Accepted Manuscript

Investigation for the presence of chaos in surface topography generated by EDM

Ushasta Aich

PII: S0301-679X(18)30013-6

DOI: 10.1016/j.triboint.2018.01.013

Reference: JTRI 5044

To appear in: *Tribology International*

Received Date: 9 August 2017

Revised Date: 3 January 2018

Accepted Date: 4 January 2018

Please cite this article as: Aich U, Investigation for the presence of chaos in surface topography generated by EDM, *Tribology International* (2018), doi: 10.1016/j.triboint.2018.01.013.

Investigation for the presence of chaos in surface topography generated by EDM

Ushasta Aich
Mechanical Engineering Department
Jadavpur University
Kolkata – 700032, India
E-mail: ushasta@yahoo.co.in

Abstract: Investigation for the presence of chaos in apparently erratic-looking fluctuations in surface profiles leads to a percipience of the mechanism behind surface generation process. Here, an organized methodology is devised to unveil the dynamics of surface generation in EDM by examining generated surfaces. Sequence of profile heights is considered as time series and inspected using nonlinear time series analytical tools. Both the test for chaos and the test for determinism postulate presence of deterministic chaos in surface topography and thereby in the occurrence of discharges during surface generation by EDM. Further, an entropy based non-dimensional index is introduced to quantify the level of deterministic chaos. The proposed methodology would guide the engineers to correlate a surface and its generation process.

Keywords: Electric discharge machining (EDM); Chaos; Determinism; Degree of deterministic chaos (DoDC)

Nomenclature

A	Amplitude of small shuffle surrogate generation
c	Randomly chosen value for 0-1 test for chaos
cur	Current (A)
$\mathbf{D_c}$	Modified Mean square displacement for particular c
DoDC	Degree of deterministic chaos
E, E*, E_1, E_2	Quantities defined in AFNN method
IND	Indexes of time series ***y***
$\boldsymbol{IND_S}$	Small shuffled indexes
K	Median of all K_cs obtained from a parent time series
$\boldsymbol{K_c}$	Asymptotic growth rate for particular c
m	Embedding dimension
M	Number of points in phase space
$\boldsymbol{M_c}$	Mean square displacement for particular c
M_{Cao}	Number of points in phase space considered in AFNN method
N	Length of time series
$NN_{dist}^{i,m}$	Distance between Y_i and Y_i^{NN} at m dimensional phase space
$NN_{dist}^{i,m+1}$	Distance between Y_i and Y_i^{NN} at m+1 dimensional phase space
$\boldsymbol{p_c}$, $\boldsymbol{q_c}$	Translational vectors for particular c
rand	Gaussian random vector
RITE	Redundance and irrelevance tradeoff exponent
SE	Spectral entropy of parent time series
SE_{SSS}	Spectral entropy of SSS time series
$\overline{SE_{SSS}}$	Mean of all values of SE_{SSS} obtained from a parent time series
SOAC	Second order autocorrelation
t_{off}	Pulse off time (μs)
t_{on}	Pulse on time (μs)
y	Profile height
Y	Phase vector
$\bar{y}$	Mean of N profile heights
$\boldsymbol{y^d}$	distances of the delay vectors from identity line in reconstructed space y_i-$y_{i+\tau}$
Y_i^{NN}	Nearest neighbor of Y_i at m dimensional phase space
$\boldsymbol{y_{sss}}$	Small shuffled surrogate time series generated from parent time series ***y***
σ_y	Standard deviation of N profile heights
τ	Embedding delay
τ_{opt}	Optimum embedding delay