Remote Sensing Recognition of Construction Waste Accumulation Based on Resources satellite three Multi-view Stereoscopic Image

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Abstract. Due to economic growth and the development of urban modernization, the amount of construction waste is increasing year by year. The rapid identification of large-scale construction waste deposit is beneficial to improving urban planning and management capabilities. This article is based on the three-line array image stereo data of Resources satellite three to obtain DEM. At that time, Renzhuang Village in Pingdingshan was a test area. Based on the DEM elevation change information, the surface roughness coefficient of the structured surface was used as an irregular elevation texture feature, combined with the slope and aspect, to obtain the construction waste accumulation of other ground objects in the surrounding area. The overall recognition rate is 85.12%, and the Kappa coefficient is 0.70. It provides application value for the rapid identification of construction waste accumulation and its change information management and safety instability analysis.

1. Introduction

Construction waste generally refers to the waste generated by the destruction of buildings caused by man-made and natural reasons, including human activities, such as the waste generated during the demolition, construction, repair, and decoration of buildings [1]. Construction waste not only occupies land, pollutes the air, destroys the urban living environment, but also wastes resources, endangers human health, hinders urban economic development, and seriously affects the coordinated development of social economy and the environment [2]. Traditional manual inspection record management is time-consuming, labor-intensive and inefficient. Therefore, how to efficiently and scientifically manage construction waste has become a problem that needs to be solved as soon as possible. An important prerequisite for the management of construction waste is how to accurately grasp the volume, location and three-dimensional change information of construction waste accumulation.

In recent years, Resources satellite three has been widely used in the surveying and mapping industry, promoting the development of the surveying and mapping geographic information industry, and comprehensively promoting the technological innovation and progress of the surveying and mapping industry [3]. In change detection, resources satellite three is widely used. For example, Peng Ling[4] used Resources satellite three to realize the spatial distribution of landslides in the Wenchuan earthquake area and the rapid identification of the landslide source area, slip area and accumulation area. Chen Yin [5] and others used the Resources satellite three data to extract DEM to obtain high-
resolution images of Lhasa urban area. The effect is good and it can provide basic data for urban geological disaster evaluation. Qi Yongju [6] et al. used a variety of methods and high-resolution images to extract buildings and found that resources satellite three is the most suitable extraction method among architectural objects is the object-oriented method. Yu Jingfeng [7] has a lot of practice in the extraction of construction land information in the high-speed railway safety control area based on the Resources satellite three. The complex construction land control area has certain guiding significance for the analysis of the change of construction waste. Sun Xiaodan [8] also measured the volume of construction waste accumulation in the study area based on the DEM model of the construction in the study area, providing a basis for construction waste treatment. Liu Yalan [9] and others used the fusion data of Beijing-1 satellite to study the impact characteristics of informal garbage dumps, and conducted interpretation and analysis through human-computer interaction. The research site was small. Qin Haichun uses Gaofen-2 satellite image data to continuously detect Wuxi City and its surrounding areas, screens suspected targets through manual identification, collects information on site to provide verification results, and efficiently finds unowned garbage dumps around towns and their objects. The scope of the site is also relatively small [10]. It proves the application potential of remote sensing technology in waste site management. However, it is difficult to obtain high-resolution images. These research works are mainly focused on the identification of garbage dumps in a small area or the dynamic change detection of individual garbage dumps. Most of the experiments use visual interpretation methods. Two-dimensional analysis, based on remote sensing methods, there is no clear practice for the identification of large-scale construction waste accumulations, landfills and disposal sites in a large area [11].

In order to identify and analyze the accumulation of construction waste at a three-dimensional level, it is planned to use the method of combining elevation information, ground roughness and slope to identify the accumulation of construction waste. Obtain DEM data of the experimental area through the remote sensing image of Resources satellite three, and set thresholds to preliminarily classify and classify the ground objects; On the basis of the preliminary classification, the ground roughness coefficient is used for three-dimensional constraints, the frequency and amplitude of the ground features in the specified area are analyzed, and the analysis results are combined with the slope aspect to obtain effective recognition results.

2. Method

2.1. Rough characteristics of construction waste accumulation

Set surface roughness coefficient \( C_b \) as a highly textured feature to participate in the classification. The surface roughness coefficient is set as the ratio of the area of the features in the detection window to the area of the features and the ground.

\[ C_b = \frac{\sum_{i=1}^{n} S_i}{\sum_{i=1}^{n} S_o} \]  

The roughness related parameters assume that the ground features are a smooth and random process. Let \( z(x) \) represent a random process. At any given position \( x_i \), its value is a one-dimensional random variable \( z(x_i) \). The statistical characteristics of the random variable can be used to describe the surface. The degree of ups and downs.
In the formula, $n$ is the number of feature points, and $\bar{z}$ is the average surface height of all feature points $\{x_i\}$. Generally speaking, the rougher the surface, the greater the root mean square height. The root mean square height only has a certain relationship with the one-dimensional probability density function of the random process. In order to be more realistic, it not only shows the random process in an isolated location, but also more accurately reflects the relationship between the features in different locations, and expresses the vertical relationship. The roughness change on the performance level is achieved by introducing an autocorrelation function and using two-dimensional probability density.

$$r(\Delta x) = \frac{1}{\sigma(x)} \left\langle(z(x) - \bar{z})(z(x + \Delta x) - \bar{z})\right\rangle$$

(3)

In the formula, $\sigma(x)$ is the root mean square height, and angle brackets indicate the average value. Any point on the ground object is related to itself, while the point on infinity is completely irrelevant. On this basis, you can get

$$r(l) = 1/e$$

(4)

$l$ is the correlation length, as a measure of the surface roughness on the level. Generally speaking, the rougher the ground feature, the smaller the correlation length [13].

2.2. Study area and pretreatment

Renzhuang Village in Pingdingshan City was selected as the research area. Pingdingshan City has developed rapidly in energy and industry in recent years, and urbanization has changed dramatically in the suburbs of the city. The demolition of bungalows in many villages has produced a large amount of construction waste. The selected area is the construction waste generated after the demolition of the village, most of which are covered by black nets, some are covered by plants, and there are high-voltage line towers. The accumulation of construction waste is relatively high. The northwest of the accumulation of construction waste is the new residents who migrated after the village was demolished. Building, this area is close to the road on the outskirts of the city, construction waste is not sorted, and the accumulation body is large.

The image data of Resources satellite three was collected on April 3, 2019, TLC sensor, orbit circle number 40153, receiving station MYN, latitude and longitude 113.235/33.8595 of the scene center. On the basis of the image, select the cropped image that contains the study area.

Figure 1. Study area. Figure 2. DEM.

Use the software to generate the DEM of your region. Perform regional network adjustment and calculate orientation parameters. First, select the connection points on the image, usually the points located in the center of the four corners or four sides; then perform regional network adjustment. The unit weight error of the adjustment result is within 0.5 pixels; Finally, the RPC parameters of the original image are used to calculate the orientation parameters. The number of connection points is
1500, the search window size is 81, the moving window size is 21, the minimum correlation coefficient is 0.95, and the average elevation is 176.00. When outputting DEM, set DEM output projection parameters, this experiment sets UTM coordinates, and the output pixel size is 5m. On the DEM parameter, the minimum correlation coefficient threshold is 0.7. This value is usually used to evaluate the matching of two points. The larger the threshold, the higher the matching accuracy and the fewer points that can be obtained. It is generally set at 0.65-0.85. The moving window is set to 13x13, the larger the value, the less accurate matching results, and the greater the amount of calculation; the terrain detail is 6, the higher the parameter, the finer the DEM generated, and the longer the processing time. The final generated DEM data is shown in Figure 2.

3. Experimental results and analysis

On the basis of DEM, the different slope and aspect analysis diagrams of DEM are obtained. The slope direction will be divided into eight aspects. The accuracy range of each direction is 22.5 degrees.

According to the ground type analysis, the slope direction of the construction waste accumulation body is relatively high. Irregularities, buildings and roads can form a more distinct classification; there are nine levels in slope. Generally speaking, the slope of buildings tends to be 90 degrees, 45 degrees, 0 degrees and other relatively regular slopes, and they are There is no obvious slope change in the area, and trees are generally similar to the construction waste accumulation body, and there will be obvious slope and slope changes in a smaller area. At this time, the elevation and the scope of the ground can be restricted.

On the basis of DEM, set the elevation threshold of buildings and construction waste. In the comparison of multiple threshold settings, it is found that when the building is set to 106 and the construction waste is set to 102, there is a better distinction in elevation segmentation.

(a) Building elevation.  
(b) Construction waste elevation.

Figure 5. Building and construction waste accumulation threshold setting.
First, make a preliminary distinction between some buildings, and combine the building elevation with slope and aspect, as shown in Figure 6. Among them, according to the architectural orientation of the building, the slope direction is true north and true south. It can be seen in the figure that the legends of true north and true south are horizontally distributed basically in line with the direction of the building; the slope is selected as nearly 90 degrees as the actual building. The walls of the objects are similar. As can be seen in the figure, the slope legend is roughly distributed around the building, which is more in line with the actual situation of the building, and the parameters of buildings in other directions are set according to the specific conditions.

Based on the auxiliary segmentation, the roughness analysis of the construction waste accumulation is carried out. On the basis of setting the roughness multiple times, when the roughness is in the range of 1.23-1.63, it has a better matching result with the segmentation result, as shown in Figure 7. On this basis, the construction waste accumulation body and the building identification result are combined, and the result is obtained, as shown in Figure 8.

From the experimental results, we can intuitively see the distribution range and location of construction waste deposits within the experimental area. The northeast and south of construction waste deposits are part of the village houses that have not been demolished or half demolished. Because the houses are relatively dilapidated, in terms of height and surface roughness, it is similar to the accumulation of construction waste, so the classification effect of this part is not ideal. Set the appropriate threshold value according to the elevation.

After experiment, 0.3m to 4.2m is a more suitable classification height range.

| Table 1. Recognition results of construction waste accumulation. |
|---------------------------------------------------------------|
| Actual features(m²)                                         |
| Recognized features Construction waste Other features |
| Construction waste                                           79171    12440 |
According to the statistics of the face-up area, the confusion matrix is used to evaluate its accuracy through the overall recognition rate and Kappa. The overall classification accuracy represents the probability that the classification result is consistent with the actual type of the corresponding area on the ground. The kappa coefficient is an index to measure the classification accuracy. It can be obtained from the recognition result data in the table. The overall recognition rate is 85.12%, and the Kappa coefficient is 0.70. It can be seen from the data results that the location information of construction waste can be effectively identified through the auxiliary classification of elevation texture and slope.

4. Concluding remarks
In this paper, the DEM data of the study area is obtained through the Resources satellite three image, and the elevation change information of the construction waste accumulation body at different times, the area ratio of the roughness and the slope aspect are combined, and the construction waste accumulation body and non-construction waste are identified at a three-dimensional level. This experiment only restricts the recognition conditions on elevation changes and features. In future research, you can combine elevation features with spectral texture and other features; the results of this experiment only use the remote sensing image of Resources satellite three, which has certain limitations on image accuracy. In future research, we can use multi-source data such as drone tilt photogrammetry and Lidar for experiments.

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