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Segmentation analysis of UAV images based on Unet deep learning algorithm

Ruiyao Ding

School of Electronic and Information Engineering, Tiangong University, Tianjin, 300387, China

Corresponding author email: RuiyaoDing@outlook.com

Abstract. The continuous development of UAV technology provides us with more and higher quality data, in which the application of UAV image segmentation technology can help us better understand and process these data. Traditional image segmentation methods can no longer meet the needs of UAV image segmentation, so researchers have begun to explore the application of deep learning methods in UAV image segmentation.U-Net, as a classical deep learning model, is also widely used in UAV image segmentation.U-Net is characterized by two parts: encoder and decoder, which are used to extract the image features, and decoder is used to map the features back to the original image size. features to map back to the original image size. UAV image segmentation technology can be applied in agriculture, urban planning, environmental monitoring and other fields. In the field of agriculture, UAV image segmentation can help farmers better manage and monitor farmland to improve crop yield and quality. In the field of urban planning, UAV image segmentation can help urban planners better understand the development status of the city and provide a more scientific basis for urban planning. In the field of environmental monitoring, UAV image segmentation can help us better monitor the changes in the natural environment and provide more effective means for environmental protection. By setting the ratio of training set, validation set and test set as 6:2:2 and performing 100 rounds of training, the U-Net model shows good results in UAV image segmentation. The loss of the model gradually stabilizes at 0.2979 and the accuracy gradually converges to 90.34%. The test results show that the prediction results are very close to the true mask, indicating that the U-Net model can segment UAV images well. The application of UAV image segmentation technology can help us better understand and process the data acquired by UAV and provide more information and basis. In the future, with the continuous development of UAV technology, UAV image segmentation technology will also be more widely used. Through the application of UAV image segmentation technology, we will better understand and protect our environment, manage our farmland more efficiently, and plan our cities more scientifically.

Keywords: UAV images, Machine learning algorithms, Constant speed AC motor.

1. Introduction

Drone image segmentation refers to the segmentation of targets in images captured by drones so that each pixel is labeled as belonging to a certain target or background [1]. This technique can be applied in agriculture, urban planning, environmental monitoring and other fields [2]. Traditional image segmentation methods such as threshold-based and edge detection methods can no longer meet the

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demand, so researchers have started to explore the application of deep learning methods in UAV image segmentation [3].

U-Net is a classical deep learning model that is widely used in image segmentation [4].U-Net is characterized by two parts, encoder and decoder, the encoder is used to extract the image features and the decoder is used to map the features back to the original image size.The structure of the U-Net is similar to a U-shape, hence the name [5].

In UAV image segmentation, researchers have also tried the application of U-Net model. For example, one study used the U-Net model to segment vegetation images captured by UAVs, realizing automatic identification and classification of vegetation [6]. Specifically, researchers used high-resolution images captured by UAVs and segmented the images by U-Net model to classify the vegetation into different categories, such as trees, grass, shrubs, etc., thus realizing automatic recognition and classification of vegetation [7,8]. In addition, there are also studies that use the U-Net model to segment buildings captured by UAVs, realizing the automatic extraction and recognition of building outlines [9]. Specifically, the researchers used the U-Net model to segment the images and separate the buildings from the background, thus realizing the automatic extraction and recognition of building outlines [10].

In conclusion, the application of U-Net model in UAV image segmentation has a broad development prospect, which can help people perform image segmentation and target recognition more efficiently.

2. Data set introduction

The Drone Image Segmentation Dataset on Kaggle is a publicly available dataset containing high-resolution images captured by drones and the corresponding pixel-level labeling information, which can be used for algorithmic research and experiments on drone image segmentation.

The dataset contains two sub-datasets, namely "Semantic Drone Dataset" and "DSTL Satellite Imagery Feature Detection". The "Semantic Drone Dataset" contains 400 images of urban scenes taken by UAVs, including streets, buildings, vehicles, pedestrians and other targets; the "DSTL Satellite Imagery Feature Detection" contains 400 images of urban scenes taken by UAVs. Feature Detection" contains satellite images, including roads, buildings, water bodies, vegetation and other targets, with a total of 25 images. The size of each image is 6000x4000 pixels and the annotation information is provided at pixel level.

The labeling information of this dataset includes 11 categories which are buildings, low vegetation, trees, sky, vehicles, water, people, roads, large vehicles, bridges and others.

The use of this dataset can help researchers to conduct research and experiments on UAV image segmentation algorithms to improve the accuracy and robustness of the algorithms. Also, the dataset can be used for teaching and learning to help students better understand and master the knowledge and techniques related to UAV image segmentation.

Part of the dataset as well as the true mask are shown in Figure 1 below:

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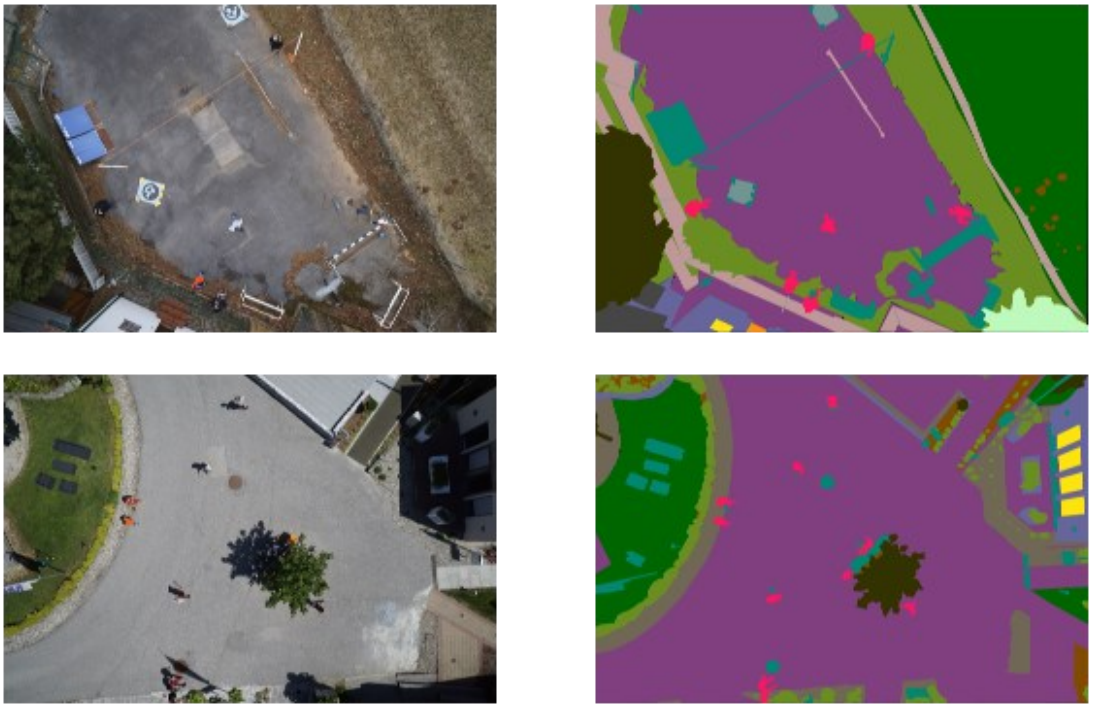

Figure 1. Part of the dataset.
(Photo credit: Original)

3. U-Net model

Net is a classical deep learning model that is widely used in the field of image segmentation.U-Net is characterized by having two parts, encoder and decoder, the encoder is used to extract the image features and the decoder is used to map the features back to the original image size.The structure of the U-Net is shown in Fig. 2.

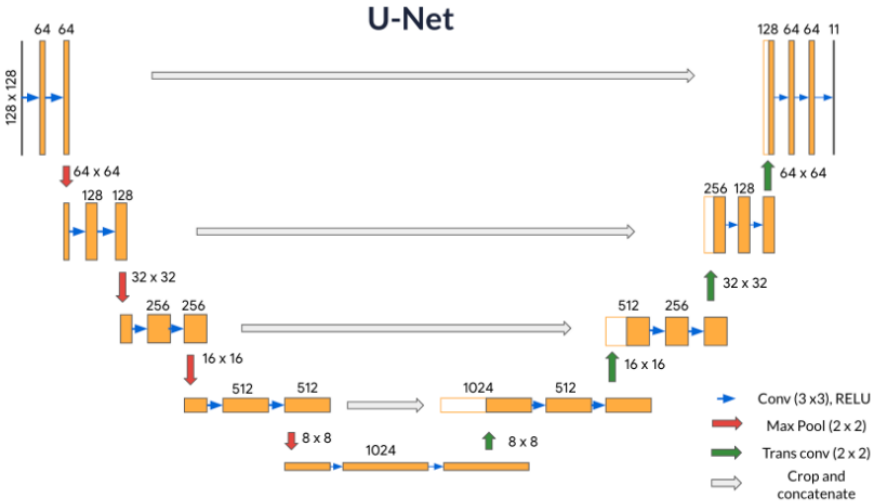

Figure 2. U-Net.
(Photo credit: Original)

The main feature of U-Net model is having symmetric encoder and decoder structure. The encoder part uses a convolutional neural network to extract features from the input image, using multilayer

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convolution and pooling operations to gradually reduce the size of the feature map and extract the high-level semantic information of the image. The decoder part then uses an inverse convolutional neural network to map the features extracted by the encoder part back to the original image size, and at the same time performs up-sampling and jump-joining operations to retain the detailed information of the feature map, thus realizing the fine segmentation of the image.

Specifically, the encoder part of the U-Net model employs multi-layer convolution and pooling operations to gradually reduce the size of the feature map and extract the high-level semantic information of the image. Each layer of convolution operation includes convolution kernel, activation function and batch normalization, where the size and number of convolution kernels can be adjusted according to the actual situation. Pooling operations are then used to reduce the size of the feature maps, usually using maximum pooling or average pooling operations. The final layer of the encoder part outputs a feature map of the same size as the input image size, which can be used as input to the decoder part.

The decoder part then uses an inverse convolutional neural network to map the features extracted by the encoder part back to the original image size, and at the same time performs up-sampling and jump-joining operations to preserve the detailed information of the feature map, thus realizing the fine segmentation of the image. Specifically, each layer of the decoder part consists of three parts: upsampling, convolution and jump-joining. The upsampling operation is used to restore the size of the feature map to the size of the original image, usually using the inverse convolution operation or the upsampling plus convolution operation. The convolution operation is used to extract the features and preserve the details of the image. The hopping connection is used to fuse the features extracted from the encoder part with those from the decoder part to preserve the local information of the image, thus improving the accuracy and robustness of the segmentation.

In conclusion, the U-Net model has a wide range of application prospects in the field of image segmentation, which can help people perform image segmentation and target recognition more efficiently. In practical application, the model can be adjusted and optimized according to the actual situation to achieve better results.

4. Model Training and Testing

Read the data, set the ratio of training set, validation set and test set to 6:2:2, the training set is used for model training, the validation set is used for validation during the training process, and the test set is used for model testing at the end of the training, the epoch is set to 100, and the model effect is evaluated by using the LOS and ACCURACY, and the LOS curves and ACCURACY curves are shown in Fig. 3:

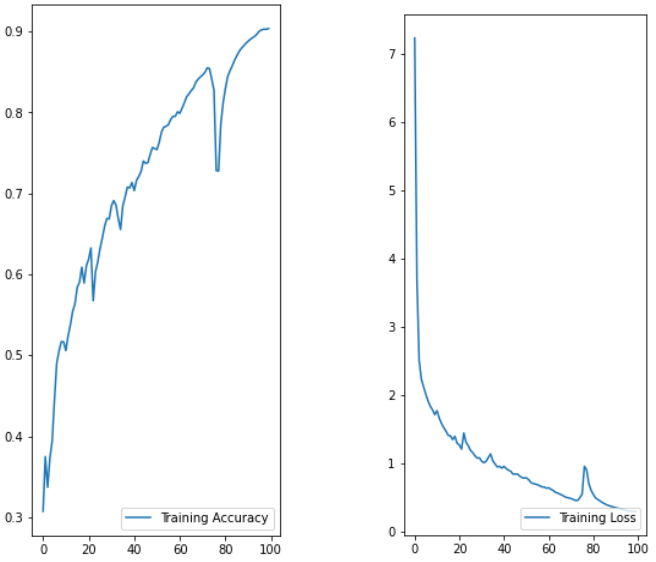

Figure 3. Loss and accuracy.
(Photo credit: Original)

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From the loss curve and accuracy curve, it can be seen that after 100 rounds of training, the loss is gradually stabilized at 0.2979, and the accuracy is gradually converging to 90.34%, and the model prediction effect is gradually getting better.

The results of model testing are shown in Fig. 4.

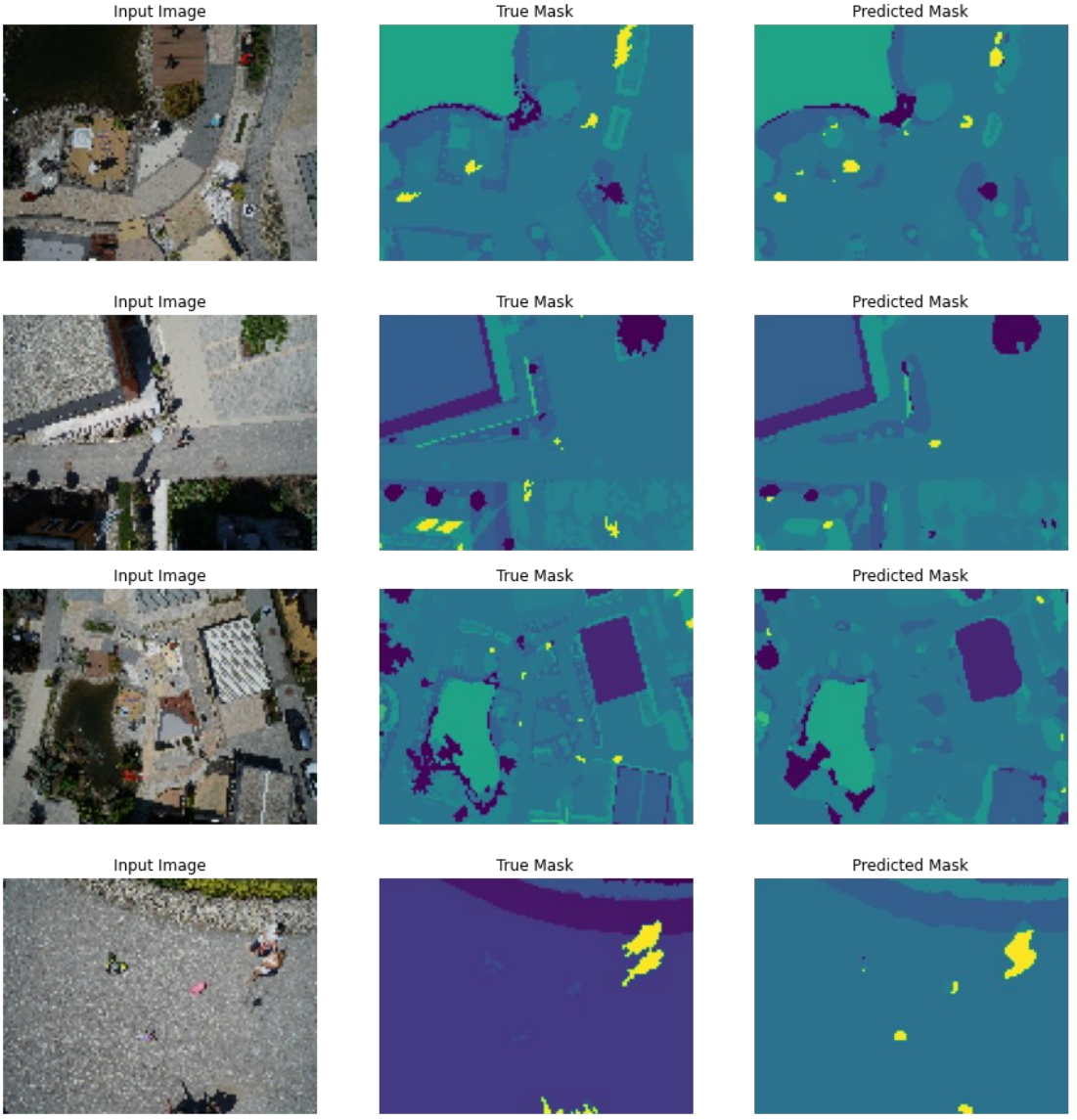

Figure 4. Model test.
(Photo credit: Original)

From the test results, the prediction results are very close to the true mask, indicating that the unet model can segment the UAV images well.

5. Conclusion

The development of drone technology allows us to obtain more and higher quality data, in which the application of drone image segmentation technology can help us better understand and process these data. In the field of agriculture, UAV image segmentation can help farmers better manage and monitor farmland, and improve the yield and quality of crops. In the field of urban planning, UAV image segmentation can help urban planners better understand the development of the city and provide a more

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scientific basis for urban planning. In the field of environmental monitoring, UAV image segmentation can help us better monitor changes in the natural environment and provide more effective means for environmental protection.

Traditional image segmentation methods can no longer meet the needs of UAV image segmentation, so deep learning methods have been widely used in this field.U-Net, as a classical deep learning model, is also widely used in UAV image segmentation.U-Net is characterized by two parts, encoder and decoder, the encoder is used for extracting the image features, and the decoder is used for mapping the features back to the original image size. By setting the ratio of training set, validation set and test set to 6:2:2 and performing 100 rounds of training, the U-Net model shows good results in UAV image segmentation. The loss of the model gradually stabilizes at 0.2979 and the accuracy gradually converges to 90.34%. The test results show that the prediction results are very close to the true mask, indicating that the U-Net model can segment UAV images well.

The application of UAV image segmentation technology can help us better understand and process the data acquired by UAVs, providing us with more information and basis. In the future, with the continuous development of UAV technology, UAV image segmentation technology will also be more widely used. We can expect that through the application of UAV image segmentation technology, we will better understand and protect our environment, manage our farmland more efficiently, and plan our cities more scientifically.

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