Hierarchical adaptive deep convolution neural network and its application to bearing fault diagnosis

Xiaojie Guo, Liang Chen, Changqing Shen

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Xiaojie Guo, Liang Chen*, Changqing Shen,
School of Mechanical and Electric Engineering, Soochow University, Suzhou, 215021,P.R. China

Corresponding author:
Dr. Chen
School of Mechanical and Electric Engineering
Soochow University, Suzhou, 215021, P.R. China
Tel:0512-67162703
E-mail address: ChenL@suda.edu.cn

Abstract: Traditional artificial methods and intelligence-based methods of classifying and diagnosing various mechanical faults with high accuracy by extracting effective features from vibration data, such as support vector machines and back propagation neural networks, have been widely investigated. However, the problems of extracting features automatically without significantly increasing the demand for machinery expertise and maximizing accuracy without overcomplicating machine structure have to date remained unsolved. Therefore, a novel hierarchical learning rate adaptive deep convolution neural network based on an improved algorithm was proposed in this study, and its use to diagnose bearing faults and determine their severity was investigated. To test the effectiveness of the proposed method, an experiment was conducted with bearing-fault data samples obtained from a test rig. The method achieved a satisfactory performance in terms of both fault-pattern recognition and fault-size evaluation. In addition, comparison revealed that the improved algorithm is well suited to the fault-diagnosis model, and that the proposed method is superior to other existing methods.

Keywords: fault diagnosis; feature extraction; adaptive learning rate; deep convolution network; hierarchical structure.

1.Introduction

Rolling-element bearings are important components of many heavy-duty machines used in auto-manufacturing, shipping, etc. Faults in rolling-element bearings may impair machine operation, resulting in large economic losses and even human casualties[1].Therefore, effective