INTERIM PROGRESS REPORT

on

Smart Windshield Monitoring and Control System Using ESP32 with Automated Wiper and Heater Functions

Submitted by

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ABSTRACT

In modern automotive systems, driver safety and visibility are crucial factors for ensuring a secure driving experience. This project presents the development of a Smart Windshield Monitoring and Control System using an ESP32 camera module. The system is designed to enhance visibility and automate vehicle responses to adverse weather conditions.

The ESP32 camera module continuously monitors the windshield for visibility impairments such as rain, fog, or other obstructions. When the camera detects any vision obstacle, it collects data from the external environment and projects the information onto a dashboard display, providing real-time alerts to the driver. Additionally, the system incorporates a rain sensor to detect rainfall and automatically activate the windshield wipers, ensuring clear visibility without manual intervention.

To further improve safety during foggy conditions, the system is equipped with a heater automation feature. When fog is detected, the heater is triggered to prevent condensation on the windshield, thus maintaining clear visibility.

The integration of these features creates an intelligent and responsive windshield management system that optimizes driving safety in various environmental conditions. The implementation of this project highlights the efficiency of using low-cost IoT components like the ESP32, rain sensor, and temperature sensors to automate critical vehicular functions, ultimately contributing to safer and smarter vehicle operations.

OBJECTIVE

- Enhance driver safety by monitoring windshield visibility and providing real-time alerts.
- Automate windshield wiper activation using a rain sensor to ensure continuous visibility during rainfall.
- Project environmental data to a dashboard display when visibility is impaired or obstacles are detected on the windshield.

CHAPTER 1

INTRODUCTION

Visibility through the windshield is critical for safe driving, particularly in adverse weather conditions like rain, fog, or when obstacles obstruct the driver’s view. Traditional manual systems for controlling windshield wipers and defogging mechanisms can be slow and inefficient, increasing the risk of accidents. To address these challenges, there is a growing interest in smart automotive technologies that can autonomously detect and respond to environmental changes, ensuring safer driving experiences.

This project introduces a **Smart Windshield Monitoring and Control System**, designed to enhance driver visibility through real-time monitoring and automation. The system utilizes an ESP32 camera module to continuously assess the visibility conditions of the windshield. When vision is impaired by rain, fog, or other obstacles, the camera gathers data from the external environment and sends it to a dashboard display, alerting the driver with necessary information. By automatically identifying visibility issues, the system reduces the driver's reliance on manual intervention, allowing them to focus on navigating the road more safely.

The core of the system involves two key automation features: a rain sensor that controls the windshield wipers and a heater that prevents fogging. When rain is detected, the rain sensor triggers the wipers to automatically clear the windshield, removing the need for manual activation. Similarly, in foggy conditions, the system activates the heater to prevent condensation buildup on the glass, maintaining clear visibility. These automated functions not only enhance safety but also improve driver comfort by reducing the need for manual controls.

By leveraging IoT components like the ESP32, this project provides a low-cost and energy-efficient solution for modern vehicles. The smart windshield system not only responds to environmental changes in real time but also offers scalability for further development, such as integrating additional sensors or expanding its applications to other automotive features. This project demonstrates the potential for smart, automated systems to play a crucial role in advancing vehicle safety and driver assistance technologies.

CHAPTER 2
LITERATURE SURVEY

1. **Intelligent Windshield for Automotive Vehicles**

   Published in: 2011 World Congress on Information and Communication Technologies
   Authors: Utpal V. Solanki and Nilesh H. Desai G.H. Patel College of Engineering and Technology, Gujarat Technological University Gujarat, India.

   This research paper discusses the development of an intelligent windshield control system for automotive vehicles. It integrates water, dust, and light sensors to control wiper speed based on rain intensity, clean dust from the windshield, and adjust the sun visor according to light levels.

2. **Smart Car Using IoT and Image Processing**

   Published in: 2023 7th International Conference On Computing, Communication, Control And Automation
   Authors: Vijay Gaikwad and and Neha Kamtalwar, Department of Computer Engineering, Vishwakarma Institute of Technology, Pune. India

   This research paper explains the development of a Smart Car System using IoT and image processing to automate critical functions in vehicles. This covers the integration of various functions such as automatic wipers triggered by a rain sensor, a parking alarm using an ultrasonic sensor, weather sensing to adjust vehicle conditions, and lane detection

3. **IoT-Based Smart Parking Management System Using ESP32 Microcontroller**

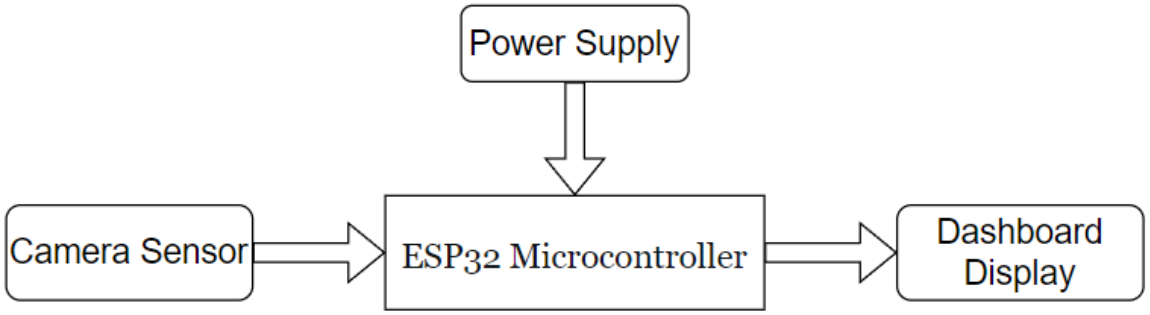
   Published in: 2022 9th International Conference on Electrical Engineering, Computer Science and Informatics (EECSI2022) - 6-7 October 2022
   Authors: Joni Welman Simatupang , Vincent, School of Electrical Engineering and Informatics Institut Teknologi Bandung Bandung 40132, Indonesia

   This research paper explains the design and implementation of an IoT-based smart parking management system using the ESP32 microcontroller. The system allows drivers to check for vacant parking spots in real-time and reserve a slot before arriving, reducing time spent searching for parking.

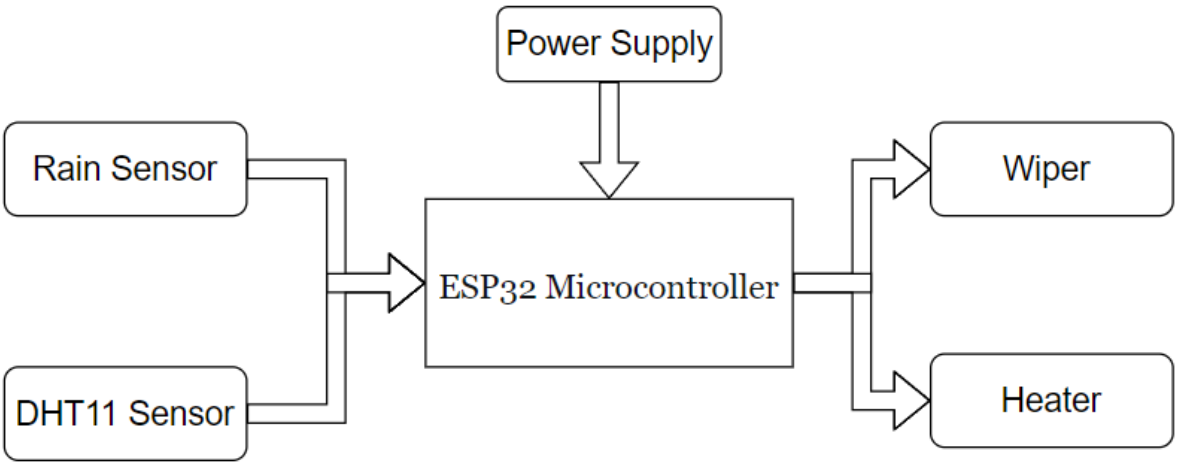
CHAPTER 3

SYSTEM DESCRIPTION

Block diagram of Environment data to Dashboard Display.



Block diagram of speech to text conversion.



CHAPTER 4

METHODOLOGY

Step1: Ultrasonic & IR sensor are placed in the corners of windshield to detect obstacles in windshield.

Step2: Depending upon the blockage of vision , camera sensor projects environmental data to dashboard display.

Step3: Rain sensor and DHT 11 sensor senses the rain / fog accordingly.

Step4: Depending on rain/fog the ESP32 enables the wiper / heater accordingly.

CHAPTER 5

CONCLUSION

This project successfully demonstrates the development of a **Smart Windshield Monitoring and Control System** using the ESP32 camera module and a range of sensors to enhance driver safety and convenience in various weather conditions. By integrating modern IoT components such as the ESP32 camera, rain sensor, fog sensor, and ultrasonic or infrared sensors, the system effectively monitors the windshield and automates critical functions like windshield wiping and fog removal. This automation reduces driver workload and distraction, allowing them to focus more on driving and less on manually controlling these functions.

The **ESP32 camera module**, combined with basic image processing algorithms, enables real-time detection of visibility impairments caused by rain, fog, or obstacles on the windshield. The system reliably detects these impairments and projects alerts to a dashboard display, providing the driver with instant feedback about the windshield's condition. Additionally, the use of complementary sensors such as the **rain sensor** and **fog sensor** ensures that environmental changes are accurately detected and prompt actions are taken.

One of the key achievements of this project is the successful automation of **wiper control** using a rain sensor, which activates the windshield wipers when moisture is detected. Similarly, the **fog sensor** triggers the heater system to prevent condensation from building up on the windshield, thus maintaining clear visibility even in foggy conditions. The system's ability to autonomously handle these tasks contributes to improved road safety by eliminating the need for the driver to manually adjust wiper speeds or activate the defogger.

The implementation of **ultrasonic or infrared sensors** adds an extra layer of obstacle detection by identifying solid objects like debris or leaves on the windshield. These sensors complement the camera's image-based detection, offering a robust and reliable mechanism for ensuring the windshield remains clear. Additionally, the real-time feedback provided through the dashboard display enhances the driver's awareness of the vehicle's automated responses to environmental changes.

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