**Invention Disclosure Details**

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**DETAILS OF THE PUBLICATION/COMMUNICATION/EXHIBITION IN WHICH THE INVENTION WAS DISCLOSED PRIOR TO PATENT FILING IN PUBLIC DOMAIN.** (If YES kindly provide details)

**Response**: YES/NO

*If yes mention the details and provide the link.*

**TITLE:** (Tentative title)

**IoT-Based Smart Helmet for Rider Safety, Accident Detection & Emergency Alerts**

## ABSTRACT (max 150 words)

The present invention discloses an NB-IoT–based intelligent safety helmet designed for real-time safety management in industrial and construction sites. The helmet integrates various modules consisting of a triaxial acceleration sensor, air pressure detector, GPS/SOS positioning, forehead, and jaw detection, and an NB-IoT communication circuit. It detects impacts, monitors environmental conditions, verifies proper wearing, and transmits data wirelessly to a cloud-based monitoring server. When impact intensity exceeds a preset threshold or an emergency is detected, the system generates alerts and provides real-time location updates. A shielding layer ensures low radiation exposure, while a neck bush enhances user comfort. The NB-IoT module reduces communication costs and allows continuous remote monitoring via a dedicated safety management application. This system supports high-precision positioning using GPS and NB-IoT base stations, making it suitable for complex environments like high-altitude construction. The helmet enhances operational safety, improves emergency response, and enables efficient workforce management.

## What problem was solved by the invention? Provide a brief literature review and how your invention is different from others. (Do mention at least 2-4 research articles/patents and the differences).

**Literature Review:**

With the rapid pace of urbanization and the surge in infrastructure and industrial development, construction sites have evolved into dynamic and often unpredictable environments. These workplaces are frequently exposed to extreme weather conditions, heavy machinery, elevated heights, and hazardous materials—factors that significantly increase the risk of injuries and accidents. Among these workers fatigue, heat stress, and lack of physiological awareness are major contributors to on-site incidents. Studies have shown that prolonged exposure to high temperatures and continuous physical exertion without adequate breaks can lead to severe health complications such as dehydration, heatstroke, and cardiovascular strain.

As a result, **ensuring real-time monitoring of worker's physical and environmental conditions has become an essential priority in occupational safety protocols**. Conventional personal protective equipment (PPE) like helmets and vests, while effective against physical trauma, lack the intelligence to detect early warning signs of physiological distress or environmental hazards. This gap has paved the way for coordination between smart technologies—such as sensors, microcontrollers, and wireless communication modules—into safety gear, particularly helmets, transforming them from passive protectors into **active safety and health management systems**. These smart helmets are designed to monitor vital signs, detect environmental changes, and provide timely alerts, thus enabling preventive interventions that drastically reduce the risk of accidents and improve overall worker health outcomes.

**1. Intelligent Rest Management through Bio-sensing**

A pioneering invention, described in **KR102583428B1**, presents a smart helmet system designed to enhance worker well-being through automated rest alerts. The system comprises biometric sensors (measuring parameters like heart rate), environmental sensors (temperature), and a wireless communication unit that transmits real-time data to a remote server. The controller interprets these inputs to determine the worker's activity level and physiological stress. If conditions indicate fatigue, the helmet triggers an audible or visual alarm to initiate rest. This personalized and adaptive alert system is unique in its focus on **preventive safety through rest management**, a domain often overlooked in conventional PPE.

**2. Fall Detection and Location Tracking Systems**

Patents like KR101778684B1 and KR101950754B1 explore fall detection systems using triaxial accelerometers. Upon detecting a fall, the helmet’s GPS module accurately identifies the worker’s location and transmits real-time alerts to site supervisors through NB-IoT communication. These systems have demonstrated effectiveness in minimizing emergency response time, potentially reducing the severity of injuries. However, they are typically reactive, triggering responses only post-incident.

**3. Environmental Hazard Monitoring and Radiation Protection**

The helmet outlined in **CN109065408A** integrates sensors that detect gas leaks and ambient radiation, while also ensuring minimal exposure through protective shielding. Such inventions are useful in chemical and nuclear construction sites but often lack personalized biometric monitoring, focusing instead on environmental data alone.

**4. Smart Monitoring through Cloud and AI Integration**

In **CN110125678A**, a comprehensive smart helmet integrates environmental and biometric sensors, a camera, a GPS unit, and NB-IoT modules for real-time data transfer to a centralized cloud server. The system supports live monitoring, task logging, and remote communication. While technologically advanced, these systems may suffer from complexity and high costs, and their usability can be hindered in remote or under-resourced sites.

**5. Biometric and Cognitive Fatigue Monitoring**

The smart helmet system described in **US10342498B2** integrates biometric sensors such as heart rate monitors and body temperature sensors along with accelerometers and gyroscopes for motion tracking. Its key functionality involves detecting signs of physical fatigue and cognitive stress through real-time physiological monitoring. The system transmits this data wirelessly to a centralized platform, where AI algorithms evaluate worker health and alert supervisors if abnormal patterns emerge. While effective in identifying early signs of fatigue and heat exhaustion, it primarily focuses on physical strain. It may not fully incorporate external environmental hazards like gas or radiation, limiting its scope in certain high-risk environments.

## ADVANTAGES OF THE INVENTION / What are the technical breakthroughs / surprising results/cost advantage achieved through the invention? (there is no minimum OR maximum word limit) *do list all the advantages be it small or big.*

The IoT-based smart helmet safety system introduces significant advancements in worker and rider safety. By incorporating cutting-edge technologies like IoT, RFID, biometric sensors, and real-time monitoring, this system not only enhances the safety of workers in hazardous environments but also ensures proactive intervention in case of accidents. The merging of sensors for accident detection, health monitoring, and emergency alerts makes it a reliable and cost-effective solution for enhancing overall safety, reducing accidents, and improving response times in critical situations.

**1. Enhanced Rider and Worker Safety**

* **Accident Detection:** Helmet sensors (MPU6050) provide immediate accident detection and impact analysis, triggering emergency alerts for swift help.
* **Real-time Monitoring:** NB-IoT integration enables real-time monitoring of workers in dangerous environments, enhancing safety with proactive tracking.

**2. Advanced Biometric and Environmental Sensors**

* **Temperature & Biometric Sensors:** The system tracks the worker’s health and body temperature, triggering alerts for anomalies.
* **Temperature Monitoring:** The helmet alerts the user about extreme temperature changes, ensuring timely intervention in extreme conditions.

**3. RFID-based Identification**

* **Enhanced Security:** The embedded RFID module provides secure worker identification, reducing the chances of unauthorized access.

**4. Emergency Alert System**

* **Automatic Alerts:** The helmet sends emergency alerts in case of an accident, ensuring immediate response from medical teams.
* **Location-based Alerts:** Real-time GPS tracking ensures that the exact location of the worker is sent to emergency services.

**5. Cost-Effectiveness**

* **Reduced Medical Costs:** Preventing accidents and improving safety reduces medical expenses related to worker injuries.
* **Affordable Technology:** The cost of sensors and components remains low, making the system economically viable for large-scale deployment.

**6. Ease of Integration and Scalability**

* **Modular Design:** The system allows easy customization and scaling with additional features or sensors.
* **Compatibility:** It can be integrated with other workplace safety systems for comprehensive monitoring.

**7. Smart Connectivity and Data Analytics**

* **Data Insights:** Collected data can be analyzed to identify safety patterns, enabling companies to enhance their safety protocols.
* **Mobile & Web Integration:** Real-time updates and alerts can be accessed through mobile apps or web portals, improving decision-making.

**8. User-Friendly and Comfortable Design**

* **Lightweight & Ergonomic:** Designed to be comfortable for long usage without compromising safety or technology.
* **Easy Maintenance:** The system’s components are easy to maintain and replace when needed.

**9. Impact on Safety Culture**

* **Promoting Awareness:** The helmet helps foster a safety-oriented approach, encouraging workers to take responsibility for their well-being.

**10. Environmental Benefits**

* **Sustainability:** The system can be made eco-friendly with renewable energy sources to power sensors, reducing its environmental impact.

**11. Technical Breakthroughs**

* **IoT Integration:**  IoT for real-time communication and monitoring is a key breakthrough, enabling quicker response times.
* **Multiple Technologies Combined:** The conjunction of biometric sensors, IoT, and RFID technology sets the system apart as a comprehensive safety solution.

## SALIENT FEATURES OF THE INVENTION / What in your view is unique about the present invention? (there is no minimum OR maximum word limit)

**METHODOLOGY ADOPTED and RESULTS OBTAINED** (there is no minimum OR maximum word limit)

**FIGURES / Diagrams related to the invention with their title.** (there is no minimum OR maximum limit to the number of figures)