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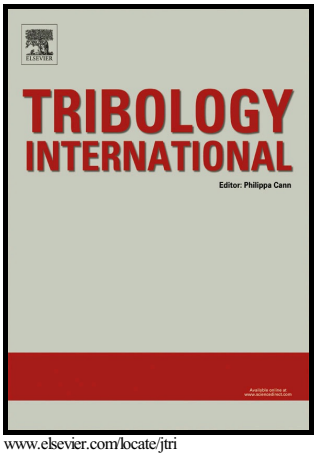

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Characterizing topography of EDM generated surface by time series and autocorrelation function

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Abstract: Characterizing topography of machined surface is a way of getting insight into the machining phenomena. Here, a statistical procedure is proposed for extracting the topographical features of electric discharge machined (EDM) surface. Computed autocorrelation functions (ACF) of roughness profiles (considering as time series) exhibit possible random and periodic features buried on the machined surface. Through the decomposition of ACF curves and using backward linear prediction method, existing random and periodic patterns are separated. Very small values of a non-dimensional index - PR ratio indicate the presence of significant random variations in the machined surface. Spatial variations of characteristic lengths within a treatment are found as the most contributive part in overall variation and assert stochastic nature of surface development.

Keywords: Electrical discharge machining (EDM); Autocorrelation function (ACF); Periodicity to randomness ratio (PR ratio)

Nomenclature

$\bar{x}$	Sample mean
$\bar{y}$	Mean of n profile heights
$\boldsymbol{A}$	Amplitude of FID
ACF	Autocorrelation function
$\boldsymbol{CA}$	Constant part FID with respect to $\boldsymbol{\tau}$
CI	Confidence interval
cur	Current (A)
$\boldsymbol{D}$	Coefficient of backward linear prediction
FID	Freely induced decay
$\boldsymbol{H}$	Hankel matrix
K	Number of FIDs buried in roughness profile
L	Predictor order of backward linear prediction
n	Number of profile heights collected from roughness profile, length of time series
N	Length of ACF
PR ratio	Periodicity to randomness ratio
$\boldsymbol{R}$,$\boldsymbol{R'}$	Root of polynomial with coefficients $\boldsymbol{d}$
s	Sample standard deviation
$\boldsymbol{SP}$	Variable part of FID with respect to $\boldsymbol{\tau}$
SVD	Singular value decomposition
t_{off}	Pulse off time (μs)
t_{on}	Pulse on time (μs)
$\boldsymbol{U^H}$, $\boldsymbol{S^H}$, $\boldsymbol{V^H}$	Components of SVD of hankel matrix $\boldsymbol{H}$
$\boldsymbol{y}$	Profile height
$\boldsymbol{\alpha}$	Decay rate of FID
$\boldsymbol{\beta}$	Characteristic length of FID
$\boldsymbol{\lambda}$	Period of FID
σ	Standard deviation of n profile heights
$\boldsymbol{\tau}$	Lag, e.g. 1, 2, 3, ... etc
$\boldsymbol{\Phi}$	Phase angle of FID
$\boldsymbol{\omega}$	Angular frequency of FID
BHS	Bezier hyper-surface
$B_{i,m}$, $B_{i,n}$, $B_{k,p}$	Bernstein blending function
$\boldsymbol{X}$	Control points on Bezier hyper-surface
$\boldsymbol{a}$	Coefficient of Bezier function
$\boldsymbol{u}$, $\boldsymbol{v}$, $\boldsymbol{w}$	Parameters along the dimensions of cur, t_{on} and t_{off} respectively