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APPLICATIONS OF WAVELETS IN SAR IMAGE ANALYSIS: AN ENVIRONMENTAL PERSPECTIVE

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ABSTRACT

Our research "Applications of Wavelets in SAR image analysis: An environmental perspective " is aimed at investigating an alternative to the conventional roughness characterization. In the main study, damage features from ceramic surface morphology are extracted and evaluated using wavelet methods, as well as damage features from surface contours are extracted and evaluated quantitatively using damage rate and damage mean spacing. A fractal dimension calculation method that was suitable for calculating the ceramic surface was chosen by comparing several fractal dimension calculation techniques, and the fractal method was then employed to characterize the ceramic surface topography as a whole. It is discovered that the vibrational method is more appropriate for calculating the fractal dimension of ceramic surfaces after comparing various methods and further verifying them with measured three-dimensional morphology. The accuracy of the calculation is also investigated, and the results demonstrate the method's reliability. A mathematical model of surface wear and surface sealing was developed based on the fractal theory. A deeper investigation of the model reveals that surfaces with large fractal dimensions have strong sealing properties, whereas surfaces with the best fractal dimensions are the most wear-resistant. The complexity of the surface profile as a whole may be described using the fractal approach.

Keywords: Applications, Wavelets, SAR, image, analysis, environmental, perspective.

I. INTRODUCTION

Ceramics are exceedingly challenging to machine because of their extreme hardness and fragility, as well as their low heat conductivity and wear resistance. Currently, grinding using diamond tools (mostly grinding wheels) is the primary method used to process ceramics [1]. The geometric structure of these rough surfaces is closely connected to numerous surface aspects, such as the following: The treated surface often exhibits textural qualities related to the processing method in addition to broken, scratched, cracked, and other damage. In the mechanical industry, the surface shape processing features have an impact on transmission accuracy as well as the overall system of contact stiffness, contact strength, friction, and wear. Have a significant impact. For example, in the electronics industry, the silicon wafer surface roughness has an increasing impact on the thin film capacitance and thin film resistance in the integrated circuit, affecting the performance and yield of the entire integrated circuit device; in the biomedical manufacturing industry, the surface morphology of artificial joints and other artificial organs will directly affect the flexibility and life of the joints; in the aero spinning industry, the surface roughness of the artificial joints and other artificial organs has an increasing impact.

Additionally, ceramic materials are typically used in high temperature, high pressure, high speed, and heavy load applications, necessitating extremely excellent surface quality. To enhance the surface quality and functionality of machined components, it is crucial to accurately define the surface morphology of ceramics [3].

Wavelet Analysis-Based Texture Analysis of Ceramic Surface Images

In order to estimate and identify edges at various scales, the wavelet transform's local and multiresolution analytic capabilities are superior [11]. It can suppress noise at large scales, pinpoint edges at tiny scales, and smooth the noise while still maintaining the image's edges. Define the two-dimensional smoothing function, use its first-order partial derivatives in the horizontal and vertical directions as the two fundamental wavelets of the image transform, and then define the convolution of the scaling wavelets of the fundamental wavelets in the two directions with the image as the horizontal and vertical components of the wavelet transform, respectively.

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The fundamental difference between the Fourier transform and the wavelet transform is that the fundamental function of the Fourier transform is unique, but the fundamental function of the wavelet transform is not. Using multiple wavelet basis functions to evaluate the same problem will yield different findings because different wavelet bases have varied time-frequency properties. Finding a wavelet foundation appropriate for assessing the ceramic grinding process' surface contour is thus closely tied to the precision of damage extraction. The choosing of wavelets is unclear and challenging due to the diversity of wavelet bases.

Previous researchers have used the trial selection method, which is very blind and time-consuming, and the results are not always reliable. In this paper, the wavelet mathematical properties are combined with the characteristics of ceramic surface contour signals to find the best wavelet basis.

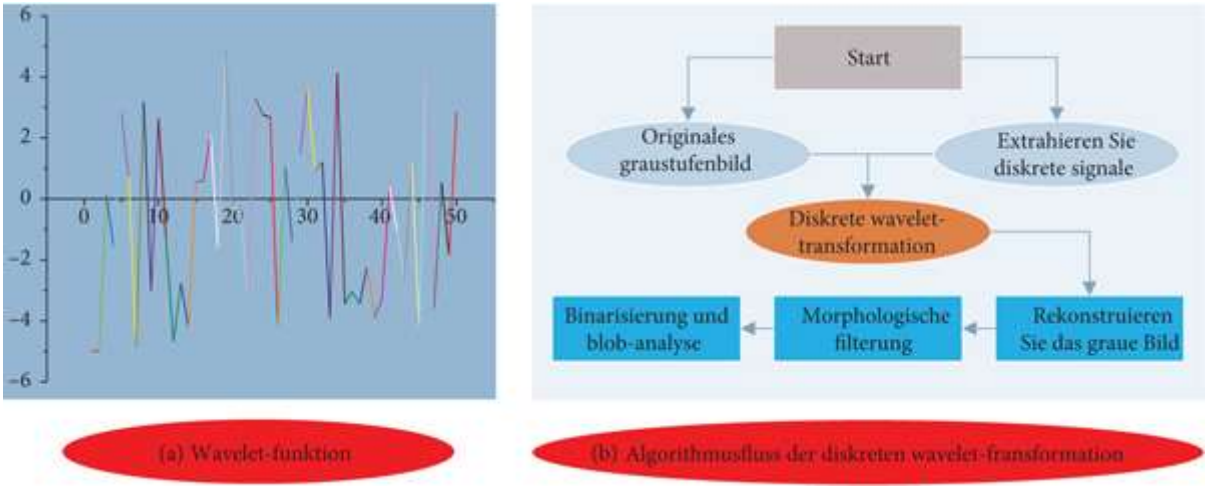

Figure 1 : Wavelet analysis algorithm flow

Ceramic Surface Image Texture Feature Analysis System Design

The Talysurf-i120 profiler serves as the hardware component of the ceramic surface measurement and processing system. The software component is an algorithm based on wavelet and fractal theories that is integrated with a visual interface with the aid of the Matlab GUI module, enabling the evaluation of the machined surface topography while lowering evaluation complexity and enhancing evaluation effectiveness. This lessens complexity and boosts assessment efficiency. Following is a synopsis of the full measuring and assessment process: Prepare ceramic samples, then use a Talysurf-i120 profiler to measure their surface and Tallyman to output the raw profile data. Talysurf's built-in post-processing program, Gold, is used to (i) analyze and process the exported data, (iii) determine the evaluation parameters, and (iv) assess the surface profile using the determined evaluation parameters. The resulting evaluation parameters may be utilized to guide the machining process and forecast the performance of the ceramic grinding surface, allowing for the optimization of the machining process. The overall structure is depicted in Figure 2(a), and by further refining the general structure diagram, the system framework for the surface measuring system indicated in Figure 2(b) may be achieved.

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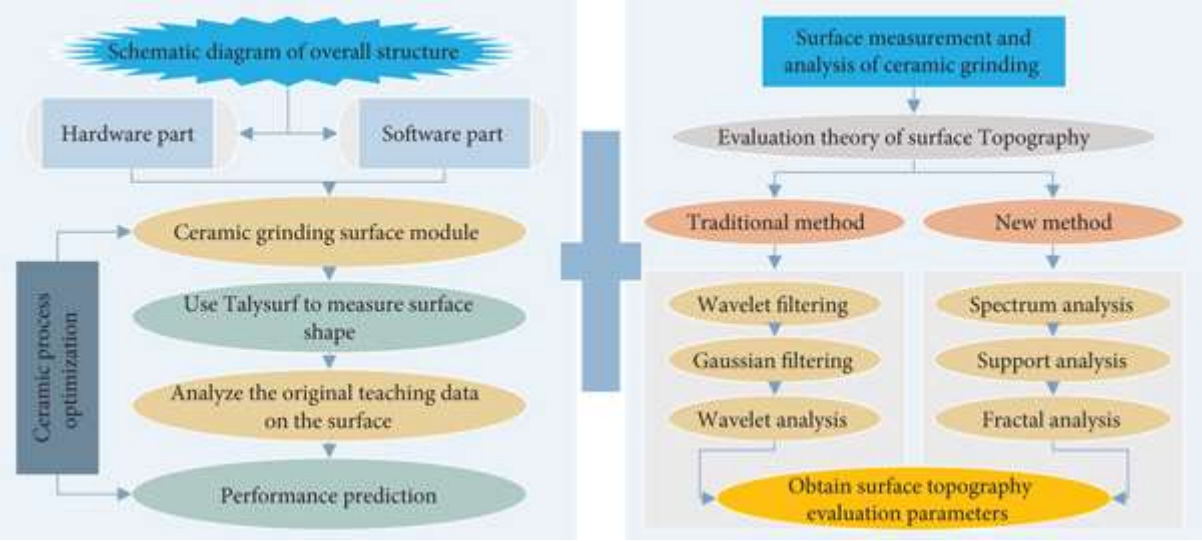

Figure 2 : Schematic diagram of the general structure and the system framework of the surface measurement system

In this research, a software system based on wavelet analysis for image recognition of ceramic surface image textures is created in order to perform automatic image texture detection on ceramic surfaces and to expand the detection to other image textures in the future. The software interface is created using Qt, while the image processing and identification algorithms are created using the C++ language and Visual Studio development environment. The development of the software system is based on the concept of modules, and each interactive module, including the interface dialog box and algorithm module, is independent from the others. Pulling and dragging may be used to combine the necessary image processing operators with additional picture capture and communication modules to create the image texture analysis project.

II. ANALYSIS OF RESULTS

The experiments on the wavelet analysis-based crack detection method and the LDGV-based detection method, respectively, used four feature combinations, including feature combinations 2, 5, 11, and 12. Figure 3 displays the algorithm runtimes for these four feature combinations. The outcomes of the experiment are examined. First, it can be said that the LDGV approach outperforms the wavelet method in the end-face identification of the magnetic ring. The LDGV approach outperforms the wavelet method in identifying various fractures. The two vary mostly in the subdivision index of TP, and the LDGV method has a lower leakage detection rate.

The greater leak identification rate of the wavelet approach shows that the fixed wavelet function's adaptability to changing cracks is weak, and the wavelet function may be adjusted adaptively according to the particular image to increase the wavelet method's recognition rate. Second, the wavelet approach and the LDGV method respond differently to grayscale characteristics. Grayscale features do not significantly affect the recognition rate for the wavelet method, but they significantly lower it for the LDGV method. This suggests that the grayscale features are not suitable for the LDGV method because they tend to confuse the crack features and interference features extracted by LDGV.

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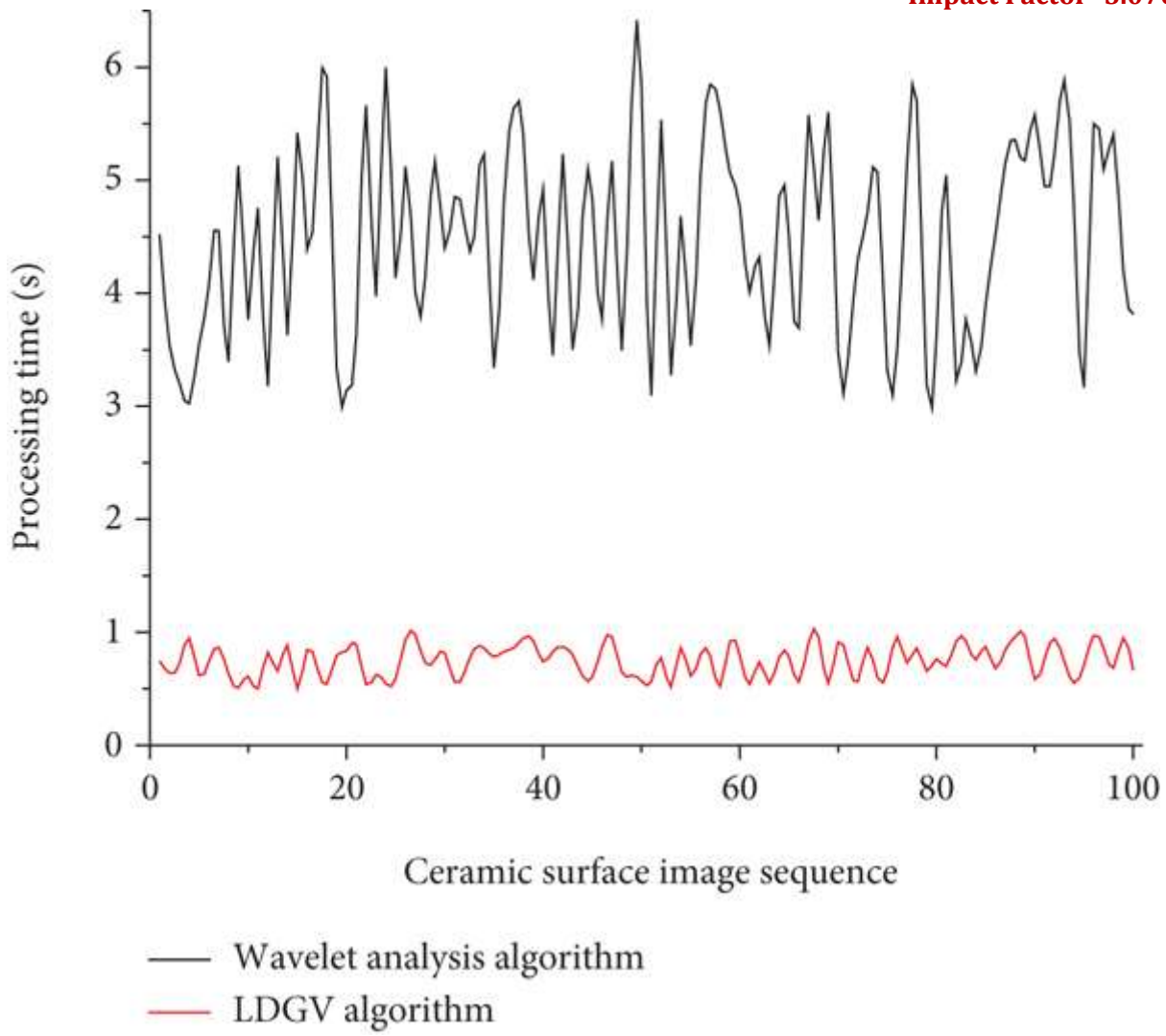

Figure 4 :Running time of magnetic ring inner wall inspection for both methods

III. CONCLUSION

Currently, the classic roughness index is used to characterize ceramic grinding processing surfaces. Even if the roughness values for metal and ceramic surfaces are the same, there are significant variances between them since ceramics are hard and brittle materials and the machined surfaces are susceptible to residual flaws such cracks, pits, and crushing. In order to supplement the conventional characterisation methods for ceramic materials, this research investigates additional characterization techniques. The characterisation of ceramic surface damage and its surface function are the main topics of this research. The main research topics cover wavelet analysis' extraction of damage features visible in the surface contour and quantitative assessment of the damage, choice of an appropriate method for calculating the fractal dimension of a ceramic surface based on that surface's contour, validation using the measured 3D model and fitting, study of sealing and wear based on fractal theory, and study of the fractal dimension by spectral analysis. The ceramic grinding surface feature measurement and analysis system was improved. The fractal theory was used to study the seal and wear, the spectral analysis was used to study the periodic components and their frequency components in the surface profile, and the support length rate was used to study the support of the surface profile.

REFERNCES

1. D. Yu, Z. Zhu, J. Min, C. Fang, D. Liao, and N. Wu, "Multi-scale decomposition enhancement algorithm for surface defect images of Si3N4ceramic bearing balls based on stationary wavelet transform," *Advances in Applied Ceramics*, vol. 120, no. 1, pp. 47–57, 2018.
2. T. Kozior and D. Gogolewski, "Dimensional and shape accuracy of foundry patterns fabricated through photo-curing," *Tehnički vjesnik*, vol. 26, no. 6, pp. 1576–1584, 2017.
3. O. Badmos, A. Kopp, T. Bernthaler, and G. Schneider, "Image-based defect detection in lithium-ion battery electrode using convolutional neural networks," *Journal of Intelligent Manufacturing*, vol. 31, no. 4, pp. 885–897, 2016.
4. Q. Luo, X. Fang, L. Liu, C. Yang, and Y. Sun, "Automated visual defect detection for flat steel surface: a survey," *IEEE Transactions on Instrumentation and Measurement*, vol. 69, no. 3, pp. 626–644, 2015.
5. A. Uka, A. Ndreu Halili, X. Polisi, A. O. Topal, G. Imeraj, and N. E. Vrana, "Basis of image analysis for evaluating cell biomaterial interaction using brightfield microscopy," *Cells, Tissues, Organs*, vol. 210, no. 2, pp. 77–104, 2018.
6. M. Strese, L. Brudermueller, J. Kirsch, and E. Steinbach, "Haptic material analysis and classification inspired by human exploratory procedures," *IEEE Transactions on Haptics*, vol. 13, no. 2, pp. 404–424, 2014.
7. A. C. Souza, G. C. Silva, and L. Caldeira, "An enhanced method for the identification of ferritic morphologies in welded fusion zones based on gray-level co-occurrence matrix: a computational intelligence approach," *Proceedings of the Institution of Mechanical Engineers, Part C: Journal of Mechanical Engineering Science*, vol. 235, no. 7, pp. 1228–1240, 2012.
8. W. Na, Z. Tingting, Y. Sheng-qiang, L. Wenhui, and Z. Kai, "Experiment and simulation analysis on the mechanism of the spindle barrel finishing," *The International Journal of Advanced Manufacturing Technology*, vol. 109, no. 1-2, pp. 57–74, 2012.
9. F. I. Ferreira, P. R. de Aguiar, R. B. da Silva et al., "Electromechanical impedance (EMI) measurements to infer features from the grinding process," *The International Journal of Advanced Manufacturing Technology*, vol. 106, no. 5-6, pp. 2035–2048, 2015.
10. N. Kushwaha and V. N. Patel, "Modelling and analysis of a cracked rotor: a review of the literature and its implications," *Archive of Applied Mechanics*, vol. 90, no. 6, pp. 1215–1245, 2016.
11. M. A. Ghannadi, M. SaadatSeresht, M. Izadi, and S. Alebooye, "Optimal texture image reconstruction method for improvement of SAR image matching," *IET Radar, Sonar & Navigation*, vol. 14, no. 8, pp. 1229–1235, 2014.
12. S. N. Tukimin, S. B. Karman, M. Y. Ahmad, and W. S. Wan Kamarul Zaman, "Polarized light-based cancer cell detection techniques: a review," *IEEE Sensors Journal*, vol. 19, no. 20, pp. 9010–9025, 2016.
13. S. H. Chen, A. H. Chiou, and C. C. Wang, "A NMF-based image restoration scheme with applications to LED integrated substrate defect detection," *IEEE Transactions on Semiconductor Manufacturing*, vol. 31, no. 4, pp. 486–494, 2018.
14. Z. Zhu, G. Han, G. Jia, and L. Shu, "Modified densenet for automatic fabric defect detection with edge computing for minimizing latency," *IEEE Internet of Things Journal*, vol. 7, no. 10, pp. 9623–9636, 2012.
15. Q. Li, X. Ji, and S. Y. Liang, "Bi-dimensional empirical mode decomposition and nonconvex penalty minimization L_q (q=0.5) regular sparse representation-based classification for image recognition," *Pattern Recognition and Image Analysis*, vol. 28, no. 1, pp. 59–70, 2018.
16. Y. Pan, R. Lu, and T. Zhang, "FPGA-accelerated textured surface defect segmentation based on complete period Fourier reconstruction," *Journal of Real-Time Image Processing*, vol. 17, no. 5, pp. 1659–1673, 2012.