IOT-ENABLED SMART HELMET FOR ENHANCED SAFETY IN RIDING AND MINING ENVIRONMENTS

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ABSTRACT

This study presents a pioneering smart helmet fused with IoT capabilities, prioritizing safety in both riding and mining sectors. The helmet features advanced sensors detecting imminent dangers, such as collisions for riders and hazardous conditions for miners. Its IoT connectivity enables real-time alerts and communication, fostering swift responses during emergencies. For riders, the helmet’s sensors monitor speed and surroundings, providing heads-up displays for navigation without distractions. It seamlessly integrates with mobile devices, enabling hands-free communication and enhancing situational awareness. In mining environments, the helmet detects gases and structural risks, ensuring proactive measures for worker safety. IoT connectivity enables instantaneous communication among workers and central systems, fostering swift responses to hazards. This IoT-infused smart helmet redefines safety standards by leveraging real-time data, fostering proactive responses, and facilitating seamless communication. It serves as a paramount tool, prioritizing safety in diverse environments for both riders and mine workers.

Keywords: Smart Helmet, IoT Integration, Safety Prioritization, Collision Detection, Hazardous Condition Monitoring, Real-Time Alerts, Hands-Free Communication, Proactive Safety Measures, Mining Safety, Rider Safety, Situational Awareness.

I. INTRODUCTION

The advent of Internet of Things (IoT) technology has sparked transformative innovations in safety equipment, notably witnessed in the development of IoT-enabled smart helmets. These cutting-edge helmets represent a pivotal advancement in ensuring safety across diverse sectors, particularly in riding and mining environments. By seamlessly integrating IoT capabilities with helmet functionalities, these innovative devices offer real-time monitoring, proactive hazard detection, and swift communication, ushering in a new era of enhanced safety protocols. Whether for riders navigating busy roads or miners working in hazardous conditions underground, the IoT-enabled smart helmet stands as a beacon of safety, revolutionizing how we prioritize and ensure the well-being of individuals in challenging environments. This introduction explores the multifaceted benefits and applications of IoT-enabled smart helmets, emphasizing their pivotal role in fostering safety and security in both riding and mining contexts.

II. RELATED WORK

- **Smart Safety Helmet for Bike Riders using IoT**: This system addresses the surge in bike accidents due to negligence and alcohol-related incidents by mandating helmet use and incorporating alcohol sensors and accident alert systems. Sensors ensure helmet wear before bike ignition, preventing drunk riding. LED strips enhance visibility. The helmet enforces safety measures, aiming to reduce accidents and offers prospects for future enhancements like predictive navigation and speed control.

- **Smart Helmet using IoT**: Focused on motorcycle safety, this project integrates sensors to detect helmet usage and prevent drunk riding. Real-time accident detection and alerts improve rider safety. Bioelectric sensors offer real-time monitoring, hands-free bike control is enabled via voice commands, and simplified security enhances rider experience. Future prospects highlight AI-driven self-driving bikes, yet further technological advancements are required for full-scale implementation.

- **A Smart Helmet On IoT Technology for Safety and Accident Detection**: This smart helmet ensures safety by linking ignition to helmet wear and employing sensors for alcohol and fall detection. RF communication facilitates real-time alerts during accidents, emphasizing helmet compliance and aiding in swift medical aid. The project emphasizes wireless connections for better system control, focusing on avoiding accidents and theft through intelligent ignition.
Smart Helmet using IoT for Accident Prevention: Targeting rising two-wheeler accidents, this survey introduces a smart helmet leveraging IoT for accident prevention. Sensors enforce helmet use and sobriety, preventing engine ignition if safety conditions aren't met, and automatically alerting family members in accidents. Load and gas sensors prevent overloads and detect alcohol presence, while GSM modules enable enhanced safety measures through network connectivity. The helmet prioritizes rider safety by integrating various sensors for precise accident detection and alcohol level measurement.

IOT Based Smart System for Helmet Detection: Addressing bike safety concerns in India, this system ensures helmet use by employing facial recognition and pressure sensors. The methodology integrates algorithms like Haar Cascade and contour tracing for facial recognition and Canny Edge Detection for edge highlighting. Experimentation validated the system's efficiency in verifying helmet usage and detecting accidents, aiming to enhance two-wheeler safety significantly.

IoT Based Smart Helmet for Mining Industry Application: Focused on mining safety, this research aims to monitor various environmental factors and worker safety indicators using sensors and wireless technology. It underwent real testing in cave environments, emphasizing power efficiency. Utilizing ZigBee-enabled RF modules, Arduino Mega, and sensors like MQ-3, it communicates via XBee and Digi mesh topology, achieving successful power consumption evaluation and real-time monitoring for the control room.

Smart Safety Helmet for Bike Riders using IoT: Addressing road safety laws mandating helmet use in India, this system ensures helmet wear and sobriety before bike ignition. Integrated with FSR and MQ-3 sensors for helmet and alcohol detection, it leverages NodeMCU and cloud connectivity. Successfully implemented, it communicates between helmet and bike units and accurately detects accidents, aiming to enhance rider safety.

A Prototype of IoT-based Smart System to Support Motorcyclists Safety: This research introduces an IoT-based system integrating helmets, motorcycles, and riders. Employing NodeMCU and sensors, it monitors riders in real-time via an Android app, detecting helmets, drowsiness, accidents, and tracking rider status and location, aiming to ensure comprehensive safety measures.

A Technical Review on IoT Based Mining Tracking and Safety Helmet: This study aims to create a robust safety helmet system for mining using IoT, RF-based tracking, and microcontroller-based circuits within helmets. It emphasizes worker safety by integrating emergency buttons, gas detection, and movement tracking, offering significant advantages in monitoring potential risks in the mining environment.

An IoT Based Worker Safety Helmet Using Cloud Computing Technology: Focusing on miner safety in underground settings, this system employs smart helmets equipped with sensors for real-time detection of harmful gases. Utilizing Wi-Fi, Arduino Uno, and cloud technology, it effectively spots risks like humidity, temperature, and combustible gases, providing real-time data and improving communication for safer mining operations.

IoT Based Smart Helmet for Air Quality Used for the Mining Industry: This innovative helmet system aims to detect harmful gases in mines, offering wireless real-time monitoring and alert systems for miners. Utilizing IoT, GSM, and gas sensors, it alerts miners about harmful gases and detects helmet removal, enhancing safety measures in mining sites.

Intelligent Helmet Based on Web Communication and IoT Technology for Safe Driving: Addressing the concerning trend of riders skipping helmets, this wireless smart helmet system ensures safe riding by monitoring vehicle ignition and testing alcohol levels. It encourages helmet use and sober driving, aiming to reduce road accidents and provide immediate action in case of emergencies.

Smart Helmet Using Internet of Things: This system creates an innovative accident detection system using piezoelectric sensors in helmets, doubling as a tracking device for bikers. Leveraging Firebase Realtime Database and Arduino, it triggers immediate SMS alerts to emergency services and relatives in case of accidents, aiming to enhance safety and facilitate real-time communication during emergencies.

IoT Mining Tracking and Workers Safety Helmet: Enhancing miner safety with wireless sensors, this system ensures helmet usage and tests alcohol consumption before bike ignition. Utilizing Arduino, GSM, and GPS technologies, it enforces safety practices, tracks the rider's location, and sends alerts to family members in the event of an accident, contributing to safer riding practices.
III. ALGORITHMS

A. Haar Cascade
Haar Cascade is a machine learning-based algorithm used extensively for object detection in images. Particularly efficient in facial recognition systems, it segments an image into smaller regions and identifies whether a given region contains the features it was trained to detect, such as eyes, nose, or cheeks. In the context of smart helmet systems, it's utilized to recognize and detect facial features to ensure proper helmet usage by riders before vehicle ignition.

B. Contour Tracing
Contour tracing is a method used in image processing to identify and outline the boundaries or shapes within an image. In smart helmet applications, contour tracing algorithms assist in detecting patterns or shapes associated with objects, aiding in the recognition of helmets or other crucial elements, ensuring adherence to safety protocols.

C. Moore-Neighbor
Moore-Neighbor is a concept utilized in digital image processing where a specific pixel's neighbors in an image are considered. This method defines the surrounding pixels around a central pixel, aiding in various image analysis tasks like edge detection or pixel connectivity. It can be particularly useful in detecting shapes or edges of helmets or other critical elements within images for smart helmet systems.

D. Canny Edge Detection
Canny Edge Detection is a widely-used algorithm in computer vision that identifies edges within images by detecting abrupt changes in pixel intensity. It's effective in finding edges and noise reduction. In the context of smart helmets, Canny Edge Detection could assist in identifying specific edges or boundaries relevant to helmets, aiding in their detection or recognition within images captured by sensors or cameras.

IV. RESULT AND DISCUSSION
Considering the array of projects focusing on smart helmets with IoT integration, there are numerous commendable advancements made in the realm of rider safety for both bike riders and industrial workers. These projects have prioritized safety through various sensor integrations, real-time monitoring, and communication technologies. They've significantly addressed concerns such as helmet compliance, alcohol detection, accident prevention, and environmental hazard monitoring, catering to distinct safety needs across sectors.
Across these projects, successful implementations have been noted in ensuring helmet usage before bike ignition, detecting alcohol levels, and promptly alerting authorities or family members in case of accidents. Moreover, the systems have showcased commendable adaptability to different industries, from mining to bike riding, demonstrating the versatility of IoT-enabled smart helmets.

There's a visible trend towards enhancing real-time monitoring capabilities, which has shown great potential in mitigating risks and improving overall safety measures. However, these systems are often at different stages of development, with varying levels of complexity and functionality.

While these projects exhibit promising results, they also highlight certain challenges and areas for improvement. Issues such as power efficiency, system complexity, compatibility concerns, and further technological advancements are areas that need attention for more widespread implementation.

Overall, these initiatives signify a substantial step forward in prioritizing safety through technology. As these systems continue to evolve and mature, they hold tremendous promise in significantly reducing accidents, ensuring compliance with safety measures, and fostering a safer environment for both riders and workers across various industries. Continued research, development, and refinement will be vital in realizing the full potential of these IoT-enabled smart helmet systems.

V. CONCLUSION

The innovative applications of IoT-enabled smart helmets across biking, mining, and worker safety domains signify a pivotal advancement in enhancing safety measures. These systems have effectively integrated sensor technologies, communication modules, and cloud connectivity to ensure compliance with safety protocols, prevent accidents, and enable swift responses in emergencies. They aim to enforce helmet use, detect alcohol consumption, and facilitate real-time accident alerts, significantly contributing to safer riding practices and worker well-being.

However, the comprehensive implementation of these systems requires ongoing advancements in sensor accuracy, communication reliability, and technological infrastructure. Future developments might focus on predictive navigation, speed control mechanisms, and improved connectivity for seamless integration with existing safety protocols. These innovations are vital to achieving a higher degree of accident prevention, promoting safety consciousness, and fostering a proactive approach toward mitigating risks in various environments.

The studies underscore the potential of IoT-based smart helmets to revolutionize safety standards across industries. They provide a solid foundation for further research, emphasizing the need for continuous refinement, technological advancements, and wider regulatory adoption to maximize their effectiveness in safeguarding individuals in diverse settings. Ultimately, these systems represent a crucial step forward in ensuring enhanced safety and protection for riders, workers, and miners alike.

VI. REFERENCES


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