Fault Classification of Linear Motion Guide under Low-speed Operation

S. H. Cho[1], S. Kim[1], H. J. Park[1], S. J. Ham[1] and J. H. Choi[2*]

[1] Dept. of Aerospace and Mechanical Engineering, Korea Aerospace University, Goyang-City, Gyeonggi-do, 10540, Republic of Korea
[2] School of Aerospace and Mechanical Engineering, Korea Aerospace University, Goyang-City, Gyeonggi-do, 10540, Republic of Korea

*Corresponding author: jhchoi@kau.ac.kr

1. Introduction

It is well known that rolling element bearings are a key component of rotating machinery. Bearings are usually located in an inaccessible area and their failure could lead to catastrophic incidents. Thus, it is very important to monitor the condition of bearings and diagnose the failure for the reliable and safe operation of rotary machinery. So, there was a lot of interest in the diagnosis and prognosis of bearings [1].

Among various types of bearings, this study focuses on rolling element bearings rotating in low-speed which are widely used in many industries, such as wind turbine power plant, paper mills [2]. When bearing rotates at slow speed (usually between 10 and 100rpm), it is difficult to capture the defective characteristics because they are buried in noise and shaft vibration. Thus, selecting the optimal signal processing and classification algorithm is essential in this topic.

In this study, several algorithms are compared to each other in the view of diagnostic performance and a framework for the diagnosis of low-speed rolling element bearing is proposed. Lastly, experiments of low-speed rolling element bearings are conducted and used to evaluate the performance of the proposed framework in this study.

2. Diagnosis of low-speed bearings

For diagnosis the condition of low-speed bearings, vibration signal and acoustic emission signal are commonly used [3]. First, the vibration signal is one of the most commonly used measurements in the field of Prognostics and Health Monitoring because of its ability to detect initial defects. However, in case of low speed, diagnosing rolling element bearing is challenging issue using the vibration signal because the noise is large compared to the signal and the defect frequencies of bearings are hard to capture. For this reason, acoustic emission may be more useful and has been frequently used in this topic [4]. However, in the real field, it is difficult to collect acoustic emission signal properly due to the noisy operating environment. Thus, this study proposes a framework of fault diagnostics of low-speed bearings using vibration signal. In order to resolve the prementioned problem, the optimal signal processing and classification algorithm are selected. Last, the framework is verified its effectiveness by experiments using the lab-scale test rig (Fig.1).

3. Conclusion

Low-speed rolling bearings are difficult to diagnose compared to bearings moving in high speed. However, it is important to monitor them because they are widely used in many heavy industries. There are two parts of the diagnosis of low-speed bearings: signal processing and classification [2]. In this study, a framework is proposed based on recent studies and its performance is verified by experiments.

Fig.1 Test rig for diagnosis of low-speed bearing

Acknowledgment

This research was supported by a grant from business of snetsystems.

References

[1] R. B. Randall and J. Antoni, "Rolling element bearing diagnostics-A tutorial," *Mech. Syst. Signal Process.*, vol. 25, no. 2, pp. 485–520, 2011.

[2] A. Widodo *et al.*, "Fault diagnosis of low speed bearing based on relevance vector machine and support vector machine," *Expert Syst. Appl.*, vol. 36, no. 3 PART 2, pp. 7252–7261, 2009.

[3] S. T. Kandukuri, A. Klausen, H. R. Karimi, and K. G. Robbersmyr, "A review of diagnostics and prognostics of low-speed machinery towards wind turbine farm-level

health management," *Renew. Sustain. Energy Rev.*, vol. 53, pp. 697–708, 2016.

[4] B. Van Hecke, J. Yoon, and D. He, "Low speed bearing fault diagnosis using acoustic emission sensors," *Appl. Acoust.*, vol. 105, pp. 35–44, 2016.