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Research on Key Technologies of Earthquake Emergency Response Based on Multi-Sensor Data

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Keywords: Multiple remote sensing sensing data, Earthquake emergency response, Key technology

Abstract: Remote sensing has achieved good application in disaster monitoring, and also exposed some problems in earthquake remote sensing emergency monitoring. This paper mainly introduces the demand for remote sensing data under different geographical environments, existing remote sensing data sources and actual earthquake cases in earthquake emergency remote sensing monitoring and evaluation, especially the use of high-resolution radar remote sensing data to successfully identify a large number of landslides and barrier lakes caused by earthquake disasters, and determine their distribution and scale, Measure the area, length, etc. When remote sensing images before and after earthquakes are from different sources, a post-classification change detection method based on object-oriented combination is proposed to overcome the requirements of traditional change detection for data type and time consistency, and realize multi-sensor data assimilation and information collaborative processing. The rapid development of multi-remote sensing sensing technology provides a timely and effective technical means for earthquake disaster monitoring and disaster assessment. This paper focuses on the research of multi-mode remote sensing image seismic disaster information identification and disaster dynamic change monitoring methods before and after the earthquake, and explores the intelligent and automatic remote sensing earthquake emergency application of multi-mode remote sensing data collaboration.

1. Introduction

A large earthquake has the characteristics of wide damage range, strong suddenness and large deformation. It can effectively reduce the damage caused by the earthquake to carry out rapid disaster assessment and start emergency response as soon as possible after the earthquake. Space-to-Earth observation technology has the characteristics of macro, fast and wide coverage, which provides an effective way to obtain disaster information and plays an important role in earthquake emergency. However, despite the continuous improvement of image acquisition ability, the ability of earthquake remote sensing information processing is insufficient, and the collaborative analysis method of multi-source image data is lacking, which leads to a low degree of mining useful information from massive data, and there is a serious imbalance between remote sensing image acquisition ability and information processing ability [1].

The rapid development of multi-remote sensing technology provides timely and effective technical means for earthquake disaster monitoring and disaster assessment. This paper focuses on the methods of earthquake damage information identification and disaster dynamic change monitoring of multi-mode remote sensing images before and after the earthquake, and explores the intelligent and automatic remote sensing earthquake emergency application of multi-mode remote sensing data collaboration. Because remote sensing technology is macroscopic, timely and dynamic, and can get images in the same region, combined with the characteristics of rapid computer processing, it is incomparable to conventional earthquake disaster investigation technology. Aiming at the confusion and inefficiency of remote sensing emergency mode after earthquake, a remote sensing earthquake emergency response framework with multi-mode data collaboration in complex space-time environment composed of mechanism system, strategy system and key technology system is put forward, and the corresponding earthquake emergency strategies and requirements are deeply analyzed [2-3]. Towns and villages were directly buried by landslides or submerged by dammed lakes, which caused heavy casualties, a large number of roads were damaged and traffic was blocked, which brought unimaginable great difficulties to rescue work.

By suggesting the selection of radar imaging parameters to data providers, the geometric distortion and information loss of radar images are greatly reduced and good imaging results are achieved. During the monitoring, the products of this level have been geocoded and ellipsoid corrected, which can meet the basic requirements of rapid interpretation and analysis. Remote sensing has achieved good application in disaster monitoring, and some problems have also been exposed in earthquake emergency monitoring. This paper mainly introduces the demand for remote sensing data, existing remote sensing data sources and actual earthquake cases in different geographical environments in earthquake emergency monitoring and evaluation, especially the use of high-resolution radar remote sensing data to successfully identify a large number of landslides and dammed lakes caused by earthquake disasters, and determine their distribution, scale, measured area and length, which makes them have a strong three-dimensional sense for mountain imaging [4]. This advantage has been well reflected in the emergency monitoring of Wenchuan earthquake, especially in the identification and characteristic analysis of landslides and dammed lakes, and reported to the State Council General Office, Ministry of Water Resources, Ministry of Land and Resources, State Seismological Bureau and rescue forces in time.

2. Multiple Remote Sensing Data Sources

When the remote sensing images before and after the earthquake are of the same origin, a method based on the correlation change detection of principal components of multiple texture features is proposed, which makes full use of the rich texture features in the image and avoids the redundancy of information; When remote sensing images before and after earthquakes are of different sources, a post-classification change detection method based on object-oriented combination is proposed to overcome the requirements of traditional change detection for data type and time consistency, and realize multi-sensor data assimilation and information collaborative processing [5-6]. When a large earthquake occurs, strengthening the analysis and research of geological structure background will help to scientifically explain the cause of the earthquake. Therefore, the first application of remote sensing in earthquake damage investigation and research is the analysis of seismic tectonic background. In the emergency monitoring and assessment of Wenchuan earthquake damage, multi-source, multi-temporal and high-resolution radar remote sensing data, including the new radar data TerraSR-XA and COSMO-SkyMed, were used. The system parameters of the two satellites are shown in Table 1.

Table 1: Parameters of Radar Satellite System

Satellite launching country		Germany	Ltaly
Satellite		COSMO-Sky Med	COSMO-Sky Med
Launch time		2007-06-15	2007-06-08
Track parameters	Track type	Solar synchronous orbit	Near-polar solar synchronization
	Recurrence	11d	16d
Sensor parameters	Incidence angle	25°- 65°	25°- 68.4°
	Irradiation direction	Right	About

These phenomena will bring many difficulties to interpretation and cause serious lack of information. According to the practical application of historical destructive earthquake and Wenchuan earthquake, the processing methods of remote sensing data include image preprocessing and information extraction. The preprocessing of remote sensing data includes image correction, mosaic and enhancement. Remote sensing data is distorted because of the instability of the shooting platform, so it is necessary to correct its geometry, eliminate its distortion and locate it in space [7]. It shows that the effective discrimination of building damage by remote sensing images requires a spatial resolution image of about 1m and the ability to repeatedly image the disaster area every day. In the emergency monitoring and evaluation of Wenchuan earthquake damage by radar remote sensing.

3. Remote Sensing Monitoring and Evaluation of Earthquake Disasters

3.1 Analysis of Geological Structure Background

From a global perspective, the distribution of seismic active zones and active tectonic zones is roughly consistent, which shows that the occurrence of earthquakes is closely related to active tectonic zones, especially active fault zones. In terms of geological structure, the Longmenshan fault zone is composed of a series of compressional and compressional faults and folds. In terms of geomorphic unit, the area is located at the western edge of the Sichuan Basin, with Dengjiu Mountain in the north extending south to Erlang Mountain in the west, and converging with Jiajin Mountain in the north and south. The seismic zone appears on the huge fracture zone or tectonic zone of the crust that is still active today. A large number of collapses and landslides triggered by the earthquake provide rich material sources for debris flow activities, which will promote the activity of debris flow, and are prone to debris flow disasters under the action of rainstorm [8].

In the remote sensing images with different spatial resolution, the manifestations of collapse and landslide are different, and the image features of post-earthquake geological disasters and background geological bodies such as hue, texture and vegetation are significantly different. The main part of the earthquake-stricken area belongs to the Qingyi River basin. The upstream is the Baoxing River, which joins the Tianquan River and Rongjing River near Feixianguan Town, Lushan County. Other main tributaries include the Zhougong River, etc. [9] The geological structures with seismic zones are generally characterized by large scale in space, so the spatial resolution of remote sensing data for investigating the seismic tectonic background does not need to be too high, and the medium-resolution remote sensing data can meet its requirements.

3.2 Regional Building Collapse Assessment

The rescue site environment is complex and changeable. In order to ensure the accuracy of detection and the efficiency of rescue, a variety of detection equipment are usually used to jointly detect the same area, and the multi-remote sensing data obtained by detection need to be managed and analyzed in a unified way [10]. The interpretation of post-earthquake remote sensing image data obtained by multi-remote sensing can quickly grasp the macro disaster situation in the disaster area, and the detailed disaster situation such as the collapse rate of buildings in the disaster area can be obtained after detailed analysis of the data, which is of great significance for evaluating or predicting casualties after the earthquake and is also an important basis for guiding rescue.

Houses are damaged, the arrangement of houses is no longer regular, the texture structure characteristics of houses change, the dihedral angle reflection effect weakens, and the roughness increases, which makes the echo generally enhanced, but the texture structure characteristics disappear, and the radar image features are highlighted targets in a certain area, and the arrangement relationship and shadow of houses cannot be seen. The organization and management of multi-remote sensing data focuses on how to express, store, correlate and query the real entities and their state changing with time. The quality of the organization and storage mechanism adopted directly affects the efficiency of data query and retrieval [11]. Therefore, the organization and management of multi-source, multi-resolution, multi-temporal and heterogeneous data focuses on how to build a scientific and efficient organization and management model, which organizes data from three dimensions: time, space and business, as shown in Figure 1.

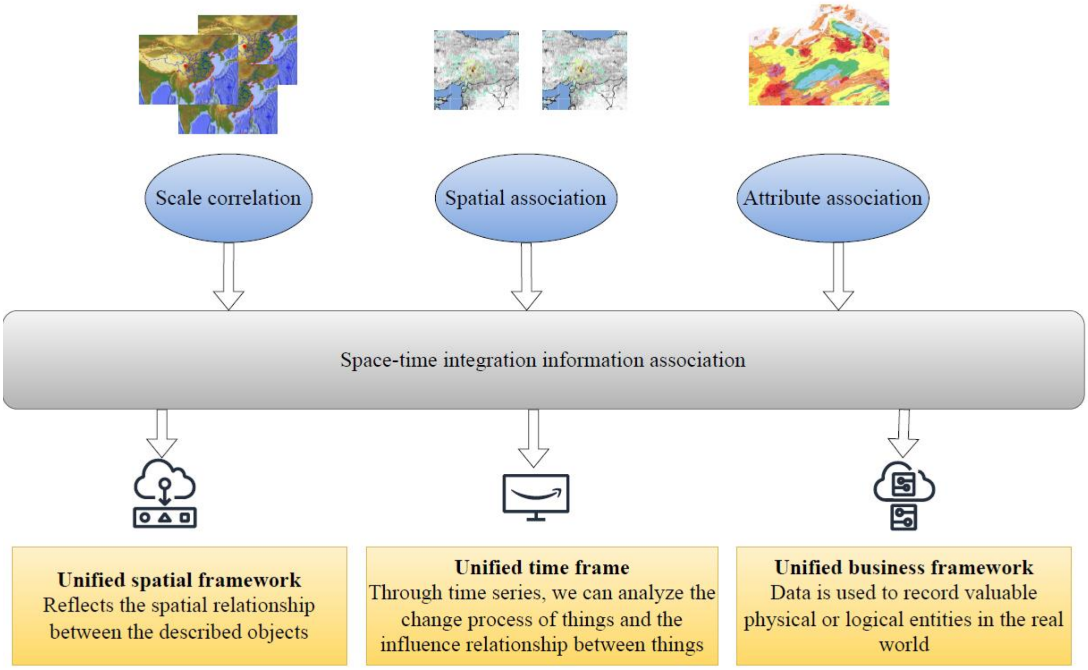

Figure 1: Data Organization Association Model under the Unified Space-Time Framework

Due to the large data size of remote sensing data, the remote sensing operation has the characteristics of inter-band correlation and inter-phase correlation. A single operation involves a large amount of data, which is limited by the memory capacity of hardware infrastructure. Considering that the earthquake-stricken area is a high and prone area of geological disasters before the earthquake, affected by heavy rainfall, geological disasters of different scales often occur in Lushan, Baoxing, Tianquan and other counties in the rainy season every year; Therefore, in the interpretation process of post-earthquake geological disasters, we must refer to the remote sensing images before the earthquake, so as to exclude the geological disasters caused by rainfall. The need for frequent access to external memory results in the low level of high performance processing of current remote sensing algorithms. The most convenient way for remote sensing images is to use parallel tasks to accelerate processing.

3.3 Damage Assessment of Lifeline Engineering

When sudden natural disasters such as earthquakes occur, lifeline projects will be damaged to varying degrees. At present, only roads, bridges, reservoirs and dams can be monitored and damaged by remote sensing. Spatial data integration should integrate spatial data by choosing suitable spatial expression and spatial data organization methods under the conditions of unified space-time model and unified geographical benchmark. The specific combination of hue, texture and geometric shape of geological disasters displayed in remote sensing images is called the direct interpretation sign of geological disaster identification, and the abnormal mutation of topography, vegetation, water system and landscape ecology caused by geological disasters can provide indirect signs for the determination of geological disasters. After the Wenchuan earthquake, a series of beaded landslides and dammed lakes occurred along the Kuijiang River. Tangjiashan dammed lake was the most serious secondary disaster induced by the earthquake. The continuous rise of water level caused part of the water in the scenic spot of Zhicheng. Solve the problem of data access and efficient loading. Using multi-remote sensing spatial analysis technology, the attribute information such as elevation and slope of earthquake secondary geological disasters is extracted. The technical process of remote sensing interpretation of seismic secondary geological disasters is shown in Figure 2.

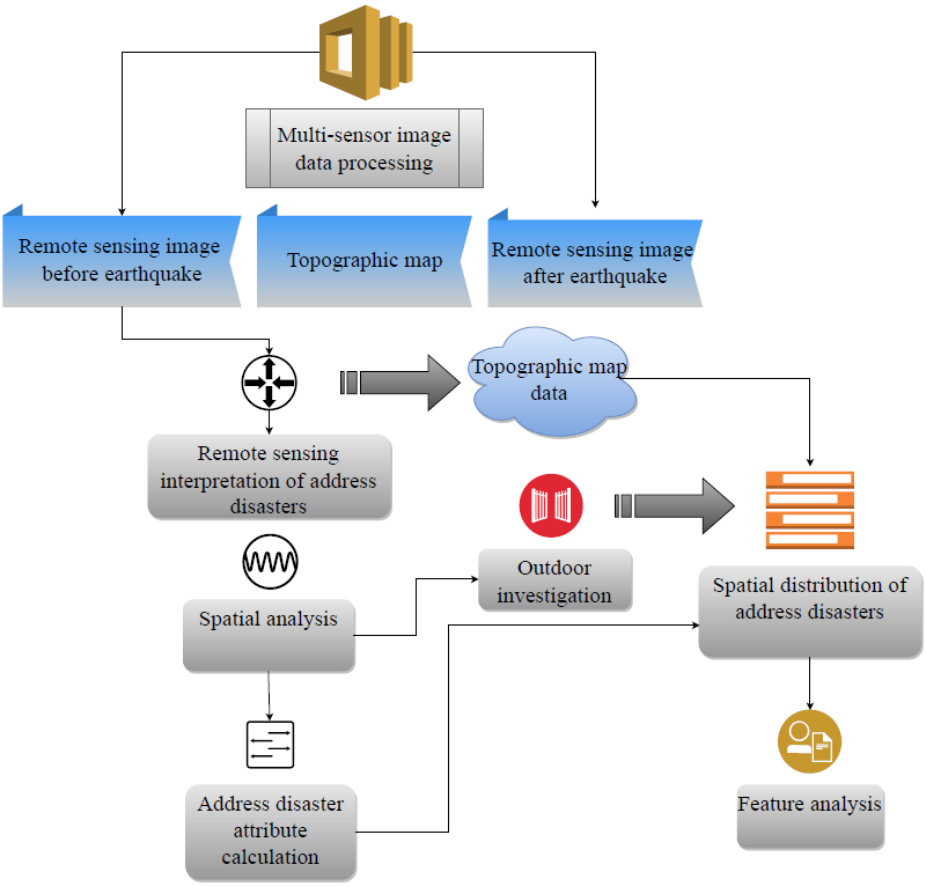

Figure 2: Technical Process of Remote Sensing Interpretation of Post-Earthquake Geological Hazards

In order to meet the demand of data call under multiple conditions of space and time, it is necessary to analyze and predict the spatial range and view-related data displayed in the window, such as view position, view target, view movement, view rotation and other elements. According to the monitoring of the Wenchuan earthquake landslides, large-scale landslides usually occur in the valley with a large number of mountain overhangs. The seismic activity induces the rock collapse of the mountain, causing landslides, blocking and blocking the river, and water storage to form a lake, namely the barrier lake. Storing all the image data directly into the memory exceeds the memory management capability of the operating system. Therefore, it is necessary to optimize the memory management of remote sensing operations to make use of the large memory of the current computing resources and achieve the effect of high-performance computing.

4. Conclusions

Multi-remote sensing technology plays an extremely important and indispensable role in all kinds of disaster monitoring because of its all-weather and all-weather imaging ability and strong stereoscopic effect. The extraction of disaster information from remote sensing images has developed from the initial manual visual interpretation to the computer automatic classification stage. Through the research and exploration of many experts, although a variety of methods for automatic extraction of earthquake damage have been developed, most of these methods are based on multi-period unified sensor images before and after the earthquake to monitor changes. When the earthquake occurs in different areas, the demand for remote sensing images is different. When the earthquake occurs in plain areas, it mainly monitors the damage of houses. The hazards of secondary disasters, such as sand liquefaction, sand blasting and water bursting, are not very urgent, but it is generally difficult to obtain such ideal data after the earthquake. It is very difficult to extract interested information by processing multi-phase images from different sources and single-scene images after the earthquake. Multi-remote sensing technology has comprehensively displayed various types of data such as geographical data, environmental data, detection data, etc. in the disaster area, realizing the fusion expression of high-precision life detection information and multi-source complex environmental data under a unified time and space framework, assisting commanders to carry out rescue command and dispatch, and improving the work efficiency of emergency rescue. Generally, the geological structures with seismic zones are of large scale in space, so the spatial resolution of remote sensing data for investigating seismic structural background does not need to be too high, and the remote sensing data with medium resolution can meet its requirements.

Acknowledgments

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