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IOT BASED SMART HELMET FOR WORKER'S SAFETY

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Abstract - IoT has been recently expanded across the different application which brought a huge attention to its construction. In the mining field, where a noisy industrial environment can take place in. The main objective of this research is to design and develop a smart helmet system for mining industry application. Where the provided system will keep on monitoring the hazardous events such as temperature, humidity, gas, removal helmet of the miner and obstacle damage to the helmet. The finalized design was built and enhanced with real environmental testing took place in GuaTempurung cave located at Gopeng, Malaysia. The power of the designed helmet system circuit was evaluated with respect to a previous work. The programming and troubleshooting were conducted on mainly two sections, helmet section and control room section. Based on the on the preliminary calculation the outcome results were obtained.

I. INTRODUCTION

Mining Industry can be categories as the most essential application for any developed country. It provides extraction and discovery of the underground materials. From Iron, gold, coal and diamond. Internet of Things is an information and Communication Technology (ICT) used to represent Wireless Sensor Network (WSN) communications, using the defined protocol IEEE 802.14.5 that enables Low Rate- Wide Area Network (LR-WAN) to communicate using specific modulation technique. The basic examples are, ZigBbee, LORA and Sigfox network and more. Each of them has its own benefits and disadvantages, depending on the project application and requirements the protocols are shortlisted. LR-WAN is the defined protocol to be used for technique which provides long transmission range over low bit rate power while the operating frequency is fixed. Which in return benefits the material fabrication cost. IOT can be used in most of the developed application such as, smart parking system, smart building managementand smart energy monitoring system. The architecture of IOT consists of three techniquesmaterials web-based model (things), protocol (Wireless) and monitoring devices (Sensors) (GYU, 2014)(NAGARAJA, 2017)(Raed et al, 2018).

***OBJECTIVE OF THE PAPER:-* *The objectives of the proposed system are to design SHS for mining industry application with the usage of IoT automated system to detect and control the significant results from the LPG, Smoke and CO gases and alert the control room center with the help of a Graphical User Interface. To design a monitoring system that monitors the climate changes and update the management with real time data. To Integrate both systems and evaluate the power consumption of the designed helmet system*.**

II. FUNDAMENTAL OF IOT BASED SMART HELMET

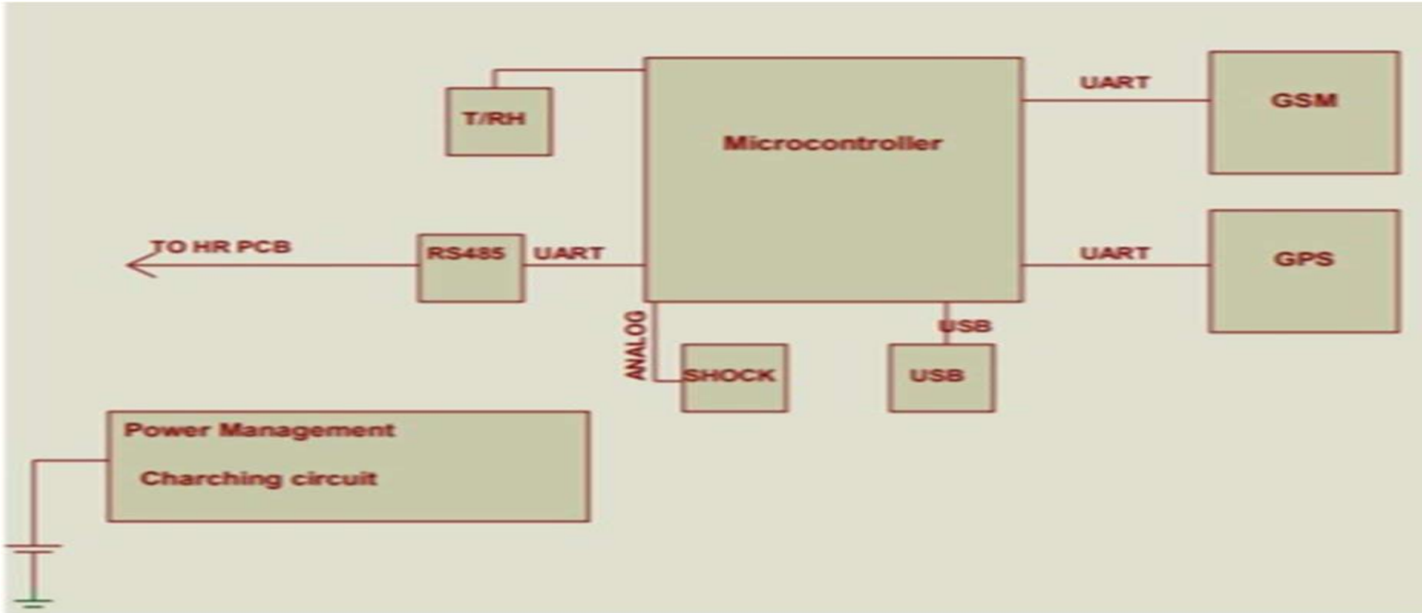

Fig 1. Circuit Diagram

The main aim for developing the concept of the smart helmet was not only focused upon the safety of the workers and labors at the construction site, but also includes many aspects of the ongoing project at the construction site. The basic principles of developing IoT – based helmet is a three – fold dimension, focusing on Safety, Management and Efficiency.

- **Tracking system**: An RF-based tracking system can map a worker's location on a mining site
- **Emergency button**: A button on the helmet can trigger an emergency sign on an IoT web interface
- **Pulse sensor**: A pulse sensor can monitor a worker's health status in real time
- **Gas monitoring**: A unit in the helmet can monitor gases in a manhole
- **Fall detection**: Sensors in the helmet can detect falls caused by fatigue or drowsiness
- **Work mode**: A system can automatically turn on the helmet's work mode when it's worn
- **Task completion button**: A button on the helmet can indicate task completion

III. PERFORMANCE EVALUATION

Fig 2**.** Photograpical Representation

- **Enhanced hazard detection:** Sensors like gas detectors can warn workers of hazardous fumes or oxygen depletion, preventing accidents this could only work well if have a enhanced battery life.
- **Improved situational awareness:** Real-time location tracking via GPS allows for quicker response during emergencies.
- **Fall detection and impact monitoring:** Accelerometers can detect falls and trigger alerts, enabling faster medical attention.
- **Ergonomic monitoring:** Some helmets can monitor posture and physical strain, reducing fatigue-related injuries. But they should be comfortable enough for the workers to wear it easily.
- **Data-driven safety insights:** Collected data can be used to identify safety risks and implement preventive but it needs to have a robust safety protocol for ensuring the safety of workers data.

IV. ENVIRONMENTAL IMPACT

The environmental impact of IoT-based smart helmets is a two-sided coin. Here's a breakdown:

Positive Impacts:

Potentially reduced resource consumption: By improving worker safety and reducing accidents, companies might require fewer resources for accident response, medical treatment, and worker replacement.

Data-driven environmental monitoring: Some smart helmets can be equipped with environmental sensors to monitor air quality, noise levels, or radiation exposure. This data can be used to implement targeted environmental improvements.

Negative Impacts:

E-waste generation: Discarded helmets, batteries, and associated electronics contribute to electronic waste (e-waste) if not disposed of responsibly.

Manufacturing footprint: Production of the helmets, sensors, and communication modules requires energy and raw materials, creating an environmental footprint.

Overall, the environmental impact of IoT-based smart helmets depends on several factors.

Here are some ways to minimize the negative impacts:

Durable and repairable helmets: Manufacturing helmets with longer lifespans and easy repair options can reduce waste.

Responsible e-waste management: Implementing proper recycling programs for discarded helmets and electronics is crucial.

Energy-efficient design: Using low-power electronics and optimizing battery life can reduce the environmental impact during operation.

Encouragingly, research is ongoing to develop more sustainable materials and production processes for electronics. By prioritizing responsible manufacturing and end-of-life management, the environmental impact of smart helmets can be minimized.

V. CHALLENGES AND FUTURE DIRECTION

[a]. Challenges –

Battery life: The sensors and communication modules in smart helmets can drain batteries quickly. Frequent charging or swapping of helmets disrupts workflow and reduces usability.

Comfort and weight: Adding sensors and communication tech can make helmets bulky and uncomfortable for extended wear, leading to reduced compliance by workers.

Data security: The data collected by smart helmets, including worker location, health metrics, and environmental conditions, needs robust security protocols to prevent hacking or misuse.

Cost: The initial investment in smart helmets and the infrastructure for data collection and analysis can be significant, posing a hurdle for some companies.

Integration with existing safety protocols: Integrating smart helmets with existing safety procedures and worker training programs requires effort and planning to ensure smooth adoption.

Worker privacy concerns: There might be concerns among workers about data privacy and potential misuse of information collected by the helmets.

Limited range of applications: While some smart helmets offer a variety of features, wider applicability across different industries and work environments requires further development.

Durability in harsh environments: Smart helmets need to be rugged enough to withstand harsh working conditions like extreme temperatures, dust, or moisture.

[b]. Future Direction –

The potential of smart helmets is only beginning to be explored. Here are some exciting possibilities:

Advanced AI for Predictive Safety: AI algorithms can analyze sensor data and real-time conditions predict and prevent accidents before they happen. Imagine smart helmets anticipating falling objects or equipment malfunctions and triggering automatic warnings.

Enhanced Situational Awareness: Augmented reality (AR) can become even more immersive, projecting relevant information directly onto the worker's visor. This could include real-time data about surrounding hazards, escape routes in case of emergencies, and even remote expert assistance through AR overlays.

Biometric Monitoring for Personalized Safety: Tracking vital signs with greater accuracy can create personalized safety protocols based on individual health conditions and fatigue levels. For example, a helmet might alert a worker prone to heat stress to take a break when their body temperature rises.

Integrated Communication and Response: Seamless communication between workers, supervisors, and emergency personnel can be facilitated through these helmets. Imagine instant alerts triggering automated emergency response drones or activating safety measures in specific zones.

Data-driven Insights for Improved Work Environments: The wealth of data collected by these helmets can be analyzed to identify safety trends, optimize workflows, and design safer workspaces. Imagine identifying patterns in near misses to prevent future accidents or using fatigue data to adjust work schedules.

VI. CONCLUSIONS

In this paper the proposed project was introduced with a literature review, methodology, system limitations, findings and testing were explained. From the summary points it is seen that the aim related to the project are successfully achieved by designing Automated system that detects the hazardous gas surrounded by the miner’s helmet was achieved, designing a monitoring system to update the control room with real time data was achieved and to integrate both design systems and evaluating the power consumption of the proposed system was integrated and achieved.

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