Experimental Methods for Engineering Mechanics

Group 6 - Bonus Contribution

Module 2: DIC AND PLANAR ELASTICITY

How to achieve a good speckle pattern for samples used in DIC?

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1 Speckle Patterning

1.1 General Guidelines

The speckle pattern on a studied sample is one of the key steps in Digital Image Correlation (DIC). It also dictates the accuracy of the results generated. We list now the conditions to obtain a good quality speckle pattern based on [1]. The speckle pattern should sufficiently cover the region of interest. Different speckle densities are shown in figure 1. The speckles should be both random yet uniform in size. The pattern should as well be compliant and deforms as the sample deforms.

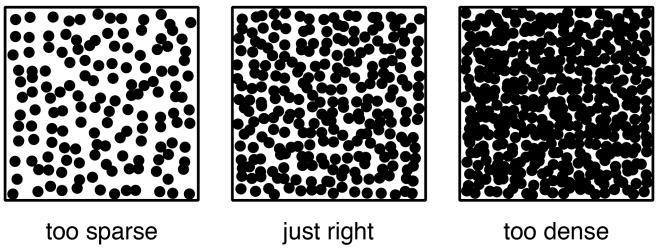

Figure 1: Speckle Densities. The middle speckle pattern density of 50% is desirable.

One check if the speckle density is sufficient and appropriate is observing the gray-scale contrast. This can be done by generating a histogram showing the number of pixels plotted with respect to the gray-scale level. The software on the lab computer corresponding to the Quantalux 2.1 MP Monochrome sCMOS Camera from THORLABS is capable of generating this graph. The camera used can be seen in figure 2. There exists several online generators and Python packages as well to generate the gray-scale histogram.

Figure 2: Camera used for DIC Analysis. The camera used in the experiment was a Quantalux 2.1 MP Monochrome sCMOS Camera from THORLABS.

The histogram should resemble a bimodal Gaussian distribution with two peaks visible in figure 3.

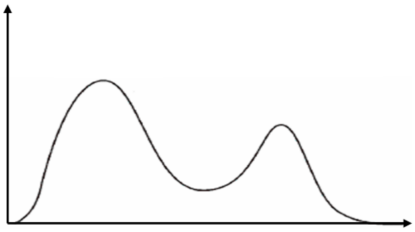

Figure 3: Bimodal Distribution. This distribution features two peaks.

1.2 Experimental Guidelines

1. Prepare the surrounding environment for spraying the paint. Wear gloves, cover surfaces not meant to be sprayed, and avoid spraying in the wind.

2. Use black or white paint depending on sample color since these two have better contrast.

3. Preferably perform the experiment within 24 to 48 hours from when painting is applied so the speckles still deform with the sample.

4. Practice first on a scrap paper with varying spray-sample distance, spraying time intervals, and varying spray can orientation. Check how varying these parameters affects the density and size of the pattern. Check figure 4.

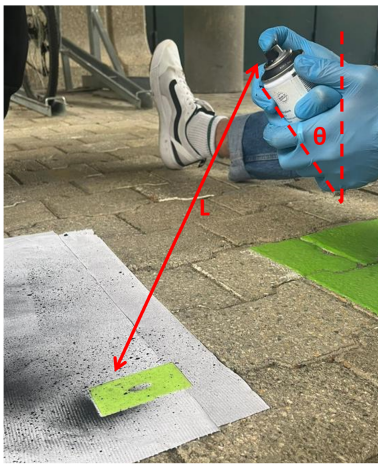

Figure 4: Spray Painting the Sample. The spray paint can is placed at a distance and orientation determined by trial and error on a scrap paper.

5. Avoid large paint spots. Clean them fast before drying or apply a special solvent to correct.

1.3 Other Speckling Methods

Several artificial speckling techniques exist. Spray painting may be the easiest but not the only solution. Spray painting produces speckles in the range of 100 to 1000 microns. However, several other techniques exist and vary in speckle size produced. Stamping, masking, stenciling are suitable for highly strained hyperelastic material. Laser engraving is suitable for high-temperature tests. Powder particles are good for achieving speckles less than 10 microns on silicone-based rubbers. Nanoparticles may be applied for even a smaller speckle size. Finally, lithography offers a solution for better control of the patterning process.

2 References

[1] Will LePage. *Digitalimagecorrelation.org*. URL: `https://digitalimagecorrelation.org/`.