Research on intelligent interpretation of covering measures of dense mesh net based on UAV remote sensing images

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Abstract. In order to explore the method of intelligent interpretation of typical measures of environmental protection and water conservation in pumped storage power station by UAV remote sensing technology, Wei Fang of pumped storage power station in North China was selected as the research area and the measure of dense mesh covering was selected for intelligent interpretation study. Firstly, a sample database of typical measures of dense mesh cover was built based on the orthophoto image of the UAV. Then the dense mesh cover recognition model is constructed using ENVI deep learning model framework. At last, the loss, accuracy and recall rate indicators provided by the ENVI deep learning module TensorBoard is usd to evaluate the accuracy of the recognition of model, which the accuracy reaches to 93%.

Keywords: Typical measures, Intelligent interpretation, covering measures of dense mesh net, UAV remote sensing.

1. Introduction

The pumped storage power station is mostly located in the mountains and has large construction disturbance area and long construction time, which has strict regional ecological and environmental protection requirements[1,2]. The pumped storage power station includes upper and lower reservoir area, which is connected by road of 5-20 kilometers. In the process of engineering construction, it is inevitable to produce the influence of human activities such as original landform breaking, surface vegetation disturbance, waste, noise and soil loss, which aggravates soil erosion such as gully erosion and surface erosion. In order to reduce the adverse impact of engineering construction on the environment and reduce impact, it is necessary to carry out environmental protection and soil and water conservation measures when the engineering begin. However, in the actual construction process, there are often problems that the measures cannot be implemented in time, or the measures fail to achieve the expected results. It is urgent to monitor the implementation of water and soil conservation measures.

At present, the conventional monitoring methods of the on-site situation of pumped storage power stations often rely on manual on-site verification, which consumes a lot of manpower and material resources. And the conventional method has poor timeliness and large errors, and even has blind spots. As an earth observation technology, remote sensing technology has the advantages of wide observation range, fast speed, safety, no obstruction by topography and geomorphology, and intuitive and accurate response to surface characteristics. The remote sense image can realize intuitive station area information display from a macro perspective for the construction of pumped storage power station[3].

The research hotspot that using large-scale images to quickly identify on-site measures and determine their location and scope has become the core task of remote sensing applications[4,5]. Machine learning method with good adaptability and generalization has gradually become the mainstream of information mining, which a method of extracting discriminative features of targets by manually designing feature operators[6,7]. Therefore, this study proposes an intelligent interpretation technology for the typical measures of soil and water conservation based on UAV images. The UAV orthophoto image is used as the main data source for target recognition, which is used to build a sample library of typical measures of dense mesh cover. Then ENVI deep learning module is used to train the identification model of the dense mesh cover measures, which is used to

measure identification of station. At last, realize the monitoring of water and soil conservation measures in the construction process of pumped storage power station, and so improve the technical level of environmental protection water and soil conservation management and control.

2. Materials and methods

2.1 Study area

Weifang pumped storage power station is selected as the study area, which is located in Wujing Town, ShanDong Province. The upper reservoir is located at the head of Dayugou Gully, and the lower reservoir is built by using the Songshan Reservoir. The elevation is generally 240-760 meters, which is the low mountain to hilly landform, and the relative height difference is less than 500 meters.

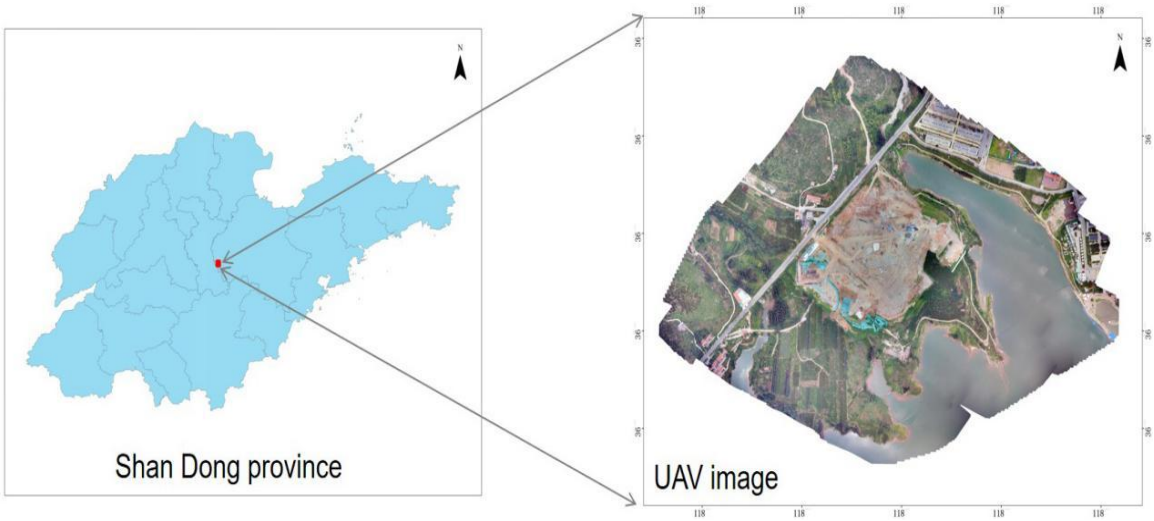


Fig. 1 The position of study area

2.2 Data source and data processing

In order to collect samples, UAV flights were carried out in Weifang Power Station in Shandong Province and Jixi Power Station in Anhui Province, and UAV images were obtained. The original image of the UAV is processed by the UAV professional software and the high-resolution orthophoto image with a resolution of 5cm can be obtained after the aerial triangulation processing. The indoor processing of UAV aerial image data includes image data preprocessing, relative orientation, absolute orientation, point cloud data extraction, orthophoto generation and other conventional processing processes. The sample library is constructed based on the UAV image of Jixi power station in Anhui and the image of Weifang power station.

Table 1. Data acquisition of UAV

Flight Mode	Camera	Date	Station	Spatial Resolution
Vertical photography	Op3000	July 6, 2021	Wei Fang	5cm
Vertical photography	DG3	From July 13, 2021 to July 16, 2021	Ji Xi	5cm

2.3 Study method

The ENVI Deep Learning deep learning module was used to extract training model and target extraction experiments for typical measures of dense mesh net cover[8,9,10]. The specific process included sample production, model training, target extraction and accuracy analysis. The specific process is as follows (Fig.2).

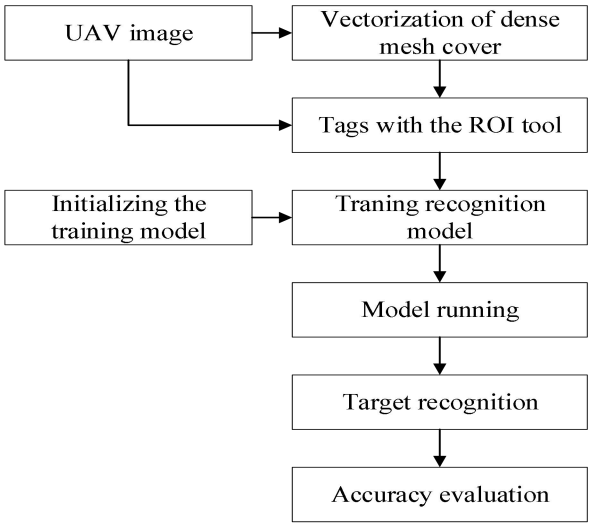


Fig. 2 Target extraction process based on ENVI Deep Learning

2.3.1 Sample production

Based on the UAV data of Jixi Power Station in Anhui Province and Weifang Power Station in Shandong Province, a sample library of dense mesh covering measures was constructed. According to consideration of recognition target background and the training speed of the model, the size of the UAV sample of dense mesh net cover is determined as 961 pixels * 961 pixels.

2.3.2 Training model

The recognition model was trained by using dense mesh coverage samples. Firstly, a TensorFlow model was initialized, which the model architecture, patch size (patch size=208), number of bands used for training and other parameters are defined. Based on the initial model, combined with the sample data, the parameters of Epochs, Batches, Augment Scale, Augment Rotation and other parameters were adjusted to train the recognition model, and the recognition model of dense mesh coverage based on UAV image was obtained.

2.3.3 Target extraction

The UAV image of Weifang power station was selected to carry out the identification test of dense mesh covering measures. The TensorFlow Mask Classification tool of ENVI Deep Learning deep learning module was used to identify the classified image, which can generate a CAM image (Class Activation Map / Raster) and Classification Raster based on CAM map.

2.3.4 Precision evaluation

In the field of machine learning, evaluation is a necessary work. Accuracy, Precision and Recall were used to evaluate the recognition accuracy of the model.

3. Result

3.1 The setting of training model

The ENVI Deep Learning deep learning module is used to carry out the training of the dense mesh recognition model. When training model, the Epochs parameter is set to 25 by continuous parameter adjustment. The Batches parameters are determined by the GPU memory size of the running computer and are automatically determined by the model. The method of scaled enhancement and rotation enhancement (90, 180, 270 rotation) were used to add samples. At the meantime, the minimum value of the Class Weight parameter was set to 0 and the maximum value was 2. In the training process, the model will learn to convert the spectral and spatial information of the label image into a CAM grayscale image, highlighting the target to be extracted.

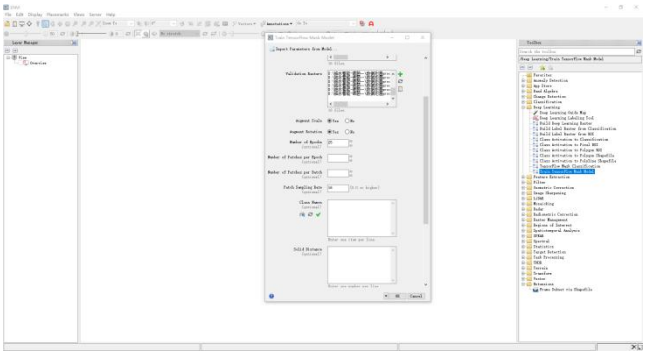
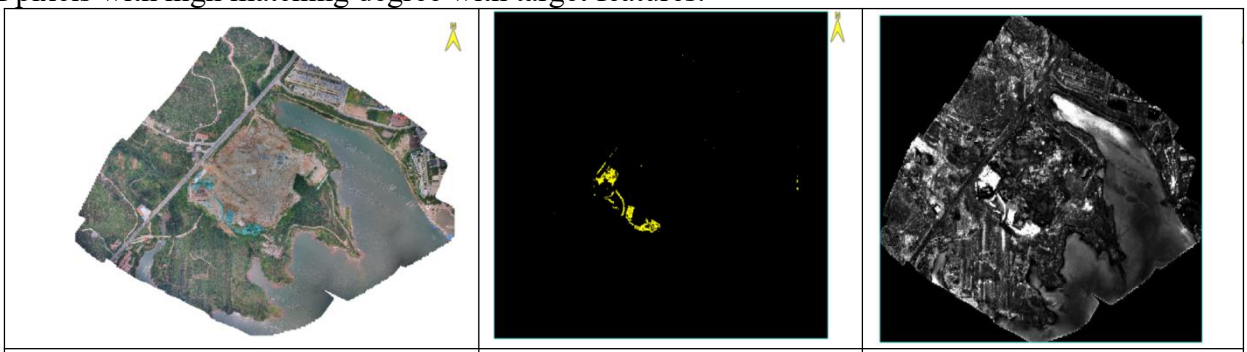


Fig. 3 Parameter settings of model when training

3.2 Object identification

The area of Weifang power station was selected for the identification test of the dense mesh coverage measures. And the TensorFlow Mask Classification tool was used to identify the classified images. The tool generates a CAM image (Class Activation Map / Raster) and a Classification Raster based on the CAM graph. CAM is a grayscale image, and its pixel value represents the probability that belonging to the target feature. The high-bright pixel has a high matching degree with the target feature. Then, grid density segmentation is used to enhance the visualization effect of pixels with high matching degree with target features.



Original image	Classification grid image	CAM image

Fig. 4 UAV image and the classification image of dense mesh coverage measures

Fig. 5 Classification image of dense mesh cover measures

3.3 Post-processing of identification results

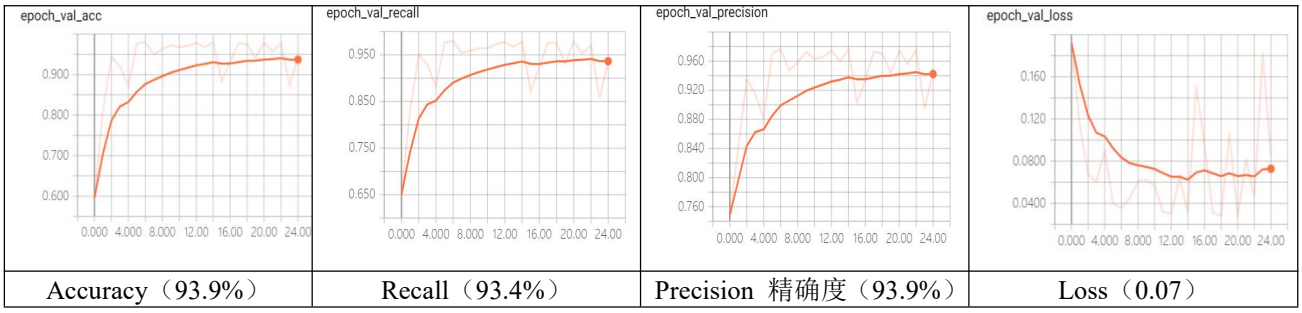
The dense mesh cover vector data can be extracted by post-processing. The Class Activation to Pixel ROI or Class Activation to Polygon ROI or Classification to Vector tool in ENVI can be used to convert the recognized classification image into a polygon ROI or shapefile file. And use

human-computer interaction to delete the wrong recognition vector, so as to calculate the area of the recognition target in Arcgis.

Fig. 6 The vectorization result diagram of dense mesh cover

3.4 Accuracy evaluation

The accuracy evaluation of the model in this study adopts the evaluation criteria of ENVI built-in deep learning, which is the commonly used indicators of deep learning including loss, accuracy, accuracy and recall rate. In the study, the model training was carried out through the samples of the dense mesh coverage measures. The region greater than 100 square meter was selected from the original image, and the typical measures are vector-labeled as the real value. The region predicted by machine learning method was the predicted value. And the recognition accuracy was above 93.9%.



Accuracy（93.9%）	Recall（93.4%）	Precision 精确度（93.9%）	Loss（0.07）

Fig. 7 Precision sketch map of dense mesh coverage model

4. Summary

By studying the current status of machine learning, the fully convolutional neural network (FCN) can accept input images of any size. The size specification of the sample input data is low and it is more efficient. As a result, the FCN algorithm is selected for the target interpretation of the pumped storage power station.

Using the established sample database and deep learning module provided by ENVI, the extracted regional targets are obtained by making label samples, model training, target recognition, and post-processing steps of recognition results.

The accuracy, precision, recall and model loss of machine learning are used to evaluate the model.

The training model was used to extract the target of the dense mesh coverage measures in Weifang power station. The accuracy of the model extraction can reach 93.9%, the recall rate can reach 93.4%, and the accuracy can reach 93.9%.

Acknowledgments

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