DEEP CONVOLUTION NEURAL NETWORKS IN CLASSIFICATION OF METALS MICROSTRUCTURE

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ABSTRACT

The main objective of presented work is an attempt of application of techniques taken from a dynamically developing field of image analysis based on Deep Convolutional Neural Networks (DCNNs) in classification of different types of microstructure photographs of metals received from the light microscopy. While microstructural characterization is very important and pretty well recognized, its classification is not a trivial task. Despite the dynamic development of digital photography and computer systems, classification of the steel microstructure remains the task of experts who "manually" evaluate a given picture of the structure. Classification appears extremely difficult especially in the cases, when there are mixtures of different phases with various substructures. There is no evidence of the computer systems which allow the automatic classification of microstructure, so any attempt in that direction can be valuable. Our first goal was to build a classification system based on DCNN, allowing classification of 8 different types (classes) of microstructure of the following different steel grades: C15, C45, C60, C80, V33, X70 and carbide free steel. The elaborated microstructure classifier was based on well-known architecture ResNet18 of Convolutional Neural Network, presented in details in [1]. The DCNN has been trained on more than 33K micrograph images of different types of microstructure. Obtained, classification system and segmentation routines achieved high accuracy of 99.8% [2]. The next goal was implementation of the Transfer Learning algorithm to build a second system for classification of microscopic images. The elaborated DCNN was trained and validated on the data set of the microstructure images of different ASTM classes of commercial nickel alloy 720. With the proposed methodology we not only managed to achieve accuracy exceeding 95% on the test data set, but we also trained our model on high resolution pictures using standard PC with GPU with only 2GB of RAM in less than one hour and using only 150 images per class [3]. It would not be possible to even get close to that results using conventional classification techniques. Presented results confirm, that DCNN can be a useful tool in microstructure classification.

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