ME – M.Tech (Res) Thesis Defense

Measuring three-dimensional deformations of elastic ribbons

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Meeting link: Click here to join the meeting **(Microsoft Teams)**

ABSTRACT

Experimental techniques to measure and visualize kinematics in structural mechanics range from humble strain gage rosettes to sophisticated digital image correlation methods. This thesis develops a stereo vision-based optical measurement technique and evaluates its efficacy for measuring three-dimensional elastic deformations of slender structures. Our motivation stems from the need to quantify/digitize the kinematics of slender elastic structures undergoing large displacements and rotations within the small strain regime. As devices composed of highly flexible elements become ubiquitous in engineering applications, especially at small length scales, it is imperative to examine the mechanics underlying their functioning through a combination of modeling and experimental studies. The technique proposed here is a step towards addressing challenges in the context of the latter.

The proposed technique relies on familiar principles of stereo vision- a pair of calibrated digital cameras, an ansatz for pixel correspondences, and triangulation of corresponding pixel pairs to reconstruct points of interest in the scene. Hence, we will photograph samples from multiple vantage points using a pair of digital cameras and reconstruct the locations of markers labeling surfaces. The novel aspects of the technique include:

- the choice of fiducial markers to paint flexible surfaces
- an algorithm to encode/decode multi-marker dictionaries to limit the number of distinct markers required to label surfaces, and
- an optimization-based algorithm to determine full-field approximations of deformations mappings by unifying independent (Lagrangian) marker and (Eulerian) shape measurements.

We adopt elastic ribbons as prototypical examples in our study to quantify the accuracy of the proposed technique at a desktop-scale. Owing to the disparities in their dimensions (length > width > thickness), ribbons naturally contort into complex three-dimensional energy-minimizing configurations in response to simple loading scenarios. For this reason, elastic ribbons furnish excellent test cases to investigate the capabilities of the proposed technique. We also compare our measurements with idealized finite element simulations available in the literature.

ABOUT THE SPEAKER

Kishan is an M. Tech (Res) student in the Mechanical Engineering department at IISc. His topic of research is related using computer vision techniques to digitize and visualize the mechanics of slender elastic structures. He has a bachelors degree in Aerospace Engineering from Nitte Meenakshi Institute of Technology.