARs. Among all of these the Lidar sensor is most implementable and suitable for self-driving cars. Speaking of the LIDAR sensor, it is used for obstacle detection which detects the obstacles in 360°. The main aim of LIDAR is to detect and analyze whether the object is real or fake and how to avoid it. This mechanism of obstacle avoidance is not only limited to self-driving cars. This same mechanism can also be implemented in robots for transfer of goods, home cleaning etc.

2. LITERATURE REVIEW

Angelo Nikko Catapang and Manuel Ramos [1], Presents that the study focuses on inexpensive 2D lidar, especially the low-cost LIDAR-Lite v1, and evaluates its dependability, efficacy, and potential integration with other sensors with the goal of improving autonomous vehicles' obstacle detection in urban settings.

Deepali Ghorpade, Anuradha D. Thakare, Sunil Doiphode [2], It presents through the use of point cloud segmentation, clustering, and a convex hull algorithm validated via MATLAB simulation, the suggested approach improves visibility, path planning, and the effectiveness of obstacle avoidance.

Nikolaos Baras, Georgios Nantzios, Dimitris Ziouzios, Minas Dasygenis [3], it elaborates for real-time obstacle avoidance and navigation, this study uses RPLidar and Raspberry Pi, adding Wi-Fi for indoor positioning. By effectively managing sensor data, the suggested algorithm for dynamic vehicle control tackles the difficulties associated with autonomous driving.

T R Madhavan, M Adharsh [4], It Presents that the proven MATLAB-based obstacle detection and avoidance algorithm, providing a simple yet effective approach to the advancement of obstacle avoidance technologies.

R. Neumann de Carvalho, H.A. Vidal, P. Vieira, M.I. Ribeiro [5], Presents those challenges in large-scale autonomous floor cleaning, presenting a template-based path planning approach based on an existing 2D map. To improve efficiency, ultrasonic data is creatively used for obstacle detection. This method, which uses a behavior-based path tracking strategy, works well with inexpensive navigation modules and may be used in commercial vacuum cleaners in the future.

Behnam Behroozpour, Phillip A. M. Sandborn, Ming C. Wu, and Bernhard E. Boser [6], The article discusses the continuous research efforts to create affordable and effective lidar solutions, which are necessary for a variety of applications like drones, robots, and diverse industries requiring 3D imaging technology, in addition to self-driving cars.

3. METHODOLOGY

Lidar sensor uses light to measure distances and scan surroundings for autonomous vehicles which provides high accuracy, precision in object detection and recognition of 3D object in ADAS. Lidar is a ranging device which measures distance from car to an obstacle. It measures the distance by sending a short laser pulse and recording the time lapse between the outgoing light pulse and the reflected light pulse. Lidar system provides 3D mapping of surface objects that may be encountered by the autonomous driving vehicle. The LIDAR sensor emits the laser beam continuously in 360 degrees of the vehicle and are reflected back by the objects in the way. Lidar sensor is very precise in terms of directionality.

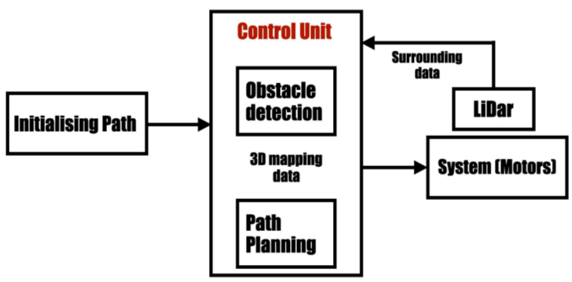

Fig. 1 Block Diagram

The concept of the system is majorly described as a self-driving car which includes sensors and modules which are mounted on the vehicle. According to the block diagram, there includes a processing unit which includes all the sensors and which takes the data as input and makes real time decision accordingly. The communication model takes the data as input from the Lidar and sends the data to the microcontroller for further processing. The microcontroller analyzes the data, interpret it and sends the information to the vehicle.

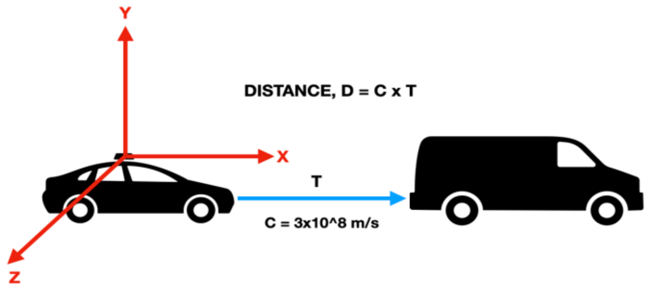

Fig. 2 Mathematical Representation

For the software related work raspberry Pi 2/3/4 is used as it is very powerful because of many GPIO pins. Firstly, Arduino will be used for testing purposes. After that for performing simulation Arduino will be replaced by a microcontroller. Lastly all the data will be gathered so here sensor integration will be done. This is the feasibility of the work hence it will be achieved at this stage.

4. APPLICATIONS

Transportation and logistics industry: With features like adaptive cruise control and collision avoidance, this game-changing solution for logistics and transportation improves safety by solving important issues. With real-time monitoring, it optimizes operational efficiency and lowers the risk of accidents while easily adjusting to the different kinds of vehicles used in the industry.

Home Automation: Cleaning robots with excellent room mapping capabilities are powering home automation, which is changing modern living. These clever gadgets use mapping algorithms and sensors to navigate and clean effectively. They allow personalized cleaning schedules and focused area cleaning, offering a preview of the time-saving features that will define home automation in the future.

Automobile Industry: In this important feature is lane assist, which tracks the position of the vehicle in the lane using cameras and sensors. In order to stop accidental lane departure, it offers corrective interventions like steering adjustments. With the use of sensors and cameras, Parking Assist helps drivers park automatically in either parallel or perpendicular spaces.

5. ADVANTAGES

Portable (Externally Installable System): It can be easily installed on a variety of manually driven vehicles without the need for extensive modifications. This portability ensures accessibility and flexibility. ADAS Level 1 to Level 2: Level 1 to Level 2 autonomy is included in the system. This indicates that it offers a range of functions that improve driver convenience and safety, such as adaptive cruise control, lane-keeping assistance, and collision avoidance. Reduced Human Dependency: The system lessens reliance on human drivers for routine tasks like keeping a safe following distance, staying in one's lane, and responding to possible obstacles by integrating ADAS functionalities. Obstacle Detection and Avoidance System: The system makes driving safer by using sensors and real-time data analysis to identify obstacles in the path of the car and automatically start avoiding collisions. 3D Mapping-Based, Efficient Path Tracking: By utilizing 3D mapping technology, the system effectively monitors the path of the vehicle. Time-Efficient Deliveries: Delivery times are accelerated and improved by the system's capacity to self-manage routine driving tasks, navigate traffic, optimize routes, and navigate it all.

6. SIMULATION AND RESULT

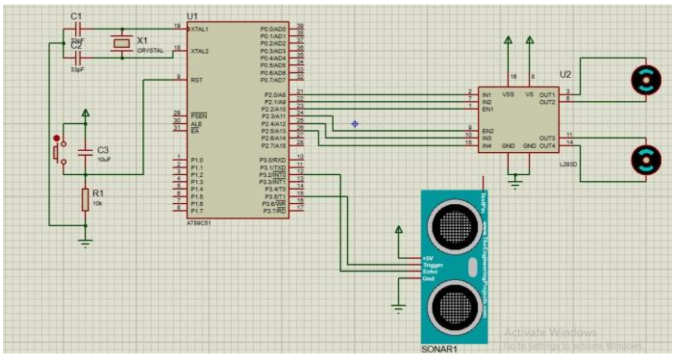

Fig. 3 Simulation

The UV sensor will be mounted on the vehicle which will rotate 90 degrees and gather the information of the surroundings. It will detect the obstacles in its path. For the detection of obstacles in 360 degrees a Lidar sensor will also be mounted. Here the sensor integration part will be carried, the sensors will gather information about the surroundings and pass the information to the microcontroller. The microcontroller will then instruct the DC motors to turn the vehicle left/right accordingly. In this way the vehicle will decide its path and move forward without any difficulty.

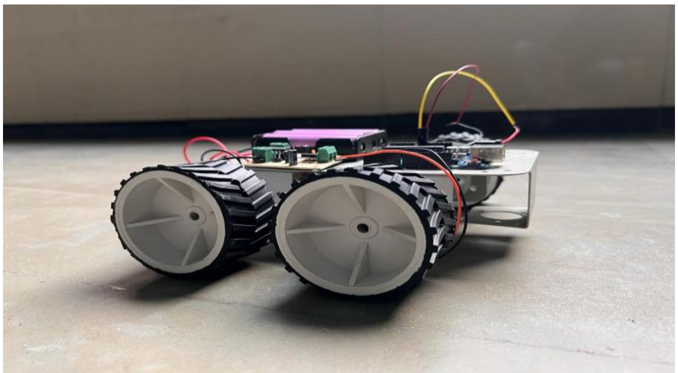

Fig. 4 Prototype

Above fig displays the prototype of the work which consists of necessary sensors, microcontroller, DC motors and batteries. This size of the prototype aids in efficient handling and better understanding of the work.

7. CONCLUSION

The goal of this work is to develop an Advanced Driver Assistance System (ADAS) that can be installed externally and is specifically designed for manually operated vehicles. This portable and unique design will find application in a variety of fields, including home automation, transportation, and the automotive industry. This work strategic goal is to fully automate driving experiences by implementing Level 3 to Level 4 ADAS systems in the transportation and logistics industry. Additionally, the work aims to offer ADAS solutions that are portable and widely accessible for a range of two-wheeler automobile vehicles. This initiative, which recognizes the growing demand, represents the first stage of automation in the transportation sector and has the potential to transform efficiency and safety in response to the industry's increasing need for expert automated solutions.

8. REFERENCES

[1] N. Baras, G. Nantzios, D. Ziouzios and M. Dasygenis," Autonomous Obstacle Avoidance Vehicle Using LIDAR and an Embedded System," 2019 8th International Conference on Modern Circuits and Systems Technologies (MOCAST), Thessaloniki, Greece, 2019, pp. 1-4, doi: 10.1109/MOCAST.2019.8742065.

[2] A. N. Catapang and M. Ramos," Obstacle detection using a 2D LIDAR system for an Autonomous Vehicle," 2016 6th IEEE International Conference on Control System, Computing and Engineering (ICCSCE), Penang, Malaysia, 2016, pp. 441-445, doi: 10.1109/ICCSCE.2016.7893614.

[3] D. Ghorpade, A. D. Thakare and S. Doiphode," Obstacle Detection and Avoidance Algorithm for Autonomous Mobile Robot using 2D LiDAR," 2017 International Conference on Computing, Communication, Control and Automation (ICCUBEA), Pune, India, 2017, pp. 1-6, doi: 10.1109/ICCUBEA.2017.8463846

[4] Erke Shang, Xiang jing An, Member, Jian Li and Hangen," A Novel Setup Method of 3D LIDAR for Negative Obstacle Detection in Field Environment". IEEE ITSC 2014.

[5] Behroozpour, Behnam, et al. "Lidar system architectures and circuits." IEEE Communications Magazine 55.10 (2017): 135-142.

[6] Raj, Thinal, et al. "A survey on LiDAR scanning mechanisms." Electronics 9.5 (2020): 741.

[7] Royo, Santiago, and Maria Ballesta-Garcia. "An overview of lidar imaging systems for autonomous vehicles." Applied sciences 9.19 (2019): 4093.

[8] Du, Xinxin, Marcelo H. Ang, and Daniela Rus. "Car detection for autonomous vehicle: LIDAR and vision fusion approach through deep learning framework." 2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS). IEEE, 2017.

[9] Xie, Desheng, Youchun Xu, and Rendong Wang. "Obstacle detection and tracking method for autonomous vehicle based on three-dimensional LiDAR." International Journal of Advanced Robotic Systems 16.2 (2019): 1729881419831587.

[10] Li, You, and Javier Ibanez-Guzman. "Lidar for autonomous driving: The principles, challenges, and trends for automotive lidar and perception systems." IEEE Signal Processing Magazine 37.4 (2020): 50-61.

[11] Rasshofer, Ralph H., and Klaus Gresser. "Automotive radar and lidar systems for next generation driver assistance functions." Advances in Radio Science 3 (2005): 205-209.

[12] De Carvalho, R. Neumann, et al. "Complete coverage path planning and guidance for cleaning robots." ISIE'97 Proceeding of the IEEE International Symposium on Industrial Electronics. Vol. 2. IEEE, 1997.