A Risk Identification and Early Warning System for Major Engineering Projects Based on Artificial Intelligence

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Abstract: Artificial intelligence (AI), as a hot topic in today's technology field, has shown enormous potential for widespread application in various fields. In the management of major engineering projects, its efficient and precise characteristics are particularly prominent. Traditional identification and early warning methods often have problems such as low efficiency and easy omission in identifying potential risk factors in major engineering projects. Therefore, risk identification and automatic warning systems based on AI technology have emerged, providing strong guarantees for the smooth progress of engineering projects. This system achieves real-time monitoring and analysis of various data in engineering projects through advanced technologies such as machine learning (ML) and big data analysis. By comprehensively processing multidimensional information such as environmental data, equipment status data, and personnel activity data, the system can automatically identify potential risk factors and provide real-time warnings based on preset rules and algorithms. This warning mechanism not only improves the accuracy of risk identification, but also greatly shortens the response time of warnings, providing valuable decision-making basis for project management personnel.

1. Introduction

As a branch of computer science and technology, AI aims to explore the essence of intelligent information and create an intelligent application machine that can simulate human thinking and behavior [1]. Its birth and development not only mark the tremendous progress of human technological civilization, but also demonstrate unprecedented application potential in multiple fields [2]. Especially in the management of major engineering projects, the application of AI technology has brought revolutionary changes to risk identification and early warning [3]. Major engineering projects, as an important driving force for socio-economic development, have quality issues directly related to people's life and property safety and social stability [4]. However, due to the complexity and uncertainty of engineering projects, identifying and warning risk factors has always been a difficult and painful point in project management [5]. Traditional risk identification and assessment methods often rely on manual experience and regular inspections, which are not only inefficient but also prone to overlooking potential risk factors, leading to accidents [6].

To overcome the limitations of traditional methods, risk identification and automatic warning systems based on AI technology have emerged. This system utilizes advanced technologies such as ML and big data analysis to monitor and analyze various data of engineering projects in real-time, thereby achieving automatic identification and early warning of potential risks [7]. This intelligent risk management model not only improves the accuracy and efficiency of risk identification, but also provides project managers with more comprehensive and timely information support, helping them better cope with various complex situations [8]. Specifically, AI based risk identification and early warning systems can comprehensively process and analyze multi-dimensional information such as environmental data, equipment status data, and personnel activity data in engineering projects, to discover abnormal patterns and potential risks. In addition, AI based warning systems

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can automatically trigger corresponding warning mechanisms based on the nature and severity of risks.

These early warning mechanisms can include sending alarm messages, displaying warning lights, activating emergency plans, and other methods, so that project managers can take timely measures to respond to risks. At the same time, the system can also predict potential risks based on historical data and trend analysis, so that project managers can prepare in advance and prevent the occurrence of risks. In summary, the AI based risk identification and automatic warning system for major engineering projects has important research value and practical application significance. It can not only improve the accuracy and efficiency of risk identification, reduce the probability and losses of accidents, but also improve the level and efficiency of project management, and promote the smooth progress of engineering projects. In the future, with the continuous development of AI technology and the expansion of application scenarios, this system will demonstrate its strong potential and value in more fields, making greater contributions to the development of human society.

2. Shortcomings in Risk Identification and Evaluation of Major Engineering Projects

2.1. The Limitations of Traditional Methods

As an important pillar of socio-economic development, the risk identification and assessment of major engineering projects are crucial for ensuring the smooth progress of the project and preventing potential losses [9]. However, traditional risk identification and assessment methods have exposed a series of shortcomings in practice, which to some extent affect the efficiency of project management and the effectiveness of risk prevention and control [10]. Traditional risk identification and assessment work largely relies on the subjective experience and qualitative analysis of experts. Although this approach has certain reference value, its accuracy and reliability are often questioned due to the lack of objective and quantitative data support. Especially in complex and ever-changing engineering project environments, it is difficult to comprehensively and accurately identify all potential risk factors based solely on experience. In addition, qualitative analysis is often influenced by the subjective factors of analysts, and different analysts may come to completely different conclusions. This difference may not only lead to inconsistent risk assessment results, but also affect the correctness and effectiveness of project decisions.

2.2. Difficulties in Data Acquisition and Processing

Major engineering projects involve a wide variety and large amount of data, and traditional data collection and processing methods are often difficult to cope with. On the one hand, incomplete or inaccurate data collection may lead to deviations in risk identification and assessment; On the other hand, slow data processing speed and low efficiency may make the risk assessment results unable to reflect the actual situation of the project in a timely manner. In addition, with the continuous development of information technology, new data collection and processing technologies continue to emerge, but many engineering projects still use traditional methods, which seriously restricts the efficiency and accuracy of risk assessment work. Traditional risk identification and assessment methods often lack systematicity and comprehensiveness. On the one hand, they often only focus on a certain aspect of risk factors, while ignoring other potential sources of risk; On the other hand, they often lack comprehensive analysis and evaluation of risk factors, resulting in inaccurate and incomplete risk assessment results. In addition, traditional risk assessment methods often lack analysis of the interrelationships and impacts between risks, and cannot reveal the complexity and correlation between risks. This makes it difficult for project managers to grasp the overall risk situation of the project and develop effective risk response measures.

3. AI Based Risk Identification and Automatic Warning System

3.1. Systems Design

In today's rapidly developing technology, AI has become an important force driving innovation and progress in various fields. Especially in the management of major engineering projects, the application of AI technology has brought revolutionary changes to risk identification and early warning. This article aims to explore the design of an AI based risk identification and automatic warning system, which achieves visualization, automation, and intelligent management of major engineering projects through video image analysis, real-time monitoring, and IoT technology. The structure is shown in Figure 1. In major engineering projects, video surveillance systems are one of the important means to ensure safety. However, traditional video surveillance often relies on manual inspection, which is inefficient and prone to missing important information. AI based video image analysis technology can achieve automatic processing and analysis of surveillance videos, extract key information, and provide strong support for risk identification. Specifically, AI algorithms can perform real-time analysis of surveillance videos and automatically detect key information such as personnel activities and equipment status at the construction site through technologies such as image recognition and target tracking.

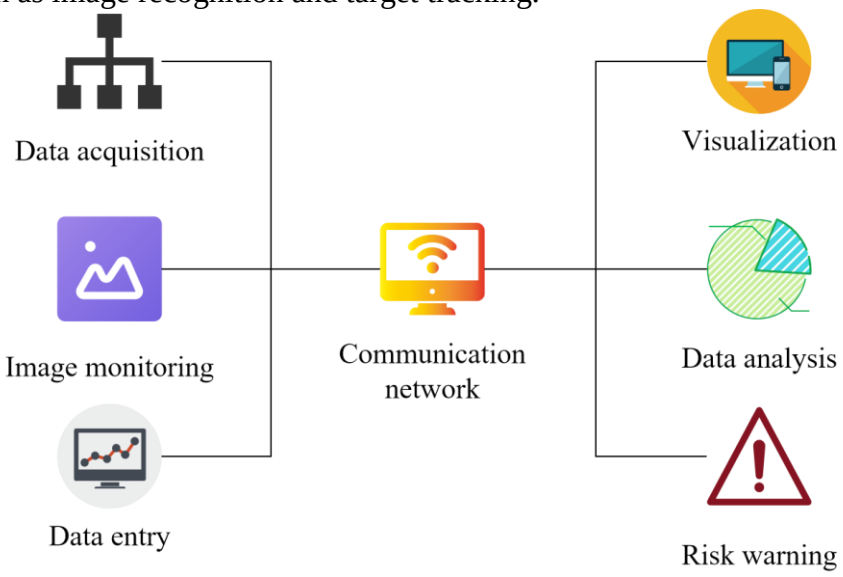

Figure 1: Structure of AI based risk identification and automatic warning system

At the same time, the system can also automatically identify and alarm for abnormal events, such as personnel violations, equipment failures, etc. Through this approach, comprehensive monitoring and risk warning of the construction site can be achieved, improving project management efficiency and safety. In addition to video image analysis, AI based risk identification and automatic warning systems also require the use of real-time monitoring and IoT technology to achieve real-time monitoring and data analysis of key indicators of major engineering projects. In terms of real-time monitoring, the system can collect key data such as temperature, humidity, and vibration of engineering projects in real time by deploying sensors, monitoring equipment, and other means. These data can be analyzed and processed by AI algorithms to promptly identify potential risk situations, such as structural damage, equipment failures, etc. Once the system detects an abnormal situation, it will automatically trigger an alert mechanism to notify project management personnel to take corresponding measures.

3.2. Algorithms and Experiments

Risk factor identification plays a crucial role in major engineering projects. With the help of AI technology, we can conduct in-depth and targeted analysis of conflict data in major engineering projects, thereby more accurately identifying potential risk factors. Set f as the warning processing level condition, which can be set and adjusted according to different risk levels. l

represents the conflict risk coefficient, reflecting the comprehensive impact of various risk factors in major engineering project conflicts. We can express the risk factor identification results of automatic warning for major engineering projects as:

$$D = \frac{\frac{f^2}{W} - l(s_1 + s_n)}{n\bar{j}} \tag{1}$$

Among them: s_1 is the first risk factor parameter; s_n is the n th risk factor parameter; $\bar{j}$ is the average identification of information related to major engineering project data.

The fuzzification of risk factors is a key step in the automatic risk warning method for major engineering projects, which is located at the end of the entire warning method construction process. Fuzzy processing helps to respond more flexibly to various potential risks in environments with high uncertainty and complexity. Set v_0, v_1 to represent the minimum and maximum application permissions for fuzzy normalization processing. These two parameters limit the scope and degree of fuzzification processing, ensuring that the processing results are neither too conservative nor too aggressive. In addition, $\bar{z}_{\max}$ represents the maximum input coefficient of risk factors for major engineering projects. By considering the value of $\bar{z}_{\max}$, we can more accurately evaluate the impact of risk factors and develop appropriate warning instructions based on this. Based on the above parameter settings, we can express the fuzzification effect of risk factors as follows:

$$K = \frac{1}{D}\int_{v_0}^{v_1} \frac{\lambda \cdot \bar{z}_{amx}}{\alpha_0^2 + \alpha_1^2} d\bar{z}_{amx} \tag{2}$$

In the formula: λ is the established fuzzification practice indicator; α_0, α_1 inputs permission coefficients for two different major engineering project risk factors.

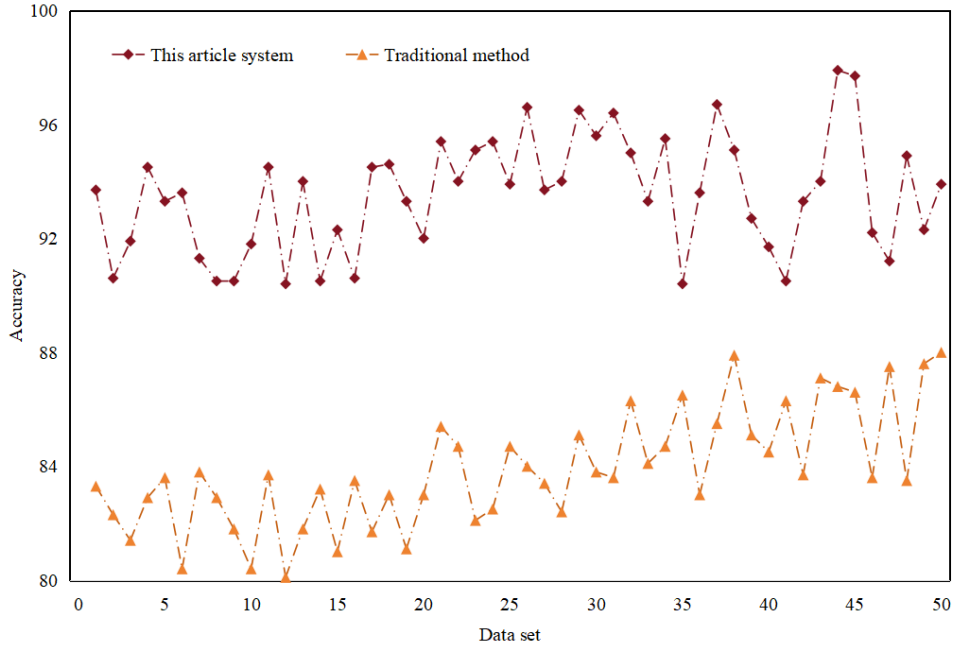

Figure 2 Comparison of recognition accuracy

Figure 2 shows the comparison between our system and traditional manual identification methods in terms of risk identification accuracy. It can be seen from the figure that our system often outperforms traditional manual identification methods in terms of risk identification accuracy. This is mainly because AI technology has powerful data processing and analysis capabilities, which can process large amounts of data and extract useful information from it. In addition, AI technology can

also automatically learn and optimize recognition models to adapt to constantly changing risk environments and patterns. In contrast, traditional manual recognition methods are often limited by human experience and cognitive abilities, and cannot handle large amounts of data and complex recognition tasks. In addition, manual recognition is also affected by subjective and fatigue factors, leading to a decrease in recognition accuracy.

4. Conclusions

After in-depth research and practical application of risk identification and automatic warning systems based on AI technology, we have come to the following conclusions. Compared with traditional manual warning methods, AI technology has shown significant advantages in automatic warning of major engineering projects. This system can not only study the qualitative ability of major engineering project data, but also calculate accurate risk rate numerical results through advanced algorithms and models, providing quantitative risk assessment basis for project management personnel. The risk identification and automatic warning system based on AI technology integrates advanced technologies such as ML and big data analysis to achieve real-time monitoring and analysis of various data in engineering projects. The system can collect and process multi-dimensional information such as environmental data, equipment status data, and personnel activity data in real-time. Through comprehensive processing and analysis of this data, the system can automatically identify potential risk factors. Compared with traditional warning methods, this AI based warning mechanism not only improves the accuracy of risk identification, but also greatly shortens the response time of warnings. The system can automatically classify and evaluate identified risks based on preset rules and algorithms, and issue real-time warning signals. This enables project management personnel to be informed of the risk situation in the first place, take quick response measures, and effectively avoid or reduce the impact of risks on the project.

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