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OBSTACLE AVOIDING ROBOT CAR

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Abstract - The intelligent autonomous vehicle utilizing GPS and camera technology has been programmed to avoid obstacles in its environment. Unlike normal vehicles, this car combines computer vision features with GPS technology. The technology helps the car recognize obstacles and make evasive maneuvers in real-time. A camera is fixed on the car's chassis, and it is constantly recording the environment around it. The video frames are then analyzed using machine learning techniques to detect obstructions like walls, cars, pedestrians as well as anything else that may prevent the car from moving. The car is able to gather accurate visual information which helps it identify the obstacles shape, size, and position. In addition, the automobile contains a GPS module that provides adequate positioning to pinpoint the exact location of the car. The GPS module picks up signals from satellites to ascertain the car's current position with a high degree of accuracy. Likewise, the car also uses a decision-making algorithm that takes into consideration visual data from the camera, GPS data, and predefined permissible routes. The algorithm processes the relevant data and helps the system determine the most optimal route while avoiding obstacles. When an obstacle is detected in its path, the car automatically alters its trajectory to avoid the obstacle while maintaining its intended route. In summary, the obstacle-avoiding car that utilizes a camera and GPS module offers a promising approach to autonomous navigation [1]. By integrating computer vision methods with GPS positioning, the car can sense and react to its surroundings, ensuring safe and efficient travel in complex and ever-changing environments.

Keywords: GPS, Camera, Computer vision

I. INTRODUCTION

Autonomous navigation is a fast-evolving area in robotics and smart transportation systems that seeks to promote mobility, safety, and efficiency in different real-world applications. Real-time obstacle detection and avoidance are among the key challenges in the development of autonomous vehicles. Conventional navigation systems use predetermined routes and rudimentary sensor-based obstacle detection, which may fall short in dynamic and uncertain environments. To overcome this shortfall, this project presents an intelligent obstacle-avoiding vehicle based on computer vision and GPS technology for better perception and decision. The presented system is built with a camera and a GPS module to achieve real-time world awareness.

The camera keeps shooting video frames of the environment, which are handled by computer vision algorithms to classify and detect the obstacles, whether they are stationary or moving like walls, vehicles, and people. This vision data offers key information about the location, shape, and size of the obstacle so that it can guide the vehicle to make informed decisions. At the same time, the GPS module gives precise location information, allowing the car to trace a pre-set route and dynamically modify the route when there is an obstacle detected. Intelligent navigation is reached through the utilization of a decision-making algorithm that combines visual perception from the camera with real-time GPS-based positioning information.

The algorithm continuously assesses incoming data and computes an optimal path for securing a safe and efficient movement. Once an obstruction is sensed, the vehicle dynamically steers around it in order to avoid collisions while staying on its intended course. Such a capability renders the system ideal for use in autonomous delivery, intelligent city transportation, and robot exploration in the presence of complex environments. The combination of computer vision and GPS-based navigation increases the system's

flexibility, making it resilient in various operating conditions. In contrast to traditional obstacle-avoidance systems that use ultrasonic or infrared sensors alone, this method offers a better perception of the environment. The integration of real-time video processing and accurate location tracking allows the car to function well in both structured and unstructured environments. This work discusses the design, development, and deployment of the obstacle-avoiding car, including the hardware components, software architecture, and algorithms employed for perception and navigation. The simulation results and real-world testing are also presented to assess the performance and reliability of the system. The results show the feasibility of combining computer vision and GPS in autonomous vehicles, opening doors to future developments in intelligent transportation and robotics.

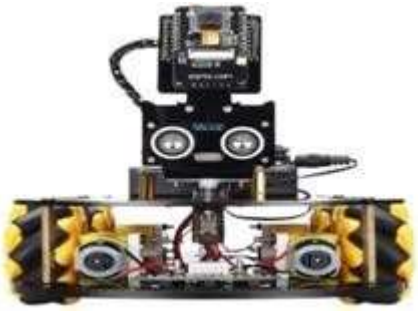

Fig 1: Prototype

II. OBJECTIVE

The objective of this project is to design and develop an intelligent obstacle-avoiding car that integrates computer vision and GPS technology to enable autonomous navigation in dynamic environments. The system aims to achieve real-time obstacle detection and classification using a camera, which continuously captures video frames and processes them using computer vision algorithms. These algorithms help the car identify obstacles such as walls, vehicles, and pedestrians, allowing it to assess its surroundings accurately. By analyzing the visual data, the vehicle determines the position, size, and shape of obstacles, improving its environmental awareness and decision-making capabilities.

Additionally, a GPS module is integrated to provide precise geolocation data, enabling the car to follow a predefined path while dynamically adjusting its route based on real-time conditions. The combination of GPS-based positioning and obstacle detection ensures that the vehicle can navigate efficiently without collisions. To achieve this, an intelligent decision-making algorithm is developed to process both visual and spatial data, ensuring that the car calculates the optimal path to reach its destination while avoiding obstacles.

A key objective is to ensure smooth and adaptive navigation, allowing the vehicle to dynamically adjust its movement in response to unexpected obstacles or changes in the environment. The system is designed to be robust and reliable, making it suitable for real-world applications such as smart city transportation, automated delivery, and robotic exploration. To validate its effectiveness, extensive testing and simulations are conducted to evaluate the car's accuracy, efficiency, and overall performance in various scenarios.

Furthermore, this project aims to contribute to the advancement of autonomous vehicle technology by demonstrating the potential of integrating computer vision and GPS for intelligent navigation. Unlike conventional obstacle-avoidance systems that rely solely on ultrasonic or infrared sensors, this approach provides a more comprehensive understanding of the environment, improving the adaptability and efficiency of autonomous vehicles. By achieving these objectives, the project lays the foundation for future innovations in intelligent transportation, enhancing safety and automation in various application.

III. LITERATURE SURVEY

Obstacle Detection Using Computer Vision

Computer vision has been widely used in autonomous navigation for detecting and classifying obstacles. Several studies have demonstrated the effectiveness of image processing and deep learning techniques in real-time obstacle detection [2]. For instance, Girshick et al. (2015) proposed the Region-based Convolutional Neural Network (R-CNN) for

object detection, which has been widely used in autonomous vehicles to recognize pedestrians, vehicles, and other obstacles. Similarly, Redmon et al. (2016) introduced YOLO (You Only Look Once), an object detection model capable of real-time obstacle recognition with high accuracy. These advancements in deep learning have significantly improved obstacle detection in autonomous vehicles, allowing them to perceive their surroundings effectively.

GPS-Based Autonomous Navigation

The Global Positioning System (GPS) plays a crucial role in autonomous navigation by providing precise location data. Misra & Enge (2006) discussed the fundamentals of GPS technology and its applications in autonomous vehicle navigation. More recently, Gao et al. (2019) proposed a GPS-based autonomous navigation system combined with sensor fusion techniques to improve accuracy in urban environments. Although GPS alone cannot detect obstacles, its integration with computer vision enables autonomous vehicles to follow predefined routes while dynamically adjusting their paths based on real-time obstacle detection.

IV. PROBLEM STATEMENT

The problem addressed in this research is the development of an intelligent obstacle-avoiding vehicle that effectively integrates computer vision and GPS technology to enhance real-time navigation and decision-making. The vehicle must be capable of continuously capturing and analyzing its surroundings using a camera and machine learning-based object detection techniques. Furthermore, the system must accurately determine its position using a GPS module and dynamically adjust its trajectory in response to detected obstacles while ensuring that it follows an optimal route.

The key challenge is designing a robust decision-making algorithm that efficiently processes visual data, GPS location information, and predefined route constraints to enable safe and smooth navigation. The system should also be capable of handling real-world complexities such as varying lighting conditions, object occlusions, and unpredictable obstacles. Addressing these challenges is crucial for improving the reliability and efficiency of autonomous vehicles in applications such as smart transportation, automated delivery, and robotic exploration.

V. BLOCK DIAGRAM

The block diagram represents an autonomous obstacle-avoiding vehicle that integrates GPS and camera technology using an Arduino-based control system. The system is powered by a 12V Li-ion battery, which supplies energy to the Arduino UNO, L298D motor driver shield, and other components. The Arduino UNO acts as the central processing unit, receiving data from the ESP32 CAM for real-time image processing and obstacle detection. The ESP32 CAM continuously captures video frames of the surroundings, allowing the system to analyze obstacles using computer vision techniques.

Additionally, a GPS module is incorporated to provide accurate positioning data, enabling the vehicle to follow predefined routes while dynamically adjusting its path to avoid obstacles. The L298D motor driver shield serves as an interface between the Arduino and the four motors, controlling their speed and direction based on navigation decisions.

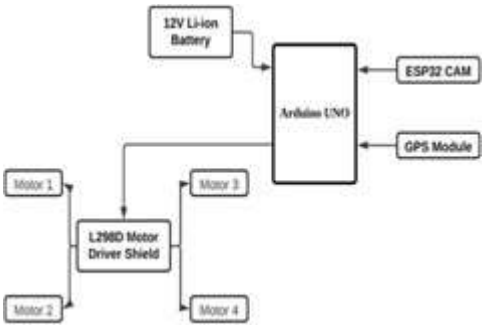

Fig 2: Block diagram

These motors enable smooth movement, allowing the vehicle to steer, stop, or change direction when necessary. The working principle involves the ESP32 CAM detecting obstacles, the GPS module providing location tracking, and the

Arduino UNO processing this data to make intelligent decisions. The motor driver shield then executes these decisions, ensuring safe and efficient navigation. This integration of computer vision and GPS-based navigation makes the system highly suitable for applications such as smart transportation, automated delivery, and robotic exploration.

VI. PROPOSED SOLUTION

In order to create an effective obstacle-avoiding autonomous car, this project suggests the use of LiDAR (Light Detection and Ranging) technology, GPS, and a real-time decision-making algorithm. The system includes an Arduino UNO microcontroller, a LiDAR sensor, a GPS module, and an L298D motor driver shield, which cooperate to provide obstacle detection and autonomous navigation. The LiDAR sensor scans the environment constantly with laser pulses to capture distance measurements with great accuracy. From the reflected signals, the system builds a real-time 2D or 3D representation of the world, precisely detecting obstacles like walls, cars, and people. This approach advances beyond traditional ultrasonic sensor-based robots by improving accuracy and environmental adaptability [5], providing stable obstacle detection irrespective of the environment.

Further, the GPS module gives accurate location tracking by capturing satellite signals, enabling the vehicle to follow a planned path while dynamically adjusting to obstacles. The decision algorithm takes input from the LiDAR sensor readings and GPS coordinates to calculate the optimum and obstacle-free path. In case the system detects an obstacle, the system intelligently adjusts the vehicle's trajectory, speed, or braking distance to avoid collisions and achieve smooth movement. By combining LiDAR for accurate obstacle detection, GPS for location accuracy, and an intelligent decision-making process, this suggested solution greatly increases safety, efficiency, and flexibility in autonomous driving.

VII. METHODOLOGY

The platforms used for the development of this project are:

- Arduino IDE
- PyCharm
- Proteus
- Visual Studio Code with Platform IO
- Android mobile

The creation of an intelligent autonomous vehicle for obstacle avoidance based on LiDAR and GPS technology requires integration of hardware, processing of sensor data, and software development. The system is capable of navigating its surroundings independently while avoiding obstacles in real-time.

Earlier research has also implemented basic Arduino-based systems for obstacle avoidance [3], while the GPS module receives real-time positioning information to drive the vehicle along a predetermined path. The Arduino UNO interprets sensor data and runs navigation instructions based on the data gathered. The obstacle avoidance and detection system process the spatial data created by LiDAR, detecting possible obstructions and deciding on the appropriate action, including slowing down, stopping, or changing route.

Fig 3: Object Detection and Recognition Using Computer Vision

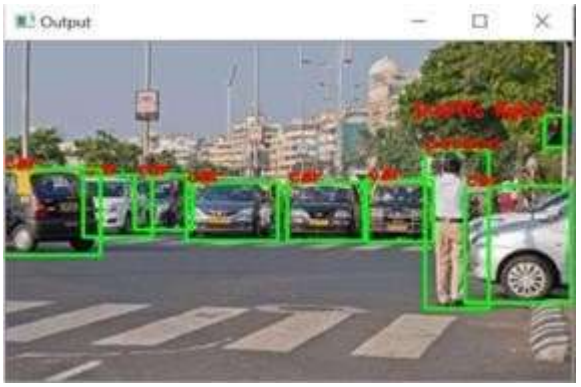

Fig 4: Real-Time Object Detection in Urban Traffic

To test and execute the system, several pieces of software are utilized, such as Arduino IDE, PyCharm, Proteus, Visual Studio Code using Platform IO, and an Android smartphone for monitoring and controlling. Programming of the Arduino UNO is done with the Arduino IDE, management of sensor data, designing obstacle detection algorithms, and controlling vehicle movement. PyCharm is used for point cloud data analysis and image processing of LiDAR-generated point clouds, utilizing Python libraries OpenCV and NumPy to process sensor data and improve the vehicle's path planning algorithm. Comparable sensor-driven approaches have been tested using basic Arduino frameworks in earlier studies [4].

For firmware creation and debugging, Visual Studio Code with Platform IO has sophisticated features such as version control, multi-board support, and real-time debugging, making it well suited for intricate embedded systems.

An Android handheld device is employed for remote monitoring, control, and real-time visualization, similar to Bluetooth-enabled robot control systems described in [6] GPS coordinates, obstacle detection warnings, and vehicle status. The interface for the mobile app, accessed through Bluetooth or Wi-Fi, provides manual override or emergency stop capability if needed.

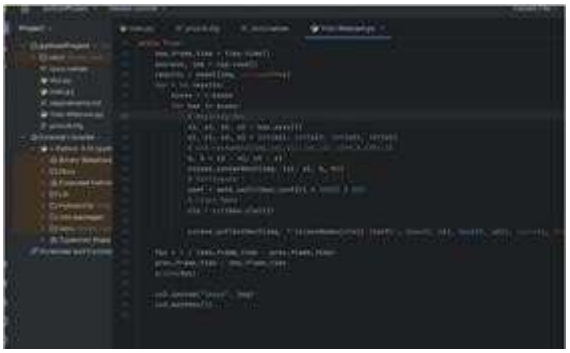

Fig 5: YOLO-Based Object Detection Script in PyCharm

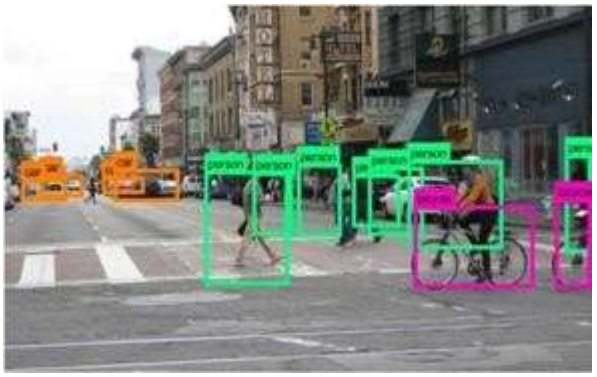

Fig 6: Intelligent Urban Scene Recognition

VII. CONCLUSION

In summary, the GPS- and camera-based obstacle-avoiding intelligent autonomous vehicle is a major leap towards autonomous navigation. Through the incorporation of computer vision and GPS technology, the vehicle can effectively detect, analyze, and steer around obstacles in real time and move safely and efficiently. The synergy of object detection machine learning algorithms and a path optimization decision algorithm improves the vehicle's capability to respond to changing environments. It aligns with previous efforts to develop autonomous navigation in car-like robotic platforms [7]. Future developments can be on improving the detection algorithms, the integration of more sensors like LiDAR, and system robustness for deployment in real-world scenarios.

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