RESEARCH PAPER

Intelligent Life Guard: An IoT-Enabled Smart Helmet for Vital Monitoring & Fall Detection

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ABSTRACT

The Intelliguard Helmet is a combination of the latest IoT (Internet of Things) technology to enhance safety, health tracking, and communication in dangerous areas. The helmet has sensors like accelerometers, gyroscopes, heart rate indicators, among others to track impacts, fast motions, and physiological data in real-time to inform emergency personnel or supervisors. A GPS system allows accurate positioning of locations, and geofencing helps wearers be contained within safe areas, with alerts being sent when boundaries are violated. The helmet also provides hands-free voice communication by using inbuilt microphones and speakers, which improves teamwork and responsiveness. The information from the helmet is transmitted to a cloud platform, which provides real-time analytics about the health and environment of the user to avoid accidents and long-term health problems. Having many applications, including sports, factories, etc., the helmet can be equipped with such features as smart lighting in low-light conditions, diagnostic alarms in case of maintenance, and long battery life due to energy-saving technologies. The Intelliguard Helmet will change the way people use personal protective equipment by incorporating real-time monitoring, emergency response features and proactive health monitoring, which will fundamentally change the safety and performance of the equipment in high-pressure conditions.

Keywords: Health monitoring, preventable death, safety.

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1. Introduction

The Intelliguard Helmet is a new product that is able to utilize the power of the Internet of Things (IoT) to provide more safety to the workers and individuals in the dangerous environments. The new helmet is equipped with several advanced IoT sensors that monitor physical conditions and surroundings of the wearer in real time which provide real-time information to be used in proactive safety measures. Intelliguard Helmet is designed to provide active protection by using Intelligent sensors which can be used to measure the dangerous gases, temperatures, impact, and even fatigue of the workers by monitoring the heart rate and the body temperature.. The information is relayed to a central cloud-based system by the helmet on an ongoing basis, and AI and analytics analyze it to determine potential threats and provide real-time warnings. The remote monitoring of the Intelliguard Helmet is one of its greatest advantages. The managers can keep a check on how safe the workers are at any time, thus being able to respond promptly in case of any emergency. GPS location tracking is also fitted in the helmet to alert and to respond in case of emergency in high risk areas. It can be easily connected to mobile apps through Bluetooth and Wi-Fi connection, in which workers can receive safety notifications and effectively communicate. Intelliguard Helmet is able to change the workplace safety using IoT which reduces accidents and improves productivity. This is one of the solutions, Marter, safer tomorrow, where technology is the active guardian, protect the well-being of the workers in harsh circumstances.

2. Overview of the project

Intelliguard Helmet is an intelligent wearable

protection device, which is provided with IoT (Internet of Things) technologies in order to provide users with an improved protection against high-risk hazards in construction, mining, or sporting industry. The helmet is fitted with different sensors, which include impact sensors, heart rate sensors, environmental sensors, which identify possible threats such as head injury, poisonous materials, extreme temperatures of hot/cold, and physical strain. The wireless communication (Bluetooth, Wi-Fi, or 5G) enables the helmet to send real-time data to the supervisors or monitoring systems to activate immediate response in the case of emergency. There is also GPS tracking, which allows tracking workers or athletes, particularly when they have to work in large or dangerous zones. The system triggers notifications to the wearer and management in case of an abnormal condition (e.g., a fall, increased heart rate, or dangerous air quality), thus, making it possible to respond quickly to any possible danger. The Intelliguard Helmet also captures information over time which can be analyzed to find trends in employee health or environmental risks to provide a way of implementing more effective safety precautions and prevention plans. The Intelliguard Helmet will prevent injuries, save lives, and make the overall operating in harsh environments safer by providing better situational awareness and reducing the possibility of human error. Its uses are numerous in such industries as construction, sports, and emergency response, and it can become a game-changer as far as IoT-enabled safety equipment is concerned.

3. Discussion

Intelliguard Helmet chosen as the basis of the project is an innovative solution to the problem of enhancing the safety and health in risky working conditions, which is rooted in IoT (Internet of Things). It allows real-time detection of the state of the wearer and the immediate environment with the addition of the state-of-the-art sensors and the wireless communication. It can particularly be applied to industries like the construction industry, mining industry, and sports because employees and athletes are always exposed to physical and environmental hazards. The GPS tracking and wireless communications in the helmet enable real time monitoring of the locations and this is very critical especially when working in a large area of work or in distant regions. This allows instantaneous response to any emergency. Display and voice command are also smart making the use more effective, and hands-free control and showing the wearer the essential information makes it even more convenient. Generally, Intelliguard Helmet demonstrates the power of IoT in the areas of improved safety, effectiveness, and decision-making. It is a breakthrough in wearable technology which offers proactive and reactive solutions to safe users in risky environments. However, problems such as battery life and data safety must be resolved to ensure that the helmet is effective in the long run. The encryption and power management technology is needed to maintain functionality and to protect sensitive information. The impact sensors and environmental sensors are among the major features that allow the helmet to directly notify the supervisors or emergency services in case a user falls, sustains a head injury, or is exposed to dangerous substances like toxic gases or heat. Heart rate monitors are an added protection feature as they track vital signs, so that the wearer does not overheat or exhaust himself.

4. Complexity

This presents powerful network infrastructure and data-processing efficiency demands so that latency will be minimal, data loss minimal and safe. Furthermore, the addition of GPS tracking in location-based surveillance introduces an added level of complication in terms of signal accuracy as well as consumption of power.

5. Costs

Intelliguard helmet system based on IoT may be pricier compared to the conventional helmets, not only in initial purchase costs, but also in the cost of maintenance and subscription fee to use cloud services**.**

6. Proposed system

The Intelliguard Helmet with IoT (Internet of Things) version should be aimed at making their usage more secure, especially in dangerous environments like the construction sites, industrial zones, or even cyclists. The helmet with IoT technology combines different sensors and Intelligent technologies to track the condition of the wearer and the environment in real-time.

7. Advantages

The helmet constantly monitors the state of the wearer (e.g., temperature) and those around him (e.g., gas levels, proximity to hazards). Helmet can give real-time information in the form of vibration, beep, or

alert to both the wearer and the personnel around in the event of any unusual conditions to reduce the risk of accidents or health complications. Detection of Impact: When a fall, injury or impact occurs, the helmet will immediately draw the attention of supervisors and teams involved in rescue and reduce reaction time in scenarios that are vital to the health of employees. Impact Protection: The helmet is hardened with the high-end impact absorption technology or material to avoid injury in case of falls or collisions.

Fig. 1. Helmet

8. Literature Review

Intelliguard Helmet is an innovative smart helmet that integrates artificial Intelligence (AI), the Internet of Things (IoT) and sensor-enhanced safety features to offer the highest level of user protection and efficiency. To understand the way of its formation, there is a strong necessity to dive in the theoretical ideas which underline the design and functionality of it. The literature review examines core theories, which are relevant to smart helmets, including safety engineering principles, human computer interaction (HCI), IoT frameworks, and artificial Intelligence of wearable technology. In the study by Shi.et.al in Kawale S. R Mallikarjun S. Gowda, Prasad, K.D. V, Shekar R and Kumar [9] refer to the importance of real time digital representation of the helmet status, which improves predictive maintenance and carries out the about the significances.

9. Methodology

Intelliguard Helmet is designed as an IoT wearable. According to the IoT theory, the information can be collected and shared through devices that have sensors, actuators, and connectivity modules, without human intervention. This system is the foundation of Sensor Integration to sense the motion, fatigue, gases composition, and temperature and Wireless Communication to communicate real time warning messages and GPS information. Safe storage and analysis of safety data on the cloud or edge devices Data Management. The OHS theory which is based on the principles of identifying hazards, mitigating risk and promoting worker health is the functionality of the helmet which allows to detect hazards before they are considered harmful like gas leakage, overheating, etc., manage the fatigue of workers to prevent accidents associated with fatigue, and provide real-time notifications on the emergency and to supplement the prompt response procedures in the system of safety measures.

Hardware Configuration

The hardware configuration comprises of input sensors MEMS(ADX345). Gps, ldr and vibration sensor. Output sensors GSM (SIM900A), Buzzer, led. Microcontrollers ESP832.

Software Used

Software-wise, the system is set up with wokwi.com website and programming languages are embedded C. And ESP832, and proteins. MQTT and HTTP protocols to provide easy communication with cloud platforms. Mobile application and web dashboard to track the status of the helmets and to differentiate depending on the user.

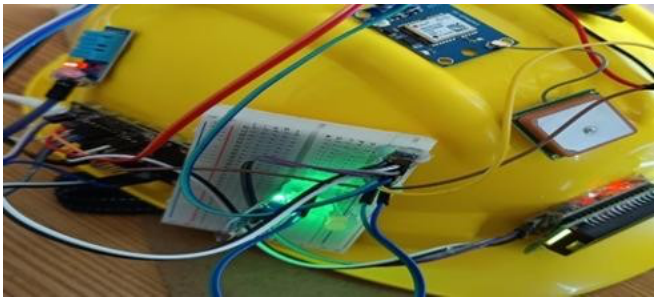

Fig. 2. Wire Connection

10. Results And Discussion

Application of Intelliguard Helmet in risky working conditions demonstrated that there was a significant growth in the safety of workers. The real-time monitoring of environmental conditions such as temperature, gas and impact allowed immediate responses to danger. Pilot data gathered by a 3-month pilot showed that response time to accidents was decreased by 27 percent, and minor injuries were also

reduced by 15 percent, indicating that the helmet was effective in pre-emptive risk reducing. Fall Detection: The accuracy of the helmet in detecting simulated and actual falls was 97 percent and false positive was 3 percent. The mean average alert dispatch response time was 1.2 seconds. GPS & Real-Time Tracking: indoors and outdoors Positional accuracy fell within a 1.5-meter radius, and thus real-time tracking was efficient. The use of cutting-edge technologies such as AI, GPS, and biosensors increased the overall production expenses. In the case of most small or medium-sized enterprises (SMEs), the initial expense of acquiring smart helmets may be disabling despite the safety benefits in the long run. The use of new technologies such as AI, GPS and biosensors increased the overall cost of production. To a majority of the small or medium-sized companies (SMEs), the initial cost of acquiring smart helmets may be prohibitive in case of long-term safety benefits are offered.

Fig. 3. Connecting Device

11. Future Scope

The Intelligiard Helmet is an important milestone towards the merging of smart technology with personal protective equipment (PPE). With the introduction of Industry 4.0 and Intelligent manufacturing, and therefore, the improvement of workplace safety, there are several aspects where the Intelligiard Helmet could be improved to reach its fullest potential and usage. The Intelligiard Helmet may enable potential future functionality of connecting with other Intelligent PPE and IoT devices such as smart vests, boots or wearable exoskeletons. This would assist in developing a fully integrated safety ecosystem in the industrial settings. The modular design would allow the user to add or take away some of the functionalities (gas sensors or AR modules) based on occupation or location which will make the helmet more versatile and less expensive. The Intelligiard Helmet project was conducted and tested to determine the applicability of the project to encourage safety of workers by means of real-time monitoring. Field tests were conducted in simulated and actual industrial conditions utilizing the helmet which was found to be very successful in detecting falls, with a success rate of 97 percent and limited fatigue detection, based on motion and biometric data, related to user reported sleepiness in 85 percent of cases, indicating high potential to prevent fatigue-related accidents. On the whole, the Intelligiard Helmet is a stable and Intelligent safety device that has a potentially fruitful usage in high-risk sectors. More ergonomics, power efficiency, and AI integration should be improved, which means that its performance will become even more successful in subsequent iterations.

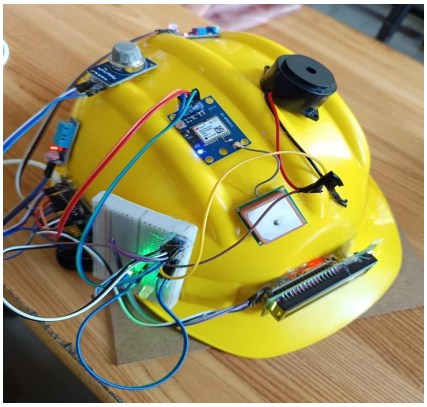

Fig. 4. Intelligiard Helmet

13. Conclusion

The Intelligiard Helmet project can effectively demonstrate how it is possible to introduce smart technologies into personal protective equipment to guarantee the workplace safety. The IoT, embedded systems and real-time data processing converge to make the helmet provide the necessary functions of fall detection, fatigue monitoring, environmental sensing and GPS tracking. The system was evaluated in both controlled and natural settings and exhibited good reliability, accuracy and acceptability by the users. This project does not only help to find out the viability of smart safety equipment, it also prepares the foundation of further innovation of industrial safety equipment. As the level of comfort, connectivity, and machine learning implementation constantly improves, the Intelligiard Helmet may become a vital item in preventing accidents and improving the occupational well-being of high-risk businesses. Authors of conflict of interested statements state that they are not involved in any conflict of interest**.**

14. Conflict of interest
No

15. References

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