**INVENTION DISCLOSURE FORM FOR PATENTS**

**Applicant Name-Marwadi University**

1. **Particulars of Inventors**

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1. **Provide title of the invention:**

Smart helmet for miners.

1. **In 100 words or less, please provide an abstract or summary of the invention:**

The invention is a wearable multi-sensor system designed to enhance the safety of underground miners by providing real-time health and environmental monitoring. Integrated into a compact, helmet-mounted device, it features gas sensors to detect hazardous gases such as oxygen (O₂), carbon monoxide (CO), and methane (CH₄). A temperature and humidity sensor monitors the surrounding environment to identify extreme conditions, while a vibration sensor detects sudden impacts or collisions, ensuring prompt response to accidents. The system also includes a light sensor to identify low-visibility situations and a heart rate monitor to track the miner's heart rate for detecting any health abnormalities. Arduino-based microcontrollers process the collected data, which is wirelessly transmitted using wifi technology to a central monitoring system for real-time oversight. The helmet is designed for ease of use, with sensors strategically placed for accurate readings without obstructing the miner's movements. This invention aims to continuously monitor both the miner's health and the underground environment, enabling early detection of hazardous conditions and swift emergency response. Ultimately, it

enhances safety, reduces risks, and provides a reliable method for emergency preparedness in extreme underground environments.

1. **Detail description of the invention:( Answer to all below are required in detail)**
   1. **Problem the invention is solving**

This invention is a helmet-mounted multi-sensor system for real-time health and environmental monitoring of underground miners. It includes gas sensors (O₂, CO, CH₄), temperature and humidity sensors, a vibration sensor, a light sensor, and a heart rate monitor. An Arduino-based controller processes data, transmitting it via WIFI to a central system. Live data is sent to administrators, and emergency alerts are automatically triggered for rapid response. The compact design ensures accurate readings without obstructing movement, enhancing miner safety and enabling early hazard detection.

* 1. **General Utility/application of the invention**

This invention is a helmet-mounted multi-sensor system for real-time health and environmental monitoring of underground miners. It includes gas sensors (O₂, CO, CH₄), temperature and humidity sensors, a vibration sensor, a light sensor, and a heart rate monitor. An Arduino-based controller processes data, transmitting it via WIFI technology to a central system for live data monitoring and emergency alerts.

Applications: Designed for underground miners, it also benefits:

* **Firefighters**: Tracks toxic gases, heat stress, and health.
* **Construction Workers**: Detects falls, collisions, and hazards.
* **Confined Space Workers**: Monitors oxygen, toxic gases, and visibility.

Key Features:

* **Gas Sensors**: Detect toxic gases and monitor oxygen.
* **Temperature & Humidity Sensors**: Assess heat stress.
* **Vibration & Collision Sensors**: Identify falls and impacts.
* **Light Sensors**: Detect low visibility.
* **Heart Rate Monitor**: Tracks real-time health.

This system enhances safety by providing continuous monitoring, early hazard detection, and swift emergency alerts across high-risk environments.

* 1. **Advantages of the invention disclosing about the increased efficiency/efficacy**

The proposed smart helmet offers significant improvements in safety, real-time monitoring, and operational efficiency. Below are the key advantages:

**Real-Time Monitoring:** Provides instant alerts for hazardous conditions, ensuring quick response times.

**Early Warning System:** Detects potential dangers in advance, preventing accidents and improving overall safety.

**Compact & Wearable Design:** Lightweight and ergonomically designed for comfortable use in helmets or miner gear.

**Low Power Consumption & Long Battery Life:** Optimized for extended operation without frequent recharging.

**Wireless Connectivity:** Enables seamless data transmission to control rooms, emergency teams, or cloud-based systems.

**Multi-Functional Sensors:** Capable of detecting gas leaks, monitoring miner health, and tracking environmental changes in a single system.

**Automated Emergency Response:** Triggers automated safety measures, such as ventilation activation or emergency notifications.

**GPS & Location Tracking:** Helps locate miners in case of emergencies, ensuring swift rescue operations.

**Durable & Rugged Build:** Designed to withstand harsh industrial or mining environments, ensuring long-term reliability.

* 1. **Best way of using the invention as well as possible variants**

**Best Usage:**

•The device is helmet-mounted for continuous real-time monitoring of environmental and health parameters.

• Data is wirelessly transmitted to a central monitoring system, ensuring supervisors and emergency teams have live updates.

• The system issues audible and visual alerts if hazardous conditions are detected, enabling miners to take immediate action.

• It can be integrated with GPS tracking to help locate miners in case of emergencies.

• Designed for underground mining, it can also be adapted for use in firefighting, construction, and other hazardous environments.

**Possible Variants:**

* 1. **Basic Version:**
     + Includes only gas and temperature sensors for fundamental safety monitoring.
  2. **Advanced Version:**
     + Adds heart rate, vibration, and collision detection for improved miner safety and real-time alerts.
     + Uses ZIGBEE communication for reliable monitoring in remote underground locations.
  3. **Long-Range Version:**
* Uses Lora communication for reliable monitoring in remote underground locations.
  1. **Industrial Adaptation:**
     + Customizable for firefighters, industrial workers, and confined space operators, ensuring safety across different high-risk professions.
  2. **Working of invention along with Drawing, schematics and flow diagrams if required with complete explanations**

**1. System Components:**

* **Gas Sensors:** Detect O₂, CO, CH₄, H₂S levels.
* **Temperature & Humidity Sensor:** Prevents heat stress.
* **Vibration & Accelerometer Sensors:** Detects falls, impacts, or unsafe movement.
* **Light Sensor:** Detects low-visibility conditions.
* **Heart Rate Sensor:** Monitors miner’s health.
* **Microcontroller (Arduino-based):** Processes sensor data.
* **Wireless Module (Wi-Fi/Bluetooth):** Sends data to the monitoring station.
* **Power Supply (Battery-Powered):** Ensures long-lasting use.

**2. Working Principle:**

* **Data Collection:**
* Various sensors (gas, temperature, humidity, vibration, accelerometer, light, and heart rate) continuously monitor the surrounding environment and the miner’s health.
* **Data Processing:**
* The collected data is processed by an Arduino-based microcontroller, which analyses the readings and determines whether any hazardous conditions exist.
* **Hazard Detection & Alerts:**
* If the system detects dangerous gas levels, excessive temperature, abnormal miner health parameters, or sudden impacts, it triggers an immediate alert.
* **Wireless Data Transmission:**
* The processed data is transmitted, Wi-Fi or Bluetooth, to a centralized monitoring station for real-time tracking and safety analysis.
* **Miner Notification:**
* The helmet provides immediate feedback to the miner through buzzers, LED indicators, or alarms, ensuring they are aware of potential dangers.
* **Emergency Response Activation:**
* In case of severe conditions, the monitoring station receives alerts and can take necessary actions, such as dispatching rescue teams or activating automated safety protocols.

**Flow Diagram:**

**Miner Helmet (with Sensors) → Microcontroller → Data Processing → Alert System → Wireless Transmission → Remote Monitoring**

1. **Have you conducted Primary Patent Search? Yes / No (if yes, attach the patent search results)**

No

1. **Existing state-of-the-art and prior arts: (Brief background of the existing knowledge/product/process in the market)**

**Background of Existing Technologies in the Market**

Underground mining safety has traditionally relied on manual gas detection, environmental monitoring, and worker health tracking. However, most current solutions are either standalone devices or lack real-time monitoring. Some key existing technologies include:

1. **Gas Detectors (Wearable)**
   * **MQ-135**: Portable gas detectors that monitor **air quality**
   * **Limitations**: No **real-time remote monitoring**, must be manually checked.
2. **Helmet-Mounted Safety Devices**
   * Smart helmets like Safetymind and Guardhat offer some environmental sensors but are costly and have limited sensor integration.
   * Limitations: Bulky, expensive, and focus mainly on communication rather than hazard detection.
3. **Environmental Monitoring Systems**
   * **Fixed gas detection systems** installed in tunnels.
   * **Limitations**: **Do not track individual miners' conditions or personal exposure levels.**
4. **Wearable Health Trackers**
   * **Fitbit, Garmin, or Zephyr Bio-Harness**: Used for monitoring **heart rate & activity**, but **not designed for hazardous environments**.
   * **Limitations**: **Not rugged or suitable for underground conditions** (dust, extreme temperatures).
5. **List out the known ways about how others have tried to solve the same or similar problems? Indicate the disadvantages of these approaches. In addition, please identify any prior art documentation or other material that explains or provides examples of such prior art efforts.**

|  |  |  |  |
| --- | --- | --- | --- |
| S. No. | Existing state of art | Drawbacks in existing state of art | Overcome (how your invention is overcoming the drawback) |
|  |  |  |  |
|  |  |  |  |

1. **List the Technical features and Elements of the invention along with the Description of your invention from start to end.**

**Technical Features and Elements**

**1. Sensor Components**

The system incorporates **multiple sensors**, each serving a specific function:

**A. Environmental Monitoring**

* **Gas Sensors (MQ-135 sensors)**
  + Detect air quality of the surrounding.
  + Ensures miners are not exposed to toxic gases or oxygen-deficient environments.
* **Temperature & Humidity Sensors (DHT11)**
  + Detects **temperature fluctuations and humidity levels** in underground conditions.
* **Pressure Sensors (SW-240)**
  + Measures atmospheric pressure, which helps **monitor ventilation and potential cave-in risks**.
* **Light Sensor (Photoresistor)**
  + Detects ambient **light levels**, helping miners navigate and monitoring tunnel illumination.

**B. Motion, Collision & Vibration Detection**

* **Accelerometer & Gyroscope (MPU6050 / ADXL345 / Bosch BNO055)**
  + Monitors **miner movement, falls, and posture** to detect fatigue or sudden collapses.
* **Vibration Sensor (Seismic Vibration Sensor / Piezoelectric Accelerometer)**
  + Detects **structural vibrations from tunnel walls, machinery, or distant collisions**.

**C. Health Monitoring**

* **Heartbeat & SpO₂ Sensor** 
  + Tracks **heart rate and oxygen levels** to detect exhaustion, stress, or oxygen deficiency.

**System Description & Working Principle**

**1. Sensor Integration & Data Collection**

* The **helmet houses all sensors**, continuously collecting real-time data on air quality, temperature, light, vibration, and miner health.
* The **data is processed via an onboard microcontroller (ESP32/Arduino-based system)**.

**2. Wireless Communication & Data Transmission**

* The helmet system **transmits real-time sensor data** to a remote monitoring centre using **Wi-Fi**
* Supervisors can **track miners in real-time and receive instant alerts** if hazardous conditions arise.

**3. Automated Alerts & Safety Mechanisms**

* **Threshold-based alerts** trigger alarms when dangerous levels of gas, temperature, vibration, or miner distress are detected.
* A **buzzer & LED alert system** warns the miner **before a hazardous situation escalates**.

**4. Power Supply & Battery Optimization**

* **Rechargeable lithium-ion battery** powers the system for extended use.
* **Low-power optimization techniques** ensure efficient operation **throughout a miner’s shift**.

**5. Variants & Adaptability**

* The system can be **customized** based on different underground environments (coal mines, metal mines, tunnels).
* Can be **adapted for firefighters, rescue teams, or military personnel**.

1. **List out the features of your invention which are believed to be new and distinguish them over the closest technology.**

a) Multi-Sensor Integration for Real-Time Monitoring

The helmet integrates multiple sensors (gas, temperature, humidity, vibration,) to monitor the miner's environment and health.

b) Smart Collision and Vibration Detection

Uses advanced vibration sensors to detect collisions, falling debris, or structural instability.

c) Oxygen and Hazardous Gas Detection with Alerts

If dangerous gas levels are detected, the system immediately alerts the miner through lights or sound alarms, ensuring quick action for safety.

d) Wireless Communication & Real-Time Alerts

Equipped with WIFI for continuous data transmission to a central monitoring system.

e) Lightweight & Low-Power Design

Optimized for long battery life with efficient low-power components while maintaining lightweight construction.

f) Health Monitoring

Incorporates a small heart rate sensor on the body and data will be communicated continuously wirelessly.

1. **Has the invention been built or tested or implemented? If yes please provide the Efficiency/Efficacy details of the invention**

No

1. **Briefly state when and how you first conceived this idea?**

People usually look for projects that can be used in daily life. However, we wanted to focus on something essential yet often overlooked. This led us to think about the safety of underground miners, who work in some of the most hazardous environments. We realized that while mining helmets provide basic protection, they lack real-time monitoring features

that could save lives in emergencies. This inspired us to develop a smart helmet for underground miners to enhance safety and efficiency in mining operations.

1. **Have you sold, offered for sale, publicly used or published anything related to this invention? If yes, please briefly explain the dates and circumstances. List those individuals to whom you have revealed your invention. Were non-discloser documents signed prior to discloser in each case? Please state any deadlines of which you may be aware for filing an application on this invention.**

No.

1. **Include any reasons that your invention would not have been obvious to someone of average skill in the art.**

This helmet-mounted multi-sensor safety system presents a non-obvious advancement in underground miner safety. Due to the limitation, constraints and environment underground it becomes difficult for the sensors to function properly. It combines multiple accurate technologies that would not have been immediately apparent to someone with average skill in the field of occupational safety or underground mining equipment.

1. **Additional comments by inventor (if you want to give more details out of scope of this IDF).**

Potential for Future Upgrades

• The invention can be further improved and modified according to the mines and the data needed.

• When the technologies advance, so does the invention can be upgraded.

Customization for Different Mining Environments

• This system can be tailored for coal mines, metal mines, and deep tunnel excavations, adjusting sensor sensitivity based on specific risks.

Integration with Existing Safety Infrastructure

• The device can be linked to existing underground monitoring stations, allowing real-time miner tracking and safety alerts for centralized control rooms.

Expansion Beyond Mining

• While designed for underground miners, this technology can also be adapted for construction workers, firefighters, and emergency responders operating in hazardous environments.

The device can be linked to existing underground monitoring stations, allowing real-time miner tracking and safety alerts for centralized control rooms.

Expansion Beyond Mining

1. **Drawings/Flowchart/Table**