EXPERIENTIAL BASED LEARNING

ENR 210 Continuum Mechanics

TITLE:
"Vision-based surface deformation tracking for gesture control"

Ahmedabad University

Objective and Motivation

In order to measure surface deformation with a tracking system based on a camera, we calculate the displacement and strain by tracking markers. Continuum mechanics help us to determine the relationship between deformation and pressure acting. This method can be applied in gesture-control system where skin deformation of a hand in motion needs to be measured. An affordable approach to vision based on non-contact and low-cost allows proper tracking without physical sensors. A balloon membrane is used as a replacement of the skin, because it displays greater and more noticeable deformation..

Methodology

- Draw black marker dots on balloon surface.
- Fix camera position and lighting.
- Record balloon inflation and deflation video.
- Extract video frames in Python.
- Track marker points using OpenCV optical flow.
- Calculate displacement and strain.
- Plot displacement vs time and strain vs time.

Result and Interpretation

Results

Results During the period of inflation, marker points stretch outwards. Displacement rose with time of balloon expansion. Strain was higher when marker distance was higher.

Interpretation

Gain in internal pressure enhances the membrane stress which leads to the strain and surface displacement. $P\uparrow \Rightarrow \sigma\uparrow \Rightarrow \varepsilon\uparrow \Rightarrow u\uparrow$ The latter justifies the principles of continuum mechanics and proves that a vision-based deformation tracking could be used in gesture control systems.

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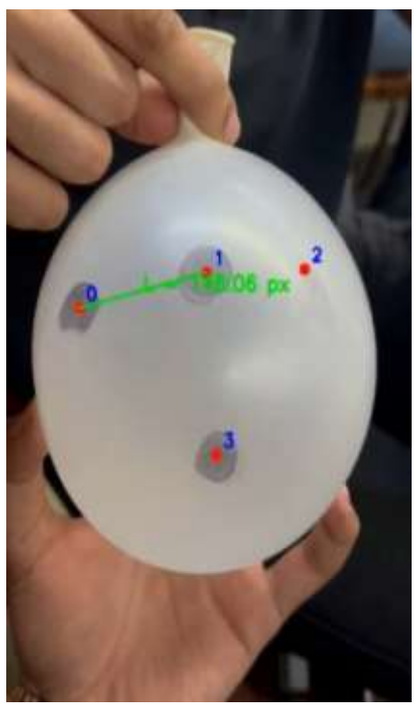

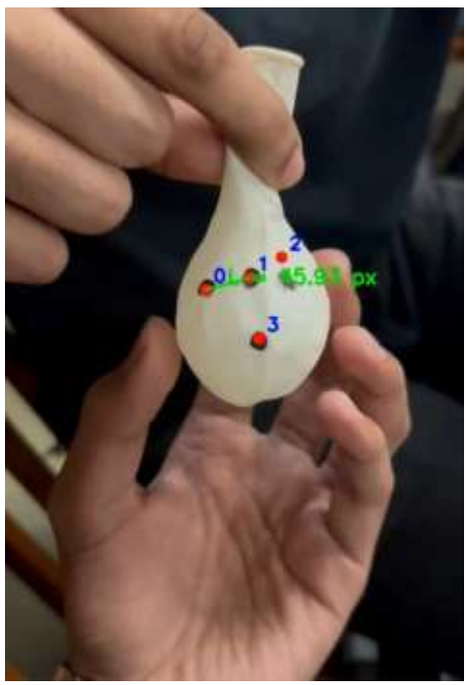

Conclusions

Tracking using vision was able to track displacement and strain.
The deformation of balloon membrane was harmonic and easily measurable.
The strain rose when inflation went up and decreased when deflation occurred.
The experiment confirms the relationships between stress and strain and deformation.
Such an approach can be used in gesture control and soft robot sensing.

References

Boresi & Schmidt, *Advanced Mechanics of Materials*
OpenCV Documentation
Continuum Mechanics Lecture Notes

Contributions

Group 11
Chintan Thacker [AU2440215]: - Report
Fenil Patel [AU2440042]: - Report
Parthiv Karangiya [AU2440016]: -Code
Pratik Agrawal [AU2440043]: - Code
Aadi Mehta [AU2440105]: -Poster
Patel Lay Yogeshbhai [AU2440258]: - Poster