Journal of
Telecommunications System & Management

Abstract

A neural network approach for detecting surface defects in hot rolling process

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Abstract:

In hot rolled steel production surface defects occur due to material problems or process problems. The production quality should be monitored real time to identify the surface defects occurring. This will help to easily identify the cause of the defect and solve it. Thus, by correctly identifying the defects in real time we could rectify the problem avoiding defective production and saving in material and process cost. The production speeds for hot rolled steel sheets will reach up to 18m/s. This makes the real time monitoring extremely difficult as the detection system must have a very high detection speed. The detection system also must have a high prediction accuracy to conform to the industrial quality management standards. The surface defect detection problem is to identify defect class in a steel surface. Automatic visual inspection systems were in the industry for a while, but they were so sensitive to the environment and could only use for a particular system. Here we are using convolutional neural network approach for identifying the type of defect. With the advancement of Deep Learning especially Convolution Neural Network (CNN) the image classification has become more sophisticated and accurate. CNN has the potential for high detection speed and at the same time high accuracy predictions. For training the neural network a dataset of 1800 images belonging to 6 defect classes were selected from North Eastern University-USA steel defect dataset. From experimentation we have learned that for this dataset sequential model architecture could be used and 8 layered CNN model is used. Loss function used is categorical cross-entropy. The optimizer function used is Nadam. The images have been pre-processed using Keras pre-processing to improve the dataset variability the various parameters that have been changed during pre-processing include width shift, height shift, shear zoom, horizontal flip and rotation. After the pre-processing process using the Keras a dataset with more variability is obtained. Max pooling is done to reduce the amount of data without affecting the quality at each level and also used a fully connected layer at the end to enable classification. The model been built to 8 layers with alternate convolutional and maxpooling layers and fully connected layer at the end. The built model then has been trained with image dataset the training is done on COLAB. The convolutional layers used 3*3 filters. The activation function used is Rectified Linear Unit. The input

shape of the images is 200*200 gray scale. The classification activation is done by softmax function. There is 68,16,198 total trainable parameters in the model. The model is trained up to 500 epochs. To improve the accuracy tuning of hyper parameters have been carried out various parameters that have been fine-tuned were, loss function which is used to find the error from model output against the desired output. Then the optimiser functions were fine tuned optimizers are functions used to change the attributes of neural network such as weights to reduce the losses. The performance evaluation of the CNN model and tuning of hyper parameters were carried out to obtain maximum accuracy. The model output accuracy of 99.36% was obtained through the fine tuning. The detection speed has been reduced to microseconds. The images collected from the local industries can be used to test the validity of the model. The implementation with YOLO V3 can be done to obtain for faster image detection on real time manufacturing scenarios.

Keywords: Steel surface defect detection system, Automatic inspection, Convolutional neural networks,

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International Conference on Ethicalhacking and Cybersecurity | May 21, 2020 | London, UK

Citation: Sam Geogi; A neural network approach for detecting surface defects in hot rolling process; Sameh Magdy; Improved Face Recognition based on Hidden Markov Model; Cyber Security 2020; May 21, 2020; London, UK