Journal of Agricultural Machinery
Vol. 7, No. 1, Spring - Summer 2017, p. 86-96

نشریه ماشین‌های کشاورزی
جلد ۷، شماره ۱، نیمسال اول ۱۳۹۶، ص ۹۶-۸۶

Fractal analysis of sound signals in SAMPO 3065 combine harvester

F. Mahdiyeh Boroujeni[1]- A. Maleki[2*]

Received: 13-02-2015
Accepted: 21-12-2015

Introduction

Nowadays, many studies were performed about noise source and its type and effects related to duration of sound emission. Most of these researches just report sound pressure level in frequency or time domain. These researches should be continued in order to find better absorber material in noise pollution. Use of fractal geometry is a new method in this filed. Wave fractal dimension value is a strong tool for diagnosis of signal instability and fractal analysis is a good method to finding sound signal characteristics. Therefore the aim of this study is on the fractal geometry of SAMPO 3065 combine harvester signals and determine the fractal dimension value of these signals in different operational conditions by Katz, Sevcik, Higuchi and MRBC methods.

Materials and Methods

In this research, sound signals of SAMPO 3065 harvester combine that were recorded by Maleki and Lashgari (2014), were analyzed. Engine speed (high and low), gear ratio (neutral, 1st, 2nd, 3rd gear), type of operation (traveling and harvesting) and microphone position (in and out of the cabin) were the main factors of this research. For determining signal fractal dimension value in time domain, wave shape supposed as a geometrical shape and for calculation of fractal dimension value of these signals, total area of wave shape was divided into boxes in 50, 100, 200 milliseconds with an interval 25 millisecond box. Then Fractal dimension value of these boxes was calculated by Katz, Sevcik, Higuchi and MRBC methods using MATLAB (2010a) software. SPSS (Ver.20) software was used for further analysis.

Results and Discussion

Results showed mean effects of engine speed, microphone position, gear ratio, type of operation, box length, calculation method and all of two way interaction effects were significant ($p<0.01$). Means of Fractal Dimension in the road and field position were 1.4 and 1.28 respectively. The Maximum growth ratio of fractal dimension value during engine speed levels was related to road position. By increasing of box length and number of data points in each box, the fractal dimension value was increased. Investigation of fractal dimension methods showed changes of box length did not affect fractal dimension value in Higuchi method and range of this factor while box length varied were 0.001, 0.171, 0.005 and 0.024 in Higuchi, Katz, MRBC and Sevcik method respectively. These results showed that Katz method has maximum sensitivity and MRBC method like Higuchi method had the minimum sensitivity by changing of box length. In this research fractal dimension value of SAMPO Combine signals in the time domain in different operation conditions were investigated by Katz, Sevcik, Higuchi and MRBC methods. These values varied from 1 to 1.5 in different conditions. Maximum fractal dimension value was 1.63 in case of no cabin by MRBC method. Increasing of box length or further the data point cause of increasing fractal dimension value with increasing of sound pressure level of combine due to increasing of engine speed and working of different parts of harvesting combine. Due to define of sound pressure level, and increasing of this item in each gear ratio ,this can be justify that in high engine speed, wave turbulent is higher than low speed and this turbulent appeared in fractal dimension value.

Conclusions

One of the important factors in the evaluation of the time series disturbance is fractal dimension. Therefore, the study of sound signals can be an effective role in this regard. Factors such as the cabin existence, gear type, engine speed and operational state of combining parts had a considerable role in distribution of combinimg

1- M.Sc. Graduated Student, Department of Mechanical Engineering of Biosystems, Shahrekord University, Shahrekord, Iran
2- Associate Professor, Department of Mechanical Engineering of Biosystems, Shahrekord University, Shahrekord, Iran
(*- Corresponding Author Email: Maleki_ali@iran.ir)

sound signals and fractal dimention of these signals. For example cabin acts as a barrier in the sound wave and decrease the sound pressure level near driver ear and cause decrease fractal dimention of signals.

The study of time series with different lengths have shown that the duration time of the calculation in various methods had a significant effect. Increasing the length of signals due to a higher number of signal data cause to increase calculation time of fractal dimension calculation, while the changes of fractal dimension in increasing of the number of data is minimum and negligible. Therefore, the choice of the appropriate length of the signal is important.

Keywords: Acoustic, Combine, Fractal Dimension, Signals