VISVESVARAYA TECHNOLOGICAL UNIVERSITY

JNANA SANGAMA, BELAGAVI-590015, KARNATAKA

Project Report

on

DESIGN AND IMPLEMENTATION OF ADAS-LEVEL01

Submitted in partial fulfillment of the requirements for the III semester

Mini Project Work [EC221]

Bachelor of Engineering

in

Electronics and Communication Engineering

of

Visvesvaraya Technological University, Belagavi.

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CERTIFICATE

It is Certified that Mr. **Dileep kumar M, Mr. Harsha R Gowda, Mr. Gururaj V and Mr. Jeethan M K** bearing **USN: 1CD23EC040, 1CD23EC052, 1CD23EC049** and **1CD23EC406** respectively, are bonafide students of Cambridge Institute of Technology, and have completed requirements of the project entitled "DESIGN AND IMPLEMENTATION OF ADAS-LEVEL01 in partial fulfillment of the requirements for III semester Bachelor of Engineering in Electronics and Communication Engineering of Visvesvaraya Technological University, Belagavi during academic year 2024-25. It is certified that all Corrections/Suggestions indicated for Internal Assessment have been incorporated in the report. The project report has been approved as it satisfies the academic requirements in respect of mini project prescribed for the Bachelor of Engineering degree.

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DECLARATION

We, **Mr. Dileep kumar M, Mr. Harsha R Gowda**, **Mr. Guru raj V and Mr. Jeethan M K** bearing **USN: 1CD23EC040, 1CD23EC052, 1CD23EC049** and **1CD23EC406** respectively, are students of III semester, Electronics and Communication Engineering, Cambridge Institute of Technology, hereby declare that the project entitled "DESIGN AND IMPLEMENTATION OF ADAS-LEVEL01" has been carried out by us and submitted in partial fulfillment of the course requirements mini projet of III semester Bachelor of **Engineering** in **Electronics and Communication Engineering** as prescribed **by Visvesvaraya Technological University, Belagavi,** during the academic year 2023-2024.

We also declare that, to the best of our knowledge and belief, the work reported here does not form part of any other report on the basis of which a degree or award was conferred on an earlier occasion on this by any other student.

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ABSTRACT

The Design and Implementation of Advanced Driver Assistance System (ADAS) Level 01 focuses on enhancing vehicle safety and driving convenience through fundamental automated features. This project aims to develop a system capable of assisting drivers with critical functions such as collision avoidance, lane-keeping assistance, and adaptive cruise control. ADAS Level 01 operates as a partially automated system, where the driver retains full control but benefits from active support through sensors, cameras, and algorithms.

The system integrates real-time data processing and sensor fusion technologies to detect and respond to environmental conditions, such as nearby vehicles, road markings, and obstacles. The implementation involves the use of microcontrollers, machine vision, and radar systems to ensure accuracy and reliability. Emphasis is placed on cost-effectiveness and scalability, making it suitable for integration into various vehicle platforms. The results demonstrate significant improvements in driving safety, reduced human error, and enhanced user experience, paving the way for higher levels of autonomy in the future..

This study highlights the potential of ADAS Level 01 to act as a foundational step toward fully autonomous vehicles, offering insights into challenges, design considerations, and real-world application scenarios.

This project focuses on the design and implementation of ADAS Level 01, enhancing vehicle safety through features like collision avoidance, lane-keeping assistance, and adaptive cruise control. Utilizing sensors, cameras, and real-time data processing, the system provides active support while keeping the driver in full control. A modular, cost-effective design ensures scalability and adaptability, with extensive testing validating its reliability under various conditions. This work serves as a foundational step toward fully autonomous vehicles, offering practical solutions and insights for future advancements in driver assistance technology.

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LIST OF FIGURES

CHAPTER 1

INTRODUCTION

OBJECTIVES:

The rapid advancements in automotive technology have led to the development of Advanced Driver Assistance Systems (ADAS), which aim to enhance vehicle safety and driving efficiency. ADAS-Level 01, being the foundational level, focuses on providing partial assistance to drivers by integrating technologies such as basic driver alerts, limited automation, and assistance systems. These features are designed to reduce human error, improve situational awareness, and promote safer driving practices.

ADAS-Level 01 primarily includes features like adaptive cruise control, lane departure warnings, and collision avoidance alerts. These systems rely on sensors, cameras, and software algorithms to monitor the vehicle's surroundings and alert drivers to potential hazards. However, the driver retains full control over the vehicle, with the system acting as a supportive tool rather than an autonomous solution. This level of automation sets the stage for more advanced levels, ensuring gradual adaptation and increased trust in automated driving technologies.

The design and implementation of ADAS-Level 01 involve a combination of hardware and software integration, such as sensor calibration, data processing, and real-time feedback mechanisms. This project explores the architecture, functionality, and deployment of ADAS-Level 01, emphasizing its potential to enhance driving safety and user experience. By understanding the challenges and opportunities associated with its implementation, this research aims to contribute to the evolution of intelligent vehicle systems.

Fig 1:ADAS Level -01

The implementation of ADAS-Level 01 also highlights the importance of standardization and compliance with safety regulations to ensure widespread adoption and reliability. These systems must undergo rigorous testing to validate their performance in diverse driving conditions, ranging from urban environments to highways. Furthermore, the integration of user-friendly interfaces is critical to ensure drivers can easily interpret alerts and respond effectively. As the foundation for more sophisticated autonomous driving systems, ADAS-Level 01 serves as a crucial stepping stone in the journey toward fully autonomous vehicles, bridging the gap between manual driving and advanced automation.

CHAPTER 2

Literature Survey

The development of Advanced Driver Assistance Systems (ADAS) Level 01 has gained significant attention in the automotive industry due to its potential to enhance safety and driving comfort. ADAS Level 01 systems are designed to provide partial automation by assisting the driver in tasks such as collision avoidance, lane-keeping, and adaptive cruise control. Research highlights the integration of sensor technologies like cameras, radar, and ultrasonic sensors for environmental perception, with algorithms such as Hough Transform and convolutional neural networks (CNNs) commonly used for tasks like lane detection and object recognition. Studies emphasize the importance of real-time data processing to ensure rapid and reliable decision-making in dynamic driving environments.

One critical focus of existing literature is the implementation of sensor fusion techniques, which combine data from multiple sensors to improve accuracy and system robustness. For example, radar is effective in detecting objects under poor visibility conditions, while cameras provide detailed visual information for lane and obstacle detection. Researchers have also explored predictive control models to enhance the performance of adaptive cruise control systems, ensuring safe distance maintenance and fuel efficiency. Additionally, human-machine interaction (HMI) has been a key area of study, with user-friendly designs and intuitive alerts improving driver trust and system usability.

Despite advancements, challenges such as cost-effectiveness, scalability, and performance under adverse conditions persist. Several studies propose modular architectures to allow easy upgrades and integration of new technologies. Furthermore, extensive testing in both simulated and real-world environments is emphasized to validate system reliability. This survey underscores the importance of combining advanced hardware, efficient algorithms, and rigorous testing to design and implement a practical ADAS Level 01 system that serves as a stepping stone toward fully autonomous vehicles.

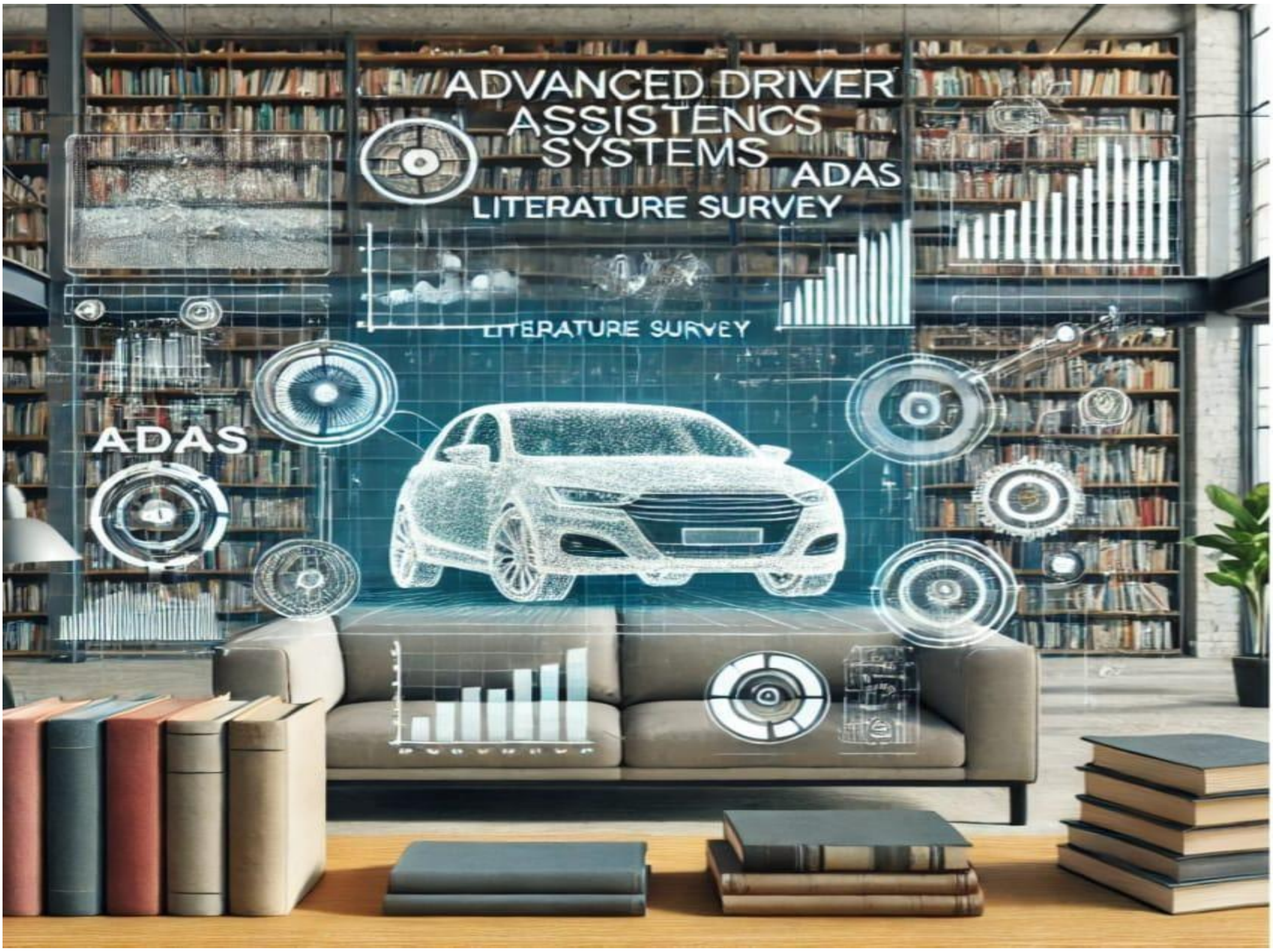

Fig 2:ADAS Leve 01 Literature survey

CHAPTER:3

FLOWCHART / DESIGN / HARDWARE & SOFTWARE USED/BLOCK DIAGRAM

FLOW CHART/ALGORITHM:

FLOWCHART FOR ADAS LEVEL 01 IMPLEMENTATION

```
START
  |
  v
1. Sensor Data Collection
  |
  v
2. Data Preprocessing
  |
  v
3. Object Detection & Tracking
  |
  v
4. Decision-Making
  |
  v
5. Actuation (Steering/Braking/Warning)
  |
  V
6. Driver Interaction
V
```

Hardware Used:

1. **<u>STM32</u>** <u>NUCLEO-F401RE</u> **<u>Microcontroller</u>** STM32 nucleo F401RE ARM@ 32-bit cortex@-M4 CPU FPU 84MHz Max CPU Frequency

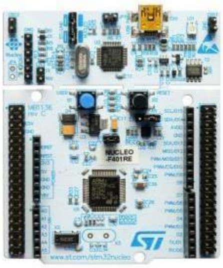

Fig 3:

2. <u>Ultrasonic Sensor (e.g., HC-SR04):</u> Detects obstacles by emitting sound waves and measuring their reflection time.

Fig 4:

3. <u>Motor Driver (e.g., L298N):</u> Enables bidirectional control of DC motors.

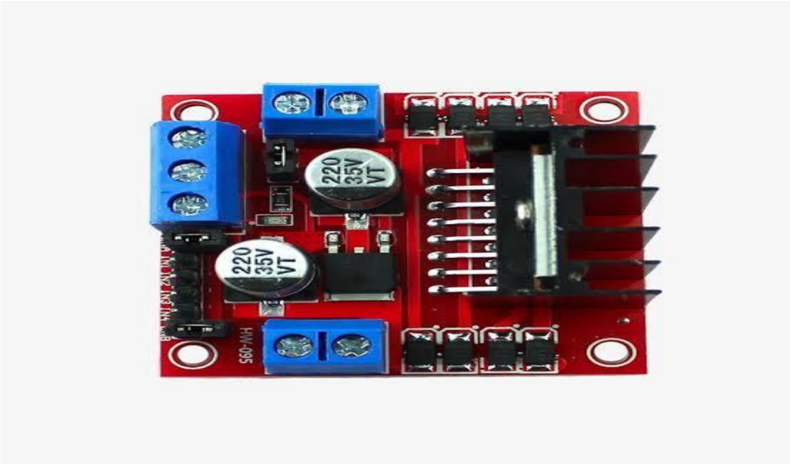

Fig 5:

4. Motors: DC motors for driving the DIY car.

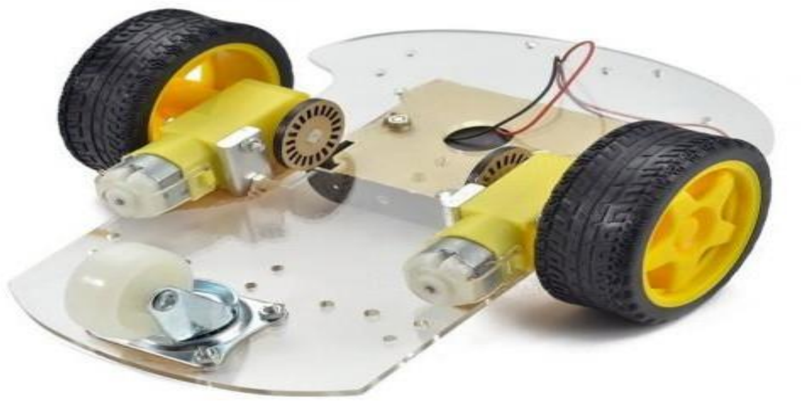

Fig 6:

5. Battery: A rechargeable Li-ion battery to power the entire system.

. Chassis and Wheels: DIY car components for mobility.

7. Wires and Connectors: For making electrical connections

Software Used

1. STM32CubeIDE: Integrated development environment for programming and debugging the STM32F051 microcontroller.

2. STM32CubeMX: A graphical tool to configure microcontroller peripherals and generate initialization code.

3. Keil u Vision : Another IDE for firmware development.

4. Embedded C/C++: Programming language used to develop the control algorithms and interface logic.

5. Simulators and Debugger: For testing the firmware and debugging issues during development.

BLOCK DIAGRAM

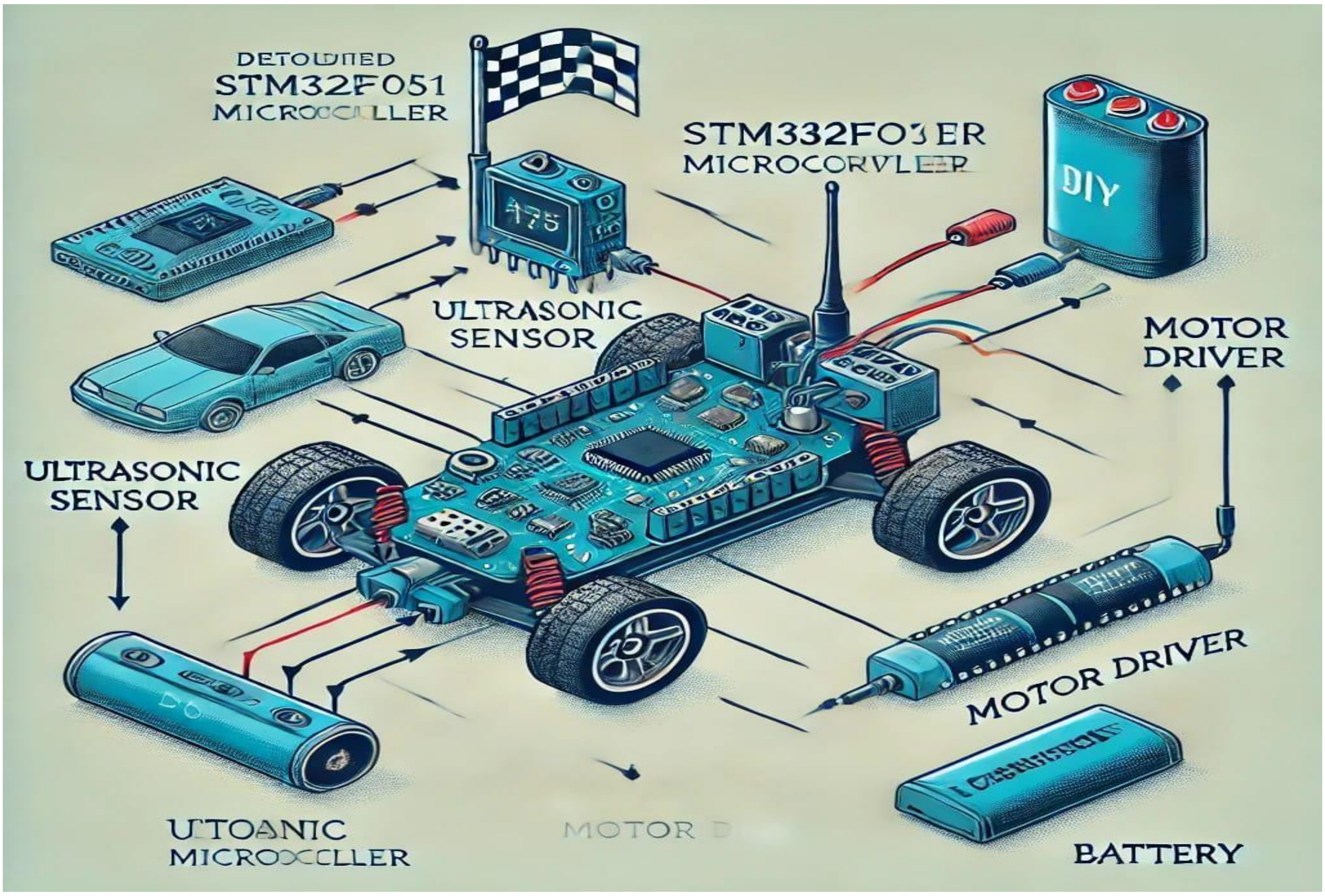

Fig 7:ADAS level 01

CHAPTER 4 Implementation/Algorithm

IMPLEMENTATON:

The implementation involves a combination of hardware integration and software development to create an efficient ADAS-Level 01 system for a motorized DIY car. The ultrasonic sensor detects obstacles by emitting ultrasonic waves and calculating the distance based on the time taken for the waves to reflect back. The STM32F401RE microcontroller processes this data and generates control signals for the motor driver, which then adjusts the motor's speed and direction. This setup allows the DIY car to stop, slow down, or navigate around obstacles effectively. The system ensures real-time response by leveraging the high-speed processing capabilities of the STM32F401RE microcontroller.

1. Hardware Design:

Ultrasonic Sensor: Used to measure the distance between the car and obstacles in its path.

STM32F401RE Microcontroller: The central unit that processes input from the ultrasonic sensor and generates control signals for the motor driver.

Motor Driver: Acts as an interface between the microcontroller and the motors, enabling directional and speed control.

DIY Motorized Car: The platform consisting of wheels, chassis, and motors.
Battery: Provides the required power for all components.

2. Software Design:

* The software controls the interaction between hardware components.
* Firmware is written using C or C++ in development environments like arArduino CubeIDE or Keil.
* Algorithms for distance measurement, motor control, and obstacle avoidance are implemented.
* PWM (Pulse Width Modulation) signals are used for motor speed control, while GPIO pins interface with the ultrasonic sensor.

ALGORITHM FOR ADAS-LEVEL 01 DIY CAR PROJECT

1. Start: Power on the system.
Perform a self-check of all hardware components (ultrasonic sensor, motor driver, and motors).
Ensure a stable connection with the battery and verify voltage levels.

2. Initialize Microcontroller
Set up GPIO pins for interfacing with the ultrasonic sensor and motor driver.
Configure PWM channels for motor speed control and timers for distance calculation.
Initialize a UART or SPI interface for debugging or data logging (if required).

3. Read Ultrasonic Sensor Data
Send a trigger pulse to the ultrasonic sensor.
Measure the time taken for the echo signal to return.
Calculate the distance using the formula:

4. Obstacle Detection
Compare the measured distance to a predefined threshold (e.g., 20 cm).

5. Decision-Making Logic
If Distance < Threshold:

Stop the motors immediately by setting PWM duty cycle to 0.
Activate a visual (LED) or auditory (buzzer) alert.

Else:
Continue forward motion by maintaining the current motor speed.

6. Dynamic Speed Adjustment (Optional)If the obstacle is detected within a warning range (e.g., 20–40 cm), reduce motor speed gradually using PWM adjustments.
7. Continuous Monitoring
Loop the process of sensor reading, decision-making, and motor control.

8. Error Handling

If the sensor fails or inconsistent data is detected, stop the system and activate an error alert.

Monitor battery voltage to ensure it remains within safe operating levels.

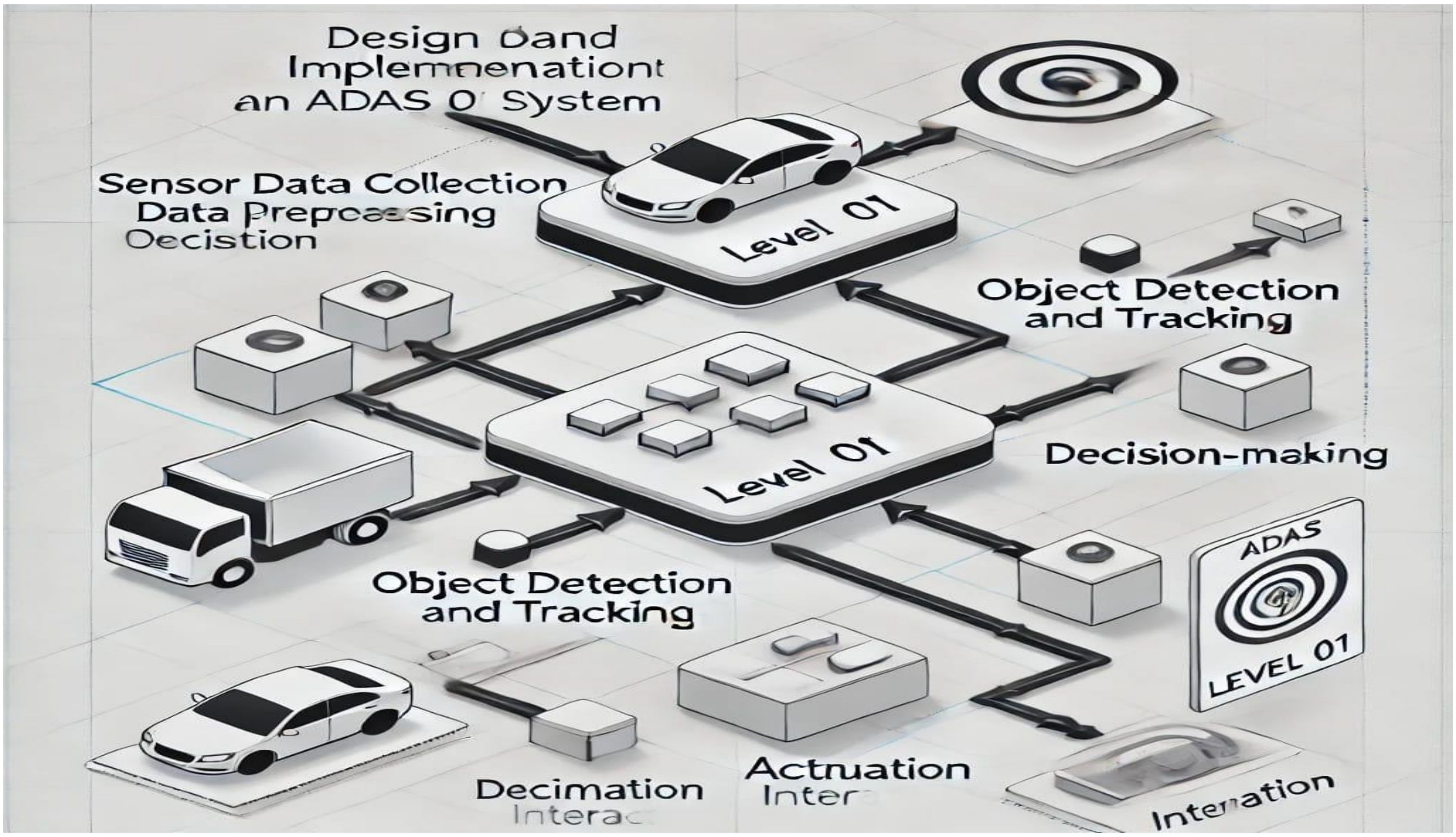

Fig 8: ADAS level -01 (IOT)

Explanation of Components

1. Sensor Data Collection:

Includes camera, radar, and ultrasonic sensors for environmental data.

2. Data Preprocessing:

Clean, normalize, and synchronize sensor data for further analysis.

3. Object Detection and Tracking:

Use machine learning models (e.g., YOLO, SSD) for detecting vehicles, pedestrians, and lanes.

4. Decision-Making:

Implements algorithms like decision trees or deep reinforcement learning for situational analysis.

5. Actuation:

Sends instructions to vehicle systems for appropriate action.

6. Driver Interaction: Provides real-time feedback and ensures driver engagement.

CHAPTER 5

SIMULATION /RESULT ANALYISIS

SIMULATION

The simulation of the ADAS-Level 01 DIY car system is essential to validate the design before physical implementation. Tools like Proteus, Tinker cad, or MATLAB Simulink can be used to simulate the system. Below is the simulation process:

1. System Setup:
*Model the STM32F051 microcontroller, ultrasonic sensor, motor driver, and DC motors in the simulation environment.
*Connect the components virtually, replicating the hardware wiring diagram.

2. Ultrasonic Sensor Simulation:
*Use a virtual ultrasonic sensor to simulate obstacle detection.
*Configure it to send pulses and measure the time of reflection based on the distance of obstacles in the simulation.

3. Microcontroller Programming:
*Load the control algorithms into the STM32F051 microcontroller model.
*Test GPIO configurations, PWM signals for motor control, and decision-making logic.

4. Motor Driver and Motor Behavior:
*Simulate motor responses based on the microcontroller's output signals.
*Verify the movement of the car model (forward, stop, or adjust speed) according to the distance detected by the sensor.
5. Power Management:
*Simulate battery performance and monitor the voltage supply to all components.

Fig 9: ADAS level -01

Result Analysis

The performance of the simulated system is evaluated based on the following criteria:

1. Obstacle Detection Accuracy:

*Verify that the system detects obstacles within the predefined threshold distance.

*Analyze the sensor's performance for different obstacle shapes and materials.

2. Response Time:

*Measure the time taken for the microcontroller to process sensor data and generate control signals for the motor driver.

*Ensure the system responds in real-time to sudden obstacles.

3. Motor Control:

Evaluate the car's stopping behavior when an obstacle is detected..

Test the PWM signals for smooth speed adjustments.

4. Error Handling: Simulate sensor failures or inconsistent data inputs and ensure the system stops safely and triggers an error alert.

5. Power Efficiency: Analyze battery consumption during operation, especially under varying motor loads

EXPECTED RESULTS

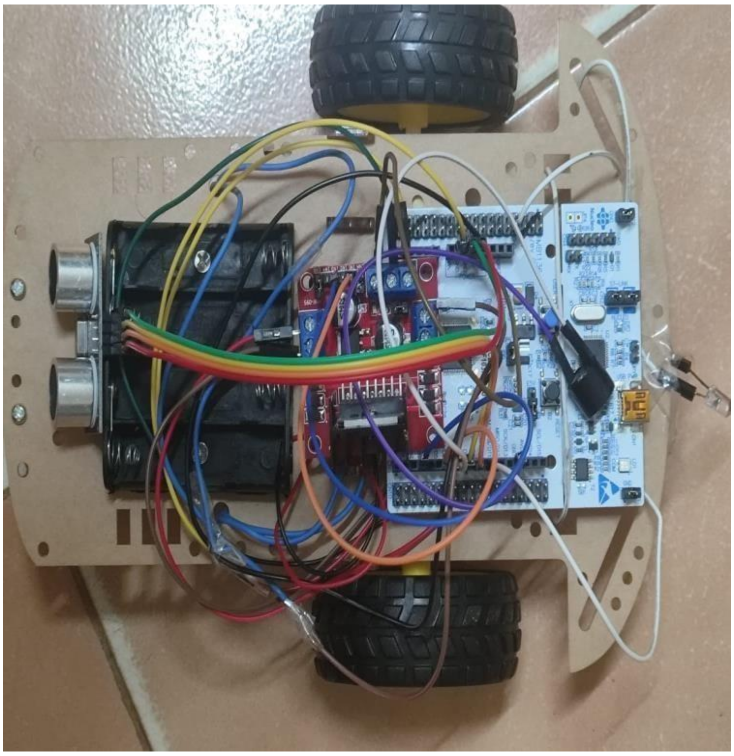

Fig 9: CIRCUIT CONNECTION

Obstacle Detection:

The ultrasonic sensor should reliably detect obstacles within the set threshold, typically up to 20 cm.

Real-Time Response:

The system should halt the car within milliseconds of detecting an obstacle.

Motor Speed Adjustment:

PWM signals should dynamically control the motor speed based on proximity to obstacles.

Energy Efficiency:

The system should operate for extended periods without significant battery drain.

Scalability:

simulation should confirm that the system can handle additional sensors or communication modules if integrated.

CHAPTER6

APPLICATIONS

1. Educational Platform:
Provides hands-on experience for students and hobbyists in embedded systems, robotics, and ADAS technology development.

2. Prototyping for Vehicle Automation:
Serves as a foundational prototype for implementing basic obstacle detection and avoidance features in autonomous vehicles.

3. Robotics and IoT Integration:
Can be expanded with IoT modules to create smart robotic systems for industrial or domestic applications, such as automated delivery systems.

4. Research and Development:
Used in R&D projects to explore advanced ADAS features, such as adaptive cruise control, lane-keeping, and collision avoidance.

5. Low-Cost Automation:
Suitable for building affordable, small-scale autonomous vehicles for tasks like warehouse navigation, surveillance, or agriculture.

CHAPTER 7 :CONCLUSION AND FUTURE SCOPE

CONCLUSION

1. The project demonstrates the successful implementation of ADAS-Level 01 features, such as obstacle detection and avoidance, in a cost-effective and scalable DIY motorized car.
2. The system, powered by an STM32F051 microcontroller, ultrasonic sensors, and motor drivers, ensures real-time responsiveness and reliable performance.
3. It serves as a practical educational and research platform, offering insights into embedded systems and autonomous vehicle technology.
4. The project highlights the potential of integrating automation into various fields, from robotics to industrial applications.
5. It sets the foundation for developing more advanced and feature-rich autonomous systems.

FUTURE SCOPE

1. Integration of Advanced Sensors:

Adding LiDAR, IR sensors, or cameras can improve obstacle detection accuracy and enable additional features like object recognition and lane tracking.

2. Wireless Communication:

Incorporating Bluetooth, Wi-Fi, or LoRa modules can allow remote control, monitoring, and data logging for real-time analysis.

3. Enhanced Path Planning:

Using GPS or visual processing algorithms for efficient navigation in complex environments.

4. Energy Optimization:

Implementing energy-efficient algorithms and advanced battery management systems to extend the system's operational time.

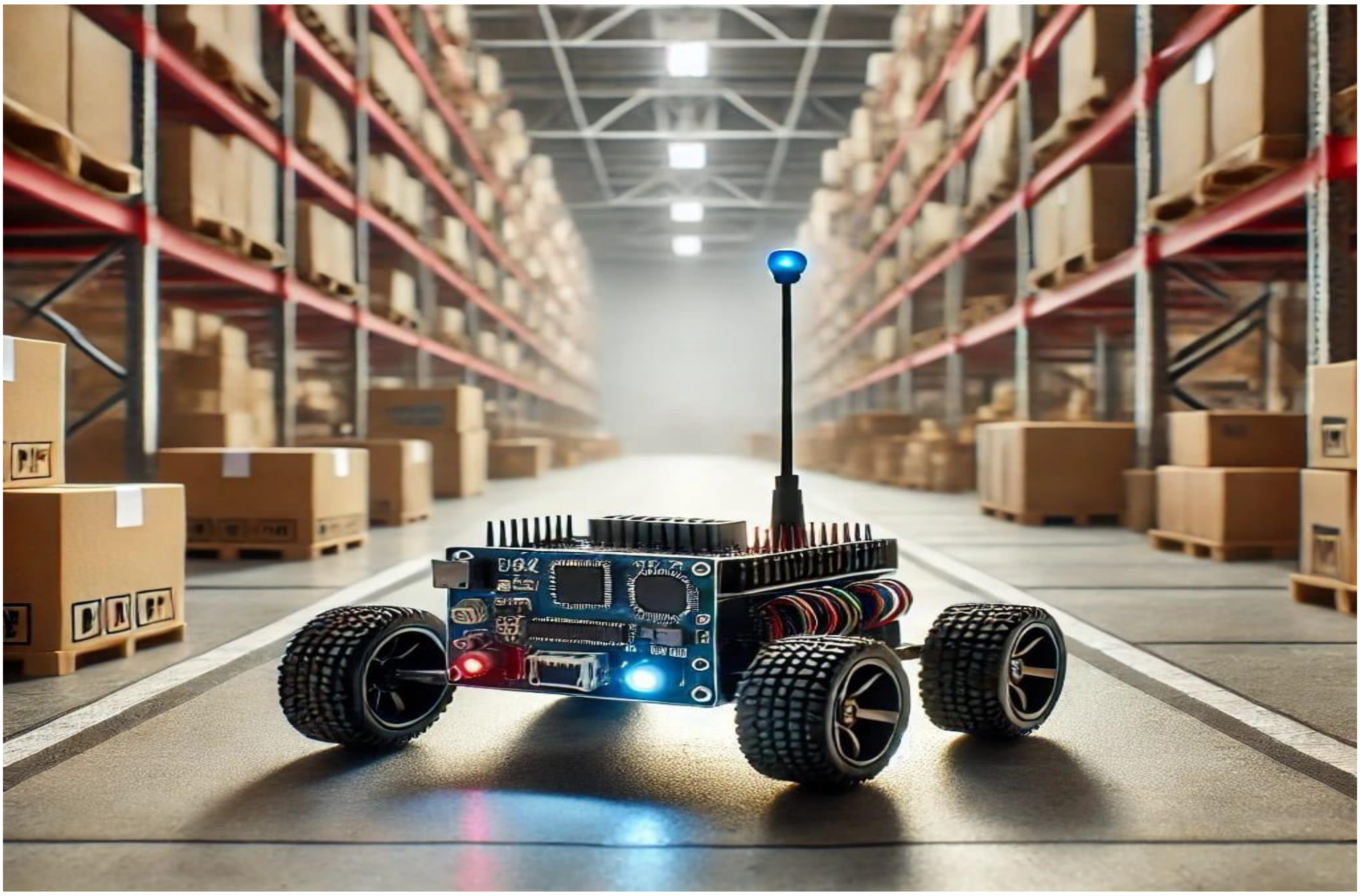

Fig 10:ADAS level 1 upgrade

5. Multi-Vehicle Coordination:

Developing algorithms for swarm robotics, where multiple cars can coordinate and communicate to perform tasks collectively.

6. ADAS-Level Upgrades:

Expanding the system to include ADAS-Level 02 features like adaptive cruise control, automatic braking, or lane departure warnings.

7. Real-World Applications:

Scaling the system for real-world applications such as warehouse automation, delivery robots, and smart agriculture systems.

The project offers a solid foundation for future innovations, enabling the development of more advanced and practical autonomous systems.

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R. Vivacqua, R. Vassallo, and F. Martins, "A Low Cost Sensors Approach for Accurate Vehicle Localization and Autonomous Driving Application," *Sensors*, vol. 17, no. 10, p. 2359, Oct. 2017, doi: https://doi.org/10.3390/s17102359.

Educational Platforms:

Embedded System Tutorials and Code Examples: www.geeksforgeeks.org

DIY Robotics and Automation Projects: www.instructables.com

These references provide the foundational knowledge and tools necessary for designing and implementing the ADAS-Level 01 project effectively.