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Current Study on the Subject of Underground Radio Positioning Systems

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ABSTRACT

This paper discusses the structural design of techniques for staff positioning in hazardous areas of underground mines, highlights the benefits and limitations of wireless sensor network technology, and addresses a cost-effective, continuously monitoring system for the safety of underground mine workers. Using this method, exact placement of both humans and machines may be managed efficiently. The development of systems, their implementation, and their administration are all discussed in this article. The practical implementation demonstrates the ZigBee technology's potential contribution to the administration of subterranean personnel data and safety.

Keywords: ZigBee, RFID, GPS technology, wireless network

INTRODUCTION

Virtual Since miners spend most of their time below ground, accurate positioning and constant monitoring are crucial to ensuring their safety and the efficiency of their work[1]. In addition to the inherent dangers of industrial sites, environmental factors might make it difficult for personnel monitoring systems to ensure worker safety at all times. The loss of life or damage to expensive equipment might result from carelessness about safety measures. For this reason, real-time locating management is crucial in order to provide subterranean workers with up-to-date, dynamic information. This is because both the underground underpasses and the staff's working area are spread out. To continually monitor various restrictions and to take appropriate action, communication is the most dynamic important aspect. Communication between miners on the move within the mine and a stationary base station or control centre on the surface is crucial for ensuring the security, safety, and efficiency of underground mines. The integrity of the communication system must never be compromised. It is exceedingly difficult to re-install a wired communication system if it has been destroyed for whatever reason, and the installation and maintenance costs are

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rather expensive, making the wired communication network system inefficient. The damage might result in a short-term outage or a long-term failure of the system.

The real concept for mine safety monitoring is wireless communication, and many other kinds of research projects are based on this concept. It all boils down to a wireless positioning subsystem. Technology like Global Positioning System (GPS) is only one example of the many available for use in operational positioning and, as well as other location technologies like ZigBee, RFID, CWUMSN (chain-type wireless underground mine sensor network), and so on. It is a two-way wireless communication method with the following advantages: short range, low complexity, low power consumption, low data rate, cheap cost, high reliability, moderate networking, and high adaptability [2]. The smart earth monitoring system and the command centre can get precise updates on staff shift changes through this positioning system.

CONNECTED TEXTS

The need for better communication in underground mining operations has arisen recently, and several studies have been published on the topic, some of which are addressed here. In 2008, Hauli Chen and Zhifen Feng investigated the development of a ZigBee and GPS-based data collecting and recording system. In the years that followed, researchers Zhiyong Cao, Hanyu Lu, and Quimin developed a wireless sensor network-based subterranean personnel locating system. In 2013, Li Zhi and his colleagues developed a position system for research employees using wireless sensor networks in high-risk environments. Following extensive prior study, this article examines and compares numerous potential subsurface navigation methods to determine which one is most applicable in each scenario.

Describe Technologies, Number Nine GPS Equipment

Most people nowadays rely on GPS. Triangulation is used to approximate a client's position [3]; this is accomplished by estimating the distance between the receiver and the satellites based on the time difference between their transmission and reception. The Global Positioning System (GPS) is reliable anytime, wherever, day or night. Using GPS is completely free of charge. Walls, deep vegetation, and high-rise buildings might all interfere with GPS signals. As a result, accurate GPS navigation data may be lacking for certain locations, especially those with limited access to the outside.

The Global Positioning System (GPS) uses a network of satellites to send and receive signals from the ground twice daily. To determine the user's specific position, GPS receivers employ these signals in conjunction with the triangulation technique. The GPS receiver basically calculates the time between when a signal was sent by a satellite and when it was received and processed. By measuring the time difference, the receiver may determine the satellite's distance. Now, the receiver calculates the user's position by averaging the distance measurements from a network of satellites. With four or more satellites in view, the receiver can control the user's three-dimensional position, while three satellites are required for the receiver to compute a two-dimensional locus. The GPS device's ability to compute the user's position paves the way for further analysis of data such as speed, tour distance, dawn and sunset time, distance to destination, etc. In order to perform the trilateration technique, just the signals from three satellites are required; your location on the earth is

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calculated by how far away you are from each of the satellites. The data received from the fourth satellite after its launch is utilised to validate the first estimate. If the location calculated from satellite "A-B-C" distances does not match the calculation based on "A-B-D," then several configurations are attempted until a valid result is attained. Disadvantages and benefits of global positioning system

Using a global positioning system (GPS) reduces driving stress significantly by providing turn-by-turn directions directly to your destination. Unlike with other types of navigational aids, GPS is not affected by weather conditions. When compared to other methods of map reading, GPS is rather cheap. The GPS system's remarkable feature is its worldwide coverage. To top it all off, it's great for finding local amenities like eateries, grocery stores, gas stations, ATMs, and banks. Mobile phones, for example, may readily include this cheaper technology because to its adaptability. Since the US government regularly improves the GPS system with new features, it is now state-of-the-art. It's the best guiding system on the water, too, because we become confused in bigger bodies of water because of a lack of directions. It's possible it won't work for various reasons, so it's always smart to have a backup map on hand. If your GPS gadget runs on batteries, eventually the batteries will run out and you'll have to find another means to power it, which isn't always an option. Sometimes the accuracy of these signals is affected by things like trees, buildings, and even weather, such as geomagnetic rainstorms. Tracking Items With Radio Frequency Identification

A non-contact and two-way communication technology, RFID enables the automated identification and data interchange of persons and objects. RFID-based positioning and navigation systems have the data encoded and sent wirelessly in a random sequence, and they also have a reasonably excellent communication protocol with the intimate anti-collision mechanism, allowing them to simultaneously recognise several, fast-moving objects [4]. The 433MHz frequency band is a viable option for this system's general functionality. Despite the fact that there are several interference sources in the 2.4GHz band, the maximum range of this communication system is up to 100 metres. When it comes to communication and positioning errors, the frequency you choose makes a difference. When operating in the 433MHz range, the location accuracy may be as high as 30 metres, and the data rate can reach 64 kilobits per second, satisfying the need even in the absence of speech and video transmission. Most base station launch capacities, however, are more than 15W, and these stations tend to be more expensive than other power sources. An explanation of how RFID-based navigation and positioning systems function.

An RFID-based positioning and navigation system typically consists of a control room and a subterranean component. In the control room, you'll find a server, printers, screens, and other hardware. Information sent by subway stations is processed at a central hub. Components like as base stations (card readers) and portable navigation devices are housed underneath. With the new monitor module, the base station can not only send out a wireless signal to activate the ID card and receive a message from the card, but it can also show its own 3-dimensional position. Navigation functionality and an ID card reader have been included into the portable device. The navigation system's core component is a three-dimensional computerised map of the mine's subterranean environment that is updated on a regular basis. The card reader sends out bursts of RF (Radio Frequency) signal to the ID module, which then couples with the ID card and reads the data stored within (card numbers and miners information). Using a fiber-optic connection, the card reader transmits this data to a centralised location. In this way, the control room may arrange the dynamic data of underground miners in real-time and identify the miner's specific information (location data, fundamental data) after processing the data.

The Pros and Cons of Radio Frequency Identification Technology
RFID technology eliminates the necessity for direct line-of-sight between the reader and the tag. These tags are capable of storing extensive data and responding to instructions. They are in a position to decide where something is. As you can see, this is a It's adaptable technology, thus its size may vary from that of a thumb tack to that of a tablet computer. A study found that using RFID on cans improved the visibility of data throughout supply chains and increased expected returns. However, there are other downsides to consider, like the potential expense of batteries for Active RFID devices, the need for more regulation of RFID methods, and the privacy concerns associated with RFID technology. Even if RFID is encoded, it may still be intercepted. We need to put in a lot of time and effort to develop the infrastructure necessary to support RFID devices. Wired connections have issues with data transport due to the geographical complexity and poor environment. RFID technology, like traditional methods, may be inaccurate when used to track people.

ZigBee technology
The ZigBee standard is a wireless protocol for exchanging data. The ZigBee protocol stack consists of the application layer, the network layer, the application support layer, the data link layer, the media access layer, and the physical layer. ZigBee is a bidirectional, low-power, simple, and inexpensive communication system. Card reader speeds can reach 20m/s or more, and the system has a range of 10m to 200m. It transmits data at a rate of 20kbps to 250kbps using the 2.4GHz band and the powerful DSSS (Direct Sequence Spread Spectrum) communication method (which can meet the needs of voice communications). Because of its inexpensive base stations and massive network capacity, this system may support as many as 65,500 users' gadgets simultaneously [5].

Micro-communications modules with fixed ZigBee chips, sometimes known as mobile nodes, are carried by miners and powered by two AA batteries [6]. The signals were sent by positioning nodes and received by the hub. The positioning node is controlled by the base station, which then reports its position to the command centre based on the intensity of the signal it is receiving [6]. The terminals are directed to their correct locations on the electronic map after the control centre reviews the terminals' position data and the subsurface conditions.

Workers' time in and out of the mine, as well as their daily output, may be accurately measured using identification cards equipped with ZigBee technology. On top of that, the Internet enabled the monitoring division to keep tabs remotely. Before a total breakdown of communication networks occurs, the system takes over management of the position of employees automatically and, after calculating the closest safe area, directs them there [7]. ZigBee systems are often broken up into an above-ground monitoring system and a below-ground set of devices. The Zigbee-based system, based on a real-world application environment, consists of an above-ground control hub and below-ground base stations and navigators.

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The data transmissions across the network are stored, calculated, and analysed at the control centre [8]. There is an electronic, three-dimensional map of the mine's inside in the control room.

Mainframe (card reader): The primary purpose of an underground base station is to assess the location of miners based on data collected from individual nodes. In addition, the base stations may transmit voice data [9].

Navigator: Miners' handheld navigation devices consist of a location node and a voice communication module. call for a directional hub that can handle voice communications as necessary for navigation. By adhering to this idea, the navigating system may function in near real-time [10]. The system will automatically retransmit any data packets that did not send successfully during transmission. Mesh, star, cluster-tree, ad hoc, and P2P topologies are all viable options in its Network layer. The Network layer enables routing and multihopping, which are used to dynamically change the network architecture. For reliable communication, security keys are created and exchanged at the media access control (MAC), application, and network layers. ZigBee will be employed in the following areas in the next couple of years: industry control, industry wireless location, home network, building mechanisation, medical equipment control, mine safety, power consumption analysis and calculation, home automation, or smart house [11].

ZigBee's Issues

Although ZigBee is a highly developed and useful technology, it is not perfect. In a large-scale wireless network, the coordinator often brings too many nodes. Nodes have batteries, and it might be difficult for humans to access certain locations to swap them out. A huge number of nodes also makes it difficult to implement new features and make improvements in the architecture [12]. The coordinator's responsibilities on the Zigbee network are limited to handling charges; all other processing duties are delegated to other nodes.

CONCLUSION

Using cutting-edge wireless communication technology in the man and machine positioning system of underground coal mines, researchers found that GPS as a navigation system cannot penetrate the earth due to its weak signal strength and was thus impractical for use in the mines. However, RFID technology is often used in the native coal mine personnel positioning system; the system's primary goal is to track employee attendance, but the precision is inadequate. The mine has a number of cutting-edge safety features, but ZigBee wireless location technology is particularly noteworthy because of its potential to save lives and prevent damage to property. It can stop high-volume manufacturing and protect workers from harm by keeping them out of restricted zones. In addition, it offers robust IT assurance and technical assistance for mine construction in the digital age. Not only is accurate underground man-machine placement and data surveillance essential for efficient rescue operations, but it is also crucial for modernising mine operations management.

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