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Mechanical Engineering

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Speckling Soft Materials Using an Airbrush Attachment for Digital Image Correlation Experiments

Objective

The objective of this research is to determine the feasibility of using an airbrush attachment as a means to speckle soft biological tissue.

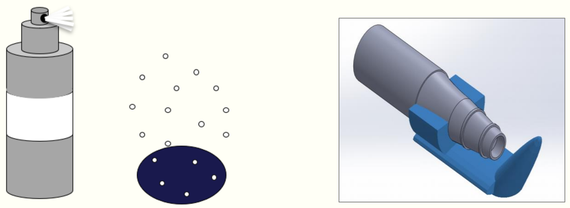
Additionally, a MATLAB code will be created to analyze speckle patterns.

Background

Digital Image Correlation (DIC) experiments can be used to generate the deformation field of a specimen subjected to an applied load. This technique relies on the ability to produce a speckle pattern with the following characteristics:

- High contrast
- Consistent speckle size
- 50% coverage
- Isotropic
- Random

Various methods can be used to generate speckle patterns such as paints and dyes. This project will use spray paint and an airbrush with a 3D-printed attachment to apply speckles.



(a) *(b)*

Figure 1: (a) Spray Paint Technique (b) and Airbrush Nozzle with Attachment

The airbrush attachment was designed for speckling purposes. It offers spray precision and speckle size control.

Research Methods

Purpose: To compare speckle patterns created using spray paint and an airbrush with attachment.

Test Procedure:

➡ Core 25 mm porcine brain sample

➡ Apply speckle patterns

- Airbrush; spray paint

➡ Perform compression tests

- 50 mm/min to achieve 20% strain

➡ Analyze images using a DIC software (i.e. VIC 3D)

➡ Compare results from airbrush vs spray paint test

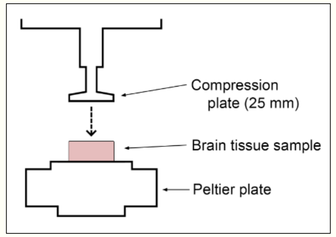
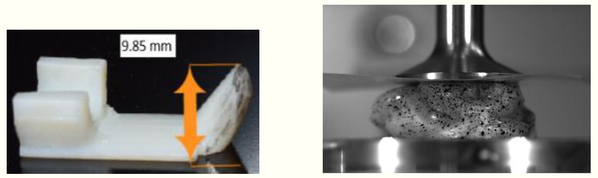


Figure 2: Compression Test Setup [1]

Preliminary experiments were conducted to establish testing parameters. The ideal airbrush attachment height for a porcine brain sample was also determined.



(a) *(b)*

Figure 3: (a) Airbrush Attachment and (b) Airbrush Speckle Pattern on Brain

Current Focus and Results

A MATLAB code was developed to **quantitatively analyze the speckle patterns** produced from using the spray paint or the airbrush attachment.

The MATLAB code provides researchers with data that can be interpreted to determine the quality of a speckle pattern.

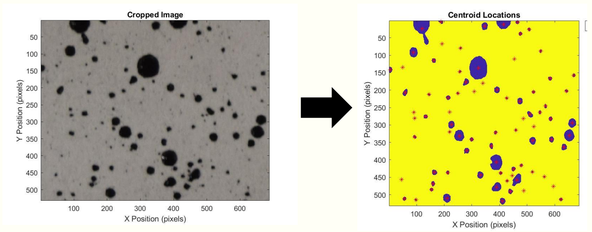


Figure 4: (left) Original Image containing Speckles (black) was analyzed using MATLAB to (right) Identify the Speckles' Centroids depicted by the Asterisks

The code displays the following characteristics:

- Total number of speckles
- Speckle centroid location
- Average speckle area
- Density percentage
- Randomness value

Future Work

Next Steps:

- Conduct compression experiments of brain tissue
- Analyze speckle patterns with MATLAB
- Verify method of using an airbrush attachment
- Compare deformation fields from airbrush and spray paint methods, using the percent difference

The speckling technique will determine the repeatability of speckle pattern created; this work will benefit researchers using DIC to characterize the mechanical properties of soft materials.

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References: [1] McCarty, Annastacia K.; Zhang, Ling; Hansen, Sarah; Jackson, William J.; Sarah A. Bentil." Viscoelastic properties of shock wave exposed brain tissue subjected to unconfined compression experiments." *Journal of the Mechanical Behavior of Biomedical Materials,* 100(2019), *ScienceDirect,* Web. 15 April 2020