Application of Texture Analysis for the Study of the Relationship Between Surface Microrelief and Laser Speckles

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The goal of the research is to develop a method for rapid, non-contact surface microstructure analysis based on laser speckle imaging. The research aims to identify quantitative relationships between complex surface microrelief parameters and speckle image statistics. Experiments were based on metal-ceramic samples with different textures. An original experimental setup was used. It allowed taking both microscopic and speckle images from the same location on the surface. A set of studied parameters was calculated for both microscopic and speckle images. Robust regression analysis techniques were applied to the collected data in order to uncover and quantify correlations between surface-measured and speckle-measured parameters. New stable monotonic relationships were discovered. The main achievement was the identification of new correspondences between speckle and microscope images. Specifically, it was uncovered that kurtosis, GLCM contrast, and fractal dimension of the surface can be reliably linked to analogous parameters of the speckle image. It has been proved that speckle images can be used to study spatial and textural characteristics of a surface. The proposed approach lays the foundation for developing automated, rapid profilometry systems. That would operate in real time on production lines or in hard-to-access environments.

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