Algorithms based on neural network for segmentation of defects on metal sheet images

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Annotation
In recent years, the use of intelligent technologies in manufacturing has become more active. This article highlights our solution to the problem of developing neural network algorithms for segmentation of defects on metal sheet images. Our algorithms based on neural network architecture - ResNet. We used Severstal steel defect detection dataset that to train them. We explored various variations of the network that to find an optimal algorithm among reviewed variations of algorithms.

Keywords
Material science, metal defects, image segmentation, smart manufacturing, ResNet

1. Introduction

In recent years, the use of intelligent technologies in manufacturing has become more active. Production companies especially need to solve a problem of automatic detection of product defects. This article highlights our solution to the problem of developing neural network algorithms based on the ResNet architecture [1] for segmentation of defects on metal sheet images.

2. Methods

We have used ResNet. This neural network architecture solves a problem of training very deep networks. That to solve that problem (by authors of this neural network) was added shortcut connections. The Skip Connections between layers add the outputs from previous layers to the outputs of stacked layers. Layers sequence consists of sequentially alternating operations of convolution and ReLU. This results in the ability to train much deeper networks than what was previously possible.

That to implement algorithms, conduct experiments based on the ResNet, we have used PyTorh framework [2]. We experimented with varying layers (18, 34, 50 layers) in ResNet that to get an optimal algorithm among these variants.

The models were trained using the Steel Defect Detection dataset [3]. This dataset consists of 12 568 images of defective sheet metal. The dataset contains four classes of defects, and there also exist images without defects. Resolution of images is 1600x256 pixels. This dataset was divided on two sub datasets train and test, in ratio 80:20 accordingly. At the training stage, each image was flipped horizontally or vertically (with a probability of 0.5) and normalized.

The training was occurred with using the Adam algorithm [4]. Moreover, training (for each version of the neural network) lasted as long as the loss function continued to decrease. In both cases, the Softmax was used as the loss function. For each epoch was computed accuracy metrics of the segmentation, such as Dice Score and IoU.

3. Results

Results of experiments showed in table 1. Results is unexpected, because turned out middle variant of the algorithm with 34 layers more optimal than with 50 layers, which at first assumed. In visual review (a one image showed as image1) of masks, we saw that out segmentation mask describes

defects more gracefully than training mask, which was sometimes rude. This results can be help for further research or for practical applications on manufactures.

Table 1
Results of experiments

	ResNet18	ResNet34	ResNet50
Loss function	0.0109	0.0067	0.0078
IoU	0.5216	0.5930	0.5650
Dice score	0.7526	0.8148	0.7910
Epoch	23	23	21
Time of epoch, Min	17.6	20.3	29.6

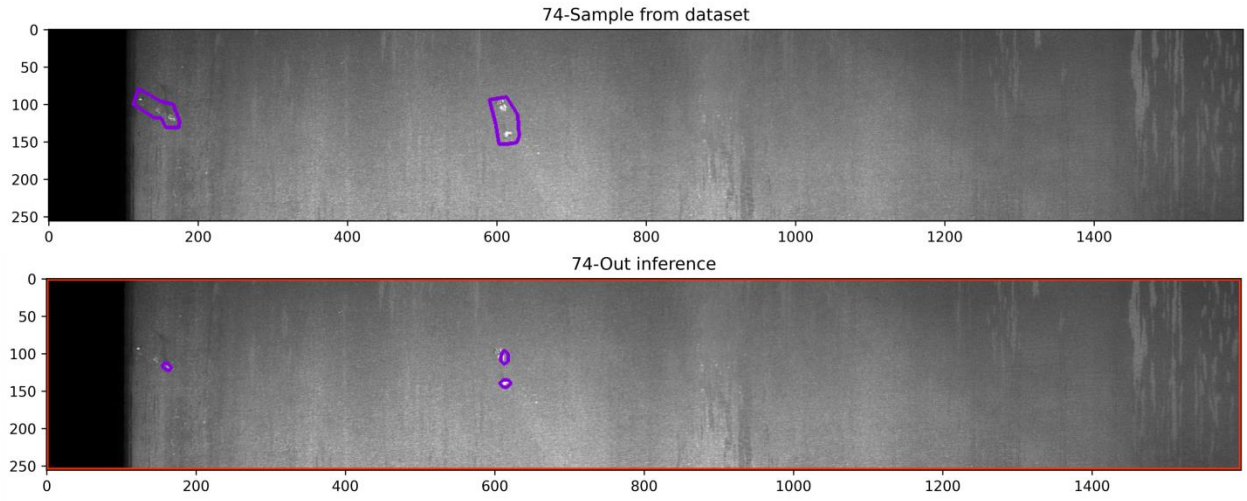

Figure 1: Visualized results of experiments

4. References

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