# 3-D Surface Reconstruction of Quasi-Cylindrical Structures Using Panoramic Digital Image Correlation

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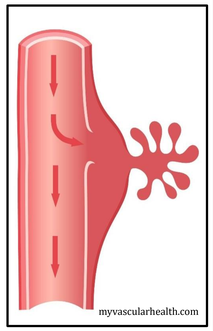
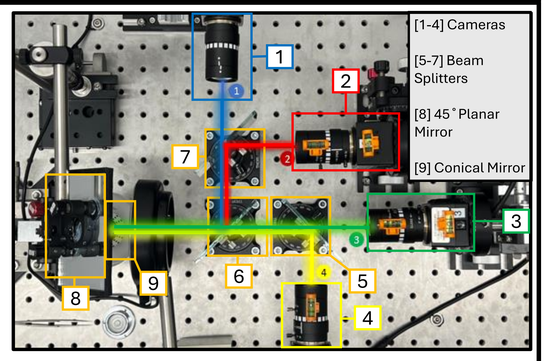
## Introduction

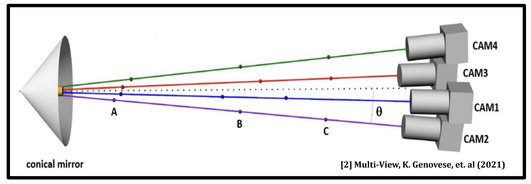
- Aortic rupture is a catastrophic event that is influenced by the localized biomechanical properties of tissue structures.
- Local changes in wall structure and composition have the potential to create defective sites susceptible to rupture.
- Understanding the impact of mechanical defects on vascular microstructures can promote improved diagnosis and prognosis of vascular disorders but requires measurement of local mechanical properties.




## Background

- The pDIC system captures full-field images of samples, allowing surface geometry to be reconstructed from two stereo view pairs.
- This system allows for dynamic image capture for shape reconstruction and deformation tracking.




## Sample Preparation

- Prior to imaging, samples are prepared by applying black and white ink to create a random speckle pattern on the outer surface.
- Biological samples are cannulated onto a construct of blunt needles to provide support to the structure prior to speckling.

## Software Advancement

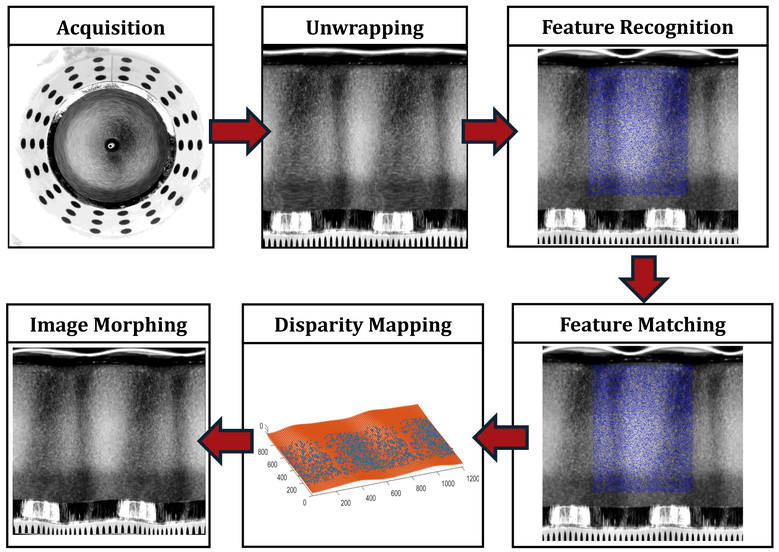
- Current advancements in the software and image analysis procedure remove excess user intervention through automatic feature detection, disparity mapping, and surface generation.
- Together, this results in a significant reduction and consolidation of the image processing and analysis workflow.

12 Steps, 27 Scripts
Manual Surface Creation

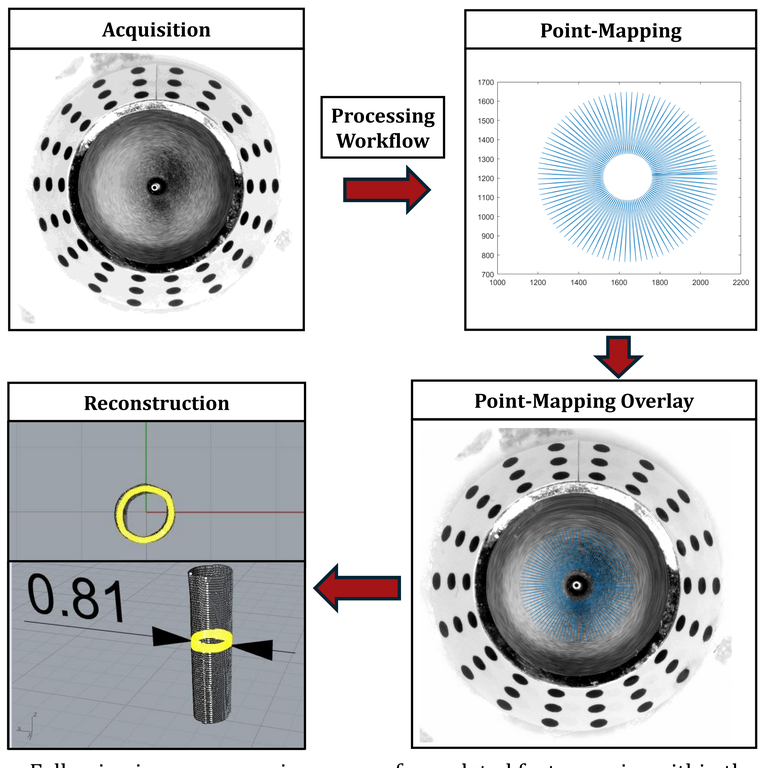
↓

2 Steps, 2 Scripts

## Image Processing



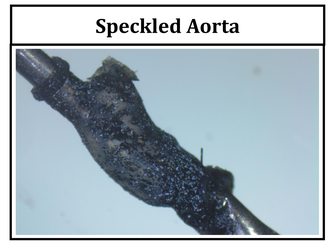

## pDIC Needle Reconstruction Process

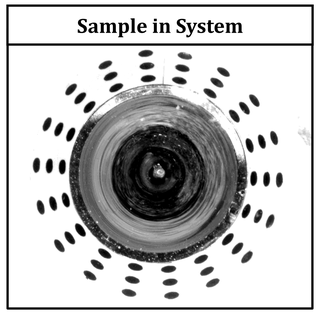


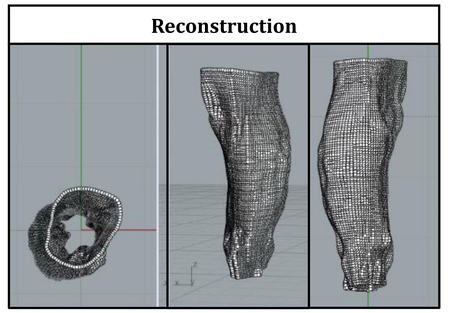

- Following image processing, maps of correlated feature pairs within the conical mirror are generated.
- Through a ray tracing procedure, it is possible to reconstruct corresponding point pairs to their real world location in 3-D space **[4]**.

## Murine Aorta Reconstruction

- pDIC can successfully be applied to reconstruct biological structures, such as murine aortae.
- The initial reconstruction of the sample has a significant amount of noise, though the general surface geometry of the aorta is present.

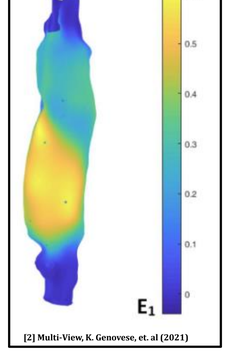



## Significance and Conclusions

- pDIC successfully reconstructs the surface geometry of tubular and quasi-tubular structures.
- Characterization of the biomechanical properties of such vascular defects will advance the current knowledge of rupture mechanics and the localized nature of aortic rupture.
- Building upon the updated analysis framework and validation presented in the current study, further work in this space will focus on spatiotemporal rupture prediction, understanding drivers of rupture, and improving diagnosis and prognosis of vascular conditions associated with rupture.

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## References

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