PARSHWANATH CHARITABLE TRUST'S
A.P. SHAH INSTITUTE OF TECHNOLOGY
Department of Computer Science and Engineering
Data Science

TAILwind : Tadpole-based AI and Lidar for Windshield-free Driving

Umesh Pawar **21107014**
Dalbirsingh Matharu **21107005**
Vedant Parulekar **21107034**
Shreyas Patil **21107061**

Project Guide
Mr.Vaibhav Yavalkar

Introduction

- A novel design and implementation of an autonomous car featuring a unique tadpole-shaped configuration. This design incorporates ultrasonic sensors, a camera, stepper motors, a Raspberry Pi, and an Arduino to facilitate autonomous navigation.
- Functionality Overview: Our autonomous car utilizes ultrasonic sensors for obstacle detection and avoidance, while employing a camera for object recognition. Control mechanisms, facilitated by stepper motors, govern steering and speed adjustments.

Literature Survey of the existing system

- In literature [1], a self-driving RC car has been developed, leveraging Artificial Neural Network (ANN) technology. The accompanying thesis explores the integration of ANN in autonomous vehicle systems
- In literature [2], Aditya Kumar Jain presents an innovative autonomous car model integrating a Raspberry Pi with a Pi camera. The Raspberry Pi and a laptop, interconnected on the same network, collaborate seamlessly. The Pi captures images, processes them in grayscale, and sends them to a Convolutional Neural Network (CNN), predicting outputs: left, right, forward, or stop.
- In literature [3], conducted by Malay Shah and Prof. Rupal Kapdi, the focus is on object detection using deep neural networks, specifically convolutional neural networks (CNNs).

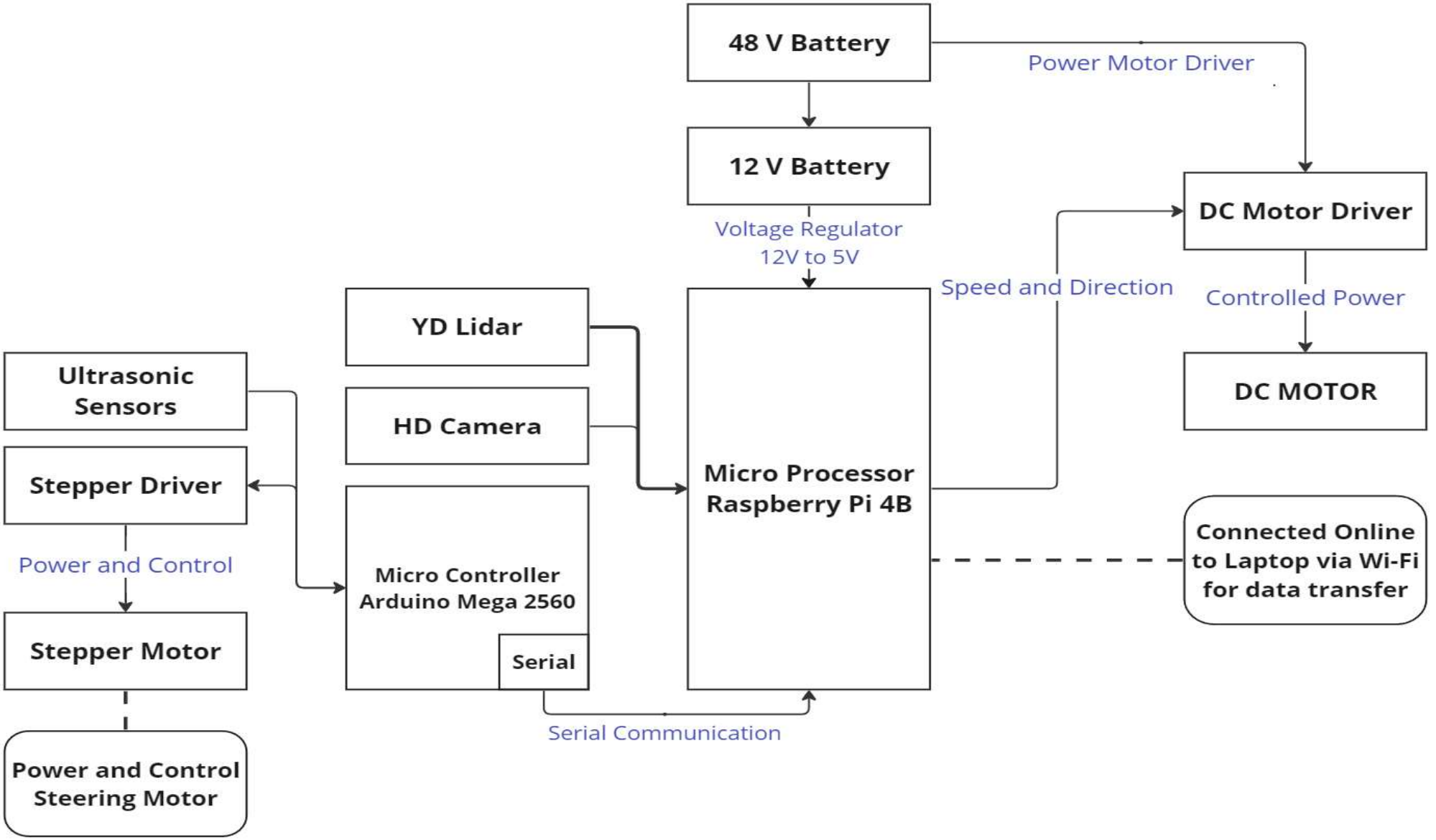
Limitations of existing systems

- In Literature[1],the simulation results suggest that augmenting the number of images during the learning phase enhances the accuracy of the artificial neural network (ANN). Additionally, it's noteworthy that while the current study employs Raspberry Pi 3, our implementation utilizes Raspberry Pi 4, potentially providing superior computational capabilities for improved training and inference outcomes.
- In Literature[2],it's acknowledged that proper lane markings are essential for effective lane detection. This requirement underscores the significance of clear and well-defined lane markings in facilitating accurate lane detection algorithms.
- In Literature[3],lack of information beyond object detection. This constraint highlights the system's focus solely on identifying objects.

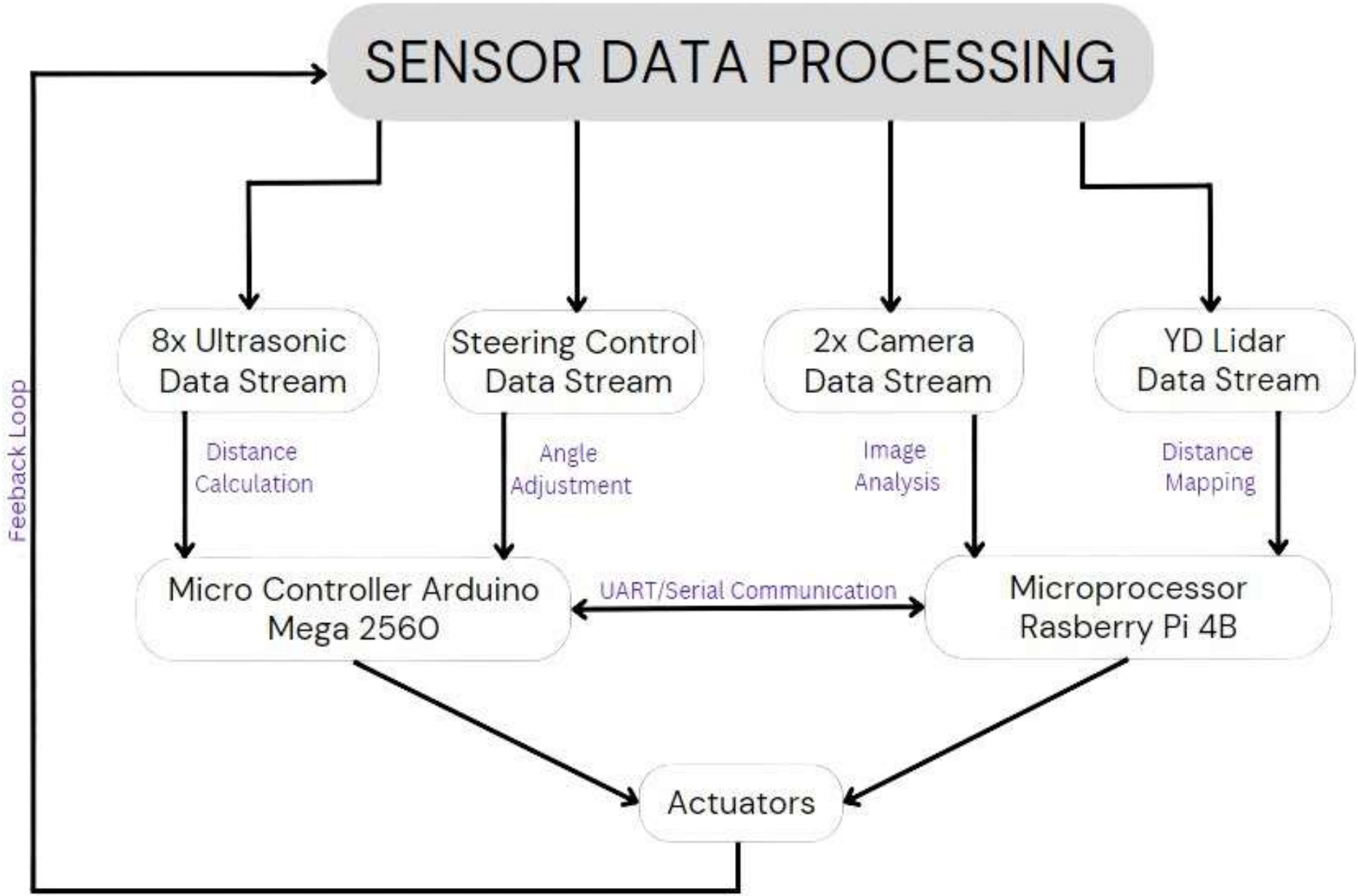
Problem statement

- Develop an autonomous driving system capable of navigating diverse road environments safely and efficiently.
- Design and implement a self-driving car solution that accurately perceives surroundings and makes real-time decisions.

System Design



Data Flow Diagram



Technologies and methodologies

Methodology

- Tadpole Design Analysis: Studied the advantages of tadpole design for autonomous vehicles.
- Electrical Component Understanding: Analyzed motor drivers and batteries for integration into vehicle architecture.
- Sensor Technology Exploration: Researched advanced sensor technologies for project alignment.
- Algorithm Implementation: Developed algorithms for efficient sensor data processing.
- System Integration: Integrated sensors and algorithms for intelligent object detection and precise steering control.

Technologies and methodologies

Technologies

Hardware :

- Battery (48 V & 12 V)
- Raspberry Pi 4B
- Arduino Mega 2560
- Ultrasonic HC-SR04
- HD Camera
- Stepper Motor

Software :

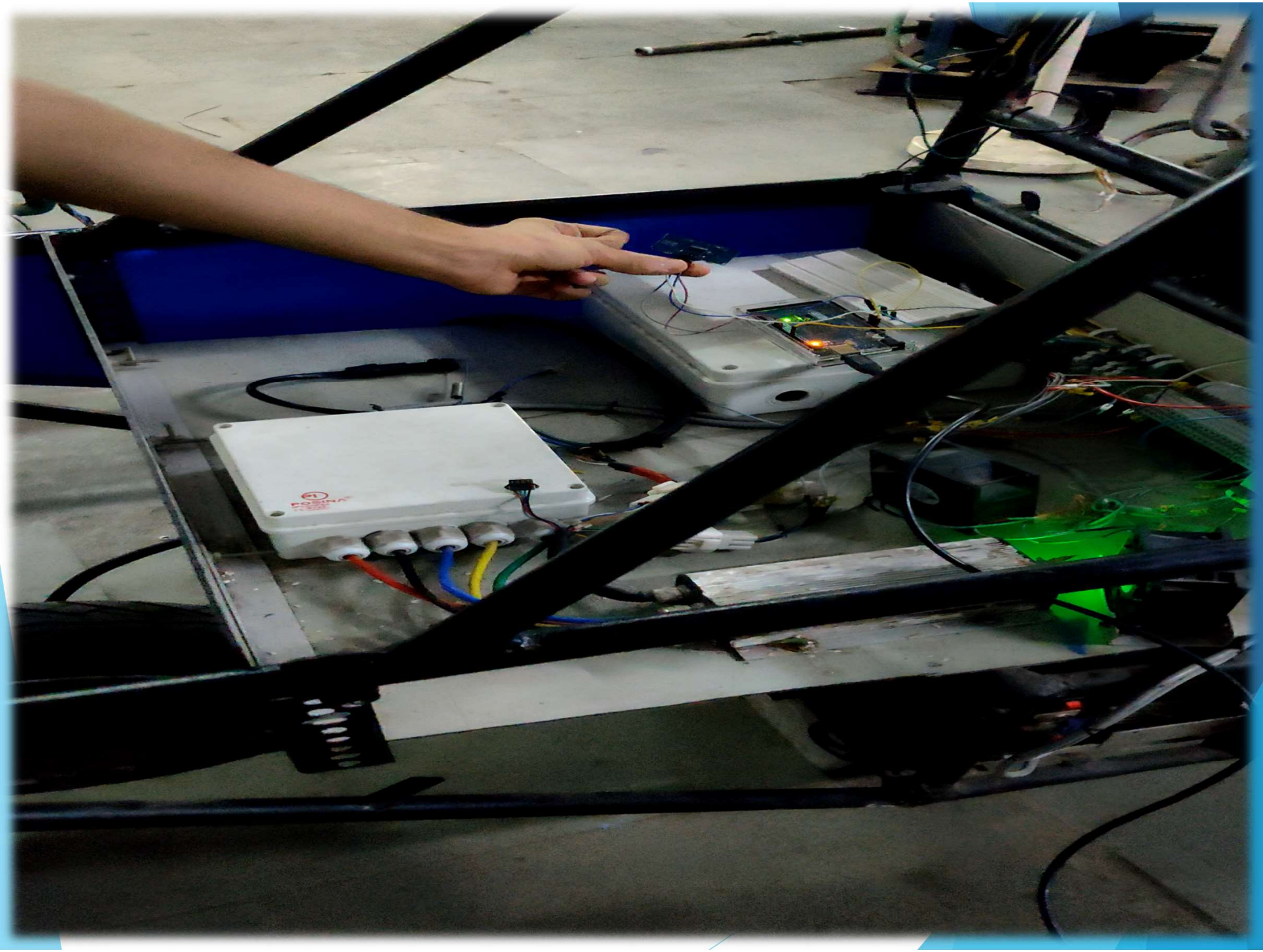
- Python
- C ++
- ROS
- Arduino IDE
- OpenCV

Implementation

- Ultrasonic Sensor Testing: Conducted thorough testing of multiple ultrasonic sensors to validate distance measurement accuracy and obstacle detection.
- Real-World Scenario Testing: Utilized Arduino IDE to test multiple sensors in scenarios mimicking real-world conditions, including stopping and restarting the vehicle.
- Machine Learning Algorithms: Implemented machine learning to enhance object detection, pedestrian detection, and avoidance capabilities.
- Integration of Algorithms and Sensors: Ensured cohesive operation by integrating all algorithms and sensors, enabling synchronized functionality for optimal autonomous vehicle performance.
- Raspberry Pi Configuration: Configured the Raspberry Pi to seamlessly integrate into the autonomous vehicle system, ensuring smooth operation.

Results

The video illustrates a scenario where the car's wheels are seen in motion when the ultrasonic sensor does not detect any obstacle in its path. However, as soon as the ultrasonic sensor registers the presence of an object, the wheels stops their rotation suddenly. This dynamic behavior showcases the real-time responsiveness of the vehicle's control system to environmental trigger



Conclusion

- The project conducted extensive testing of ultrasonic sensors, validating their accuracy in distance measurement and obstacle detection under real-world scenarios. Through rigorous testing in the Arduino IDE, multiple sensors were assessed in scenarios replicating actual conditions, including vehicle stopping and restarting, ensuring their reliability and effectiveness.

- Seamless integration of the Raspberry Pi into the system enabled centralized control and processing, contributing to smooth operation and improved overall system efficiency and performance. This integration facilitated streamlined communication and decision-making processes, enhancing the autonomy and functionality of the autonomous vehicle.

References

[1] Hajer Omrane, Mohamed Slim Masmoudi, and Mohamed Masmoudi, “Neural controller of an autonomous driving mobile robot by an embedded camera” in International Conference on Advanced Technologies For Signal and Image Processing - ATSIP, 2018

[2] Aditya Kumar Jain, “Working model of Self-driving car using Convolutional Neural Network, Raspberry Pi and Arduino”, in Proceedings of the 2nd International Conference on Electronics,Communication and Aerospace Technology ICECA 2018.

[3] Malay Shah, Prof, Rupal Kapdi,“Object Detection Using Deep Neural Networks”, in International Conference on Intelligent Computing and Control Systems ICICCS 2017.

Thank You...!!