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LORAWAN BASED COALMINERS RESCUE AND HEALTH MONITORING SYSTEM USING IOT

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SUMMARY

The coal mining industry is one of the industries that possess inherent risks since workers are faced with a range of risks that include health risks, the extreme environment, and geology. To address these daunting tasks, we propose the deployment of an Integrated Safety and Monitoring System (ISMS) enhanced with LoRaWAN and IoT gadgets. A wide range of detectors, such as thermal sensors, gaseous detectors, oxygen and cardiac monitors, and state-of-the-art minerals analysis technologies, are integrated into our comprehensive ISMS design. Together, these detectors keep surveillance of the health of colliers along with their surroundings. The primary feature of ISMS is the continuous data transmit capability of the LoRaWAN invention, which permits the error-free transfer of critical sensor facts to a storage system that is remotely placed. This is acting as a kind of control station, giving officials data they can use to tackle safety problems and make things less dangerous quickly. Another special provision that ISMS offers is a series of coloured indicators representing severity levels. The device also saves the lives of coal miners in critical situations as it improves response time for search and rescue operations. Such powerful safety precautions during coal mining operations in this case can be considered as a huge advancement with the integration of smart appliances and LoRaWAN technology into ISMS. This improves operational efficiency as well, incites smart choices, and makes more powerful already existing security mechanisms. The proposed system, ISMS, is innovative and progressive, leading to the development of new safety layers in the high-risk arena of mining.

Key words: *LoRaWAN, ISMS, coal mine, collier, IoT.*

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INTRODUCTION

The mining sectors, especially in coal-based mines, face tremendous problems associated with environmental monitoring and the safety of workers, as underground conditions during mining activities are inherently dangerous. To address this issue, a generic monitoring and protecting architecture based on state-of-the-art solutions is proposed in [1]. The reference architecture aims to monitor in real-time most of the variables related to the safety and efficiency of workers using IoT devices and LoRaWAN technology [2] during mining. Traditional workers' monitoring in terms of their health as well as their surroundings sometimes lacks the immediateness that may cause the occurrence of hazardous events, and rescue operations also become insufficiently effective [3]. This gap is proposed to be filled up by adding a number of devices that can measure certain variables (temperature changes, oxygen level in blood, circulation in cardiac organs, presence of toxic substances) as well as beneficial geological features (mineral contents) to the LoRaWAN network for monitoring collier and situational indicators [4]. The gathered information is instantly sent to a central information system, where this information is ready for quick decisions and actions by relevant authorities [5]. Additionally, the performance of response operations is improved by the use of coloured signs to indicate the degree of complexity of rescuing crews [6]. As an application of modern technology, computational intelligence, and big data mining, this initiative has the purpose of elevating safety and productivity in coal mining industries [7].

EXISTING SYSTEM

Techniques for warning people in the coal mines currently use WSN and detection tools. A smart surveillance system deployed at the coal plant employs the ZigBee landmines used to collect several forms of information. On the other hand, underground surveillance devices use an interface to set up a ring network so that communication can be convenient [8]. It also creates another control and observation point located beneath the ground [17]. Through a networking link, information is transferred. The framework consists of an industrialized Ethernet broadcast component, and a distant surveillance framework, including an autonomous information-gathering module that utilizes the ZigBee connection [9]. Employing virtualization, atmospheric inspection, colliers' management, and protection solutions utilizing the Internet of Things, suggested solutions effectively establish a proactive protection procedure using statistics [10]. Bluetooth is used by IoT for transferring signals to a customizable Arduino sensor. Information exchange including monitoring the coal plant's operation efficiency is made easier through the web. Employing Zig-bee gadgets the coal plant flaming detection system talks about how connection information flows inside the framework [11]. The approach produces an effective flame-tracking impact whenever it is used at a real mining site. Several components constitute the WSN coal plant flames tracking structure: crisis management component, governance center component, along information collection component [12]. Five aspects that constitute WSN are detector units comprising fundamental systems, therapeutic modules, transmission modules, geolocation modules, along energy source modules. The equipment can determine collier's weather, dampness, along smoky percentage. This may act as an asset allowing the tracking section to render judgments upon evacuations and protection [13]. The entire procedure of information harvesting, collecting information, and information interpretation for such basic platforms has no reliance on the web [14]. They are entirely reliant upon WSN, nonetheless web service, for transmitting information among nodal locations [15]. In a crisis, such might render the technology to be ineffective. Under emergencies, there will be greater urgency in sharing information along with management [16].

PROPOSED SYSTEM

While delivering an innovative, combined approach that makes use of LoRaWAN connectivity and Internet of Things components, our suggested approach seeks to completely transform protection and tracking procedures in mining operations. The primary elements of architecture include a range of detectors that have been carefully placed across the excavation that track every facet that is vital to the reliability of the atmosphere, employee security, including productivity. Initially, cardiac detectors are incorporated concerning the framework in order to constantly monitor individuals' physiological indications while offering immediate information concerning their physical and mental state. By

ensuring that appropriate air quality persists in various mining locations, oxygenation detectors reduce the possibility of breathing failure. To prevent exploding or breathing issues, gas monitors are utilized to identify and track the occurrence of dangerous gases. Heat sensors are employed to keep an eye on the overall temperature inside underground in order to avoid heat diseases or hardware breakdowns. The framework monitors surroundings along with employee security, using detectors that can identify ecological elements including subsurface fragility and earthquakes. Utilizing advancements in minerals discovery, it is possible to identify both prospective natural risks and beneficial assets, which helps with risk elimination and extracting minerals. LoRaWAN gadgets, an economical protocol suitable for enabling distant networking in rural or subterranean situations, are used to send information gathered through those detectors instantaneously. After that, this information is consolidated into a database that executives and other appropriate officials can access, facilitating rapid action and early reaction to unforeseen problems.

Additionally, this technique has user-friendly colored indications to help rescuers determine how challenging the circumstance is in a crisis. Rescuers may swiftly evaluate their intervention attempts, maximizing the use of resources and reducing reaction times by offering transparent graphical indications. All factors considered, our proposal provides an extensive approach for tracking well-being in mining operations by fusing cutting-edge detector devices, an effective way network, and smart statistical analysis to make working conditions highly secure and easier for both rescuers and colliers. Figure 1 & 2 respectively represent architecture of transmitter-side and receiver-side. Figure 3 & 4 represent Implementation of the proposed system in coal mining and Proposed hardware implementation at transmitter and receiver end.

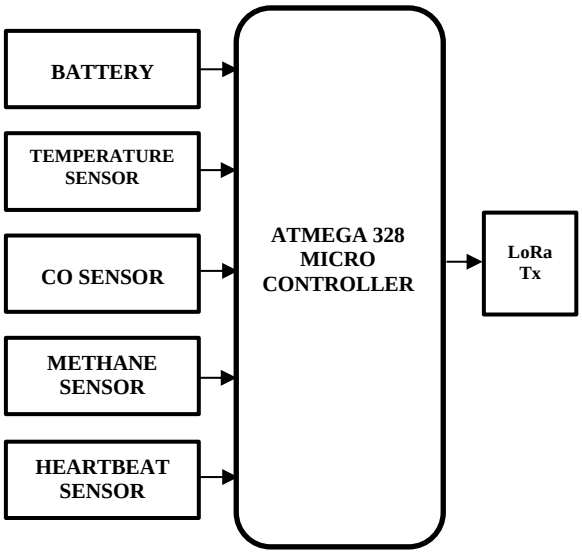

Figure 1. Architecture of transmitter-side

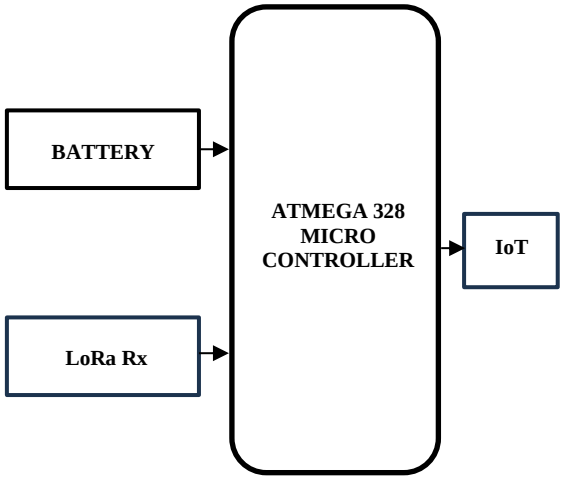

Figure 2. Architecture of receiver-side

IMPLEMENTATION AND WORKING

Figure 3. Implementation of the proposed system in coal mining

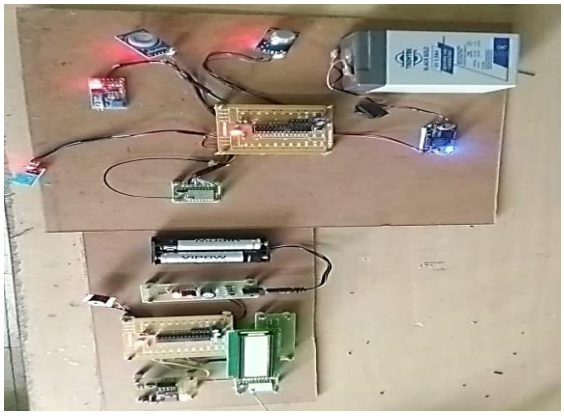

Figure 4. Proposed hardware implementation at transmitter and receiver end

Sensor Deployment

The first step in constituting the surveillance network is to lay down detectors around the mining site at different points. These detectors should be placed accurately to monitor several kinds of parameters regarding colliers' health (heart rate, oxygenation saturation), conditions (temperature, gases' volumes), and geographic data (minerals).

IoT Device Integration

For secure data transfer, all sensors must be paired to the Internet of Things equipment that has the LoRaWAN protocol deployed. Information collected by detectors could be gathered by those Internet of Things gadgets, which will subsequently transfer information to a controlling portal inside the excavation.

Centralized Database

Every implanted detector information shall be acquired by a hub terminal, which utilizes a LoRaWAN connection to send information to the unified server. The information acquired shall be kept on the server and will be made available for evaluation and choice-making to authorized authorities.

Real-time Monitoring and Alerts

Continuous constant surveillance shall be done in real-time using information obtained from detectors. The detectors will alert the collier and other appropriate officials of any unusual readings or potential hazards at the site. Notifications might be issued, for instance, when a collier's pulse rises beyond the allowed range or when toxic gasses are detected in the air to facilitate timely and appropriate consequences.

Emergency Response

The proposed system will be essential in assisting recovery operations in the case of a crisis, especially an explosion or gasoline leakage. Recovery squads' reaction initiatives shall be directed by coloured indications that indicate the degree of challenges, enabling them to efficiently distribute along with priority assets.

Data Analysis and Reporting

The acquired information shall be used to identify signs, trends, and potential areas where security measures should be strengthened. These information assessments will contribute to improving the general decision-making and safety rating and performance of collier.

RESULTS AND DISCUSSION

From suggestions for security and tracking platform utilization in coal-mine settings, Collier safeguarding, productivity, and crisis-management skills have been enhanced across the board. The basic cardiovascular function, oxygen levels, and levels of gasoline could all be checked on the spot. It also enables early detection of any threats to the wellness of the workers and quick intervention to mitigate the threats.

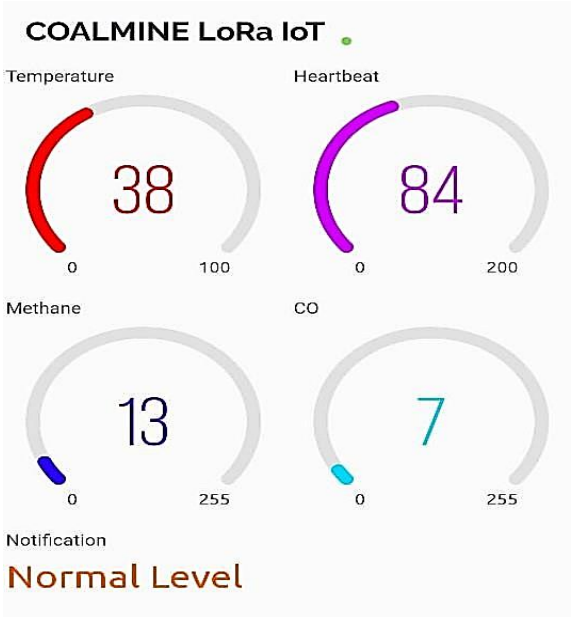

Figure 5. Sample Outputs obtained from Blynk App

Colliers now have instant accessibility to essential data for deciding choices thanks to the flawless sharing of information through a database made achievable by the incorporation of IoT with LoRaWAN connectivity. Moreover, rescue efforts have been enhanced by the addition of colored indications that define the degree of complexity for rescuers. This has enabled improved resource allocation along with assistance in establishing priorities. This feature decreased response to emergencies as well as contributed to greater success, elevating the benchmark for Colliers' safety measures globally shows in Figure 5.

Technological innovation has improved protection and rescue immediately. However, it also provides beneficial knowledge using the collection and presentation of information. Thereafter, security measures and efficiency have been enhanced due to behaviors and trends identified in the information collected. These improvements and patterning were applicable for future safety measures and operations. Taking all into consideration, outcomes indicate how effective the proposed security and tracking approach is in addressing the specific challenges of coal extraction sites.

The solution makes a huge impact on the coal mining facility by ensuring safety and avoiding the slowdown of their operations. ISMS has implemented different kinds of sensors, including thermal sensors, portable gas sensor cards, and oxygen-detecting stripes in the gas monitor badges, and these very capable miners doing sulphur mining now have access to on-board cardiac monitoring devices in their own body health; further, ISMS provides advanced mineral analysis equipment that helps the identification of new areas that we didn't have any historical records of locations; these are beneficial as well. With the collection of all these detectors, potential incidents and health issues can be monitored closely and avoided, thus making the overall safety of the area a lot better. LoRaWAN technology operates smoothly with even and instant data transmission, which is then sent directly to the remote-control station. Moreover, the degree of danger is signified by assigned colors, with healthy activating signals leading to a prompt exchange between several teams so that they can singly and collectively prevent or at least limit the defined hazards, which results in faster and more effective actions for the situation.

CONCLUSION

The establishment and execution of a surveillance and tracking framework in mining operations is a remarkable achievement in terms of ensuring colliers' welfare and enhancing performance in dangerous situations. The platform makes possible the tracking of important indicators almost in real time, related to worker health and ambient conditions, supported by the usage of state-of-the-art technologies such as IoT and LoRaWAN connectivity. Indicators related to coloured crisis management increase the efficacy of rescue operations as well as contribute to reaction time reduction and increased efficiency in emergency situations. The model produces informative results that support ongoing safety plans and procedures based on continuous data analysis and dissemination, stimulating incremental improvements in overall safety conditions and operational performance. In general, it can be affirmed that acquired results indicate very well how well this platform works toward risk reduction, increased safety levels, and productivity growth. Taking into account that this sector is growing more and more, a mechanism for monitoring or preventing is needed to ensure that safety does not decrease when productivity increases. Giving priority to safety and taking advantage of modern approaches, methodology sets new standards of reliability and security in the coal mining industry, which ultimately paves the way toward a brighter, reliable, safe, and promising future for this industrial sector.

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