Hindawi
Mobile Information Systems
Volume 2022, Article ID 1019564, 6 pages
https://doi.org/10.1155/2022/1019564

*Research Article*

# Ocean Modeling Analysis and Modeling Based on Deep Learning

**Ming Hui Niu and Joung Hyung Cho**

*Department of Marine Design Convergence Engineering, Pukyong National University, Busan 612022, Republic of Korea*

Correspondence should be addressed to Ming Hui Niu; niuminghui0424@gmail.com and Joung Hyung Cho; 202056731@pukyong.ac.kr

Received 6 May 2022; Revised 9 June 2022; Accepted 1 July 2022; Published 30 July 2022

Academic Editor: Mian Ahmad Jan



The ocean comprises an uninterrupted body of salt water confined within a vast basin on the earth's surface. The ocean is the largest ecosystem on earth with rich and diverse biological resources. Organisms that reside in salty water are referred to as "marine life." Plants, animals, and microorganisms including archaea and bacteria are examples of these. The existence of marine life is not only a biological resource but also an economic source. Toys and other industries that imitate marine life have emerged in the market. A different modeling design of marine life has improved with the passage of time and the concept of modeling aesthetics has been incorporated. The identification of marine life images is challenging due to the complexity of the maritime environment, and there are several flaws in marine life models. The rise of deep learning has brought some new ideas for the weaknesses in marine life modeling, and the advantages of convolutional neural networks have contributed to some of the concepts based on deep learning. This research analyses marine modeling by using the benefits of convolutional neural networks, so that people can better understand marine life modeling. The experimental results indicate that the proposed approach has achieved good results in marine life detection, and the modeling effect of ocean modeling analysis based on deep learning is good.

## 1. Introduction

The ocean is an uninterrupted body of salt water confined in a massive basin on the earth's surface. The primary oceans and their peripheral seas encompass almost 71% of the earth's surface having an average position of 3,688 meters (12,100 feet) [1]. The ocean is the largest ecosystem on earth, with rich and diverse biological resources. The plants, animals, and other species that survive in the salt water of the sea or ocean are referred to as marine life. At its most basic, marine life influences the nature of our world [2]. Most of the oxygen we breathe comes from marine species. Marine life shapes and protects shorelines and some marine creatures help to generate new land. Most living species began in saltwater environments. Strong marine ecosystems are vital for civilization because they generate services such as food security, animal feed, natural resources for medications, construction materials made from coral rock plus sand, and natural defense against threats including coastal erosion and inundation [3].

The marine economy has become a new development point for all nations' national economies worldwide, and China has also begun to execute the marine ranching project and fiercely supports it as a growing strategic business [4]. It is critical for human civilization to understand how to develop marine biological resources in an effective and sensible manner. Marine biological image detection technology has been widely employed in marine biodiversity monitoring, ecosystem health assessment, and intelligent aquatic fishing since the introduction of marine pastures. The detection difficulties of marine biological images are exacerbated in practical applications due to the complexity of marine environment [5]. With the fast advancement of computer vision technology, researchers from all over the world have steadily used deep learning to the identification of marine items, providing a new direction for the detection of marine life images, as well as new concepts and directions for marine life modeling [6].

Life evolved in the ocean, occupies the majority of the earth's surface, and influences the shape of human activities as well as human dwelling space. Protecting the ocean is the same as protecting humans [7]. Based on deep learning, this study analyses marine life modeling and builds a model to better comprehend and appreciate marine life and the beauty of natural life.

*1.1. Modeling of Marine Creatures.* Before the invention of photography, scientists relied on the skillful hands of painters to translate their ocean discoveries into paper. The product is a set of scientific maps of marine life that are surprisingly lifelike and occasionally humorous [8]. With the advancement of science, the ability of human beings to explore the world is continuously enhanced and the art of natural illustration is constantly improving. In the nineteenth century, artists were fundamental members of the scientific society, contributing to the expression and distribution of knowledge gained by scientists in nature [9]. The ocean century is a term used to describe the twenty-first century. Humans have steadily shifted their attention to the ocean, which provides abundant natural resources, as terrestrial resources have dwindled and the world's attention to the ocean has expanded rapidly [10]. However, there are many different species of marine life, and drawing photographs with people and equipment is tough, tedious process and extracts picture information. The underwater world is very desirable and the mysterious appearance of marine life attracts our attention. With the advancement of science and technology, the appearance of marine life is displayed in front of humans through high-precision instruments. The introduction of marine life modeling design has transformed information from photographs into finished goods, providing us with more knowledge on marine life, allowing us to get a deeper understanding of the subject and stimulating the development of dolls, toys, and other businesses. Figure 1 shows pictures of marine life. Figure 2 shows a charming dolphin key chain pendant that has been used in the real world.

Figure 1: Picture of marine life.


Figure 2: Cute dolphin keychain pendant picture.

*1.2. Modeling Aesthetics.* The Chinese Encyclopedia of Fine Arts defines plastic arts as "Plastic arts refers to the art of visual static space images created with certain material and means, generally including architecture, sculpture, painting, arts and crafts, design, calligraphy, seal cutting and other types" [11]. Modern plastic art is also known as visual art, since the creative picture generated by plastic art is visible and relies on vision to create and admire. The term plastic art comes from the German "bildende kunst" and the English "plastic art" refers to sculpture in a narrow sense. The German literary theorist Lessing first used this concept; in 1766, Lessing's masterpiece of art criticism, Laocoon, was published, in which painting and poetry were distinguished [12]. Art has been the principal object of study in aesthetics since its inception as a separate subject in the mid-eighteenth century. Aesthetics can be separated into several categories depending on the art forms studied, such as music aesthetics and architectural aesthetics. As a result, plastic aesthetics, according to the author, is theoretical research on plastic art forms including painting, architecture, and sculpture. Plastic aesthetics concepts are regularly supplemented with fresh content as the categories of plastic arts develop [13]. Plastic aesthetics is an essential aspect of aesthetics, as well as the focus of current aesthetic study, and it can be found in various forms in contemporary visual culture. The artistic culture of the twentieth century had a significant influence.

*1.3. Deep Learning.* Deep learning is an important branch of machine learning and one of the current research hotspots in the field of artificial intelligence as a new machine learning approach [14]. Deep learning transforms the feature representation into a new feature space of the sample in the original space by performing layer-by-layer feature transformation on the original data and learns to obtain a hierarchical feature representation, which is more conducive to classification or feature visualization [15]. Deep learning has become one of the research hotspots and mainstream growth areas in the field of artificial intelligence in recent years, due to the fast development of ultra-large-scale computers, big data, smart chips, and other technologies [16].

Deep learning is highly appreciated by academia and industry, and the reasons for its rapid growth are inextricably linked to rapid advancements in computer hardware (major improvements in computer computing power) and software (widespread usage of open-source software). On the one hand, the training phase of deep learning requires high-density parallel computing processing for a large amount of data. Traditional central processing units (CPUs) are difficult to perform such tasks. Therefore, new processors are constantly being designed and manufactured. The most representative typical processors include the Nvidia and AMD series of graphics processing units (GPUs), Google's Tensor Processing Units (TPUs), and Huawei's Ascend processors. Open-source software, on the other hand, has emerged as the primary engine of deep learning research in recent years, with widely used programming languages and efficient algorithm programming frameworks serving as supporting aspects. The main programming languages suitable for deep learning are Python, Julia, MATLAB, and C++. Python, created by Guido van Rossum of the Netherlands in the early 1990s, is the most popular deep learning programming language, with high simplicity, readability, and scalability.

Deep neural networks are the most common type of deep learning today, and the deep convolutional neural network (CNN) is one of the most well-known and commonly utilized architectures. Deep convolutional neural networks have demonstrated outstanding results in a variety of applications in recent years [17].

The remainder of the study is composed of the following sections: Section 2 is the ocean modeling analysis and modeling based on the convolutional neural network in deep learning, Section 3 is the experiment and application analysis, while the conclusion is present in Section 4.

## 2. Ocean Modeling Analysis and Modeling Based on the Convolutional Neural Network in Deep Learning

This section is composed of the two subsections, which are convolutional neural networks and You Only Look Once Version 3 (YOLOv3) network structure.

*2.1. Convolutional Neural Networks.* The convolutional neural network is a kind of neural network with deep structure and convolution calculation, which has the characteristics of weight sharing, local connection, and convolution pooling operation [18]. These features can effectively reduce the number of training parameters and the complexity of the network, making the model robust and fault-tolerant. Because of these properties, convolutional neural networks perform much better than fully connected neural networks in various signal and information processing tasks [19].

The convolutional neural network contains four modules such as convolutional layer, pooling layer, activation function, and fully connected layer. Convolution is an efficient method to extract image features. The convolutional layer is the core layer of the convolutional neural network and includes a significant amount of computation. Convolution kernel (filter), stride, and padding are all convolutional layer parameters. The filling approach can be used to compute the edge numerous times to avoid edge information from being lost. There are many methods of pooling, such as max pooling and mean pooling. While, max pooling is a commonly used method in convolutional neural networks. The pooling process is shown in Figure 3. The Sigmoid or Tanh functions were utilized in the early convolutional neural networks, and subsequently, the rectified linear unit (ReLU) function was included, as shown in Figure 4. In addition, the exponential linear units (ELU) function and MaxOut function are also often used. The fully connected layer is the classifier of the convolutional neural network, usually at the end of the network. Convolution operations can implement fully connected layers. Each node in the fully connected layer must be linked to every node in the preceding layer, learn model parameters, conduct feature fitting, and synthesize the previous layer's output features; then, therefore, this layer's weight parameters are the highest in the network.

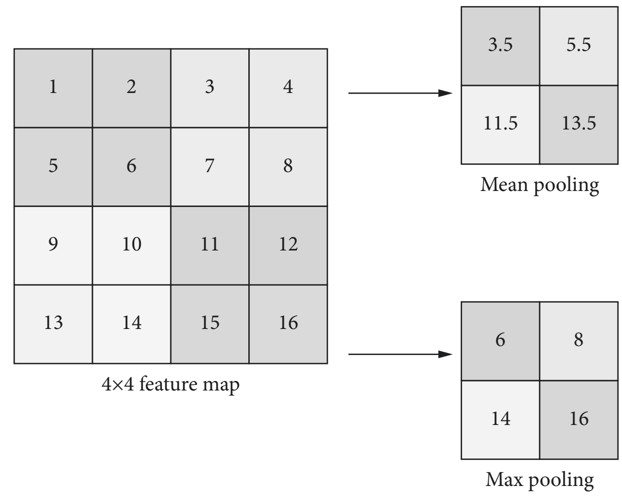


Figure 3: Pooling process.

*2.2. YOLOv3 Network Structure.* The network structure of this experiment is improved based on YOLOv3. YOLOv3 is a kind of YOLO network series, which belongs to the convolutional neural network based on candidate regions [20]. It improves the network structure of YOLOv2 and introduces the residual structure. The method of multifeature scale prediction is realized for detection, and finally, a good detection effect is obtained. In addition, compared with other convolutional neural networks based on candidate regions, in terms of network structure, YOLOv3 is more concise, and it is simple to improve the network structure. In this research, an enhanced structure suited for marine biological identification is provided based on the original YOLOv3 network model. The structure of each layer for the YOLOv3 network is shown in Figure 5.

The overall structure of the YOLOv3 network can be divided into two parts as follows: feature extractor and multichannel fusion detection. The multiscale fusion detection branch of YOLOv3 is another component. YOLOv3

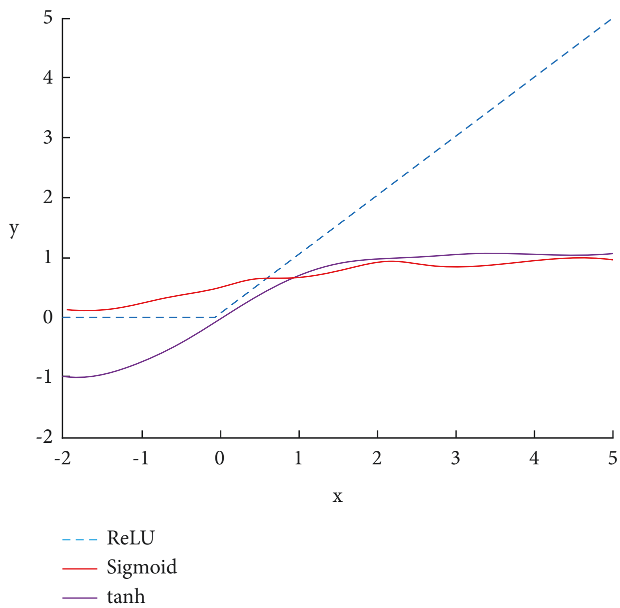


Figure 4: Three activation functions.

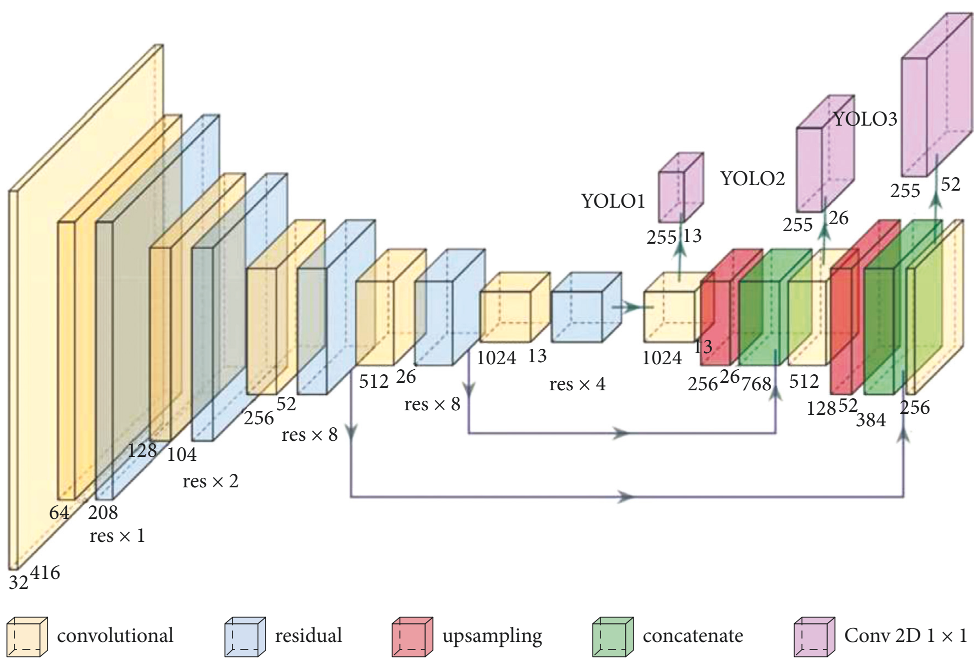


Figure 5: YOLOv3 network structure.

combines the feature maps obtained by the feature extraction network through multiscale local fusion. The method is directly detected by convolution.

## 3. Experiment and Application Analysis

The PyTorch framework is used in this study's experimental implementation, runs on a server with Intel(R)Xeon(R)CPU E5-2620v3@2.40 GHz processor, and uses 64 GB memory, the graphics card is NVIDIA TeslaT4 GPU and Ubuntu16.04 operating system and YOLOv3 improved network. The performance of the YOLOv3 improved network in terms of iterative convergence is shown in Figure 6. The National Underwater Robot Competition provided the datasets used in this work, with a total number of 8220 images. There are four types of marine organisms in the dataset as follows: sea cucumber (holothurian), sea urchin (echinus), scallop (scallop), and starfish (starfish). Label and save the dataset as an XML file using LabelImg and then split it into 6580 training sets and 1640 testing sets in an 8 : 2 ratio.

In the marine biology dataset, the tests contrasted the detection accuracy of the original YOLOv3 network against the enhanced network. Table 1 provides the detection results. The results of the experiments indicate that the impact of

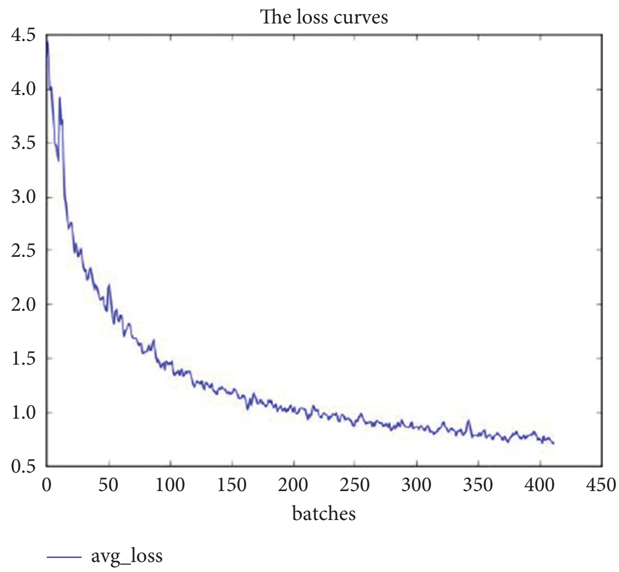


Figure 6: Convergence effect of YOLOv3 improved iteration.

Table 1: Comparison of different network detection results.

| Network model | Iteration times | Detection accuracy |
|---|---|---|
| YOLOv3_improved | 10000 | 0.7432 |
| YOLOv3 | 10000 | 0.7116 |
| VGG-SSD | 10000 | 0.7208 |

Table 2: Performance comparison of different algorithms.

| Algorithm | Holothurian AP/(%) | Echinus AP/(%) | Scallop AP/(%) | Starfish AP/(%) | MAP/(%) | FPS |
|---|---|---|---|---|---|---|
| Faster R-CNN | 69.03 | 87.86 | 70.24 | 82.11 | 77.35 | 7 |
| SSD | 62.91 | 80.23 | 61.32 | 80.03 | 73.12 | 9 |
| YOLOv3 | 72.61 | 88.01 | 69.36 | 81.69 | 78.09 | 13 |

YOLOv3 has improved. Few algorithms are selected to compare with IYOLOv3's performance. The IYOLOv3 algorithm has obtained good results in the identification of marine creatures, as given in Table 2. It can be shown that the algorithm modeling effect of deep learning-based ocean modeling analysis is good.

## 4. Conclusion

Due to the complexity of the maritime environment and various shortcomings in marine life models, identifying photos of marine life is difficult. The convolutional neural network technique is used in this experiment based on deep learning to create and evaluate marine life modeling, and the produced model realizes the network's deployment and application. The original model of the convolutional neural network is selected more often in this process and the accuracy is better, but it uses more computational resources. The size of the network model is gradually shrinking in the present research and development process of the convolutional neural network. Because of this study, a network topology with fewer parameters and lower model complexity is chosen, and a multiscale feature fusion and data improvement technique for marine creatures is implemented to decrease the amount of calculation and the resulting delay loss. It has a positive influence and promotional value.

## Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

## Acknowledgments

This work was supported by a grant from Brain Korea 21 Program for Leading Universities and Students (BK21 FOUR) MADEC Marine Designeering Education Research Group.

## References

[1] Z. Zhang, F. Xu, P. Li, X. Wang, F. Liu, and G. Liu, *Design of Automatic Operated Modular Underwater Vehicle System for*

*Marine Ranch Breeding Design of Automatic Operated Modular Underwater Vehicle System for Marine Ranch Breeding*, Computer Science, Xi'an, China, 2021.

[2] W. Qiang, Y. He, Y. Guo, B. Li, and L. He, "Exploring underwater target detection algorithm based on improved SSD," *Xibei Gongye Daxue Xuebao/Journal of Northwestern Polytechnical University*, vol. 38, no. 4, pp. 747–754, 2020.

[3] G. E. Hinton, S. Osindero, and Y. W. Teh, "A fast learning algorithm for deep belief nets," *Neural Computation*, vol. 18, no. 7, pp. 1527–1554, 2006.

[4] C. Yang, Z. Zhao, and S. Hu, "Image-based laparoscopic tool detection and tracking using convolutional neural networks: a review of the literature," *Computer Assisted Surgery*, vol. 25, no. 1, pp. 15–28, 2020.

[5] L. Li, "Application of deep learning in image recognition," *Journal of Physics: Conference Series*, vol. 1693, no. 1, Article ID 012128, 2020.

[6] D. Alapatt, P. Mascagni, V. Srivastav, and N. Padoy, "Neural networks and deep learning," *Artificial Intelligence in Surgery*, McGraw-Hill, New York, 2020.

[7] T. Guo, Y. Wei, H. Shao, and B. Ma, "Research on underwater target detection method based on improved MSRCP and YOLOv3," in *Proceedings of the 2021 IEEE International Conference on Mechatronics And Automation (ICMA)*, pp. 1158–1163, IEEE, Takamatsu, Japan, August, 2021.

[8] A. Ajit, K. Acharya, and A. Samanta, "A review of convolutional neural networks," *2020 International Conference on Emerging Trends in Information Technology and Engineering*, IEEE, Vellore, india, pp. 1–5, February, 2020.

[9] Y. Hu, S. Sun, and L. Qiao, "Plate defect recognition based on convolutional neural network," *Computer and Digital Engineering*, vol. 49, no. 12, pp. 2611–2617, 2021.

[10] X. Wei, L. Yu, S. Tian, P. Feng, and X. Ning, "Underwater target detection with an attention mechanism and improved scale," *Multimedia Tools and Applications*, vol. 80, no. 25, Article ID 33747, 2021.

[11] F. Lei, F. Tang, and S. Li, "Underwater target detection algorithm based on improved YOLOv5," *Journal of Marine Science and Engineering*, vol. 10, no. 3, p. 310, 2022.

[12] M. Qin, X. Wang, and Y. Du, "Factors affecting marine ranching risk in China and their hierarchical relationships based on DEMATEL, ISM, and BN," *Aquaculture*, vol. 549, Article ID 737802, 2022.

[13] C. Deng, B. Zhao, M. Yang, and Y. Zhao, "Simulation research of full-ocean-depth manned submersible based on experimental data," *2022 IEEE International Conference on Electrical Engineering, Big Data And Algorithms (EEBDA)*, IEEE, ChangChun, China, pp. 468–471, February, 2022.

[14] "Encyclopedia of China·Art I," *China Encyclopedia Publishing House*, Springer, Linfa, CA, USA, 1993.

[15] L. C. Jiao, S. Y. Yang, F. Liu, S. G. Wang, and Z. X. Feng, "Seventy years beyond neural networks: retrospect and prospect," *Chinese Journal of Computers*, vol. 39, no. 8, pp. 1697–1716, 2016.

[16] R. Miikkulainen, J. Liang, E. Meyerson et al., "Evolving deep neural networks," in *Artificial Intelligence in the Age of Neural Networks and Brain Computing*, pp. 293–312, Academic Press, 2019.

[17] B. B. Traore, B. Kamsu-Foguem, and F. Tangara, "Deep convolution neural network for image recognition," *Ecological Informatics*, vol. 48, pp. 257–268, 2018.

[18] Y. Xiao, Z. Tian, J. Yu et al., "A review of object detection based on deep learning," *Multimedia Tools and Applications*, vol. 79, no. 33-34, Article ID 23729, 2020.

[19] X. Peng, X. Zhang, Y. Li, and B. Liu, "Research on image feature extraction and retrieval algorithms based on convolutional neural network," *Journal of Visual Communication and Image Representation*, vol. 69, Article ID 102705, 2020.

[20] J. M. Gonzalez-Ondina, L. Sampson, and G. I. Shapiro, "A projection method for the estimation of error covariance matrices for variational data assimilation in ocean modelling," *Journal of Marine Science and Engineering*, vol. 9, no. 12, p. 1461, 2021.