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IoT-Enabled Safety System for Enhanced Rider Protection

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Abstract: - In today's automotive landscape, advancements in digital technology have transformed vehicle systems. However, the need to monitor navigation displays often diverts drivers' attention, posing potential safety risks. To address this, we propose an innovative IoT-based safety system for bike riders, integrating augmented reality (AR) to project navigation instructions directly within the rider's line of sight. This system utilizes real-time navigation data sourced from an AI-powered server, relayed to a central controller that projects essential route guidance onto an AR display positioned within the rider's field of vision. By seamlessly overlaying navigation cues onto the rider's view, the system enhances route awareness without requiring them to look away from the road, thereby improving focus and reducing accident risks. Beyond navigation, the system also includes an accident alert feature, which further reinforces rider safety. Through the integration of AR and AI, this work aims to reshape how riders interact with navigation systems, promoting a safer, more efficient road experience.

Keywords: IoT, Augmented Reality (AR), AI-powered navigation, Rider safety, Real-time navigation, Accident alert system.

I. INTRODUCTION *(HEADING 1)*

In the rapidly evolving landscape of automotive technology, rider distraction during navigation remains a critical safety concern. This work introduces an innovative IoT-enabled safety system that integrates augmented reality (AR) with AI-driven data to minimize distractions and enhance rider protection. By leveraging real-time navigation data from an AI-powered server, the system projects route guidance directly into the rider's line of sight, improving both situational awareness and road safety. Additionally, the inclusion of an accident alert feature strengthens proactive safety measures, setting a new benchmark for secure and efficient riding experiences. Bringing down pollution levels require much longer time than the severity of the problem is allowing.

Existing vehicular navigation systems primarily focus on GPS solutions for personal use, often in the form of standalone devices or mobile apps. These systems typically deliver visual and verbal instructions to guide drivers to their destinations. While effective, these interfaces sometimes require drivers to divert their attention from the road to view navigation information on graphical displays. This distraction can compromise safety by reducing the driver's focus on driving.

Current systems are based on outdated interaction models that fail to fully utilize the driver's display unit's potential. They often overlook the opportunity to integrate navigation with the driving experience in a more seamless and natural way, limiting the overall effectiveness of the system.

II. LITERATURE REVIEW

Srinivasan et al [1] the authors explore advancements in vehicular navigation systems, focusing on safety improvements. They employed IoT and GPS integration for real-time tracking and accident avoidance. Results indicated that their system enhanced driver awareness and reduced response time in emergency situations.

Verma et.al [2] this study proposes IoT-based solutions for real-time traffic management and driver assistance. They used sensors and cloud computing for dynamic traffic updates and driver alerts. Results showed significant reductions in congestion and accident rates through adaptive traffic control.

Patel et.al [3] developed smart navigation systems aimed at accident prevention in Indian cities, integrating IoT and AI for predictive accident risk detection. Their system's implementation in urban areas showed a 30% decrease in traffic-related accidents by providing real-time safety warnings to drivers.

Reddy et. al [4] review article examines the state of intelligent transportation systems (ITS) in India, identifying key challenges and opportunities. The authors analyzed existing systems and recommended the integration of IoT

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and AI to optimize traffic flow and improve safety. Their findings suggest that India could significantly benefit from adaptive, data-driven transportation systems**.**

Sharma et.al [5] designed an IoT-based smart traffic management system to improve urban traffic flow. Using real-time sensor data and AI algorithms, their system adjusted traffic signals dynamically based on traffic density. Results showed enhanced traffic efficiency and a 20% reduction in traffic-related delays.

III. PROPOSED SYSTEM

The proposed system aims to enhance rider safety by addressing driver distraction through the integration of Augmented Reality (AR) technology. This system projects navigational information directly within the rider's line of sight, reducing the need for them to divert their attention. The AR interface is designed for simplicity, ensuring that graphical instructions are easily understood at a glance. Additionally, the system incorporates AI-driven real-time updates, providing traffic and road condition alerts as needed. Its adaptable design allows for seamless implementation across different vehicle models, making it a versatile solution for improving situational awareness and overall road safety.

III.I BLOCK DIAGRAM

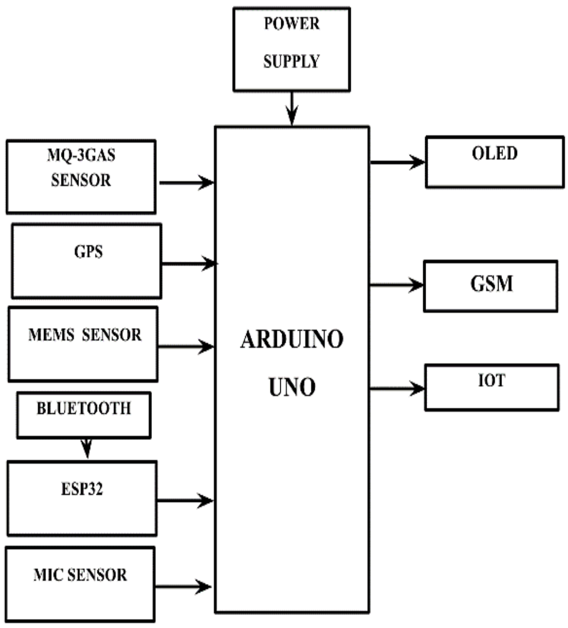

Fig-1 Block Diagram of Helmet Section

The Fig 1 & 2 illustrates the integrated system utilizes an Arduino UNO as its central controller, working alongside the AI GEMINI kit to provide navigation data. The AI GEMINI kit wirelessly transmits information to a display unit. A MEMS sensor monitors angle variations for safety, triggering GPS to locate coordinates in case of an accident, which are then sent via GSM for emergency alerts. An MQ-3 gas sensor detects alcohol consumption, notifying specific contacts if detected. An IR sensor ensures helmet usage, sending alerts if absent. The OLED display provides real-time updates. This system combines sensor technology, mobile communication, and AI to enhance road safety.

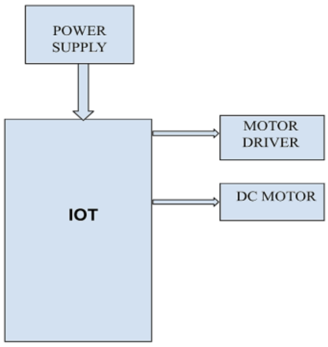

Fig-2 Block Diagram of Motor Section

III.II Modules Description

i. AI Gemini server

ii. AI Gemini server to display

iii. Alcohol and proximity sensor working

iv. Accident detection and alert

Each section provides a detailed description of the functionality and operation of the listed modules.

1. **AI Gemini server:** Fig 3 is the AI Gemini Server serves as the central component of the system, handling advanced AI algorithms to process and deliver structured navigational data in real time. An ESP32 microcontroller, utilizing Bluetooth communication, establishes a connection with the server. Through this interface, the system transmits user queries or current location data, which the server analyzes before responding with relevant routing, traffic updates, and navigation assistance. This dynamic framework allows the server to adjust directions in real time, considering factors such as traffic congestion, weather conditions, or road incidents. The Bluetooth functionality of the ESP32 ensures a stable and efficient connection, enabling continuous data exchange, which is essential for keeping navigation information accurate and up to date.

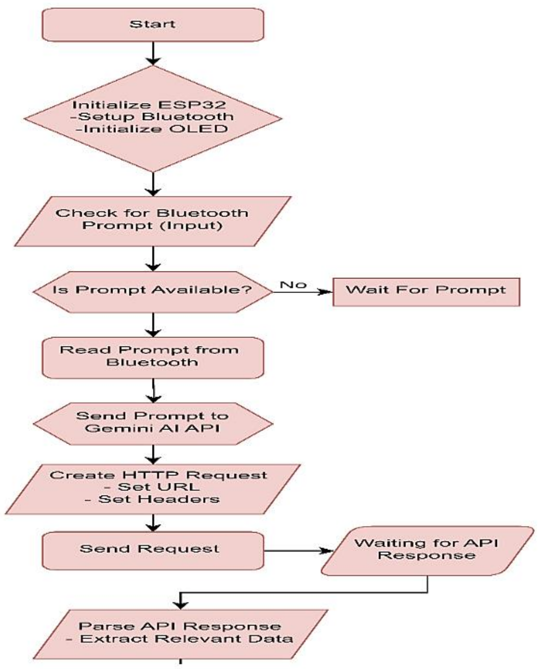

Fig-3 Flowchart of AI Gemini Server

2. AI Gemini server to display:

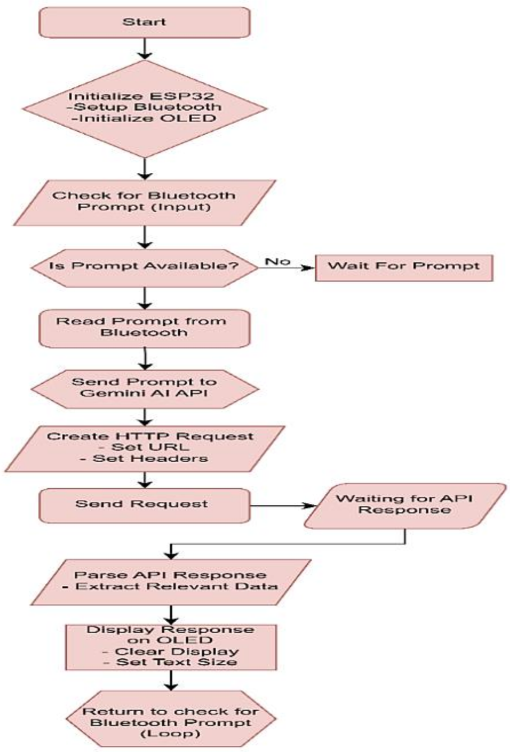

Fig 4 Flowchart of AI Gemini Server to Display

Fig 4 is the flowchart outlines a system designed with an ESP32 microcontroller, integrated with the Gemini AI application's programming interface. The process begins with configuring the ESP32 controller, followed by the activation of Bluetooth and an OLED display. The system then enters a standby mode, continuously monitoring Bluetooth signals and detecting verbal commands if present. Once a command is identified, it is transmitted to the Gemini AI API through an HTTP request, which includes a predefined URL and header details. The system remains in standby mode until a response is received from the API. Upon receiving the response, the data is programmatically processed and displayed on the OLED screen. Additionally, the diagram will be removed, and the text size will be increased for better readability. After completing the initial cycle, the system will resume scanning for Bluetooth signals, ensuring ongoing interaction with the Gemini AI API.

3. Alcohol and proximity sensor working:

Fig 5 illustrates microcontroller technology plays a crucial role in vehicle safety systems. In this setup, an Arduino Mega microcontroller is utilized to interface with various sensors. An MQ-2 gas sensor detects the presence of alcohol in the driver's breath, while an IR sensor ensures that the driver is wearing a helmet. If any safety requirements are not met, the system promptly notifies the user via a GSM module. This approach enhances road safety by preventing intoxicated driving and promoting the use of protective helmets.

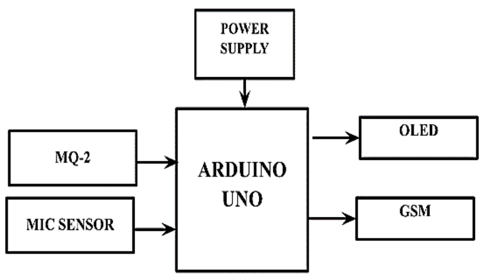

Fig-5 Block Diagram of Alcohol and Proximity Sensors

4.Accident detection and alert: The fig 6 system integrates sensors with an Arduino Mega microcontroller, utilizing a MEMS accelerometer to detect vehicle accidents. When an incident occurs, the GPS, in conjunction with the gyroscope, determines the vehicle's location. The Arduino board then triggers an alert via a GSM module, notifying designated contacts. This functionality enables the system to raise an alarm and facilitate assistance during emergencies, thereby enhancing overall safety measures.

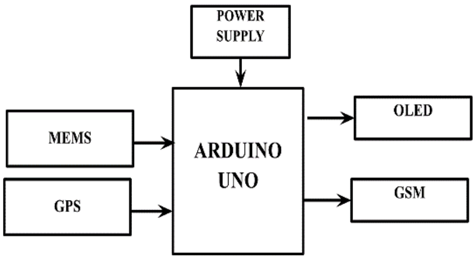

Fig 6. Block Diagram of Accident Detection and Alert System

IV. Results

The IoT-enabled safety system was successfully tested, demonstrating its effectiveness in enhancing rider protection. The MQ-2 gas sensor accurately detected alcohol consumption, while the IR sensor ensured helmet compliance by sending alerts when not worn. The MEMS sensor detected accidents by monitoring angular variations, triggering GPS tracking and emergency notifications via GSM. Additionally, the AI GEMINI kit provided real-time navigation updates displayed on the OLED screen. Overall, the system functioned reliably, integrating IoT technology to improve road safety through automated monitoring and real-time communication.

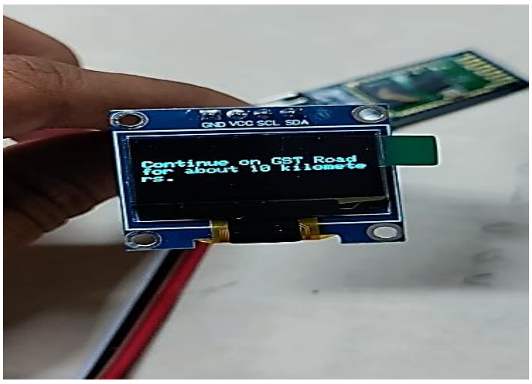

Fig 7. Real-Time Display Unit

V. Conclusion

In today's automotive landscape, vehicles are immersed in advanced digital systems. The evolution of navigation raises concerns about distracted driving. To combat this, a pioneering project proposes integrating augmented reality (AR) technology for seamless navigation instructions. The innovation lies in sourcing navigation data from the AI GEMINI server, relayed to the main controller, and displayed within the driver's line of sight. AR overlays instructions on the driver's view, ensuring focus on the road. This not only improves the driving experience but significantly reduces accident rates. The system, enriched with an accident alert feature, proactively enhances road safety, revolutionizing how drivers interact with navigation for a safer driving environment.

VI. References

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