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Application Research of AR Technology Based on Ergonomic Theory in Mining Industry

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Abstract. In order to make the planning, design and production activities of mining parks more efficient, simple, safe and people-oriented, these processes are optimized and innovated from the perspective of workers. Based on the theory of ergonomics, combining a series of design and production process with AR technology in mining area, making the advantages of AR technology to reach its full potential. Using the ideas and methods of industrial design to establish the solving model of problems and proposing new design methods for mineral industry, so that advanced technology and the traditional industrial model can be highly connected, and in the end it must meet the consequence of human and machine with environment.

1. Necessity of introducing AR technology into mining Parks

AR, or Augmented Reality, is also known as Augmented Reality. By calculating the position and angle of the camera image in real time and adding the corresponding image technology, the physical information which is difficult to experience in a certain time and space in the real world is superimposed through computer science and technology simulation, so that the real environment and virtual objects appear in the same picture or space in real time and are perceived by human senses, and the superposition is realized. More realistic sensory experience. Augmented reality technology comes into being with the development of virtual reality technology, but there are great differences between them. First of all, they have different requirements for the sense of submergence and different emphasis in the application field. The development and design of mining parks is a comprehensive process. The project is huge and the task is arduous. There are many aspects to be considered. For example, to understand the topographic characteristics, to survey the geological environment of mining areas, to determine the location of main wells and auxiliary wells, to reasonably construct office areas, to do a good job of water resources reserve and ore transportation routes, and to do these meticulous work, it is necessary to unite the strength and knowledge of the staff of various departments. A certain decision from the macro-coordination to the early design to the approval of execution must be through multiple parties. It takes a long time and there will be mistakes in the handover process. It consumes a lot of energy in the process of design and construction. The operation of the mining industry has not yet introduced products and technical means in the field of high-tech. There are many shortcomings in the current working mode. For example, 1. There is no good overall working environment, including light environment and acoustic environment. 2. It poses a great challenge to the reliability of people, because people's emotions and mental states have a high impact on their work reliability, thus affecting the production process.^[1] 3. People's safety is not guaranteed to the maximum. However, the introduction of AR technology can bring new experiences, which can



effectively improve people's reliability and increase work comfort. The design, implementation and management of mining areas can be greatly improved.(Fig. 1)

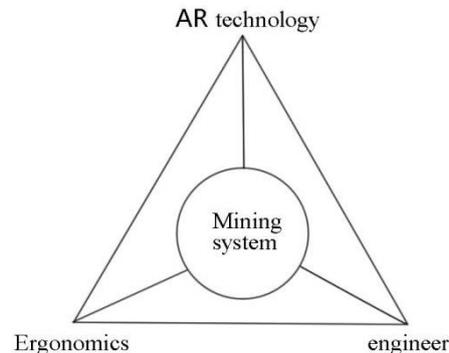


Figure 1 architecture diagram

2. Application of AR Technology in Mining Environment

Some scholars have studied the application prospects of combining AR technology with the coal mining industry.^[2]From the perspective of high technology, this article will be based on ergonomics to push this application method to a wider area. On the other hand, it is applied to the entire mining area. Mining and rough processing is a very large project involving many details such as ground facilities and underground facilities. The following experimental explorations are proposed for the combination of certain aspects of the production process with AR technology.

2.1. AR technology effectively improves people's reliability

Human reliability refers to the possibility of a person's successful performance in a certain work or task under the given time parameter conditions.^[3]For example, when transporting road wiring inside a mining area, it is inevitable that people will have omissions, the layout of the line is unreasonable, and the possibility of rework is very high. However, using AR technology to analyze the distance and relationship between the facilities of the site, processing the ground layout of the input computer, transforming the layout principle into its own design language, can present the best route, and the contact of transportation between the facilities is more convenient, the distance is shorter, the engineering quantity is smaller, the line is more compact, and with adequate room for development. The overall characteristics of AR technology can make the road and facilities along the site coordinate in distance and elevation according to their respective technical requirements. It can also be applied to railway transportation routing, so that workshops and warehouses with large freight volume can be arranged along the line. The line strives to be short and reduce the number of turnouts, and people will be greatly liberated.

In addition, the detection of all kinds of production and living pipe network lines in the mine is also very costly, because there are too many pipe routes, such as underground drainage pipes to the surface water tank, water supply pipes for underground production water supply, up and down pipes for domestic use, and hot water heating pipes for domestic use in northern mines. The damage or failure of underground pipeline route is inevitable. Once the fault occurs, it will cause the mine work to be unable to operate, resulting in property losses. AR technology can be used to test various pipelines and analyze the thickness of pipelines for timely repair and replacement to avoid leakage accidents. The use of AR technology is to prevent the occurrence of danger, rather than to save the accident has occurred.

2.2. AR technology improves auditory display design.

The application range of sound transmission information is very large, because people's auditory response is fast and the range of perception is wide.^[4] We all know that the mine explosive storehouse is dangerous and the safety requirements are very strict, but some risk factors cannot be identified and

identified with the naked eye in time, which will cause very serious consequences. It is a good choice to use the sound alarm device and AR technology for the safety detection of explosive magazine, because the magazine design supporting facilities should have fire pool and fire shed, fire ditch, power supply, communication and lightning protection facilities, walls, etc. The AR technology can detect the surrounding heat, humidity, and tightness coefficient, and is represented by different parameters. For example, the blue and red colors indicate the heat distribution (Fig. 2), and when the heat around the explosives exceeds the safety factor, prompts and warnings are given;

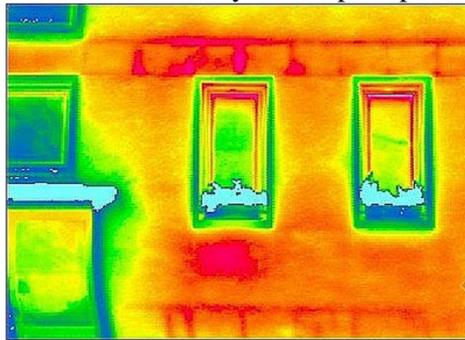


Figure 2 Heat distribution map



Figure 3 rigorous indication map

The rigor can be represented by a value of 0-10 (Fig. 3); the degree of humidity is represented by a plane coordinate system, the abscissa is time, and the ordinate is humidity, so as to show the change of humidity. Assume that, as shown (Fig. 4), the humidity requirement is below 3, which is acceptable. No matter how the curve changes, it can be as long as it is below 3. A final alarm is given when the humidity is above 3. As shown (Fig. 5), if the humidity suddenly increases at 8:00, the initial alarm is given when the change is too fast, and the alarm sound is a beep. The sound pressure level and frequency of the ringtone are only slightly larger than the buzzer sound, mainly in the quiet environment attracts people's attention. When the safety factor exceeds the safety factor at 9:00, the sound of the alarm becomes the sound of the alarm. This sound is strong, the frequency is from low to high, and the tone is raised and lowered, which is used as an alarm for dangerous situations. From this model, it can be seen that 8:00 is a sudden change node. At this moment, the cause of the problem can be found, for example, it is raining, water leakage, and a valve is not closed, so as to get a solution to prevent it from happening. This is more intuitive, easier to manage, and safer to produce.

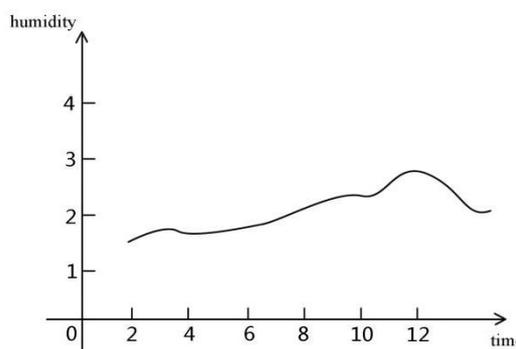


Fig. 4 Humidity Change Diagram (1)

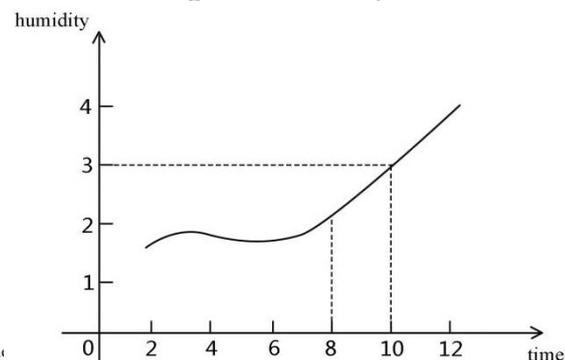


Fig. 5 Humidity Change Diagram (2)

This is the accident control strategy based on the key links and main methods of accident control. The above examples are only the technical principles in the 3E principle, because the technical countermeasures are one of the main measures to ensure safety. AR technology monitoring is a key technology based on careful research and analysis of potential hazards to predict, monitor and respond to hazards.

2.3. AR technology improves the working environment.

The light environment of underground operation is generally artificial lighting rather than natural lighting. Reasonable lighting and lighting in the work place are of great significance for the efficiency, safety and health in production. ^[5]Good light environment is the improvement of visual conditions on the one hand, on the other hand is the improvement of the environment. Wear AR glasses, you can create a reasonable level of illumination, so that the direction and diffusion of light is more reasonable, do not let the light directly to the eye. AR glasses can choose a reasonable light source color to coordinate lighting and hue, so that employees can concentrate more, reduce fatigue, improve labor enthusiasm and labor interest, thereby improving efficiency and attendance, and reducing labor accidents. The interactive experience is enhanced, the interaction between people and the environment, and the human-machine-environment form a coordinated system. In this system, the AR device improves the environment and enables the user to have a better working experience. For the enterprise, it improves the labor problem, improves management, reduces waste of materials and labor, improves production efficiency, and creates higher performance.

The mine air environment also needs to be monitored. The mine air mainly contains CO, SO₂, H₂S, H₂, N₂ and so on. These toxic and harmful gases are extremely harmful to the health and safety of underground workers in the mine. AR technology can detect the gas index in the mine air in real time. When a certain harmful gas content is too large, the user will be prompted. This prompt is a classification suggestion. If the hydrogen sulfide content is too large, it should be represented by the color and sound of hydrogen sulfide gas. So that when we know which gas is more than the conventional value, we can use the corresponding means to reduce it, using physical methods such as opening the ventilating ventilation, use chemical methods such as neutralization reactions. In addition, records will be kept in the long-term detection process and a database will be formed. Under the database model, users can know which harmful gases are prone to anomalies and find the source of problems. As mentioned in engineering psychology, technology is designed to meet human needs, display data in an appropriate way, and ensure that representation and task requirements are displayed. Therefore, the design or technology that is really considered for users should be seriously explored and considered.

2.4. AR technology enhances feature recognition.

This is for the layout and design of the ground pipe network system. We all know that the mining park needs to set up many pipes and lines. If the various pipeline lines are crossed together, it will be particularly irregular. Even if the order is not reflected in its individual characteristics, Easy to repair and replace, so the pipe network system needs to be easily identified. Applying characterization and AR technology to this part of the project can eliminate a lot of unnecessary troubles. The ground pipe network system has water and sewage pipes, compressed gas pipelines, high and low voltage power lines, communication lines, etc. If this part of the pipeline is laid and laid The form only considers its own layout requirements without considering or not fully considering the layout of other pipelines, which may cause pipeline congestion and conflicts, so there must be a master plan to determine the plane coordinates and elevation of various pipelines. AR technology simplifies this part of the operation, allowing various pipelines to be coordinated on the plane and on the facade, and to maintain the required connection between buildings, structures, and transportation lines. The safety distance, erection mode, laying depth, laying sequence, groove specification of the various pipelines are all specified in the safety technical regulations. These requirements are converted into computer language, and virtual 3D models are generated. Different pipelines are used in different colors and The thickness is marked, for example, green represents the compressed gas pipeline, red represents the transmission line, blue represents the tailings pipeline, and orange represents the communication line. This makes it easy to identify and classify, and it is easy to distinguish the nature of the pipeline and the line by using different visual features, which greatly facilitates the design and engineering technicians. (Fig. 6).

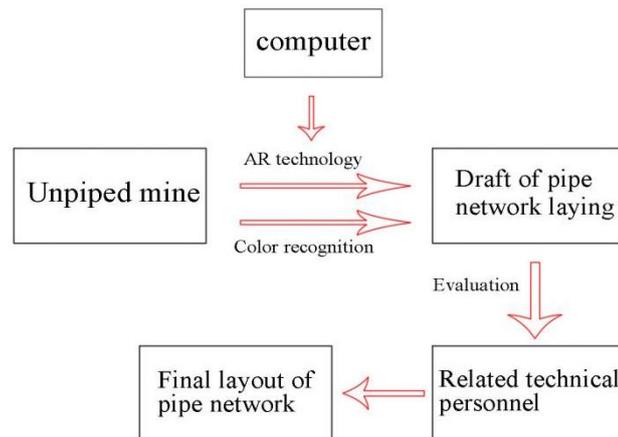


Figure 6 implementation model

3. Conclusion

Aiming at AR technology and mining industry, this paper puts forward a lot of applied research, and puts forward corresponding solutions for these application strategies. Because it is very difficult to combine high-tech with traditional industries, but there is a demand for this technology in the mining industry. Because these means and methods can be beneficial to the staff of the industry and the development of the industry, it is necessary to study the combination of the two from an academic perspective. In reverse engineering, there is a method called image reversal. It is based on the geometric dimension and color dimension information provided by the product digital image and video picture to realize the model reconstruction. Image reverse is a complex innovation process, generally using perspective transformation. And perspective projection, forming different perspectives, extracting geometric parameters from the information such as shape, size, proportion, color, etc., and then implementing the geometrical dimensions and the inverse of the color dimension through a professional system. This provides a solution method, through which the highway routing model and pipe network layout model mentioned above can be constructed, which is more conducive to construction. Although the industry of the future of augmented reality is optimistic, but after all, this is only a young industry into public view a few years. If these methods are implemented at home, we still need to look forward to the continuous improvement of AR technology. We believe that in the era of rapid development of science and technology, all methods can be effectively applied and all difficulties can be solved.^[6]

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