Antal Ákos

Error analysis and identification of optically generated Moiré surfaces with use of measuring applications.

New scientific results

First thesis

Within the traditional shadow moiré equipment the common form of the generated moiré surface was solved in the function of the setting error. This final model shall complete the scientific literature and can be validated by generating the given base cases with neglecting the setting error. The executed measurements based on the theoretical model proved the preliminary calculated results. As the omission of the setting error more reconstructed surfaces is needed for one moiré surface. It was stated, that for avoiding the phenomenon of the false moiré surface generation it is essential to execute a preliminary calibration, which measurement is defined to minimize the setting error.
According to the setting error based model, for the shadow moiré equipment the following statement was put down:

1. Within the traditional shadow moiré equipment the shape of the moiré surfaces is affected by the Δy setting error – as variable - can be described with the equation of hyperbolic cylinders or degenerated cylinder shapes.
2. All shadow moiré orders have such point, that is independent from value of preliminary calibration error and coincides with the according point of ideal surface.
3. For the correct decoding of the output pattern information coming from the shadow moiré equipment it is essential to know not just the absolute value of the setting error, but its position as well – if the setting error occurs.
Therefore it is essential to execute a preliminary calibration before the start of the measuring process to minimize the setting error. It based on the next steps:

3.1. Determine the parameters of the ideal moiré equipment according to the examined object size and required resolution.
3.2. Determine the required test surface area according to the ideal resolution and examined object size.
3.3. Place the test surface near the highest order of the useful moiré surface in line with the reference grating and keep slanting its normal-vector until the prescribed session of fringes appears.
3.4. The shape of moiré fringes is estimated and the setting error is controlled by the moving of the observation point position in the direction of reference grating surface's normal vector.
3.5. If the checked equipment resolution is not appropriate than the equipment geometry will be modified and the calibration process will be repeated.

Second thesis

By application of the shadow moiré equipment according to the viewing point the most advantageous measuring range should be based on the following statement:

Comparison of the ideal and false moiré surfaces is performed by ordinate differences of given abscissa. This difference value would be less, if the actual position of light source is between the reference grating and the ideal position of light source.

Third thesis

Based on the analysis of the false moiré surface generation model the calibration algorithm, the shadow moiré equipment was developed. Additionally the following statement could be settled regarding to the false moiré surfaces:

1. By choosing the correct geometry for the applied equipment the hyperbole centers of the false moiré surfaces and hyperbole legs concerning to the asymptotes of the reference grating could be positioned out from the measurement range in order to achieve the correction of the errors coming from the geometry of the hyperbole legs coincide with reference grating

2. It was pointed out that the measurement range is limited by special points of the hyperbole legs, therefore according to the measurement accuracy it is possible to draw a parallel line cutting the false moiré surface, where the measuring interval is limited by the arose intersection point.

Fourth thesis

For sorting out the concave and convex parts of the examined surfaces a special projection moiré method was developed applying divided grating. With this method due to the asymmetry of the intensity distribution in the moiré fringes the type of surfaces can be determined. The divided grating differs from the classical Ronchi type. Its transparent slit is unchanged but the black one is divided into equal width black and gray parts. For the validation of the above mentioned method the equipment was built up. According to the results series of experiments the following statement was settled:

By applying the special projection moiré method with divided grating the generated moiré fringe intensity distribution has asymmetry which makes the concave and convex surfaces dissolvable according to a single moiré image.