EXPERIMENTAL RESEARCHES OF SPECKLE INTERFEROMETRY METHOD OF LATERAL MICRO-DISPLACEMENTS OF A SCATTERING OBJECT WITH DIGITAL PROCESSING OF REGISTERED SPECKLE-MODULATED INTERFERENCE IMAGES

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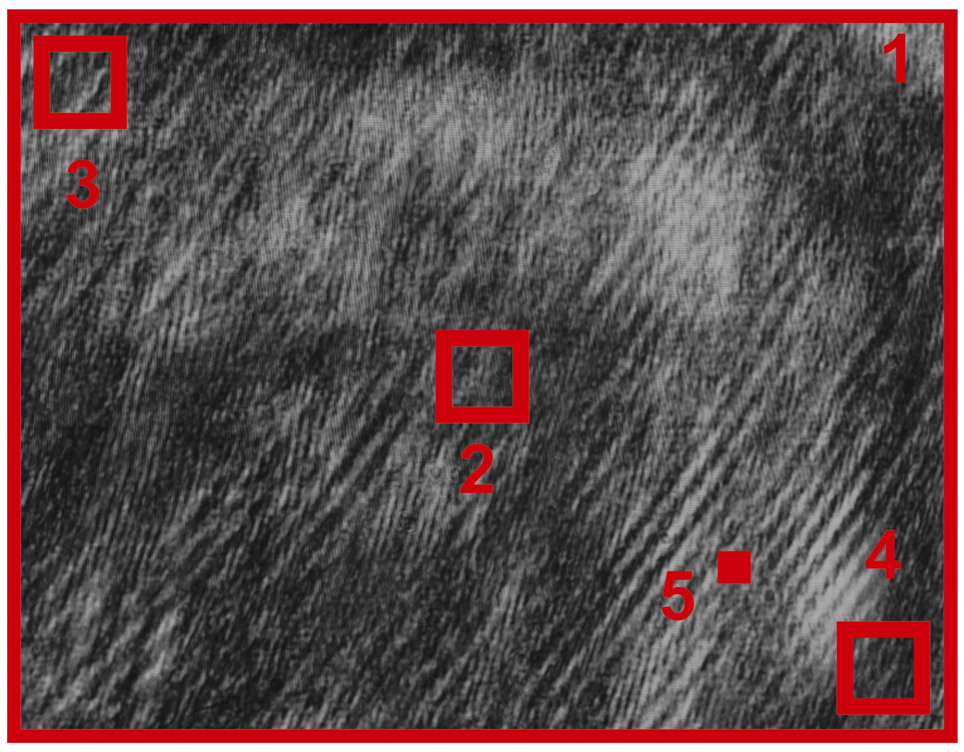
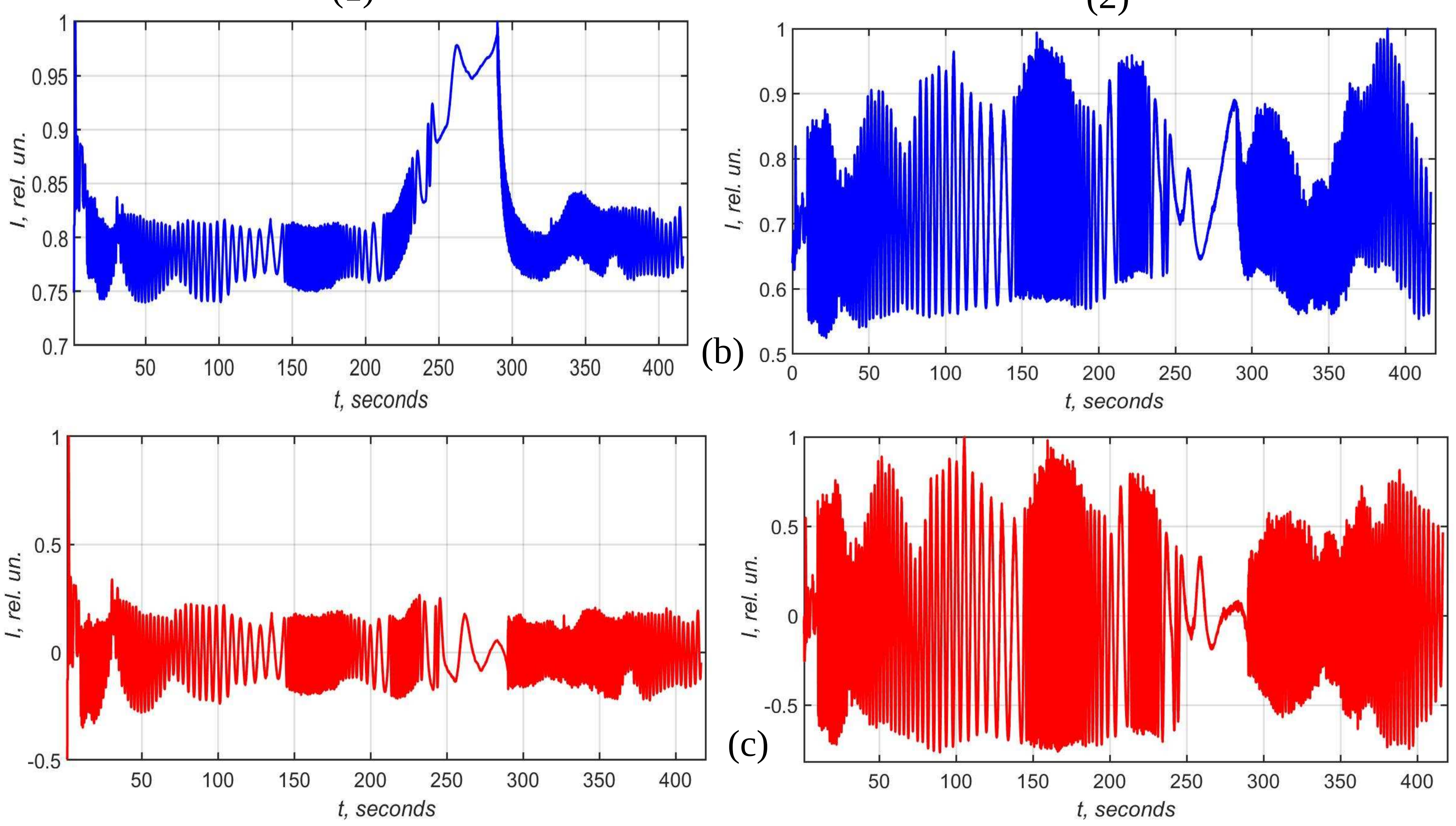
The processes of measuring signal formation using the method of laser speckle interferometry of micro-displacements of the scattering rough surface of technical objects are experimentally researched. With this method lateral or longitudinal micro-displacements can be measured. Digital processing of registered speckle-modulated interference images in the method of laser speckle interferometry of lateral and longitudinal micro-displacements of the scattering rough surface is the same. The possibilities of numerical processing of speckle-modulated interference images recorded in the experiment are investigated. In the work, speckle-modulated interference images were recorded at the output of the speckle interferometer after a certain time interval. On the matrices with the registered images, a local area was allocated in which the total intensity was calculated. The relative intensity distribution was determined during heating to the maximum temperature. The micro-displacement of the scattering rough surface increased to the maximum value, then the displacement stopped at the maximum value. Then the glow voltage was switched off and the reverse process of shifting the scattering surface to its original position began. Experimental oscillograms of the longitudinal displacement of the scattering surface of a technical object due to its heating and cooling are obtained. The studies were carried out at different locations of the selected area on the original recorded images. These studies have shown the repeatability of qualitative and quantitative results in the experiment. The oscillograms were recorded in the far diffraction region with Gaussian illuminating beams. The results of experimental studies are in good agreement with the results of numerical modeling of the complex amplitudes of wave fields at the output of the speckle interferometer and confirm the correctness of the mathematical model of the speckle interferometer of longitudinal micro-displacements based on diffraction transformations of wave fields.

Fig. 1 The recorded speckle-modulated interference image having a matrix size of 744x572 pixels. An area of 70x70 pixels was allocated on this matrix, in which the total intensity was calculated. The studies were carried out at different locations of the selected area on the initial recorded matrix (a). Experimental oscillograms of the longitudinal displacement of the scattering surface obtained in far diffraction region with Gaussian illuminating beams (b). Processed interferogram with subtracted average values (c). To find the average values near which the deviation of the intensity values occurs, the built-in MATLAB function for smoothing deviations of values using a polynomial, in our case 11 degrees, was used; the laser wavelength λ_0=0.63μm

(a)

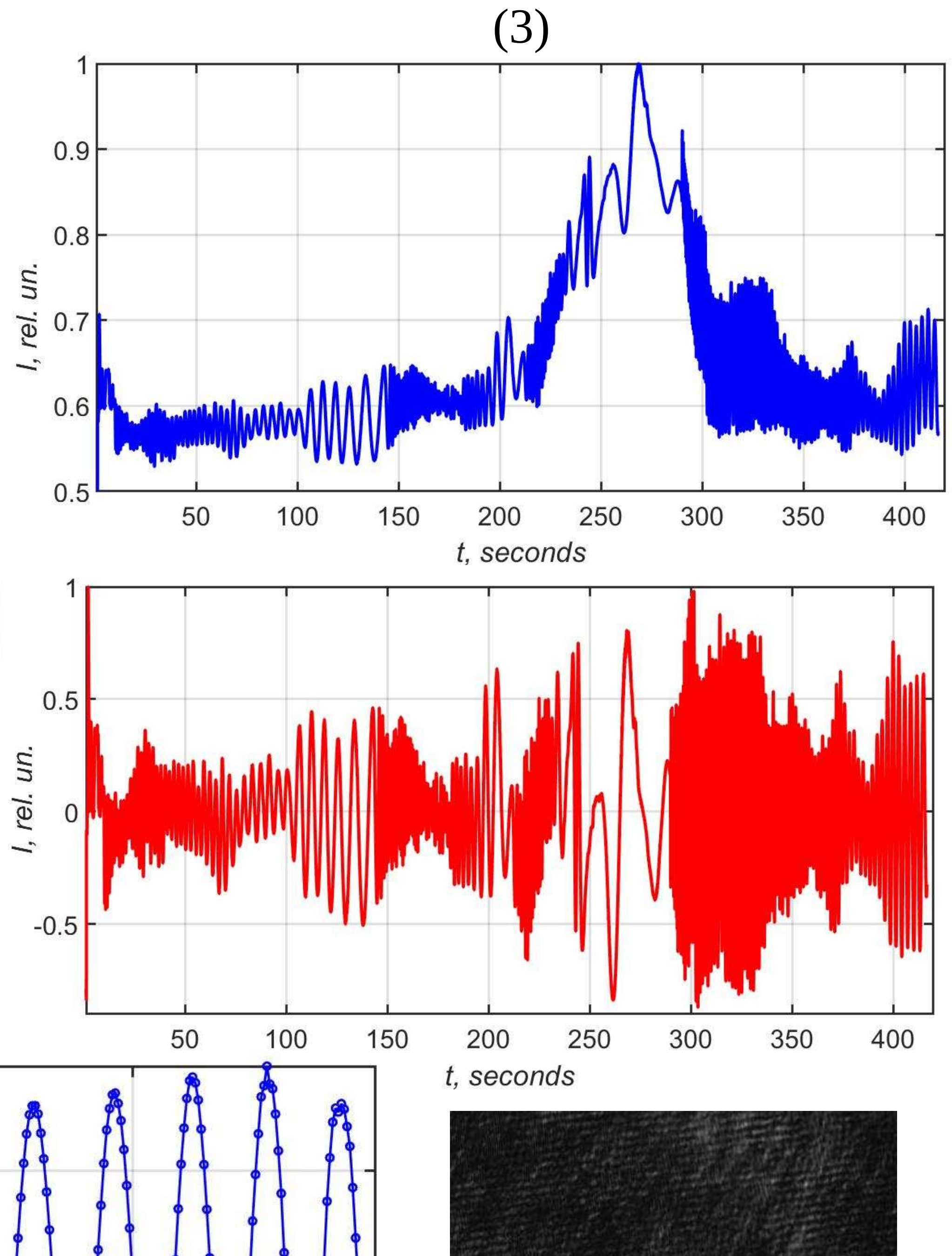


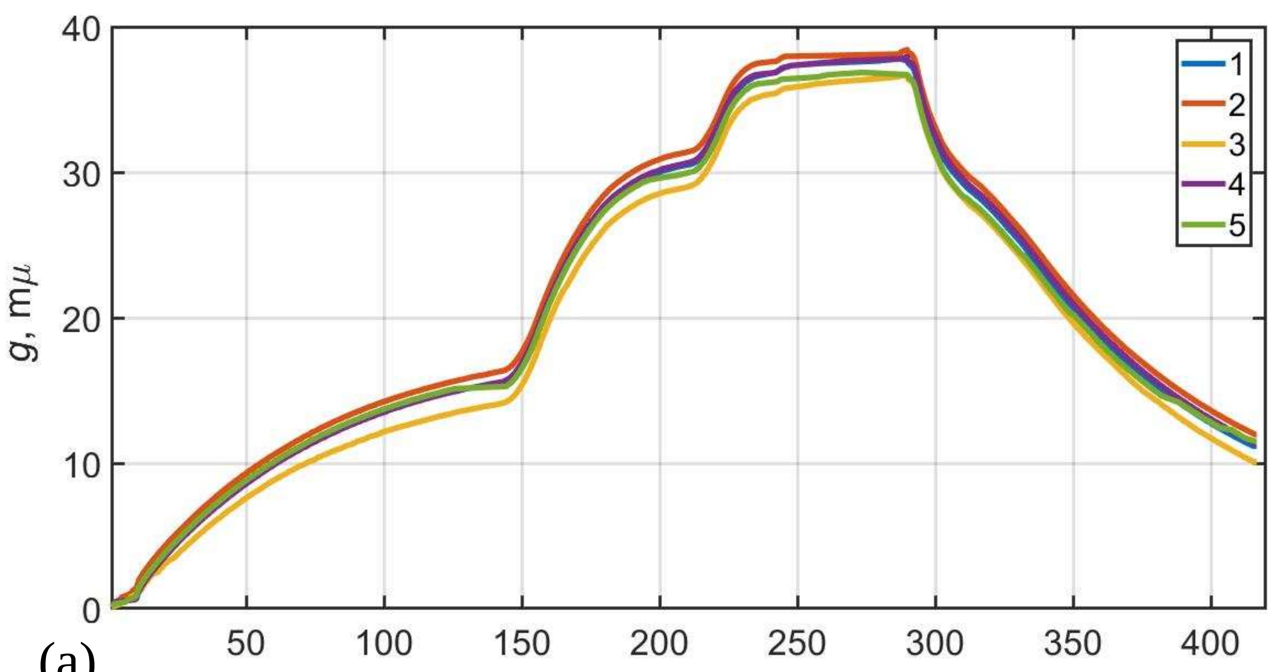
(1) (2)



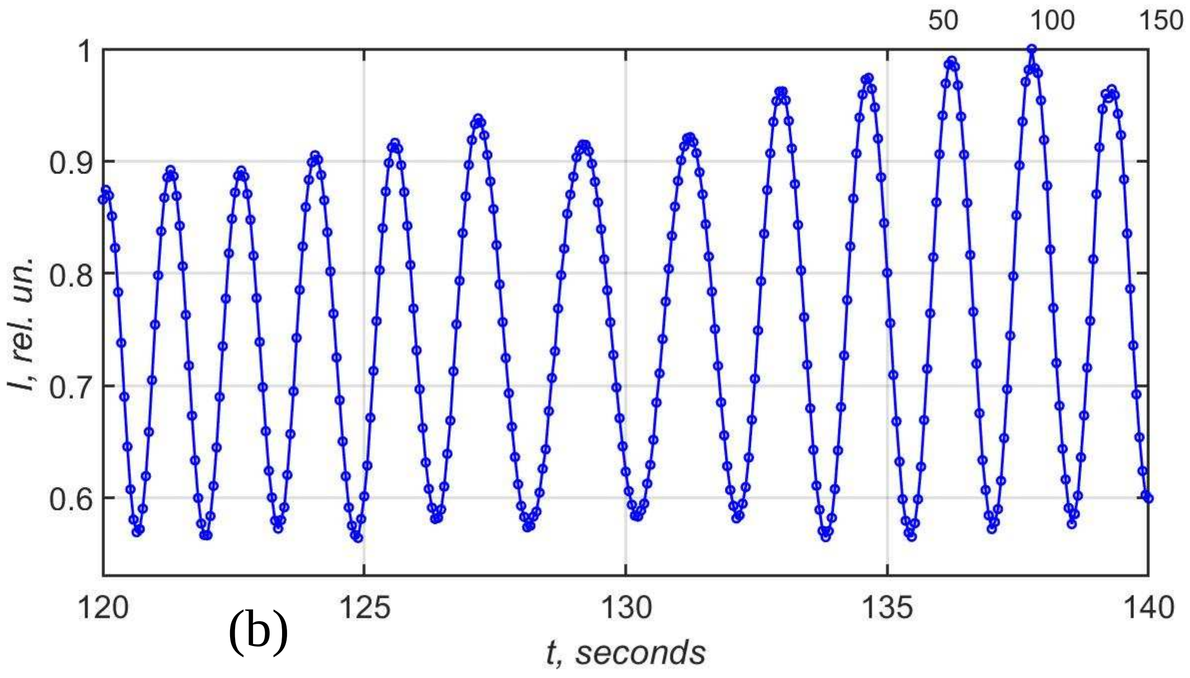
(b) (c)

(3)

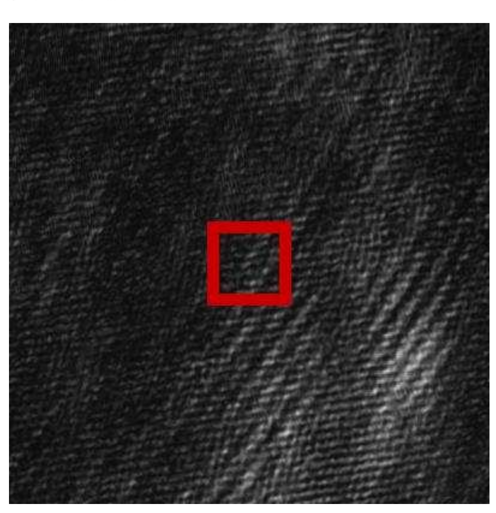




(a)



(b)



(c)

Fig. 2. Graphs of longitudinal displacement of scattering surface (a) obtained from the interferogram (Fig. 1). Frequency in time recording is 26 frames per second. The displacement value $g(t)$ was calculated according to the formula "the number of semi-oscillations $m(t)$ - transitions through zero of the variable intensity (Fig. 1b) component was multiplied by a quarter of the wavelength of a helium-neon laser" $g(t) = m(t)\lambda_0/4$. Example of the enlarged fragment of experimental oscillogram (b). Example of the experimental speckle-modulated interference image with selected area on the initial recorded matrix with size of 200x200 pixels (c)