Adaptive High Precision Hollow Turbine Blade CT Image Contour Extraction

Jia Zheng[1], Chuan Tang[2], Tao Hong[3], Yuanxi Sun[4]

[1]School of Advanced Manufacturing Engineering, Chongqing University of Posts and Telecommunications, China, [1]College of Advanced Manufacturing Engineering, Chongqing University of Posts and Telecommunications, China, [1]School of Advanced Manufacturing Engineering, Chongqing University of Posts and Telecommunication, China, [1]College of Mechanical and Vehicle Engineering, Chongqing University, China

Hollow turbine blade has complex closed structure and special material. ICT (industrial computed tomography) is a promising nondestructive detection method to detect hollow turbine blade qualitatively and quantitatively. The detection precision mainly depends on the ICT image quality and precision of post-processing methods. As a key step of post-processing, segmentation decides the final precision. However, small holes, closed structures and special materials of hollow turbine blade cause artifacts, low contrast, and blur issues in ICT slice images. These facts make it hard to segment blade images precisely. In our previous work, we found that Phansalkar can acquire satisfying segmentation precision for blade images. However, Phansalkar's 5 parameters (local window size, p, q, r, k) should be adjusted manually for each slice according to experience, which results in insufficient efficiency and poor automation. Moreover, for traditional Phansalkar, one image has only one local window size, which makes small structures (such as film cooling holes) and big structures (such as blade basin and back) cannot be segmented precisely at the same time. Hence, we propose a high precision, adaptive, and paremeterless method based on Phansalkar, which can segment hollow turbine blades' CT images precisely. Firstly, an adaptive local window division method is proposed to divide hollow turbine blade's CT image into appropriate small local windows. Then, the structure connectivity of neighboring slice images is used to acquire appropriate Phansalkar parameters of each slice. In this step, 1 slice image is marked manually every 50 slices. Then the marked image is applied in GA (Genetic Algorithm) to optimize parameters of Phansalkar. In the last step, the optimized parameters are used to calculate thresholds of each local window for the other 49 slices. We have testified our method by experiments on 2 real hollow turbine blades. BF (Boundary F-measure) is used to evaluate segmentation precision. The results show that our method can acquire overall higher BF than comparing methods. Besides, our methods acquire better visual results. Our proposed method can also be applied to segment other types of images with low contrast and inhomogeneity.