Tool condition monitoring system using tool load estimation in drilling process

B. Park[1], D. Kwon[2] and C. Lee[2*]

[1]Department of Mechanical Design & Production Engineering, Konkuk University, Seoul, Republic of Korea
[2]Department of Mechanical Engineering, Konkuk University, Seoul, Republic of Korea

[*]Corresponding author: leewoo1220@konkuk.ac.kr

1. Introduction

In a machining manufacturing system, it is necessary to predict tool condition in order to improve machining efficiency. Tool condition monitoring in the machining process aims to identify the cutting tool condition, in order to reduce brought by tool wear or tool failure, by applying appropriate sensor signal processing and pattern recognition method [1]. In this study, tool load estimation study has been carried out via kurtosis from sensitive signal. Using the estimated load, we studied to predict tool state so that maintain the precision of a workpiece.

2. Proposed algorithm

Signal which was measured using over sampling method was segmented manually based on a cutting cycle that is the number of revolutions per minute [2]. The segmented signal was calculated as a kurtosis after standardization. This is more sensitive to peak values. The cutting tool condition is confirmed by analyzing the relationship between the calculated kurtosis and time.

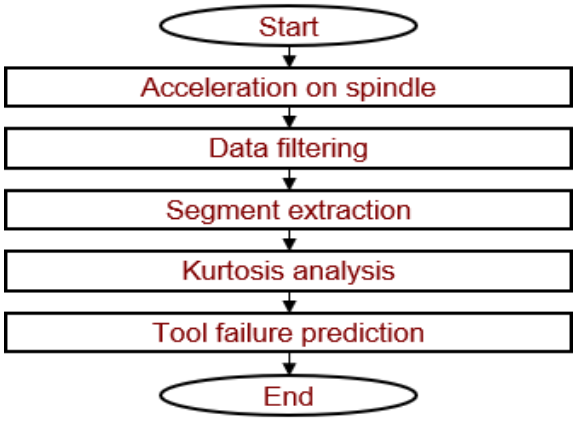

Fig.1 Diagnosis flow chart of tool failure

3. Experiment

The experiments were carried out on a machining center (SNK DIC80/5). The acceleration of the main spindle was measured by an accelerometer (PCB356A15) was attached to the head of spindle. A workpiece SM45C was machined. The tools employed was TiAlN-coated Co-HSS twist drills with diameters of 2.0mm.

Acceleration data from normal tool and chisel edge worn tool were analyzed by the proposed algorithm. Fig. 2 shows the estimated load according to tool condition. Thrust direction is x axis. Torque directions are y and z axis. The estimated load of the fault tool is larger than normal tool because it had more peak value per the cutting cycle.

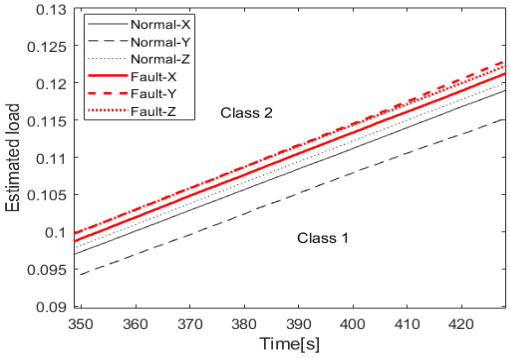

Fig.2 Tool load estimation

4. Conclusion

This study proposes the tool condition monitoring algorithm using the kurtosis. The tool load can be estimated by calculating kurtosis in drilling process.

Acknowledgment

This research was supported by the Ministry of Trade, Industry & Energy(MOTIE), Korea Institute for Advancement of Technology(KIAT) through the Encouragement Program for The Industries of Economic Cooperation Region(P0002215) and the Technology Innovation Program(No. 20003806 Line center development with more than 15% compact index applying IoT/AI smart condition monitoring system and dual head for processing complex shape parts)

References

[1] G. Byrne, D. Dornfeld, I. Inasaki, G. Ketteler, W.Konig, R. Teti, Tool condition monitoring-the status of research and industrial application, *CIRP Annals*, 44 (1995) 541-567.

[2] M. Uekita, Y. Takaya, Tool condition monitoring technique for deep-hole drilling of large components based on chatter identification in time-frequency domain, *Measurement*, Netherlands, 103 (2017) 199-207.