Study of Surface Roughness using Laser-Optical Imaging Techniques

By

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APPROVAL SHEET

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Dedication

There are a number of people to whom I would like to dedicate this thesis, and to whom I am greatly indebted.

To my family, who offered me unconditional love and support during my study:

My Father, my biggest champion and cheerleader, for everything he did and still doing for me.

My Mom, who was so amazed and perhaps amused at the way my life turned out, who continues to learn, grow and develop.

My Wife, who has been the source of motivation and inspiration, who has been the wind beneath my wings until I completed this work.

My daughter, the best thing happened in my life.

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Abstract

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Name: Ahmed Mohamed Ali Ashour Ahmed

Titled: Study of Surface Roughness using Laser-Optical Imaging Techniques

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Speckle phenomena produced by using interference of scattered laser beams from certain rough object. Digital speckle images were recorded for different rougher and smoother surfaces, using an optical imaging system in two and three dimensions with a high resolution CCD camera. The obtained speckle images were transformed to equivalent binary images. The values of surface roughness depend on the degree of agglomeration of the speckle images. The optical density was calculated and it was found that it depends on the different conditions for the optical imaging system. The back projection technique was used to reconstruct 3-dimensional surface roughness profiles from multi-directional projection data. Also, interference microscope was used for the reconstruction of surface topography for different rough surfaces.

Key Words:

- Surface roughness.
- Laser optical imaging techniques.
- Back projection technique.
- 3-D surface roughness profiles.
- Interference microscope.

Summary

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When a coherent light beam is allowed to be incident on an optical rough surface (the height and depths of its surface features are in the order of the light wavelength). This light will scattered randomly through all directions in the form of coherent wavelets. Interference of these wavelets leads to the formation of a bright spots (when the interference is constructive) and dark spots (when the interference is destructive) these were called "Laser Speckles". Surface roughness parameters can be used for the characterization of surface roughness. Statistical parameter such as the arithmetic mean of the surface roughness, R_a and the root mean square surface roughness, R_q, are most frequently used.

This thesis presents, the recording of laser speckle pattern of different rough surfaces along different projections (directions).Then the reconstruction of surface roughness in 3-dimension using the back projection technique. Study of surface topography of some surfaces using Zygo Interference Microscope has been presented in order to measure the surface roughness parameters. A comparison between different surface roughness measuring techniques has been presented.

In the first chapter, the thesis presents the different techniques for measuring the surface roughness. (Laser Speckles, Interference Microscope, and the back projection techniques).

In the second chapter, the thesis presents the previous work for study the surface roughness.

In the third chapter, the far-field speckle contrast method is presented. The laser speckle contrast technique

depends on the existence of an approximately linear relationship between the speckle contrast and the roughness of the illuminated surface. The roughness Ra of different metallic surfaces of Nickel and Aluminum has been measured using the relation between speckle contrast and surface roughness. Investigation on the contrast variation of image speckle patterns is conducted systematically for various surface roughnesses of the objects. The speckle pattern obtained with nine different roughnesses namely: 0.4064, 0.6096, 0.8128, 1.143, 1.6002, 2.286, 3.175, 4.572, and 6.35 μm. of Nickel. And other rough surfaces 20, 80, and 600 μm. of Aluminum.

The back projection technique is used for reconstructing the 3-D of these rough surfaces.

The Interference Microscope is used for measuring the roughness of these surfaces.

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