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Smart Helmet for Coal Mines Safety Monitoring with Mobile App

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Abstract:- Massive coal deposits, mostly in Sindh, amounting to 184.623 billion tonnes, are present in Pakistan. The market in our nation has been growing quickly. As we all know, accidents are occurring increasingly frequently in mines as a result of a lack of qualified workers, the safety of miners cannot be ensured, and coal manipulation is not possible. Men who work in coal mining today must deal with environmental restrictions. They are endangered by temperature, carbon dioxide, and methane. We must thus guarantee the security of the men and women who are now working in coal mining. This study's objective is to offer a communication- and security-based mining solution. In the current world, coal mining plays a special role since it has the ability to save the lives of coal miners by inventing specific tools that will be very useful to the workforce. People who operate in underground coal mines are required to wear a variety of equipment, including smart helmets that have sensors for gas detectors, collision detectors and removers. Here, we must set up our Smart Helmet's circuit to ensure the security of the man who is currently working as a coal miner. The release of harmful gases during mining operations is only one example of how coal mining can have a number of detrimental environmental effects. A Wi-Fi-based monitoring system is built inside the helmet, and it exchanges data with all of the trackers via Wi-Fi networks. In order to avoid any potentially hazardous situations, the Smart Helmet Indicator takes the necessary safeguards and gives out an alarm through a buzzer and Cloud Based Monitoring. ESP32 tracker circuitry made by Arduino is used to collect the data. It helps with worker location mapping.

Keywords:- *Smart Helmet, IoT, coal mines safety monitoring, mobile application.*

I. INTRODUCTION

Any nation's economy needs mining because it creates numerous opportunities across many industries. We are fortunate as a society to be able to recognise the advantages that this industry creates by processing the raw materials and goods that supply us. There are numerous distinct threats to one's health and safety when working outdoors. The surroundings are unpleasant or unstable. The danger of doing chores may increase as the depth of the mines increases. [1] There are difficulties there. Therefore, utilising microcontroller-based circuits, we propose a security system in addition to a mining monitoring system for the mining industry. Circuitry is used to find workers moving around the mining site. The helmet has a monitoring system that uses Wi-Fi to connect to all of the trackers and exchange data with them. "Mega microcontroller-based Wi-Fi tracker circuitry" is used by the system to collect the data. This aids in mapping out where each employee is located. The helmet circuit for each employee has been integrated utilizing a button. A crisis indicator is displayed on this button. This can be applied to practically any form of emergency, including the inhalation of noxious gas, cave-ins, physical damage, etc. Consequently, the IoT ensures the safety of mining employees. Sindh, where the majority of Pakistan's coal reserves are located, is thought to contain 184.623 billion tonnes of coal. The market in our nation has been rising quickly, which has led to an increase in the availability of raw materials. The finding of coal reserves is being helped by fresh foreign businesses. As we all know, terrible accidents in mines are on the rise as a result of a lack of qualified employees, and neither the safety of workers nor the manipulation of coal can be ensured. Environmental issues are something that coal mining men must deal with. They are harmed by fever, carbon dioxide, and methane. We must thus guarantee the security of the men and women who are now working in coal mining. Through communication and security monitoring, this study seeks to offer a mining solution. When performing underground work, the individual must wear a helmet. Here, we must arrange our circuit inside the kit to give the man, who is currently employed as a coal miner, security. Coal mining is still a risky industry today that can have numerous detrimental effects on the environment, such as the production of hazardous gases during mining operations. Security is the most important aspect of the enterprise. Security and safety are the most important factors in the mining industry. Every mining operation takes various preventative measures to ward off specific situations. [2] IoT has a unique function in information technology; by creating specific tools that can be incredibly useful for coal workers, it can even save coal miners' lives. Different criteria, such as helmet removers and collision detectors, constantly use detectors like collision detectors, gas detectors, and Smart Helmet detectors to take critical steps in order to prevent any kind of hazardous situations and provide an alarm with the buzzer. Moving a base station away from the mine workers is required to achieve security in a communication system. A wired "communication system technology" system is probably not going to be very useful. [3]Due to the environment beneath the mines, communication systems have substantial setup and maintenance costs. A Wi-Fi transmitter and receiver are used in this for efficient wireless data transmission. Wireless, budget-friendly mine surveillance system. A Wi-Fi-based monitoring system that connects to all of the trackers and communicates with the helmet provides information. The system obtains the data using tracker circuitry built into the ESP32 Arduino platform. The assists in locating employees. A panic/emergency button has also been integrated into each employee's helmet circuit. A crisis indicator is displayed on this button. This can be applied to practically any form of emergency, including the inhalation

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of noxious gas, cave-ins, physical damage, etc. Consequently, the IoT ensures the safety of mining employees.

II. RELATED WORKS

A wearable IoT-based jacket has been unveiled. It was created to protect those who work in coal mines and are frequently exposed to danger. This prototype is designed to sense a variety of things, including the presence of hazardous chemicals, a coal miner's heartbeat, the circumstances underground, and the location of the miner via GPS. These parameters will likely be sent to a dynamic internet protocol over a Wi-Fi protected channel. [4] This group of students created a tool that can locate a coal miner precisely.

The precise location of the person is discovered, saving the priceless life of any worker during a disaster. RFID is used in this system to track and locate objects. The exact location will aid in the rescue as soon as an incident is reported. Automation was created by D. Kock et al. [5] and is particularly productive for coal miners. It was created for South African miners. They collaborated on a study of the coal port detection (CID). They did this by using two well-liked techniques, including analysis and natural gamma radiation vibration. A safety system for mine employees was proposed by Gaidhane et al. [6], and it is based on Zig Bee technology. Additionally, it keeps an eye on gas levels, which are hazardous because most of the deaths that occur in mines are due to the deposition of hazardous gases in mines. The alarm is routed over ZigBee by sounding the alarm and turning on various LEDs as soon as the value crosses the threshold. A wireless communication system for coal miners that utilises the Internet of Things and monitors temperature, humidity, and CH4 (methane) levels was proposed by Cheng Qiang et al. [7]. Through voice contact, the miner is alerted about the situation by the man tracking in the floor channel. Guo Feng, Yongping Wu, and others. These scientists created a tool that is extremely helpful for risk reduction in regions where mining for minerals like coal, gold, etc. is being done. The most accurate method for locating the coal worker is this one. With this gadget, tracking is simple, and any emergency assistance may be provided very quickly. The system's main flaw is that Bluetooth is a limited-range wireless technology, making cabling difficult to use.

[8] Al-Suwaidi &Zemerl, 2009. They have proposed a method that uses GPS to provide solutions for a number of problems. Any missing coal worker can be readily located using this application's pinpoint location search, which uses GPS. The client-server architectural design is used in this system. The server allows the client's mobile phone to register and log in, and it stores the client's password and login information in the server's database. Pranjal Hazarika as well as associates. This helmet, which was made for coal miners, is ideal for deep coal mining because it protects against harmful gases like methane and carbon, among others. This helmet has sensors for the aforementioned dangerous chemicals, and a wireless module called ZigBee that is connected to the helmet transmits data wirelessly to the control centre.

III. RESEARCH METHODOLOGY

The smart helmet used in the proposed study is Internet of Things-based, and it benefits subterranean workers in numerous ways.

[9] It provides information on the predetermined services provided by coal miners, including information about temperatures, humidity, and many other factors crucial to the miners' safety. A helmet with detectors makes up this helmet. A microcontroller in the transmitter segment processes data from many parts, including sensors for the helmet remover, collision, and gas. The helmet transfer alert towards the application is fixed on multiple different regions of the coal mine at a specific time when a risky occurrence occurs.

[10] The collision sensors, gas sensors, and helmet remover will sense the corresponding parameters. The project's aim dictates the design specification. The project is divided into three phases. Start with the hardware design stage, then go on to the software design stage, and ultimately, test, tune, and debug the project design. The steps of hardware design act as checkpoints to determine whether the transducer is accurate and appropriate for the circuit architecture. At this point, the transducer is selected based on experimental characteristics like accuracy, precision, measurement variables, and performance under pressure. The testing, tweaking, and debugging phases of the software design process are essential to the operation of the research. programme in sequence and interface the design process.

[11] These processes take place after the software components have been coupled with the hardware and programming, the two categories in which they fall. Even split as a consequence. Both a tiny design defect could be time-consuming, needing pieces to be joined and run at the same time, in order to accomplish the project's permitted purpose. in order to confirm, going back to prior steps.

IV. EXPPERIMENTAL RESULTS AND DISCUSSION

The Arduino and PC are linked together through this system. Open-source solutions were made available to build this system, and several parts, such as the MQ-2, MQ-7, MQ137 Gas Sensor, ESP32, IR Sensor, DHT11, LDR, and others, are simply attached to the Arduino platform.

V. SMART HELMET DESIGN

The ESP32 has a CPU core, additional GPIO pins, faster Wi-Fi, and Bluetooth low energy functionality. In addition, the ESP32 features touch-sensitive pins, a hall effect sensor, and a temperature sensor built in. Both boards are extremely economical. The ESP32 has more pins than the ESP8266, and you may specify in the code whether you want the pins to be UART, SPI, or I2C. This is possible because to the ESP32 processor's multiplexing function,

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which enables many uses to be assigned to a single pin. They will be near the pins that are already defined if you don't place them on the code. A CPU core, more GPIO pins, quicker Wi-Fi, and Bluetooth low energy capabilities are all features of the ESP32.

The ESP32 also includes built-in touch-sensitive pins, a hall effect sensor, and a temperature sensor. Both boards are incredibly affordable. In the code, you can indicate whether you want the ESP32's pins to be UART, SPI, or I2C. The ESP32 has more pins than the ESP8266. This is made feasible by the multiplexing capability of the ESP32 processor, which allows many purposes to be assigned to a single pin. If you don't put them on the code, they will be close to the defined pins. Additionally, there is an increase in voltage between the sensor and the load resistor. The MQ-7 semiconductor sensor's main use is the detection of carbon monoxide (CO). The MQ-7 gas sensor is made of Tin Dioxide SnO2 (Tin(IV) Oxide) and tiny Al2O3 (Aluminium Oxide) ceramic tubes. Between the heater and the electrode, a crust has formed. The sensor cleans another gas that has been adsorbed at a lower temperature after being heated to a higher temperature by 5V. The MQ-7 contains six pins, of which two are used to supply heating current and two are used to bring signals. Air quality sensor module MQ135 It is a great tool for evaluating gas sensitive components as well as detecting dangerous gases like ammonia, sulphur, aromatic compounds, smoke, and benzene vapour. It is safe for use around people and the environment. An air quality sensor may pick up gases like smoke, nitrogen oxide, ammonia, benzene, alcohol, and carbon dioxide. With a straightforward drive and monitoring circuit, it functions effectively in a production or office environment. optical sensor, It is possible to tell if a mine worker has taken off his safety helmet using a technology based on an infrared ray sensor. A continuous signal is sent from one end of an infrared sensor to the other when the sign is blocked. It shows the miner is donning a helmet. In addition to a condition and moisture sensor, this DHT11 Temperature and Humidity Sensor has a survey mac cue harvest. By accepting the popular numerical-alarm acquisition routine as well as heat and moisture detecting mechanisation, it ensures high trustworthiness and attractive global establishment. With a resistive-type steaminess measuring segment and an NTC climate assessment piece, this sensor links to a high-speed 8-bit microcontroller and offers a completed condition rapid response, anti interference strength, and cost-effectiveness. The buzzer will ring when the sensor output exceeds the threshold quantity that the sensor has detected. A piezoelectric sensor is employed. A convenient sound generator that can be utilised to provide a sound indicator in digital circuitry is the piezo buzzer. It is widely used as an alarm in digital devices. A Piezo buzzer is composed of an oscillator and a Piezo disc. 3 to 12 volts DC are used to power a typical Piezo buzzer. According to our research, monitoring psychological variables at high altitude ensures the safety of mine personnel. Using sensors, we can keep an eye on the mine's physical state continually and alert staff in the event of an emergency before anyone perishes. A coal miner's life could be saved through IoT and a wireless network. The monitoring equipment will receive the data about each person from it. In order to alert paramedics to help workers in the event of a tragedy, the project also helps in calling emergency numbers. The warning system signalled the critical levels of these poisonous gases from the mining sector, including CH4 (methane), NO2 (nitrogen dioxide), CO (carbon monoxide), CO2 (carbon dioxide), and SO2 (sulphur dioxide). The evaluation of helmet removal using an off-the-shelf IR distance sensor was successful. The IR sensor was a functional device that was constructed entirely from scratch. The sent IR signals were found to reflect off the head and continue to reflect off the helmet surface until they reached the receiver after the system had been fully integrated. The magnitude of the signal received on the receiver side was quite similar.

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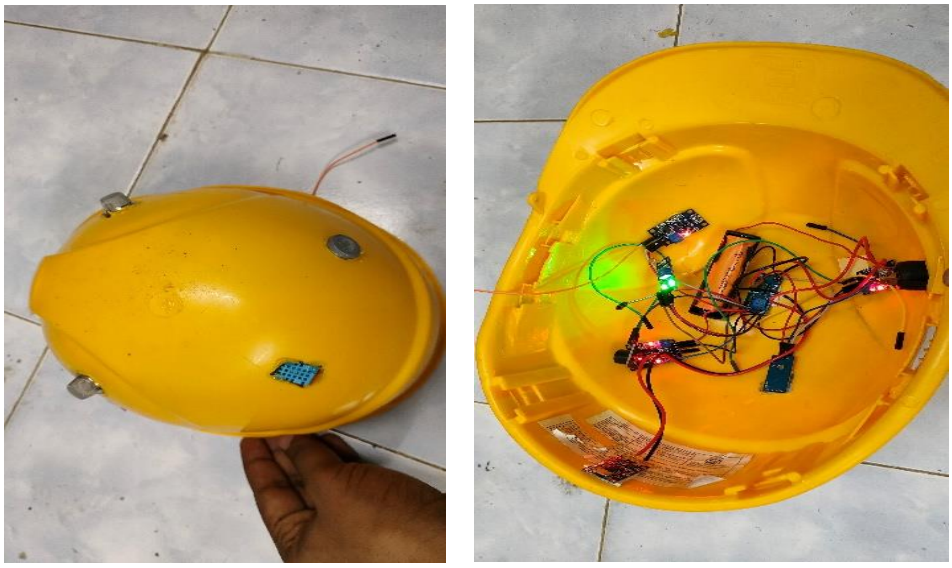

Fig. 1: Mobile App Monitoring

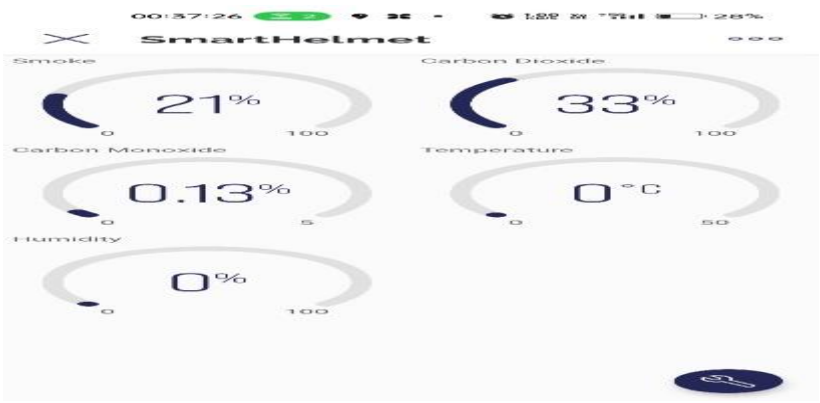

Fig. 2: Mobile App Monitoring

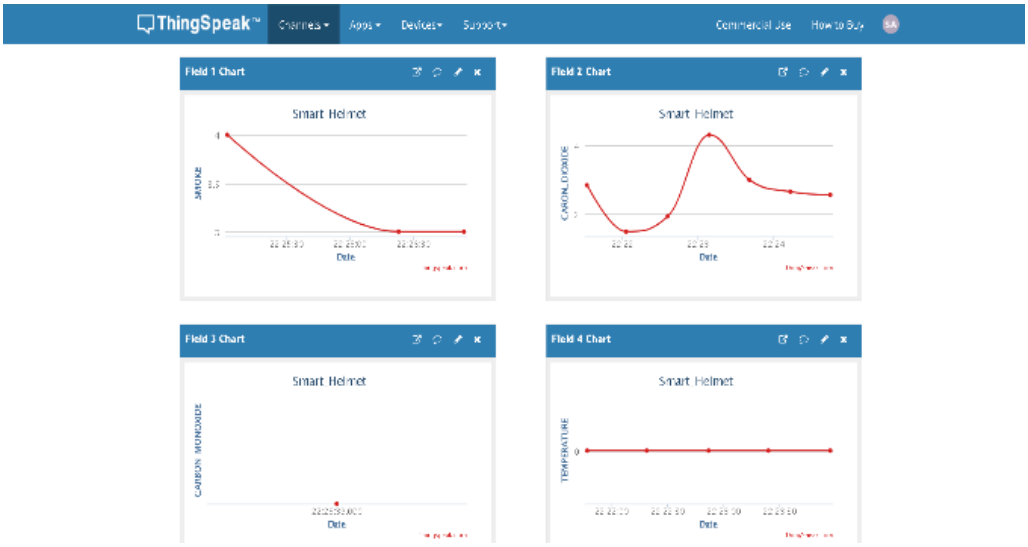

Fig. 3: Web Monitoring

VI. CONCLUSION

Three potentially hazardous occurrences can be detected by a cleverly built mining helmet: toxic gas levels, mining helmet removal and collision, and effect. A dangerous incident was deemed to have occurred when a miner pulled their mining helmet off of their head. When a miner is struck against their will by an object that has a force greater than 1000 on the HIC (Head Injury Criteria), that is another potentially deadly situation. In addition, gas concentrations can be measured.

REFERENCES

[1.] Bindu Sebastian Priyanka Kp, Hridhya Kuttikrishanan, Smart Helmet International Journal of Technology & Advanced Engineering, Volume5, Issue:12, December 2015.

[2.] Professor Chitte P.P., SalunkeAkshay S., Thorat Aniruddha, N Bhosale, Smart Helmet & Intelligent Bike System, International Research Journal of Engineering and Technology (IRJET) Volume: 03 Issue: 05, May2016.

[3.] S. Chandran, S. Chandrashekhar, E. Elizabeth N, Konnect: An Internet of Things (IoT) based Smart Helmet for Accident Detection and Notification, India Conference (INDICON), 2016 IEEE Annual.

[4.] Jiya Tian , Juan Zhu, "POSITIONING SYSTEM FOR MINERS BASED ON RFID" 2011 International Conference on Multimedia Technology

[5.] D. Kock and J. W. Oberholzer, THE DEVELOPMENT AND APPLICATION OF ELECTRONIC TECHNOLOGY TO INCREASE HEALTH, SAFETY, and productivity in the South African coal mining industry," IEEE Trans. on Industry Applications, vol. 33,no 1997.

[6.] Gaidhane, MahendraDhame and Prof. Rizwana Qureshi "SMART HELMET FOR COAL MINERS USING ZIGBEE TECHNOLOGY" Imperial Journal of Interdisciplinary Research (IJIR) Vol-2, Issue-6, 2016 ISSN: 2454-1362

[7.] CHENG Qiang, SUN Ji-ping, ZHANG Zhe, ZHANG Fan "ZIGBEE BASED INTELLIGENT HELMET FOR COAL MINERS" World Congress on Computer Science and Information Engineering 2009

[8.] Yongping Wu , Guo Feng , Zhang Meng,"THE STUDY ON COAL MINE USING THE BLUETOOTH WIRELESS TRANSMISSION" 2014 IEEE Workshop on Electronics, Computer and Applications.

[9.] Jianyun Ni; Jing Luo; "Microcontroller-based engineering education innovation, " Educational and Information Technology (ICEIT), 2010 International Conference on, vol.3, no., pp. V3-109-V3-112, 17-19 Sept. 2010.
[10.] Jennifer William, Kaustubh Padwal, Nexon Samuel, AkshayBawkar, SmitaRukhande intelligent Helmet International Journals of Scientific& Engineering Research, volume 7, issue 3, March-2016.
[11.] Shoeb Ahmed Shabbeer, Merin Melleet Smart helmet for accident detection and notification 2nd IEEE international conference on computational systems and information technology 2017.