Aluminum Casting Inspection Using Deep Learning: A Method Based on Convolutional Neural Networks

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Abstract:

Castings produced for the automotive industry are considered important components for overall roadworthiness. To ensure the safety of construction, it is necessary to check every part thoroughly using non-destructive testing. X-ray testing rapidly became the accepted way of controlling the quality of die-cast pieces. In this paper, we present a Convolutional Neural Network (CNN) for defect detection in castings. In order to train the CNN model, a large dataset is necessary. We build the dataset by using synthetic defects. They are simulated using 3D ellipsoidal models and Generative Adversarial Networks (GAN). We compare different portions of ellipsoidal/GAN defects in the training subset. In our experiments, the use of GAN defects does not play a relevant role in this solution. However, ellipsoidal defects helped to achieve better performance. Ellipsoidal defects from any size and orientation could be superimposed onto real X-ray images in any location. In addition, we tested several CNN configurations, the best one, that we call Xnet-II, has 30 layers and more than 1,350,000 parameters. It has been trained using a dataset with around 640,000 patches containing 50% of ellipsoidal defects and 50% of real background captured from different casting types. The model was tested using sliding-windows methodology on whole X-ray images achieving promising results (mPA = 0.7102): the model was able to detect real defects from different casting types. We believe that the methodology presented could be used in similar projects that have to deal with automated detection of defects.