A Review of Underwater Target Recognition Based on Deep Learning

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Abstract. Underwater target detection is an important part of national defense, which is related to national defense security. Underwater target recognition technology based on deep learning has made great progress in recent years, but there are still some problems, such as the feature is not obvious, the contour is not obvious, and so on. This paper introduces the current situation of underwater target recognition based on deep learning, analyzes the commonly used deep learning methods, and provides a new idea for the further research of underwater target recognition based.

Keywords: Underwater Target; Identification; Deep Learning

1. Research Background
Underwater moving small target detection sonar technology is the focus and difficulty of development at home and abroad. According to the current research situation at home and abroad, the long-distance transmission effect of acoustic signal in water is the best, especially the low-frequency wave in water is the first choice signal for detection of small underwater target in shallow water area. The reverberation intensity caused by terrain undulation and the superposition of unknown noise make the target pixel be interfered by noise points, which affects the recognition effect of underwater small target. In view of the current research status, it is urgent to carry out the corresponding research work on the underwater target detection system, so as to make it have the ability to detect the moving underwater target in the complex shallow water marine environment, so that it can be competent for the use requirements of the complex shallow water ocean, and ensure the safety of underwater warning in the shallow water area of ports and islands.

2. Research Status At Home and Abroad
With the rapid development of acoustic imaging technology, acoustic image detection has been widely used in the field of ocean development.

It has become an important subject in the field of digital image processing to recognize the target with sound and image. Although sound images, like optical images, are essentially planar or spatial distributions of energy. However, the sound and vision system should be in the environment in which it is used. The underwater acoustic channel is time-varying and spatiotemporal, which produces various complex operations for the acoustic information transmitted in it. In order to ensure the image resolution, the center frequency of imaging sonar is more than hundreds of kHz. However, the absorption of sound energy by seawater medium increases squarely with the increase of its center
With the propagation of sound energy and the diffusion of volume, high frequency sound wave loses considerable energy in seawater. At the same time, the influence of multipath, reverberation and environmental noise makes the identification more difficult. All of these make the acoustic image have many characteristics, and the face is different from the optical image. Due to the characteristics and limitations of sound image, many optical image processing methods are used. This method must be modified to a certain extent before it is applied to the analysis, processing and recognition of sound image. In addition, due to the large sound field, small interference, low resolution, less pixel information and other reasons, there is no mature foundation for some sound field images. The traditional underwater target image recognition method is to extract features manually. After comparing with the target image or classifying the feature image with the classifier, it can be used to classify the feature image, which is greatly affected by the image recognition. Manual extraction function. If the number of pixels in the image is small or the feature extraction is not accurate enough, the recognition effect is not ideal. Deep learning is a concept proposed in recent years.

The intuitive expression of "depth" is that the network layer is very deep, and the main form is neural network with multiple hidden layers. Because the network layer is very deep, the model can learn a lot of "deep" features, so deep learning is named, but it will also increase the risk of over fitting in neural network, so a series of methods to prevent over fitting are developed. In recent years, people have begun to use neural network to recognize underwater image targets. In 2012, Chen Qiang uses simple BP neural network to classify and recognize underwater image targets with an accuracy rate of 80%. The training samples only had 20 images. The features were selected manually and sent to the neural network for classification training. In 2013, David P. Williams applied deep convolution network to side scan sonar image recognition. He used a simple convolution neural network to recognize objects in the ocean, with an average recognition rate of more than 85%. In 2015, Matias valdenegro Toro et al. Applied the deep convolution neural network to underwater small target recognition. Its samples were seven different small objects scanned by 3000 pre sonar. The average recognition rate on the test set can reach 90%, and the performance is better than SVM, RF and other machine learning algorithms. However, its defect is when training

When the training sample is larger than the target, the effect is very poor. In 2016, Zhang Wenliang manually extracted the features of underwater small target sonar image, and recognized the underwater small target through the improved boost method. The recognition rate of different targets reached more than 85% In 2017, Bai Jisong used a variety of noise reduction methods and manual extraction methods to analyze the characteristics of underwater target image, and then used image segmentation and morphology to identify the target, but the experimental target was a regular ball And the work of both of them is based on the condition that the features are extracted manually, so when the feature of the target is good When the feature is not obvious or the contour is irregular, there are some limitations. In the case of suspected water, it is often impossible to capture images of a single target. If we can accurately identify the target category and mark its position in the image, we can greatly reduce the background. Or the interference of other irrelevant objects can improve the recognition rate, reduce the false alarm rate and improve the reliability of the algorithm. Therefore, in the same year, juhwan Kim underwater ROV pre sonar collected samples using sliding window and depth convolution network. The target is successfully recognized from the background image, and the boundary line of the target is given, which can solve the problem that the target is affected by the background. However, it is not able to identify the specific target. The image detection and recognition model in deep learning can solve this problem well. It has achieved great success in the field of optical image, and the recognition rate has exceeded the human eye.

3. Identification Framework
A typical pattern classification and recognition system is also a conventional framework of underwater target passive recognition system, which mainly includes the following processes: (1) data acquisition; (2) data preprocessing; (3) feature extraction; (4) classifier design; (5) classifier. After the introduction of deep learning method, because the deep neural network has the function of classifier first, so the
classifier design and classifier link will adopt a specific depth neural network structure, and use a certain number of samples to complete the model training of the deep neural network; secondly, because the deep neural network has good feature learning ability, it is more traditional. After using the deep neural network, the key feature extraction process is relatively weakened or even completely replaced.

4. Common Neural Network Structure
In the framework of underwater target passive recognition, the modeling ability of the back-end classifier will significantly affect the performance of the whole target recognition system. Compared with traditional artificial neural network (ANN) or support vector machine (SVM) classifier, the complex structure of deep neural network makes it more potential in modeling ability. In the published literature, the deep belief networks (DBN), full connected neural networks (full connected neural networks), time delay neural networks (TDNN), convolutional neural networks (CNN) and cyclic neural networks (CNN) are mainly used in this field (Recurrent Neural Network, RNN). Next, we will briefly introduce a few.

The deep belief network was proposed by Canadian scholar Hinton in 2006. It is composed of multi-layer restricted Boltzmann machine. The schematic diagram of single-layer restricted Boltzmann machine is shown in Figure 1.

![Figure 1. Deep confidence network](image)

Fully connected neural network (FNN) is the basic form of feed forward neural network (FNN), which is a kind of multilayer perceptron in essence, and has its unique advantages in dealing with nonlinear problems. The structure of fully connected neural network is shown in Figure 2, which is composed of input layer, hidden layer and output layer, and the number of hidden layers is unlimited. Before the emergence of deep learning methods, researchers usually used shallow fully connected neural networks with only one hidden layer, which was also called artificial neural networks in the early literature. In deep learning, deep fully connected neural network with two or more hidden layers is generally used. Sometimes, some literatures refer to deep fully connected neural network with its upper concept feedforward neural network or deep neural network.

![Figure 2. Fully connected neural network](image)

The convolutional neural network is a kind of feedforward neural network which includes convolution computation and has deep structure. Its artificial neurons can respond to a part of the surrounding units in the coverage area, which is very suitable for processing and analyzing the original signal. A typical convolution neural network consists of one or more convolution layers and the top
full connection layer, and also includes correlation weight and pooling layer. The frame diagram of convolution neural network is shown in Figure 3.

![Figure 3. Convolution neural network](image)

New ideas
From the current domestic development level, underwater target recognition has a long way to go. The first thing to consider is the front-end data acquisition, there is no authoritative data set in the field of underwater acoustic target recognition, and the realization of any recognition method can not exist without the data set, and the deep learning method especially depends on the good data set, so we still need to work hard on the data set. Secondly, how to realize automatic recognition on the automatic control equipment such as embedded control system is not To a direction of development.

5. Conclusion
This paper introduces the research status of underwater target recognition which is about to be deeply studied, introduces the commonly used deep confidence network, full connection network, convolution neural network, etc., and puts forward its own views on the future research direction of underwater target recognition.

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