Analysis on the Research Progress of Remote Sensing Image Change Detection Method

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Abstract: Remote sensing image change detection is the detection process of determining the surface change area and change feature type for the same image area from multiple time series remote sensing data. It is the core technical means of land use change detection and land cover change detection, and it is also the key research field of remote sensing applied science. In view of the problems of time-consuming, labor-intensive, and low detection accuracy in the past image change detection methods, researchers in related fields have proposed more and more cutting-edge remote sensing image change detection methods. This article first describes the development of remote sensing image change detection methods, then explains the conventional processing flow of change detection and the conventional methods of change monitoring, and finally discusses the research progress of more mainstream change detection methods.

1. Introduction

Remote sensing is a technology that uses various sensing devices to detect the object without contact with the object itself, and to receive information from the target object, and remote sensing image change detection is an important research field in the field of remote sensing. In recent years, with the rapid advancement of science and technology in my country, remote sensing image change detection technology has become a key core technology for updating national conditions data, and a large number of studies have applied it to natural disaster monitoring [1], urbanization expansion monitoring [2] and other territorial fields.

The essence of remote sensing image change detection is to use remote sensing images of different time phases to identify the dynamic monitoring of changes in surface features over time in the same area. The change refers to whether the feature has changed or not, whether the location of the feature has changed, the type of change and the temporal and spatial distribution characteristics of the change. The general processing process consists of four parts: data selection, data preprocessing, change information extraction, and accuracy evaluation. A large number of researchers have done a lot of research in data selection (Zhu Fangyan, 2019) and data preprocessing (Yun Hongquan, 2019) in order to improve detection accuracy. Results.

However, with the continuous update and iteration of big data artificial intelligence technology and hardware and software equipment, scholars are more enthusiastic about the research of change detection technology, and they have developed a higher level of automation and better detection results for object change detection methods. Due to the disadvantages of time-consuming, manpower-wasting, and poor detection accuracy, the change detection technology of this paper is gradually abandoned.
This article will focus on the core technology of change detection method to explain the latest progress of current research accordingly.

2. Development context of change detection methods
Since the 1980s, the development process of remote sensing image change detection technology has been more than 40 years. Many scholars at home and abroad have successively developed different types of change detection methods based on remote sensing images. In the entire development period, it can be roughly divided into four development stages, namely:

Firstly: the budding stage of change detection: The change detection method first appeared in this period. In this stage, since the spatial resolution of image data sources used in various countries is mostly low and medium resolution, it is difficult to construct objects due to blurry pixels. As the basic detection unit, it analyzes the spectral feature difference between pixels based on one pixel and one pixel to extract the changed feature information, including the difference method, ratio method, regression analysis method and the direct comparison method, etc.

Secondly: the rise of change detection: While the rapid development of machine learning technology, it also injected new life into change detection. During this period, the change detection methods proposed by various scholars improved the level of automation to a certain extent, such as support Vector machine (Chu Yanli, 2016), decision tree (Li Fangfang, 2008), random forest (Liu Xia, 2020), artificial neural network and other machine learning methods are widely used in the research of remote sensing image change detection. These theories and technologies have made the change detection accuracy to a certain extent. Big improvement.

Thirdly: Change detection climax stage: As aerospace remote sensing technology is becoming more mature, high-resolution remote sensing images are gradually entering the commercialization stage. At this stage, object-oriented image analysis change detection methods are proposed, and the basic unit of change detection is also changed. The pixel level transitioned to the object level, and the target detection technology of segmenting the image to construct the object was proposed. Of course, the emergence of the mixed class research [8] also pushed the change detection method to a new stage.

Lastly: Change detection boom stage: With the arrival of the big data wave and the era of artificial intelligence, change detection has been pushed into a new boom, and deep learning methods are quickly introduced into change detection. It provides a new and powerful channel for data mining of high-resolution images.

3. Routine process of change detection
The remote sensing image change detection process is mainly composed of four parts: data selection, data preprocessing, change information extraction, and accuracy evaluation. The processing flow is shown in Figure 1. The selection of the change detection method is the key to the extraction of change information, and it is also the core of the entire detection process. It plays an important role in the quality of target detection. Therefore, more domestic and foreign scholars have carried out a lot of research mainly for this stage.

4. Traditional remote sensing image change detection method
The traditional methods of change detection are generally divided into direct comparison method, post-classification comparison method, machine learning method and image-oriented analysis method, as shown in Figure 2.
5. Remote sensing image change detection based on deep learning method

In the context of the era of big data, artificial intelligence technology is developing rapidly, and deep learning is playing an increasingly important role in the fields of transportation, agriculture, and urban planning. Its ultimate goal is to enable machines to mine data like humans. The ability to analyze data greatly improves the level of automation. Therefore, target change detection also uses this powerful analysis method. The methods included in deep learning are listed below, as shown in Figure 3.

5.1. Change detection based on deep belief network algorithm (abbreviated as DBN)

DBN algorithm is a kind of probability generation model of neural network in machine learning. It is different from traditional neural network of discriminant model. By using DBN algorithm, it can identify features of features and classify data, so it can be applied to image processing. Its overall structure consists of multiple restricted Boltzmann machines, back-propagation neural networks, and a top-level Soft max classifier (Zhu Chunyu, 2020). The restricted Boltzmann machine structure (abbreviated as RBN) and the DBN structure are shown in Figure 4 and Figure 5, respectively. As shown, h1, h2 are classified as hidden layers, and v1, v2, and v3 are classified as visible layers.
DBN play a cornerstone role in change detection. Many scholars use it as a basis and introduce other methods to integrate them, thereby improving the accuracy of change detection in building change detection based on high-resolution images. Zhu Chunyu et al. [9] proposed a DBN and mathematical morphology fusion model, using the search window to select a large number of labeled samples from a small number of marked changes and unchanged sample areas to train the fusion model classifier for change detection, and the change detection is accurate. The rate reaches about 90%. Zhang Haiming et al. [10] used domain knowledge as an optimization strategy to obtain an optimized deep learning method based on domain knowledge, which introduced the plate shape feature index and spectral knowledge in domain knowledge, obtained high-quality training samples, and constructed and The deep confidence network is trained, and the detection result is about 7.58% higher than the accuracy before optimization.

5.2. Change detection based on convolutional neural network algorithm (abbreviated as CNN)

Since the rise of CNN algorithm, many typical network structure models have appeared, and some network models have milestone significance in the development history of deep learning. The typical representative CNN model that has just begun to appear is the Le Net model, which is a shallow network model. Later, other classic network models appeared one after another: Alex Net network model, Google Net model, VGG model, Res Net model, etc. Based on these models, scholars continue to update and optimize, and propose many change detection fusion methods with efficient detection rates, and have relatively successful research results (Yang Zixian,2018. Pu Shi,2018).

Among them, Meng Congtang et al. [13] used the Sianese Network as the network framework, and improved the VGG16 as the network structure based on the encoding and decoding network structure. The front and back time phase images were input through two channels, and the images were subtracted after each convolution. And then use the jump connection and the image of the decoding end to overlap to extract the features, and obtain a good test result. Compared with using the VGG16 network structure alone, it is not possible to judge whether the image with a small range of change is shortcoming, and because the set image block is relatively large, the training speed is increased, and it is difficult to ensure a good visual effect. The disadvantage is improved. The model has achieved good test results. Cui Bin et al. [14] developed an unsupervised SAR change detection method that combines hierarchical fuzzy C-means clustering (FCM) and CNN, and obtained high detection accuracy. Wan Ran Ran [15] developed a high-precision change monitoring algorithm based on SCNN based on the sky map image to quickly find the change area and realize the detection of geographic change information.

5.3. Change detection based on deep neural network algorithm (abbreviated as DNN)

DNN can be said to be a neural network with a large number of hidden layers, and the neural network is an extension based on the perceptron. According to the different layers of the DNN, the internal neural network layers can be divided into three categories: input layer, hidden layer and output layer.

Under normal circumstances, the first layer belongs to the input layer, and the tail layer belongs to the output layer, and the number of layers in the middle are all hidden layers. Zhang Kai [16] detects the time series changes of Landsat images based on the DNN algorithm. Researched out an optimized, deep-enhanced learning algorithm with MDP as the core of the loop. The purpose is to automate the
optimization of the optimized neural network, speed up the training of the neural network, and help the neural network to jump out of the local optimum. Song Yong et al. [17] developed a brain-like model based on a DNN to achieve high-precision detection of targets under complex conditions.

6. Conclusion
With the continuous development of artificial intelligence big data technology, remote sensing image change detection technology has also been pushed to a new wave. In order to pursue a higher level of automation, the past traditional change detection methods such as difference method and ratio method are time-consuming. Low efficiency, poor accuracy, and gradually replaced, and deep learning methods have played a new protagonist in this field, including deep belief networks, convolutional neural networks, and deep neural networks. Based on these network structures, in order to improve the accuracy of detection, many optimization strategies have been proposed. Therefore, hybrid methods are also emerging. Such as the deep convolutional neural network that combines deep neural network and convolutional neural network, the fusion of mathematical morphology and deep belief network, etc. all in all. In the field of remote sensing science in the future, whether in various fields such as agriculture, transportation or urban planning, change detection technology will play a key role, and deep learning methods will surely be the protagonist of the artificial intelligence big data arena.

In the future change detection research, due to the maturity of space satellite remote sensing technology, the availability of high-resolution images is better. You can try to transition the two-dimensional mode feature of the change detection target to the three-dimensional mode feature, and the deep learning method Three-dimensional scene analysis is combined to detect target changes in remote sensing images, and promotes the advancement of remote sensing image change detection methods in a more advanced direction.

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