Missing Data Bearing Fault Diagnosis Based on SVT-1DCNN

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Key Words

missing data, one-dimensional convolutional neural network (1DCNN), singular value thresholding (SVT)

Abstract

Missing data is a common phenomenon in induction motor fault datasets, which could lead to a loss of statistical ability and/or biased results for fault diagnosis.
In this paper, we address the rolling bearing fault diagnosis in the presence of missing data, where a bearing fault diagnosis method based on singular value thresholding (SVT) low-rank matrix filling and one-dimension convolutional neural network (1DCNN) is proposed. Specifically, the SVT low-rank matrix filling is first used to recover the missing fault bearing data,
and then 1DCNN is adopted to extract the fault feature and classify each fault automatically.
The experimental results show that the classification accuracy of the proposed method can be promoted as high as 96.38%, which is better than that of other methods.

Our Method

1、Singular Value Thresholding (SVT)

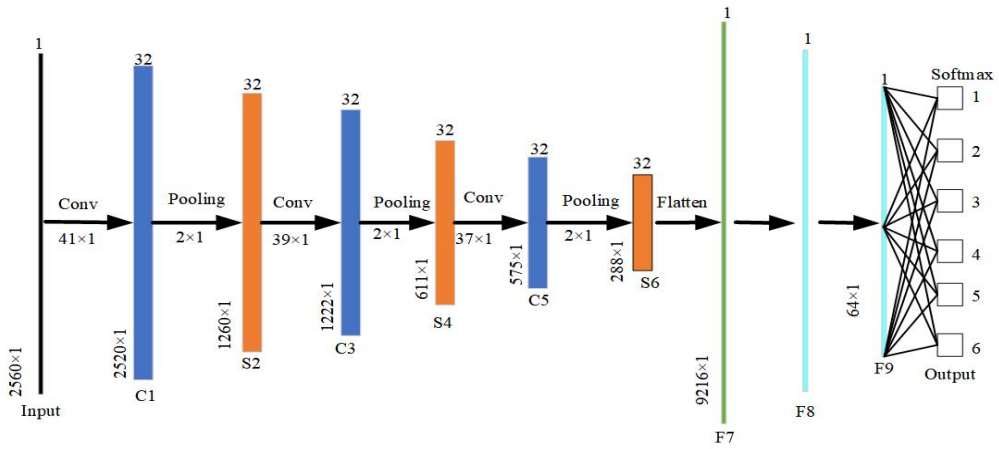
The problem solved by the singular value threshold algorithm (SVT) is:

$$\min \|\mathbf{X}\|_*$$

$$s.t. \mathrm{P}_{\Omega}(\mathbf{X}) = \mathrm{P}_{\Omega}(\mathbf{M})$$

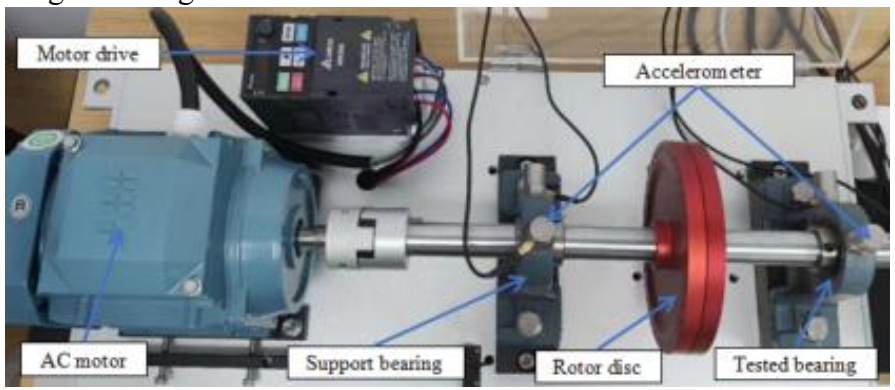
where the kernel norm is minimized and is also the best convex approximation of rank(**X**). For the missing data filling problem in this paper, the missing low-rank dataset can be supplemented in the case of incomplete data.

2、One-dimension convolutional neural network (1DCNN)



Datasets

This paper uses a private dataset to verify the effectiveness of the experiments. The dataset is obtained through experiments on the PT100 bearing fault diagnosis simulation test bench.



Experiments

In this experiment, the original bearing vibration data which we used were randomly lost at 30%. First, we use various missing value filling methods to recover the original missing data. Second, the recovered vibration signals are classified and diagnosed by using 1DCNN. Finally, we compare the accuracy and convergence of each method.

EXPERIMENTAL RESULTS

Method	Running times	Convergence	Accuracy
Mean-1DCNN	250	True	85.56%
Median-1DCNN	250	True	65.78%
Mode-1DCNN	250	False	41.56%
KNN-1DCNN	250	True	87.56%
SVT-1DCNN	250	True	96.38%

Conclusion

In this paper, the problem of missing data recovery and fault classification diagnosis in the field of motor fault diagnosis are studied. In order to solve these problems, a SVT-1DCNN is proposed to deal with the missing data in the faulty bearing. In this method, the low-rank matrix completion method can be used to recover the low-rank fault data more effectively, which can make the data more consistent with the appearance of the original fault data. The experiments show that this method has higher accuracy than Mean-1DCNN, Median-1DCNN, Mode-1DCNN and KNN-1DCNN, moreover, it also proves that this method has greater advantages in the field of missing data fault diagnosis.