Research on Natural Disaster Early Warning System Based on UAV Technology

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Abstract. Unmanned aerial vehicle (UAV) and low-altitude remote sensing technology can provide a new technical way for remote sensing monitoring tasks in large-scale and dangerous areas. Through the monomer and visual information query of BIM model, they are organically integrated into the disaster occurrence traceability system, forming a "1+4+N" (a disaster system early warning center, four basic platforms for video surveillance, data service, information sharing and intelligent planning, and the application of multiple scene topics) structure system in disaster system construction. That is, to carry out intelligent, information-based and systematic disaster scenario simulation, prediction analysis and rescue measures, so as to achieve the visual goals of comprehensive control of information, rapid rescue response and ensuring personal safety, and form an integrated natural disaster early warning system.

1. Introduction
In recent years, with the rapid development of China's urbanization process, the fire safety problem has become increasingly severe. Satellite remote sensing and manned aerial remote sensing technologies currently used in China are vulnerable to the influence of time and space resolution and external environment when acquiring disaster information, which has caused great potential safety hazards to the fire rescue personnel's own safety during emergency rescue and disaster relief. In addition, it is difficult to obtain all kinds of investigation information required by on-site command quickly and comprehensively, which poses new difficulties for commanders to make scientific decisions, accurately judge and acquire information. In terms of data sources and data processing of UAV technology, it has the characteristics of high timeliness and high precision, and can obtain information intuitively and accurately. Through BIM, the layout information of fire protection facilities in each floor of the building is integrated, and Pathfinder evacuation route simulation is combined with UAV technology, and natural disaster early warning system research is carried out, so as to formulate rescue strategies and control fires in the shortest time, reduce unnecessary losses caused by fires, ensure personal safety and reduce property losses.

2. BIM Technology, Pathfinder and UAV Technology

2.1. BIM model data
BIM model is not only a digital model, but also a digital process, and its core lies in informationization and visualization. BIM model data has the characteristics of completeness and consistency, which can truly reflect all engineering information of buildings[1]. Applying BIM model and data to disaster
research can provide model data and information parameters of shared information for disaster research, which not only improves the utilization rate of information, but also accurately locates the floor where the disaster occurred and queries the corresponding information of the floor.

2.2. **Pathfinder**
Pathfinder evacuation and escape simulation system can carry out emergency evacuation and escape in different environments and scenes. In addition, synchronous simulation can analyze the relevant data of evacuation and enhance the scientificity and accuracy of experimental data. Through such intuitive and scientific data, the best escape route can be worked out in the shortest time. Through the relevant data such as escape route and time established by Pathfinder, pedestrians' behavior will react with the change of evacuation environment after evacuation, and choose the best evacuation route. And judge whether it can ensure the safe evacuation of personnel in emergency[2]. If it can not meet the safety evacuation of personnel in disaster, it is necessary to optimize the configuration of building safety facilities and improve the building's ability to respond to sudden accidents such as fire.

2.3. **UAV technology**

2.3.1. **UAV technology application.**
Unmanned aerial vehicle remote sensing can be applied and managed in UAV application fields such as land surveying and mapping, earthwork survey, natural disaster detection, forest patrol, image aerial photography, etc. , using unmanned aerial vehicle, remote sensing sensor, GPS and other technologies, we can quickly obtain local, environment, resources and other spatial remote sensing information, and complete the analysis, BIM modeling and comprehensive application of remote sensing data information[3]. The real-life modeling technology of UAV tilt photography is to collect high-resolution aerial photos by using the trinity of UAV, pan/tilt camera, integrate positioning control points, aerial survey calculation and other technologies, and establish a real-life geographic model with high simulation degree by using professional terrain calculation software.

2.3.2. **UAV data sources and data processing.**
Make use of Dajiang Elf 4RTK and Yu 2Pro equipment to model a school in Tianjin. The data result is the data source. Import the image file into Smart 3D, add POS (Position and Orientation System) data, and select the corresponding coordinate system. Then, import control points and carry out puncturing control points on the photos. After the puncturing points cover about 75% of the total number, carry out aerial triangulation, and then view the 3D view. Presenting the real world as a parameterized image provides scientific and reliable information basis for the efficient decision-making of public emergencies[4]. According to the ContextCapture software, the 3D visual building information processing of the photos taken by unmanned aerial vehicles is carried out, and it is assumed that in the event of a public emergency, the route planning, area and volume measurement of the building can be quickly completed in the software, so that the accident site can be fully presented with information, which has obvious advantages in disaster assessment.
3. Application of UAV, BIM+Pathfinder in Fire Emergency Prevention and Control

3.1. The combination of BIM model and unmanned aerial vehicle remote sensing

According to BIM model, the detailed building information is loaded into the building model through parameterized objects, and at the same time, the original appearance of the building is restored to the greatest extent. Therefore, in the aspect of fire emergency prevention and control, firefighters can quickly retrieve the complete information of buildings and understand the characteristics of buildings. According to the advantages of UAV aerial remote sensing system, such as strong effectiveness, high sensitivity, high image resolution and low cost, BIM information is connected with UAV systematic information to achieve perfect cooperation. Providing disaster information for rescue workers in the shortest time has decisive advantages in formulating rescue strategies, thus improving rescue speed and reducing personal and property losses[5].

Compared with the traditional satellite remote sensing and manned aerial remote sensing, which are affected by time-space resolution and external environment when acquiring disaster information, unmanned aerial vehicle remote sensing has three advantages: flexibility, quick data acquisition and low-altitude flight. Combining BIM model, the data of various specialties of the project are included, the original appearance of the building is truly restored through 3D visualization model, and data sharing is realized. By understanding the structural characteristics of the building, the avoidable loss caused by fire can be prevented in advance, and a reasonable and efficient fire fighting plan is formulated, which just makes up for the gap of traditional technology. The combination of BIM model and unmanned aerial
vehicle remote sensing has obvious advantages in disaster prevention and relief decision-making and disaster assessment, which provides an accurate basis for the formulation of disaster prevention and mitigation and rescue plans.

3.2. The combination of BIM model and Pathfinder
Pathfinder software contains the simulation design and implementation of image user interface and 3D visualization tools. During the process of building 3D grid model, such as room, entrance, stairs, pedestrians, etc., 3D simulation is carried out to analyze emergency evacuation, disaster situation and rescue measures, simulate evacuation routes, obtain the dynamic process of evacuation intuitively and clearly, record evacuation related data, and calculate detailed result reports, thus providing reliable basis for evacuation scheme optimization.

According to relevant data such as escape route and time established by Pathfinder, it can be judged whether it can ensure the safe evacuation of personnel in emergency. If it cannot meet the requirement of safe evacuation of personnel in disaster, it is necessary to optimize the configuration of building safety facilities and improve the building’s ability to respond to sudden accidents such as fire. We can name the rooms on each floor through the BIM model of the building, count the layout of fire-fighting equipment in each floor, walkway and room according to the actual floor situation, and export the data for archiving, so as to assess the ability of the building to cope with the fire to the maximum extent in case of fire. Combining BIM with Pathfinder software, this paper analyzes the floors and stairs as the main escape routes, plans the best escape route, and improves the emergency response ability of buildings to emergencies.

![Figure 3 BIM model](image)

Taking the comprehensive teaching building of a school in Tianjin as an example, it is assumed that when a fire occurs, the smoke height determined by the fire smoke alarm system can be used as an index to evaluate the evacuation safety, and the available evacuation time under the minimum height of critical smoke can be obtained. The evacuation simulation is carried out through personnel quantification, and the necessary evacuation time is obtained and compared with the available evacuation time, and the BIM model of the comprehensive teaching building can be evaluated and optimized to achieve the goal of the lowest potential safety hazard. If the requirements are not met, the data will be fed back to the school safety department. After discussion, it is decided that the safety factor of the building can be improved by increasing the layout density of fire-fighting equipment such as sprinkler, fire box, thermal sensor and fire panic button. According to the BIM model provided by the school and the information about the number of daily classes in the teaching building, the relevant settings are made in Pathfinder software for escape simulation. Finally, it is concluded that the teaching building can effectively simulate the fire situation of the teaching building and the safe evacuation of personnel. Therefore, it has
important guiding significance for standardizing the fire prevention management of domestic buildings and the safe evacuation of personnel when disasters occur.

Figure 4  Pathfinder escape simulation

3.3. Application of UAV tilt photography information technology in natural disasters

In view of the current situation that the domestic satellite map software has not reached the level displayed by 3D architectural entities all over the country, the following two reasons are summarized. First, the department uses map software for civil use. The panorama is captured by a special shooting car. Laser point cloud mapping technology is used. Because this technology is expensive to use, the remote low area will be abandoned[6]. Second, at present, the pictures taken by satellites in China are not up to the centimeter-level high-precision level of the United States, so it is difficult to transform the map images into 3D real-life maps. If you rely on the help of the authoritative ground survey team, the cost will increase significantly, and you can't achieve full coverage in China.

Therefore, UAV tilt photography technology is an excellent choice. First, reflect the real situation around the ground objects. Oblique image technology can view the image information of ground buildings and natural landscapes from multiple perspectives, and truly reflect the actual situation. Deep information of the side can be obtained according to oblique photography. Second, measure a single image. The measurement of required information can be completed by using measurement software such as Camera Measure. Third, share the data format of network distributed oblique images in real time. By transmitting the information data of images, applications can be shared quickly and conveniently. Fourthly, collect the side texture of the building. Make use of the advantages of aerial photography and the method of batch extraction and texture mapping of oblique images.

Figure 5  Real-life modeling analysis of UAV
4. Natural disaster early warning system

4.1. Build data information
Based on UAV technology and BIM+Pathfinder technology, a natural disaster early warning system is built, which can enable technicians to obtain digital images of the disaster area in a short time when the disaster occurs, and provide effective data information for building the disaster area model. Technicians can accurately map the topography, rivers, soil, road distribution and surrounding information of the disaster area through various mapping tools, and can summarize all kinds of important disaster information in the disaster system, so that it can be presented in the database of the disaster relief command center in a very intuitive and clear way. On the basis of the geographical model, a comprehensive BIM model including the information of main traffic arteries, rivers and core disaster areas is established, which provides scientific and accurate decision-making basis for emergency mobilization and development of various emergency rescue and disaster relief work.

![Data information construction of disaster occurrence traceability system](image)

4.2. System route planning
Based on the basic data collected by the natural disaster early warning system, the early warning area is analyzed, and the basic information is clearly reflected. The system automatically carries out intelligent analysis and planning on the site, combining with ground command, integrating early warning, exploration and command, and imaging in real time, which makes the analysis process clearer, more intuitive, reliable and accurate, and provides complete information for the preparation of plans and rescue work. The information obtained by the handheld ground station is fed back to the communication base station, and the command center use the server to convey the information and take measures.

4.3. Comprehensive analysis of system data
Combining BIM+Pathfinder information and UAV technical information, this natural disaster traceability system forms a "1+4+n" structure system (a natural disaster system early warning center, four basic platforms for video surveillance, data service, information sharing and intelligent planning, and the application of countless scenes and topics) in the construction of disaster system management platform. Integrate UAV data information, BIM model information and Pathfinder information into natural disaster early warning system, access operation information such as video surveillance and personnel management, conduct fire drills and route planning, complete the construction of N thematic data information bases, and achieve "one system" to look at disaster data analysis measures, realize comprehensive perception of the operation situation of disaster early warning system, comprehensively perceive and monitor disaster areas, predict and analyze disasters, analyze the optimal rescue route, and analyze points and lines by using buffer zones.
Figure 7 Natural disaster early warning system

Architecture of natural disaster early warning system based on UAV technology and BIM informatization

Disaster operations management center
Video surveillance sharing platform
Data resource service platform
Public information decision-making platform
Intelligent monitoring and analysis
Intelligent planning, operation and maintenance
Disaster summary archived
Scene restore thematic application

Input real-time disaster situation, comprehensive uploading down
Monitoring environmental changes and predicting potential disasters
Analyze data information and systemically summarize disaster situation
Build the comprehensive model and provide the decision basis
Remote sensing disaster monitoring, buffer analysis of disaster situation
Plan rescue routes, real-time sensing operation and maintenance
Summarize the situation of the disaster area, file and keep the measures
Restore the real time disaster situation and perceive the disaster situation

Figure 8 "1 + 4 + N" Disaster early warning structure system

5. Conclusion
The unmanned aerial vehicle (UAV) technology +BIM model's monomer and visual information query, combined with Pathfinder simulator, organically integrate the three technologies into the disaster occurrence traceability system, and form a "1+4+N" (one disaster system early warning center, four basic platforms for video monitoring platform, data service platform, information sharing platform and intelligent planning platform, and N special scene applications) structure system in disaster system construction. Intelligent, informationized and systematic disaster prediction, analysis and rescue measures can be carried out, so as to achieve the visual goals of comprehensive control of information, rapid rescue response and ensuring personal safety. To achieve "one system" to look at the disaster data for planning and early warning, realize the operation perception of the natural disaster early warning
system, comprehensively perceive and monitor the situation of the disaster area, monitor and analyze the disaster situation, analyze the causes of the disaster and rescue measures, formulate the best rescue route, so as to ensure the safety of personal and property and reduce the loss of the national economy, and finally keep the case on file.

Acknowledgments
This paper was supported by Tianjin University Renai College Special projects of Natural Science (XX20007) "Research on the influence mechanism of collaborative governance of construction supply chain under BIM + IPD mode", and 2020 Tianjin University Students Innovation and entrepreneurship training program (202014038059) "Design and research of disaster occurrence traceability system based on BIM + GIS fusion technology".

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