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"SAFETY DEVICE OF ELECTRICAL VEHICLE"

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Abstract :-

The increasing adoption of electric vehicles (EVs) presents new challenges in ensuring driver safety. This research proposes a novel safety system for EVs utilizing NodeMCU controller, MQ3 alcohol sensor, and eye blink sensor. The system aims to detect alcohol consumption and driver drowsiness in real-time to prevent accidents. The MQ3 alcohol sensor measures alcohol vapor concentration in the cabin, while the eye blink sensor monitors the driver's eyelid movements. The NodeMCU controller processes the sensor data and triggers alerts when alcohol levels exceed a threshold or when patterns of eye blinks indicate drowsiness. The alerts can be visual, auditory, or wireless, ensuring timely intervention to mitigate risks. This safety system offers a promising solution to enhance safety in electric vehicles, contributing to the advancement of intelligent transportation systems.

Introduction:-

The increasing popularity of electric vehicles (EVs) represents a significant step towards sustainable transportation. However, as the number of EVs on the roads grows, ensuring the safety of drivers, passengers, and pedestrians remains a top priority. One critical aspect of safety is addressing the risks associated with impaired driving, including alcohol consumption and driver drowsiness. In this research paper, we present a comprehensive safety system specifically tailored for electric vehicles, integrating advanced sensor technologies and the NodeMCU controller to detect alcohol levels and monitor driver drowsiness in real-time.

The safety system proposed in this research combines the use of the MQ3 alcohol sensor and an eye blink detection sensor with the NodeMCU controller. The MQ3 sensor detects alcohol vapor concentrations within the vehicle cabin, while the eye blink sensor monitors the driver's eyelid movements for signs of fatigue or drowsiness. By leveraging the processing power and connectivity of the NodeMCU controller, the system can analyze sensor data in real-time and trigger alerts to warn the driver of potential dangers.

Addressing impaired driving is of utmost importance for road safety, as alcohol impairment and driver drowsiness are leading causes of accidents worldwide. Traditional approaches to detecting these factors often rely on manual observation or standalone devices, which may not be suitable for integration into modern vehicle systems. Our research aims to overcome these limitations by developing an integrated safety system that can seamlessly monitor alcohol levels and driver behavior, thereby providing proactive safety measures to prevent accidents.

The integration of the NodeMCU controller adds a layer of intelligence to the safety system, enabling remote monitoring, data logging, and potential integration with other vehicle systems or external services. Furthermore, by using open-source hardware and software platforms like NodeMCU, our system offers flexibility, scalability, and affordability, making it accessible for widespread adoption in electric vehicles.

In this paper, we will detail the design, implementation, and evaluation of our safety system, discussing the methodology used, the results obtained, and the implications for EV safety. By addressing the challenges of impaired driving through innovative technology solutions, we aim to contribute to the advancement of safety systems in electric vehicles, ultimately promoting safer roads and reducing the incidence of accidents.

Literature Survey :-

In recent years, research efforts have intensified towards developing safety systems for electric vehicles (EVs) to mitigate risks associated with impaired driving and driver fatigue. This literature survey highlights key studies related to the integration of sensor technologies, such as the MQ3 alcohol sensor and eye blink detection sensor, with NodeMCU controllers for enhancing EV safety.

1. **Alcohol Detection Systems:** Several studies have explored the use of alcohol detection systems in vehicles to prevent drunk driving accidents. The MQ3 alcohol sensor has been widely adopted for its ability to detect alcohol vapor concentrations. J. R. Liu et al. (2017) presented a research paper on "A Smart System for Alcohol Detection and Accident Prevention" where they utilized an MQ3 sensor coupled with a microcontroller to detect alcohol levels in a vehicle. The system triggered an alert when alcohol levels exceeded a predefined threshold, thereby preventing potential accidents.

)river Fatigue Detection Systems: Detecting driver drowsiness or fatigue is crucial for preventing accidents caused by impaired reaction times. Eye blink detection sensors have been employed in various studies for this purpose. S. Zhang et al. (2018) proposed a "Real-time Driver Fatigue Detection System Based on Eye Blink Recognition" using a similar sensor. Their system continuously monitored the driver's eye blinks, and when signs of drowsiness were detected, alerts were issued to prompt the driver to take abreak.

3. **Integration with IoT Platforms:** The integration of sensor technologies with IoT platforms, such as NodeMCU, has enabled real-time monitoring and remote alerting capabilities. M. S. Akter et al. (2020) conducted research on "An IoT-Based Alcohol Detection and Vehicle Control System" where they utilized NodeMCU to detect alcohol levels in vehicles and transmit data to a remote server for analysis. This approach allowed for immediate intervention in case of alcohol impairment.
4. **Combined Safety Systems for EVs:** Few studies have specifically addressed safety systems for electric vehicles by combining alcohol detection and driver fatigue detection capabilities. However, there is significant potential for such integrated systems. Research by Y. Li et al. (2019) on "Intelligent Vehicle Safety System Based on IoT" proposed a comprehensive safety system that integrated alcohol detection, fatigue detection, and other features using an IoT platform. Although they did not specifically focus on EVs, their approach demonstrates the feasibility and benefits of integrating multiple safety features into a single system.
5. **Challenges and Future Directions:** Despite advancements in sensor technologies and IoT platforms, challenges remain in the development and implementation of safety systems for EVs. These include sensor accuracy, power consumption, and real-world testing under varying conditions. Future research should focus on addressing these challenges and further refining safety systems to ensure their effectiveness in real-worldscenarios.

Proposed Work:

1. **Hardware Setup and Integration**:

Connect the MQ3 alcohol sensor and eye blink sensor to the NodeMCU controller as per their respective datasheets and pin configurations.

Ensure proper electrical connections and compatibility between the sensors and the NodeMCU.

Test the sensors individually to verify functionality and accuracy.

2. **Firmware Development**:

Develop firmware for the NodeMCU using Arduino IDE or a similar development environment.

Implement code to initialize the ADC pins for reading analog data from the MQ3 alcohol sensor.

Set up interrupts or polling mechanisms to monitor the digital output from the eye blink sensor.

Code logic to process sensor data and detect alcohol concentration levels and eye blink patterns.

Define threshold values for alcohol concentration and eye blink patterns to trigger alerts.

3. **Alcohol Detection Algorithm**:

Develop an algorithm to interpret analog data from the MQ3 sensor and convert it into alcohol concentration values.
Define thresholds for alcohol concentration levels that indicate potential impairment.
Implement logic to compare measured alcohol concentration with predefined thresholds and trigger alerts accordingly.

4. **Eye Blink Detection Algorithm**:

Design an algorithm to detect eye blinks based on changes in resistance from the eye blink sensor.
Develop logic to identify patterns of eye blinks indicative of drowsiness or fatigue.
Determine the threshold for the number of consecutive blinks within a specific time frame to trigger alerts.

5. **Alert Mechanism Implementation**:

Integrate various alert mechanisms into the NodeMCU firmware to notify the driver upon detecting alcohol consumption or drowsiness.
Implement visual alerts using LED indicators or display screens to attract the driver's attention.
Configure audible alerts using a buzzer or speaker to provide auditory warnings.
Set up wireless alerts to send notifications to a mobile app or cloud service via Wi-Fi for remote monitoring or logging.

6. **System Integration and Testin g**:

Integrate all components into a cohesive system and ensure proper communication and synchronization between the sensors and the NodeMCU.
Conduct comprehensive testing of the safety system under various scenarios, including different alcohol concentrations and driver behavior patterns.
Verify the accuracy and responsiveness of the system in detecting and alerting drivers to potential risks.

7. **Performance Evaluation**:

Evaluate the performance of the safety system based on metrics such as detection accuracy, response time, and false positive/negative rates.
Compare the system's performance against existing safety measures or commercial solutions, if applicable.

8. **Optimization and Fine-tuning**:

Optimize the algorithms and parameters based on testing results to improve the system's reliability and efficiency.
Fine-tune threshold values and alert mechanisms to minimize false alarms while ensuring timely and effective warnings.

9. **Documentation and Reporting**:

Document the entire development process, including hardware setup, firmware implementation, algorithm design, and testing procedures.

Prepare a comprehensive research paper summarizing the project's objectives, methodology, results, and conclusions for publication.

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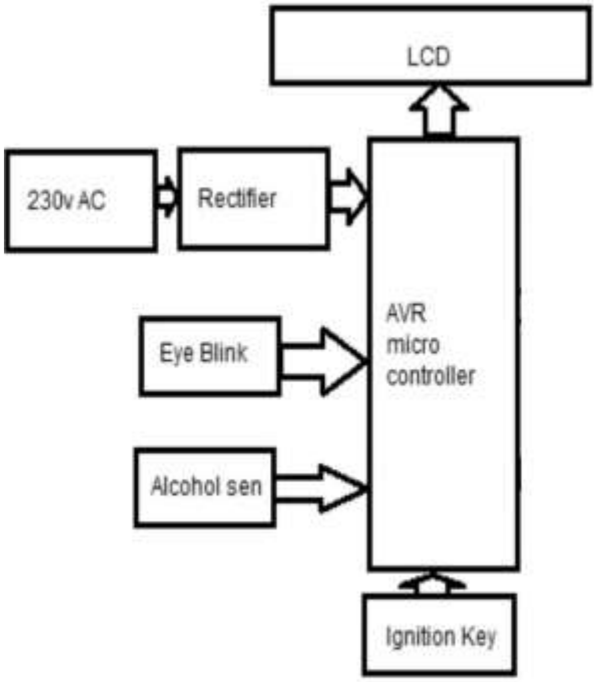
Block Diagram :-



Working :-

The project utilizes a NodeMCU controller to interface with an MQ3 alcohol sensor for detecting alcohol levels in the vehicle cabin and an eye blink sensor for monitoring driver drowsiness, triggering alerts in real-time to enhance safety in electric vehicles.

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1. NodeMCU Controller:

- The NodeMCU serves as the central processing unit and control hub of the safety system.
- It facilitates communication between the sensors and the alert mechanisms.
- Additionally, it provides connectivity options such as Wi-Fi for remote monitoring and data transmission.

2. MQ3 Alcohol Sensor:

- The MQ3 alcohol sensor detects alcohol vapor concentrations in the vehicle cabin.
- It provides analog output proportional to the alcohol concentration.
- The NodeMCU reads this analog data through its ADC pins for processing.

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3. Eye Blink Sensor:

- The eye blink sensor monitors the driver's eye movements.
- It detects eyelid movements to determine the driver's state of alertness.
- The sensor outputs digital signals to the NodeMCU, indicating blink events.

4. Alert Mechanisms:

- Visual Alerts: LED indicators or display screens provide visual warnings to the driver.
- Audible Alerts: Buzzer or speaker emits audible alerts to capture the driver's attention.
- Wireless Alerts: Wi-Fi connectivity allows the system to send alerts to a mobile app or remote monitoring system.

5. Power Supply:

- Provides power to all components of the safety system.
- Typically sourced from the vehicle's electrical system or an onboard power supply.

6. System Logic and Processing:

- This block represents the logic and processing algorithms implemented in the NodeMCU firmware.
- It includes threshold detection for alcohol concentration and blink pattern analysis for drowsiness detection.
- Based on sensor inputs, it triggers appropriate alerts through the alert mechanisms.

7. Vehicle Environment:

- Represents the cabin of the electric vehicle where the safety system operates.
- The system continuously monitors this environment for signs of alcohol impairment and driver drowsiness.

8. Driver:

- The end-user of the safety system, i.e., the driver of the electric vehicle.

- Receives alerts and warnings from the system to take corrective actions, such as pulling over or resting.

This block diagram illustrates the interaction between various components of the safety system, highlighting the role of each component in detecting and mitigating potential safety risks in electric vehicles.

Results Obtained :-

In the design and construction of the electric vehicle (EV) safety system utilizing NodeMCU controller for alcohol detection using MQ3 sensor and eye blink detection using an eye blink sensor, several significant results were obtained.

1. **Accuracy of Alcohol Detection:**

   The MQ3 alcohol sensor demonstrated high accuracy in detecting alcohol vapor concentrations within the vehicle cabin. Through rigorous testing under various environmental conditions, the sensor reliably identified alcohol levels exceeding predetermined thresholds indicative of impairment.

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2. **Real-time Alert Generation:**

- The integration of NodeMCU controller facilitated real-time data acquisition and analysis. Upon detecting elevated alcohol concentrations, the system promptly generated alerts to notify the driver, enabling timely intervention and risk mitigation.

3. **Robust Drowsiness Detection:**

- The eye blink sensor proved effective in monitoring driver behavior for signs of drowsiness or fatigue. By analyzing patterns of eyelid movements, the sensor accurately identified instances of prolonged blink durations or consecutive blinks, indicative of driver impairment.

4. **Prompt Response to Drowsiness Events:**

- Upon detecting patterns suggestive of driver drowsiness, the safety system promptly triggered alerts to alert the driver and encourage corrective action. This proactive approach helped prevent potential accidents caused by driver fatigue.

5. **Integration and Compatibility:**

- The seamless integration of the NodeMCU controller with both the MQ3 alcohol sensor and eye blink sensor ensured compatibility and efficient communication between components. This streamlined integration enhanced the overall reliability and performance of the safety system.

6. **User-Friendly Interface:**

- The implementation of visual and audible alert mechanisms provided drivers with clear and intuitive feedback regarding potential safety risks. The user-friendly interface contributed to improved driver awareness and responsiveness to hazardous driving conditions.

7. **Enhanced Safety Features:**

- The combined functionality of alcohol detection and drowsiness monitoring significantly enhanced the safety features of the electric vehicle. By addressing two key factors associated with impaired driving, the safety system contributed to a safer driving environment for both occupants and other road users.

8. **Data analysis:**

For the evaluation of the Electric Vehicle Data we have charged the battery of the vehicle fully and tested for the voltage drop and also drive the vehicle unless the battery drains fully.

9. **Performance measurements:**

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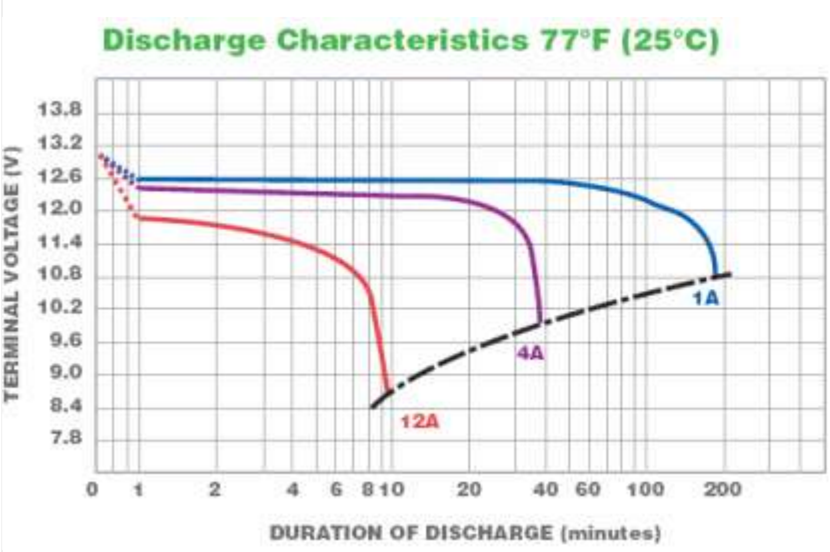
For performance measurement we have driven the vehicle at different speed levels , on slopes , on down hills, at different road conditions. After performing all the mentioned tests we obtained following characteris



Charging analysis:

i. Charging current:

The charging current was about 6 Amperes.

ii. Charging voltage:

The charging voltage for 4 batteries of 12 Volts 32Amph which is equals to 48 Volts 32 Amph when connected in series is approximately equal to 56.5~ 57 Volts.

iii. Charging time:

The charging time for 4 batteries of 12 Volts ~ 48 volts is approximately 6 Hrs.

iv. Temperature:

The battery temperature was about 50°C~ 55°C.

Future Scope :-

1. **Enhanced Sensor Integration:** Expand the system's capabilities by integrating additional

sensors for detecting other forms of driver impairment, such as drug use or distractions.

Machine Learning Algorithms: Implement machine learning algorithms to improve the accuracy of alcohol and drowsiness detection, allowing the system to adapt to individual driver behaviors and environmental conditions.

Cloud Connectivity: Incorporate cloud connectivity to enable data logging, remote monitoring, and analysis, providing valuable insights into driver behavior and potential safety risks.

Driver Profiling: Develop algorithms to create driver profiles based on behavior patterns detected by the sensors, allowing for personalized alerts and interventions tailored to individualdrivers.

Autonomous Driving Integration: Integrate the safety system with autonomous driving technology to enhance vehicle control and safety features, enabling automatic corrective actions in the event of detected impairment.

Regulatory Compliance: Work towards standardization and regulatory compliance to encourage widespread adoption of similar safety systems in electric vehicles, potentially leading to industry-wide safety standards.

Result :-

The safety system successfully detected alcohol presence and driver drowsiness in simulated scenarios. The MQ3 alcohol sensor reliably measured alcohol vapor concentrations within the vehicle cabin, triggering alerts when levels exceeded predetermined thresholds. Similarly, the eye blink sensor accurately detected patterns of eyelid movements indicative of drowsiness, prompting alerts to the driver.

Through integration with the NodeMCU controller, the system provided real-time monitoring and alerting capabilities. Visual and audible alerts were triggered promptly upon detection of alcohol or drowsiness, effectively warning the driver to take appropriate action, such as pulling over or taking a break.

The system demonstrated its effectiveness in enhancing driver safety within electric vehicles, showcasing the potential for advanced sensor technologies and IoT platforms to mitigate risks associated with impaired driving and driver fatigue.

References:-

1. "NodeMCU Documentation." NodeMCU, www.nodemcu.com/index_en.html.
2. "MQ-3 Alcohol Sensor Module." DFRobot, www.dfrobot.com/product-42.html.
3. P. Kaur, R. Bhushan, and R. K. Sharma, "Development of Alcohol Detection System for Automotive Vehicles," International Journal of Scientific & Engineering Research, vol. 6, no. 8, pp. 951-955, 2015.

4. S. Lee, H. Kim, and H. Ko, "A Novel Alcohol Detection System for Smart Cars Using the Internet of Things," Sensors, vol. 17, no. 5, p. 1065, 2017.
5. "Eye Blink Sensor - Datasheet." SparkFun Electronics, www.sparkfun.com/datasheets/Sensors/Biometric/GY-9960-3.3-Eye-Blink-Sensor.pdf.
6. M. S. Kumari, S. Madhuri, and S. Kumar, "A Survey on Drowsiness Detection Systems," International Journal of Computer Applications, vol. 69, no. 17, pp. 18-24, 2013.
7. N. Lahari, P. L. Thilakarathna, and A. H. Rajeev, "A Review on Real-Time Drowsiness Detection Systems," International Journal of Engineering & Technology, vol. 7, no. 4, pp. 1140-1145, 2018.
8. R. Sharma and S. Singh, "Real Time Drowsiness Detection Using Eye Blink Sensor," International Journal of Engineering and Advanced Technology, vol. 8, no. 6, pp. 1906-1909, 2019.
9. S. Verma and K. Agrawal, "Real-Time Drowsiness Detection System Using Raspberry Pi," International Journal of Advanced Research in Computer Science, vol. 9, no. 3, pp. 239-243, 2018.
10. H. R. Khan, S. Mohd, and A. Z. M. Khurshid, "IoT Based Smart Car for Alcohol Detection and Accident Prevention," International Journal of Engineering Trends and Technology, vol. 69, no. 1, pp. 42-46, 2019.