Hindawi
Journal of Sensors
Volume 2021, Article ID 9915430, 11 pages
https://doi.org/10.1155/2021/9915430

Research Article

Research on Risk Assessment of Multitarget Wireless Sensing Detection Auxiliary Engineering in Mine Geological Environment

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Received 25 August 2021; Revised 7 September 2021; Accepted 7 September 2021; Published 18 September 2021

Academic Editor: Guolong Shi

In this paper, we evaluate the risk of auxiliary engineering of mine geological environment utilizing multiobjective wireless sensing detection. After vectorization of each evaluation factor, we evaluate the geological environment of a high-top mountain mine by fuzzy comprehensive evaluation method and get the evaluation results of our geological environment. Firstly, an in-depth analysis is carried out for the tracking gate that most association methods pay little attention to. In terms of optimization of traditional tracking gate, an attempt is made to propose a genetic algorithm fusion coding for tracking gate optimization, and then, the principal characteristics of traditional data association algorithm are focused on, and a particle swarm annealing association algorithm is proposed. Finally, the image information fusion of multisensors is studied, and the image information fusion level, fusion technology, and fusion process are discussed in detail, and the optimized discrete wavelet and color space alignment method is proposed, and good results are achieved through experiments. Among them, the area of poor geological environment evaluation is $0.32\,km^2$, accounting for 6.6% of the whole study area, the area of average geological environment evaluation is $0.63\,km^2$, accounting for 12.7% of the whole study area, and the area of good geological environment evaluation is $3.98\,km^2$, accounting for 80.7% of the whole study area. The evaluation results can fully reflect the degree of mining influence on the Gaodingshan mining area and provide a theoretical basis for the study of mine environment restoration and management.

1. Introduction

The environmental geological problems in the mine area are mainly geological hazards, but there are also problems of mine ecological damage and environmental pollution. The more prominent mining geological hazards in the study area are dangerous rock collapse, landslide, and mudslide at the same time. The dangerous rock bodies are mainly distributed in the limestone quarries and other open mining areas. The mining forms steep slopes, which collapse under the influence of adverse factors such as rainfall, weathering, and fracture development [1]. Landslide hazards in the area are mainly unstable slopes generated by the unreasonable accumulation of slag. The accumulation itself has a loose structure and low strength, and the steep cans with a slope greater than the natural rest angle of the accumulation are formed locally by artificial excavation, which becomes the main part of the slope destabilization and deformation damage. My debris flow disaster, mainly for the abandoned slag pile on top of the steep slope, especially in the slag distribution on both sides of the channel, by heavy rainfall combined with the upper hydrodynamic action, slag scouring start, in the lower section can locally produce slope-type mudslide or water and stone flow disaster. Since no large-scale mudslide outbreak has occurred in the history of Yanjia River, this time no hazard evaluation work will be conducted for the main ditch of Yanjia River [2]. The evaluation indexes affecting the geological environment of abandoned mines in the study area were selected, an evaluation system applicable to the study area was established, the background evaluation of the geological environment and the evaluation of the current situation of the geological environment were conducted, respectively, and the hierarchical analysis method and statistical index method were used to conduct a comprehensive evaluation of the geological environment of abandoned mines [3]. Based on the results of the comprehensive evaluation of the geological environment of abandoned mines and the zoning evaluation of the geological environment of individual abandoned mines and considering the development plan of Shenzhen and the case of restoration and treatment of abandoned mines, recommendations are made for the treatment and restoration of the geological environment of abandoned open-pit mines in the study area.

In selection collaboration, all relay nodes do not need to participate in data transmission, but only one best relay node from all relay nodes is needed to send data and has been a research hotspot in the field of wireless communication for having low complexity and high reliability [4]. In large-scale wireless sensor networks, nodes collect small packets of varying lengths, and multiple nodes waste a lot of resources by frequently interacting with aggregation nodes. Packet aggregation refers to the aggregation of multiple packets of shorter length to be forwarded and the packets to be sent by themselves to form an aggregated packet before transmission, which is very suitable for packet group forwarding in large-scale wireless sensor networks and can significantly reduce the transmission delay, reduce the energy consumption of forwarded data, save the power of nodes, and extend the network life cycle [5]. Therefore, this paper combines selective collaboration technology with packet aggregation technology and applies it to wireless sensor networks, which can effectively improve network performance, ensure reliable data transmission, and reduce the consumption of unnecessary network resources. The packet aggregation-based selective collaboration approach in multisource multitarget collaborative networks is investigated. A distributed packet aggregation-based selective collaboration method for multisource multitarget collaborative networks is designed to reduce energy consumption while ensuring transmission reliability. Meanwhile, three scheduling methods and three optimal relay selection strategies are proposed considering the effects of transmission order of source nodes and relay selection on network performance.

We have a detailed understanding of the requirements and contents of mine geological environment assessment and summarize and analyze the conventional problems, then explain the geophysical methods one by one and clarify the conditions of their use, and establish the theoretical basis for using geophysical methods for mine environment assessment; in reality, we analyze the heavy magnetic anomaly characteristics of the Yifeng Mountain mining area in Zhejiang Province and then conduct electromagnetic and seismic detection and heavy magnetic data analysis to derive. Specific assessment results and problem solutions are developed. There are differences in geological environment, mining technology, and natural resource application in different mining areas, so the process of choosing geophysical methods also needs to be analyzed from multiple perspectives to select reasonable and scientific geophysical methods for research and to make comprehensive adjustments to the utilization of resources, costs, and production of the geological environment of the mine, which will have a positive effect on the optimization of the geological environment assessment of the mine and mining and other work.

2. Current Status of Research

The number of mining resources exploited in the world is rising, resulting in the intensification of geological disasters and increasing losses, and disaster mitigation in the process of mining has become a fundamental work, and some developed countries have an early start in the relevant research, not only focusing on the study of the mechanism of disaster occurrence, conditions, and activity processes, but also the development of disaster assessment work is increasingly strengthened, the main purpose of which is to analyze the relationship between mining input George [6]. To improve, Sanaga and Frueh used a geophysical scheme to study the geological changes in the mine environment, the destruction of genus resources, and the pollution of the soil and water environment [7]. The authors used the seismic image method to analyze the presence or absence of mines and the distribution of minerals in the mine area, to realize the effective management of geological resources in the mine are based on the analysis of mine environmental changes as well utilization of our resources [8]. Si et al. proposed a new idea of environmental quality evaluation, treating different environmental units as different factors affecting the quality, and the complex units can be used as simple units for integrated representation [9]. The evaluation factors are selected according to the specific problems of environmental quality, unified into comparable indicators, and then weighted and combined according to their importance, and finally, the integrated indicators are used to evaluate the environmental quality.

Geoenvironmental risk is an innovative research problem at the intersection of multiple disciplines, involving geology, environmental geology, disaster science, statistics, economics, and management [10]. Compared with the traditional geological disaster genesis mechanism and disaster prediction, risk research targets the loss of disasters, takes the risk level acceptable to human society and economy as the basis of geological disaster management and management engineering, and proposes a variety of feasible ways to reduce disaster loss [11]. Dangerous rock bodies are mainly distributed in open-pit mining areas such as limestone quarries. The mining formed a steep slope, which collapsed under the influence of unfavorable factors such as rainfall, weathering, and crack development. After more than 30 years of development, geological disaster risk has become an important basis for land use planning and restricting development in disaster-affected areas, as well as the preparation of disaster reduction planning [12]. The compensation is studied from the perspective of the environmental cost of mineral resource development, and it is proposed that the cost compensation includes not only the economic loss arising from environmental pollution and ecological damage, but also the protective expenditure to avoid or reduce environmental damage and the cost of restoration and treatment of the already damaged ecological environment. The unstable slope caused by unreasonable accumulation, the accumulation body itself has a loose structure and low strength, and because of the artificial excavation, a steep ridge with a slope greater than the natural angle of repose of the accumulation body is formed locally, which becomes the main part of the slope instability deformation and failure.

We have studied articles and books related to mine geological environment evaluation and restoration management, understood the latest research results and directions at home and abroad, found out the existing problems, and determined the topic and research ideas of the thesis. Through data collection, field geological survey, and indoor data analysis, we analyzed the geological environment of the Gaodingshan mining area and its environmental geological problems and obtained geological environment evaluation data; we used the comprehensive assignment method combining hierarchical analysis and entropy value method to establish the mine geological environment evaluation model for the specific actual situation of the study area. On this basis, the comprehensive evaluation of the mine geological environment is completed. Based on the geological environment evaluation and the actual situation of the study area, the relevant research is conducted on the mine environment restoration and management of the Gaodingshan mining area. A selection collaboration protocol supporting multiple packet aggregation is designed for multisource single-target collaboration networks, which improves the data transmission reliability of the network. Based on this protocol, three goal-oriented single-objective-based optimized packet selection strategies and two multiobjective hierarchical optimized packet selection strategies are proposed to perform packet selection.

3. Multitarget Wireless Sensing Detection of Mining Geological Environment to Assist Engineering Risk Assessment Analysis

3.1. Analysis of Multitarget Wireless Sensing Detection. There are many core elements of a multisensor target tracking system, and data correlation is one of its main points. The predictive tracking quality of target units is inextricably linked to the data association algorithm [13]. The process of completing the vector estimation of the target in a limited time, corresponding to matching the relationship of the measured targets, is called data association. The association process includes both static data association for steady-state targets and dynamic data association for dynamically estimated targets [14]. The main process is to extract the regular candidate echoes from the tracking gate output and compare them with the actual trajectory to determine the observed information. In a multitarget environment, the data ambiguity factor is increased even more due to uncertainties such as the number of tracking targets, measurement errors of sensors, and the absence of a priori information about the target's environment. A tracking gate is generally a specific space that exists inside the sensor detection space, and the center of the tracking gate is at the predicted position of the next point in time. Based on the results of the comprehensive evaluation of the geological environment of abandoned mines and the regional evaluation of the geological environment of individual abandoned mines, combined with development planning and abandoned mine restoration treatment cases, suggestions are made for the treatment and restoration of the geological environment of the open-pit abandoned mines in the study area. The size of the tracking gate is determined based on the probability of tracking valid data. We can perform an estimation check by aligning the measured data with the formed target trajectory, thus improving the detection performance to some extent. The tracked target is only updated in its tracking gate with valid detection data from the sensor, while those not in the tracking gate range are generally spurious signals [15]. A good tracking gate theory improves the system performance while also ensuring the real-time tracking target trajectory update.

The wireless sensor network is a kind of wireless network that senses external physical quantities through nodes in the network and transmits data by wireless communication. The flexibility of the network and the easy access of the nodes make wireless sensor networks widely used in many industries such as military, aviation, smart home, medical, and environmental monitoring. Wireless sensor networks are mainly composed of many wireless sensor nodes. The general structure of wireless sensor nodes is given in Figure 1. Wireless sensor nodes are composed of four modules: sensor module, a processing module, wireless communication module, and energy module, and different modules realize different functions. The sensing module is mainly used for detecting sensing and collecting information; the function of the processing module is to carry out preliminary processing of information, such as coding and storage; the wireless communication module is mainly responsible for communication and sending information to the aggregation node by wireless communication; the energy module is mainly responsible for providing energy supply for other modules.

As a special kind of wireless network, a wireless sensor network has both the basic characteristics of a wireless network and the characteristics that a wireless network does not have. Generally, many detection nodes are usually scattered in the detection area for long-term and reliable detection of the monitoring area. Due to the large number of wireless sensing nodes in a wireless sensor network, the nodes are small and powered only by batteries, limiting the energy, bandwidth, storage, and computing power of the nodes. Wireless sensing nodes are usually placed in harsh environments and not easily accessible, and the large size of nodes in wireless sensing networks, which are not easy to maintain and other characteristics, requires high reliability of each node [16]. In this paper, the selective collaboration technology and the packet aggregation technology are combined and applied to wireless sensor networks, which can effectively improve network performance, ensure reliable data transmission, and reduce unnecessary network resource consumption. In wireless sensor networks, each node is in the same position without any priority, and any node in the network can engage in the work of other nodes. In wireless sensor networks, some nodes exit the network, or new nodes join the network due to a harsh environment and

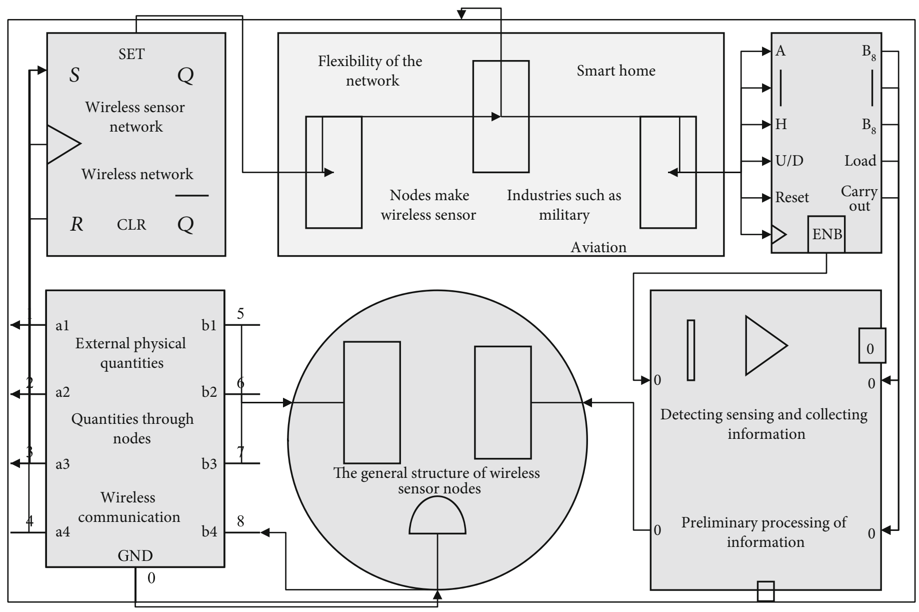

Figure 1: Wireless sensor node structure.

limited energy, which affects the topology of the network. In wireless sensor networks, what runs through the entire network work process from the beginning to the end is data, whether it is collecting data information, storing data information, or sending information.

The wireless sensor network sends data by wireless communication, which requires high data reliability, and it is unrealistic to improve the network performance from the node side due to cost and resource constraints. Selection collaboration can be introduced into the wireless sensor network, and a selection collaboration method applicable to the wireless sensor network can be designed to achieve the improvement of the network performance. Firstly, the population initialization is carried out, and the simulated data of radar signal output through the trajectory generator is input to the tracking prediction module for genetic fusion, in which the output simulated tracking trajectory is compared with the actual trajectory through the difference method to derive the adaptation value of specially marked individuals, and the data generated through the tracking prediction module, keeping the same number of other controls, is entered into the system as a parameter setting, and it is judged whether to satisfy. The convergence criterion is used to determine the optimal tracking gate size and shape.

$$W = N\left(x, \sum x\right),$$
$$d_H = 1 + \sqrt{\frac{\sqrt{\delta\left(\sum x \sum y\right)}}{\delta\left[0.5\left(\sum x - \sum y\right)\right]} \exp\,(\delta)}. \tag{1}$$

Calculating the estimation accuracy in unbiased estimation relatively can use the Cramer-Rao Lower Bound (CRLB) as the uncertainty, and the Hellinger distance is then the deviation distance of the estimate at time. Then, the following matching adaptation function can be constructed.

$$f_{\text{fitness}}(G) = 100\left(1 + \frac{\sum_{k=0}^{t} d_{H|K}(f, g)}{t}\right)^2. \tag{2}$$

The optimization parameter problem can be approximated according to the adaptation function by the following equation.

$$G = \arg\min f_{\text{fitness}}(G). \tag{3}$$

Since the crossover variation process can cause interference with solution finding, using an optimized storage strategy model, constant selection, and replication to ensure the stability of the genetic algorithm, first of all, the fitness ratio statistics for the single individuals in the population is common in genetic algorithms to require multiple selections and replications and other operations as a way to ensure that the optimal individuals are not destroyed by crossover, variation, and other genetic operations [17]. Here, we use an optimal solution survival strategy to ensure the accuracy of the population; first, we calculate the fitness ratio, not in the form of a group at this time but for the individual individuals in the population, through a proportional selection method in which the probability of being selected is proportional to the calculated value of its fitness, and select the ones with greater fitness to increase the genetic probability to the subsequent population. For shapes, a single-point mixed coding is used, while a random mixed cross-coding threshold constant is used. Select reasonable and scientific geophysical methods for research, comprehensively adjust the utilization, cost, and output of geological environmental resources of mines, and play a positive role in the optimization of mine geological environmental assessment and mining.

The nearest neighbor algorithm is a simple but powerful association algorithm in the early stages of data association system formation. The core idea of this algorithm is to define the nearest monitoring point inside the tracking gate at the distance from the tracking target unit as the association point location.

$$d^2(z(k)) = \left[z(k) + z(k-1)S^{-1}[z(k) + z(k+1]\right]. \quad (4)$$

So, we can know that in certain cases, the target quantity is not 100% the quantity measured closest to the detection unit, especially in the case of complex high-density clutter. This algorithm, although less computationally intensive and simpler to implement, has a high probability of false tracking or missing cases.

Also, consider the possibility of separate measurement data falling into the intersection region; the binary variable ωjt is introduced in the correspondence, specifically, at t of 0 to represent the presence of no target unit inside the region. This binary variable can indicate whether the measurement data j is present in the confirmation gate range of the corresponding unit. Due to the presence of clutter or interference, the initialized confirmation matrix first column element value is 1. The core process of joint probability data correlation is shown in the figure below. The probability of association of a single measurement data with a target unit in the region is given in focus, as shown in Figure 2.

In WSN localization technology, the ratio of the total number of nodes in a certain region to the area of the region is defined as the node density, and the accuracy of the localization algorithm is directly affected by the node density. Sparse nodes are not able to complete the entire localization of the region; if there are too many nodes, not only will increase the cost overhead but also the frequent exchange of data between nodes will hurt the accuracy, which will cause the accumulation of errors and affect the localization accuracy. Therefore, the number of nodes should be carefully selected [18]. In WSN localization technology, the ratio of the number of beacon nodes in the network to the area of the monitoring area is defined as the beacon node density. Beacon nodes in the monitoring area generally with global positioning equipment, so that they can access their location information at any time, so the general cost of beacon nodes is relatively high, but considering the cost, it is not possible to use many beacon nodes, so usually, the number of beacon nodes invested in the monitoring area is relatively small. In general, the higher the density of beacon nodes used in the monitoring area, the higher the accuracy of localization, which also makes the density of beacon nodes an important evaluation index of a localization algorithm.

$$\mathrm{RSSI}(d) = \mathrm{RSSI}(d_0) + 10 \ln \frac{d}{d_0} - \beta. \quad (5)$$

The angle θ (relative angle) between the pole diameter and its initial assumed pole axis is calculated as shown in Equation (6).

$$\theta = \frac{x^2\pi}{4n^2}. \quad (6)$$

By performing the abovementioned hive construction and coordinate calibration steps, the hexagonal nodes on each layer have been located. For other nodes that are not on the topology are regionalized, i.e., each positive hexagon in the area to be detected is divided into some equilateral triangles. The nodes whose positions have been determined in the cellular topology are upgraded to collaborative nodes to assist other nodes in localization. At this point, the locations of all nodes in the monitoring area can be determined. Tracking the predicted position of the center of the gate at the next point in time and determining the size of the tracking gate are based on the probability of tracking valid data. We can perform estimation verification by registering the measured data with the formed target trajectory, thereby improving the detection performance to a certain extent. The performance metrics of collaborative transmission include BER, bandwidth efficiency, system throughput, network life cycle, and outage probability. The focus of this paper is on the transmission reliability of collaborative communication networks, so this paper focuses on the outage probability of collaborative communication systems.

3.2. Experimental Design of Mine Geological Environment-Assisted Engineering Risk Assessment. Based on the discussion of the basic concepts and technical processes of geoenvironmental risk analysis, this section attempts to establish the framework model and technical processes of mine geoenvironmental risk evaluation. Taking limestone mines around Fengshan County as an example, the key techniques of risk evaluation of sudden-type geological environmental problems in mines are elaborated [19]. In the wireless sensor network, each node is in the same position, there is no distinction between primary and secondary, any node in the network can be engaged in the work of other nodes. Firstly, through geological environment survey, field measurement, laser scanning, and rock mechanics test, we obtain the data of mine geological environment risk analysis and discuss the basis of geological environment zoning and the technical method of geological environment data compilation; then, combining with the common emergent geological environment problems in limestone mines around Fengshan County, we comprehensively apply block theory, rigid body limit equilibrium method, reliability analysis, and numerical analysis. Then, based on the type of building structure and resistance to horizontal impact, SAP2000 was applied to simulate the damage of buildings under the action of falling rocks and analyze the vulnerability of buildings under the action of different intensities of falling rocks and collapsing geological disasters. Finally, based on the hazard and vulnerability evaluation, a comprehensive evaluation of the specific risk of the buildings was conducted based on the distribution of the existing main buildings [20].

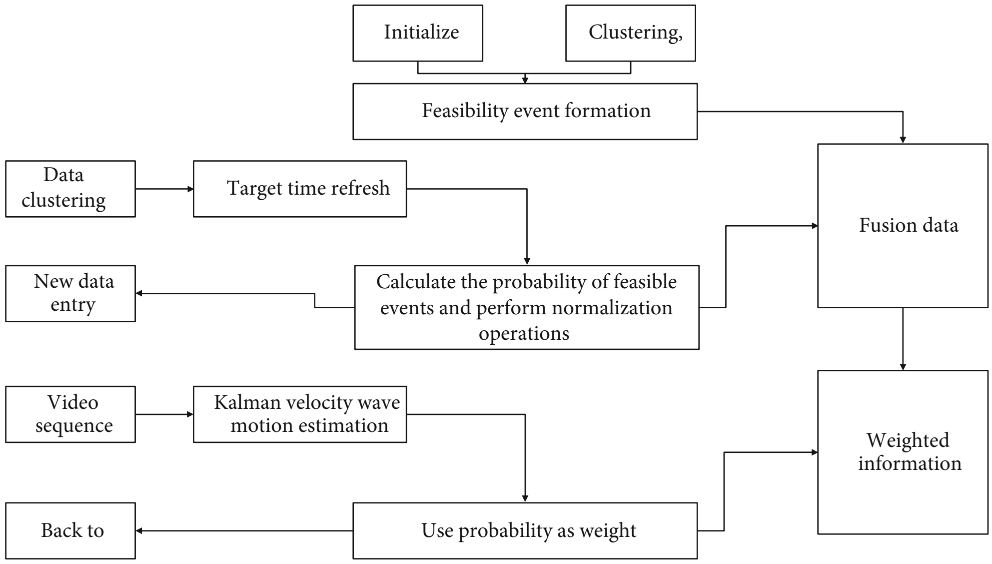

Figure 2: Flow chart of the evaluation algorithm.

According to the analysis of the evolution law of geological environmental problems themselves, from the perspective of risk analysis and management, mine geological environmental problems can be divided into sudden-onset mine geological environmental problems and gradual-onset geological environmental problems. For sudden-onset mine geoenvironmental problems, the predisaster risk assessment and postdisaster damage assessment are mainly carried out [21]. The risk quantification theory and method of sudden mine geological environmental problems and gradual mine geological environmental problems are discussed. From the perspective of disaster prevention and mitigation engineering, the predisaster risk assessment is particularly important and is the basis for formulating management measures such as risk disposal and control; for gradual-change geoenvironmental problems, the predisaster gestation stage and the disaster activity stage are often slow and gradual, and it is difficult to define with the postdisaster recovery work. Therefore, risk assessment is mainly the risk assessment during the disaster process, and its purpose is to provide a basis for decision-making in implementing disaster reduction projects.

My geological environment vulnerability evaluation is the core and difficult point of risk evaluation. In terms of disaster-causing effects, the hazard of mine geological environment problems to human society and mining ecosystems is related to the vulnerability, fragility, and recoverability of the bearer. If the mine is located around cities and towns, the consequences are also closely related to the degradation of nature and the quality of the built environment. From a social perspective, some scholars see vulnerability as a deficiency or deficit in the process of social construction, which is related to physical entities and natural spaces. In some places, increased vulnerability is seen as the inability to control rapidly developing urban sprawl and environmental degradation, leading to a decline in quality of life, destruction of natural resources, geomorphic landscapes, and destruction of heritage and cultural diversity, as shown in Figure 3.

For the environment, ecology and social economy, there is a lack of resilience. It is usually the focus of the vulnerability evaluation of progressive geoenvironmental problems. The sources of the above three parts of vulnerability can be grouped into two categories in the vulnerability evaluation. The first category focuses on the vulnerability evaluation of physical entities, which focuses on the evaluation of potential human losses and the degree of damage to the foundation of physical entities, and its evaluation process will be described in detail in the risk evaluation of sudden-onset mining geoenvironmental problems in this chapter; the second category focuses on the social, economic, and ecological vulnerability and the ecological and socioeconomic lack of restoration capacity for evaluation. The focus is on evaluating the degree of harm to human society from potential social, ecological, and environmental impacts, and its evaluation process will be described in detail in the risk evaluation of progressive geoenvironmental problems in Chapter 4.

Finally, the mudflow or water-logging disaster, mainly for the slag into Yanjia River, especially the slag is mainly distributed in the upstream section of the ditch on both sides, heavy rainfall scouring, coupled with the upper hydrodynamic action, slag scouring start, then in the lower section can locally produce mudflow or water-logging disaster. The Yanjia River has not historically been subject to mudslides and is classified as a nonmudslide ditch based on the available results. Due to the limitation of the project, the possibility of mudslide in the main ditch of the Yanjia River is not studied. First, we first calculate the fitness ratio. Currently, it is not in the form of a group but for a single individual in the population. The fitness is selected by a proportional selection method in which the probability of being selected is proportional to the calculated fitness value. Larger ones increase the genetic probability to subsequent populations. The triggering factors and types of manifestations of

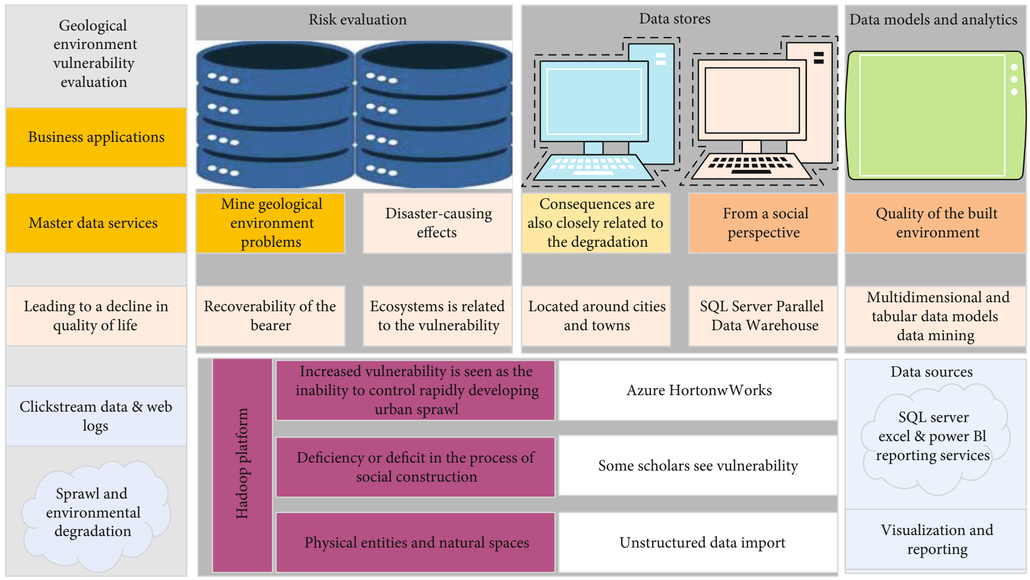

Figure 3: Mine geological environment risk assessment.

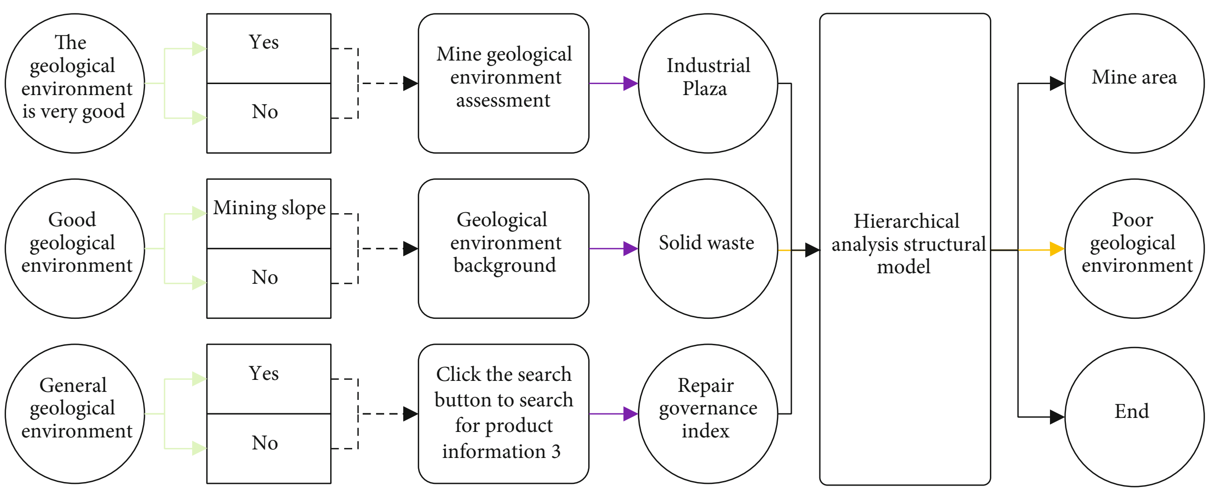

Figure 4: Hierarchical analysis structural model.

environmental geological problems in mines are complex, and there are differences in manifestations. The industrial site of the mine construction site, the mine road excavation ruling ore, the stripping of topsoil from the open pit, and the dumping of waste materials will have a direct impact on the overall geological environment and ecological characteristics of the mine site. The mining activities will affect the original stress balance and induce geological disasters such as ground collapse, cave-in, and mudflow, and the discharge of "three wastes" from the mine will cause water, figure, and air pollution.

The emergence of mining environmental geological problems is the result of the joint action of a variety of activity processes such as mining and beneficiation, and there are more causative factors, for example, the occupation and destruction of land resources, which are directly related to mining waste and beneficiation tailings. My environmental geological problems also have the characteristic of recurring in situ many times, and landslides, mudflows, and ground collapse are extremely easy to recur and affect the protection of the geological environment. The characteristics of environmental geological problems can vary depending on the differences in mine types, the severity of the problems, and the natural geographic environment. For example, geological hazards such as landslides, landslides, and mudflows are concentrated in hilly areas, while geological hazards such as ground subsidence and ground cracks will occur in plain areas, as shown in Figure 4.

The ductility or scale of the structural surface in space is expressed by the area of the structural surface. In the actual rock mass, on the artificial excavation surface or natural outcrop, except for a few structural faces that can be exposed completely, most of the structural faces can only be observed by the trace line tangent between the structural face and the outcrop surface, and the length of the structural face trace line is called the trace length. In the case of disc-shaped joints, the trace length measured by field energy is only a chord of the structural surface of the disc rather than its diameter [22]. Xu Guangli's statistical analysis shows that the average trace length maybe 0.786 times the diameter of the disc. There are two statistical methods to derive the full trace length from the measured trace lengths on-field outcrops, namely, the line estimation method and the statistical window method, which is used in this study. Then, according to the structure type of the building and the resistance to horizontal impact, SAP2000 is used to simulate the damage of the building under the action of rockfall, and the vulnerability of the building under the action of different intensities of rockfall and collapse geological disasters is analyzed. The structural surface spacing and density are indicators to describe the density of structural surface development in the rock body, and the structural surface spacing is the distance between two adjacent structural surfaces in the normal direction of the same group of structural surfaces. The statistical method of structural surface spacing, the measuring line method, and the statistical window method is often used in engineering. In this paper, the true spacing of structural surfaces is calculated by arranging multiple measuring lines in the statistical window to complete the statistical, measuring the apparent spacing of the same group of structural surfaces intersecting with the measuring lines.

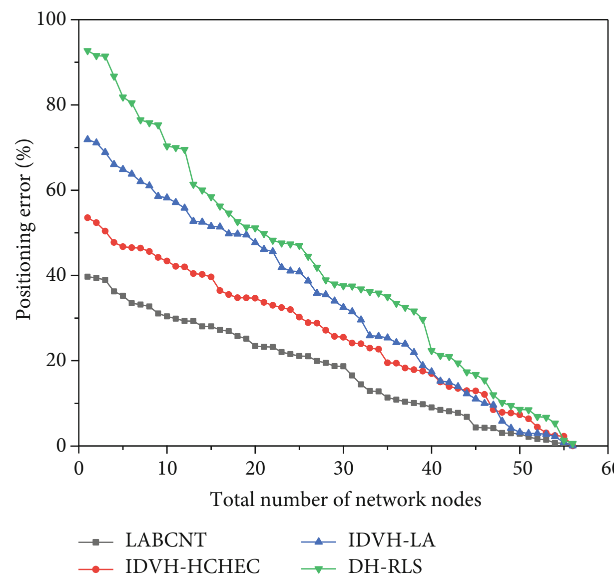

Figure 5: Relationship between the total number of network nodes and positioning error.

4. Analysis of Results

4.1. Multitarget Wireless Sensing Detection Results. The relationship between the total number of network nodes and the localization error is shown in Figure 5. As can be seen from the figure, the localization accuracy of the four algorithms in the monitoring area increases with the increase of the total number of nodes, and the final localization accuracy tends to be stable, and the localization accuracy of the LABCNT algorithm is significantly higher than the other three algorithms. The DH-RLS algorithm uses the search localization algorithm for postprocessing, and the total number of nodes increases while the convergence degree is weak, and the localization error is high. The IDVH-LA algorithm corrects the average hop distance of the beacon nodes, but the number of hops increases due to the increase of nodes, which generates a large amount of cumulative error. The IDVH-HCHEC algorithm improves the hop distance and number of hops, but the loop structure induced by the increase of nodes is unavoidable, so the error rate is higher.

The relationship between the node communication radius and the localization error is shown in Figure 5. From the figure, the localization accuracy of the four algorithms increases with the increase of the communication radius. The parameters of this experiment are set to the total number of 130 nodes, and the density of beacon nodes is taken as 8%. It will have an impact on the original stress balance and induce geological disasters such as ground collapse, avalanches, and mudslides. The discharge of the "three wastes" from mines will cause water, map, and atmospheric environmental pollution problems. The accuracy of each algorithm is improved by increasing the node radius, which increases the number of neighboring nodes of each node and improves the connectivity of the network. The LABCNT algorithm is less dependent on the beacon nodes and first determines the unknown node locations in the cellular topology network and then uses the RSSI technique with the topology to regionalize the least-squares positioning of all nodes in the domain, which avoids the redundancy error caused by the DV-Hop algorithm. The DH-RLS algorithm relies on beacon nodes, and the localization error of the center-of-mass localization algorithm increases as the radius increases; the IDVH-LA algorithm optimizes the average hop distance and its range but ignores the cumulative error generated by the calculation, and the cumulative error increases as the node communication radius increases; the IDVH-HCHEC algorithm makes extensive use of the information of unknown nodes. The average trace length may be up to 0.786 times the diameter of the disc. There are two statistical methods to derive the total trace length based on the trace length measured on the outcrops, namely, the survey line estimation method and the statistical window method. The statistical window method is used in this study. The spacing and density of discontinuities are indicators to describe the density of discontinuities in the rock mass. The IDVH-HCHEC algorithm uses a lot of information about unknown nodes, the radius between nodes increases, and more nodes with unknown locations are involved in localization, which makes the error rate of the algorithm increase.

According to the single-objective optimization strategy, it is found in the process of selecting multiple packets: other secondary performance of the system can be optimized based on the single-objective optimization. For example, when selecting packets based on the maximum throughput, the maximum throughput of a single packet transmission can be obtained. To achieve multiobjective hierarchical optimization, the transmission delay and the number of transmitted packets of the system can be optimized while

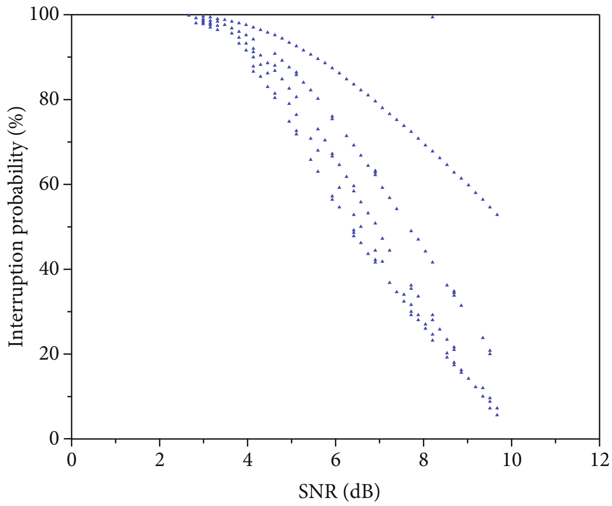

Figure 6: Comparison of the outage probability of the system with different numbers of packets aggregated.

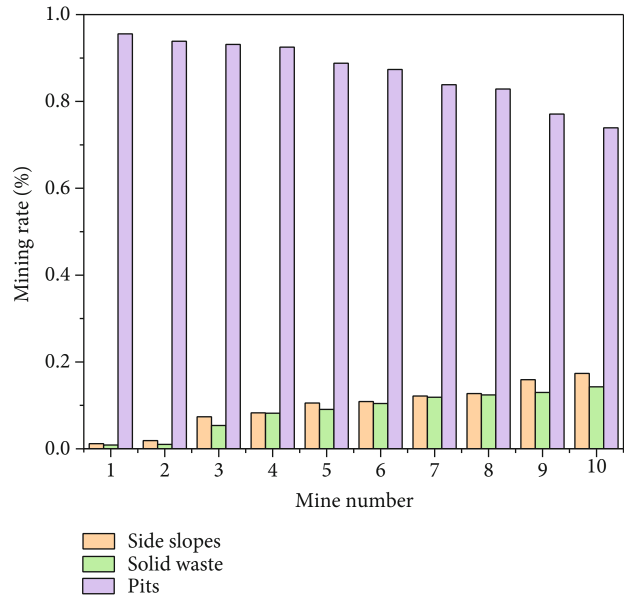

Figure 7: Calculation results of topographic landscape destruction rate and classification level.

ensuring the maximum throughput. Similarly, the maximum number of aggregated packet selection strategy can guarantee the maximum number of single packets, and the analysis finds that the delay and throughput of the system can be optimized while guaranteeing the maximum number of packets. Therefore, the next work investigates the hierarchical optimization of packets and proposes 2 multiobjective hierarchical optimization packet selection strategies.

Figure 6 gives a comparison of the outage probability of the system for aggregating a different number of packets in a multisource single-target network. The proposed method is used for better transmission reliability compared to direct transmission, and the outage probability of the system gradually decreases as the number of aggregated packets increases, which is mainly because as the number of aggregated packets increases, more packets are sent to the target node and the overall data transmission reliability of the system increases.

Figure 6 gives a comparison of the throughput of the system with different numbers of packets aggregated, which increases with the number of aggregated packets at the same signal-to-noise ratio. Among them, the throughput of the system is the highest with the maximum number of aggregated packets. Figure 6 gives the energy consumption of the system with a different number of packets aggregated. From the figure, as the number of aggregated packets increases, the system consumes more energy because the lower the probability of interruption, the more packets are successfully sent to the target node, and more energy is consumed. The throughput of the system is the largest under the maximum number of aggregated packets.

4.2. Experimental Results of Environmental Auxiliary Engineering Risks at Mine Addresses. According to the calculated topographic landscape damage rate, the grade of topographic landscape damage is divided. According to the requirements, the terrain and landscape damage evaluation grade is divided into serious, more serious, and less serious three levels. The topography and landscape damage rate of serious level is more than 40%; the topography and landscape damage rate of more serious level is 20-40%; the topography and landscape damage rate of less serious level is less than 20%. The calculated topographic and geomorphic landscape destruction rates of different evaluation areas of each abandoned mine and the topographic and geomorphic landscape destruction levels are shown in Figure 7.

For the evaluation area of mining slopes, there are 24 abandoned mines with serious geoenvironmental problems, 11 abandoned mines with more serious geoenvironmental problems, 20 abandoned mines with minor geoenvironmental problems, and 6 abandoned mines with no geoenvironmental problems, accounting for 39.34%, 18.03%, 32.79%, and 9.84% of the number of abandoned mines, respectively. For the evaluation area of mining pits, there are 2, 5, 2, and 52 abandoned mines with serious, more serious, minor, and none geological environment problems, accounting for 3.28%, 8.20%, 3.28%, and 85.25% of the number of abandoned mines, respectively; for the evaluation area of solid waste, there are 4, 2, 4, and 51 abandoned mines with serious, more serious, minor, and none geological environment problems, accounting for 6.56%, 3.56%, and 3.25% of the number of abandoned mines, respectively. For the evaluation area of the industrial plaza, there are 19, 11, 11, and 20 abandoned mines with serious, more serious, minor, and none geological environment problems, accounting for 31.15%, 18.03%, 18.03%, and 32.79% of the number of abandoned mines, respectively.

There are many cases of successful ecological restoration of limestone mines, mostly using the pits, steps, and topographic levels left after mining to build ecological landscapes in relatively gentle sections, using climbing plants or shrubs to hide the surrounding rock walls. For this mining site, the slope of the palm face is as high as 130 m, and the foot of the slope is an urban building, so there is no advantageous terrain to use. It is determined that the susceptibility level of

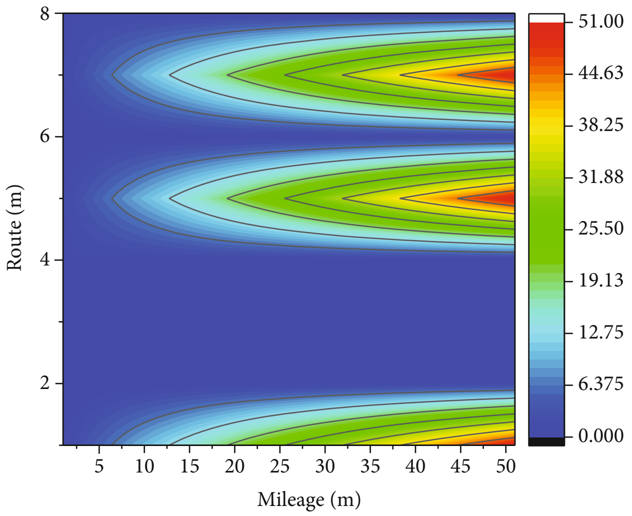

Figure 8: High-density electrical inversion results of the mine area.

ecological resource damage of this mine is 4, and the possibility of ecological recovery is low, which is a high-risk area for ecological resource damage. Integrating the risk assessment of terrain and landscape damage with the risk assessment of ecological resource damage, the risk level of geological environment damage of this mine is high risk. This also suggests that we should not consider ecological restoration measures alone, but can take comprehensive management measures in combination with local socioeconomic development needs, as shown in Figure 8.

Focusing on the research theme of geological environmental risk analysis and management in limestone mines, the classification scheme of geological environmental problems in mines based on the characteristics and essence of geological environmental problems and from the perspective of risk analysis and control is proposed, and the combination pattern and disaster-causing effects of geological environmental problems in limestone mines are summarized. Based on the internationally recognized geohazard risk assessment system, the framework model of mine geoenvironmental risk evaluation is modified and improved according to the actual mine environmental, and the theory and method of risk quantification for sudden-onset mine geoenvironmental problems and gradual-change mine geoenvironmental problems are discussed. In the management and control engineering of mine geological environment problems, a management model consisting of multiobjective risk decisions, dynamic tracking and information feedback, and system analysis is proposed. The above theoretical methods are applied to the limestone mine geological environment management project in Fengshan County, Guangxi, which effectively guides the mine geological environment risk control and the program determination and design of the mine geological environment management project.

5. Conclusion

Mine geoenvironmental problems are divided into two categories: sudden-onset mine geoenvironmental problems and gradual-onset mine geoenvironmental problems. Sudden mine geoenvironmental problems cannot be accurately predicted by statistical, empirical models, and nonlinear models, and their hazards can be expressed by damage probability or reliability. Its risk mitigation measures must be deployed before the occurrence of the disaster when it encounters a geological disaster that cannot be managed and avoided and needs to be formulated for emergency rescue can be determined by statistical or warp type geoenvironmental problems occurring and evolving slowly and continuously, which can be predicted in a short period, and its hazard can be determined by statistical or empirical models, and then, the risk can be evaluated more accurately, such problems will not directly cause human casualties, and risk mitigation measures can be deployed before or during the development of geoenvironmental problems, and no management measures such as early warning or emergency response are required. Acceptability and tolerance are used as the criteria for risk assessment to determine whether the risk is accepted, tolerated, or intolerant, which is influenced by the degree of social development around the mine. Adaptive crossover probability and adaptive variation probability are also set to automatically vary the crossover and variation probabilities according to the situation and to determine whether to perform a variable crossover variation operation based on their probabilities. The algorithm uses three different selection strategies for the next generation of exploding fireworks nodes, which enables the optimal explosion point to enter the next generation along with a random explosion point. This strategy ensures the optimality of the next-generation exploding fireworks and preserves the diversity of fireworks, thus improving the algorithm positioning accuracy.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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